CHAPTER 5

ENVIRONMENTAL IMPACTS OF OPERATION

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ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
$\mu gm/m^3$	micrograms per cubic meter
/Q	relative air concentration
AADT	annual average daily traffic
A/B	auxiliary building
ac	acre
AC	alternating current
ac-ft	acre-feet
ACFT	acre-feet
ACRS	advisory committee on reactor safeguards
ACSR	aluminum-clad steel reinforced
ADFGR	Alaska Department of Fish and Game Restoration
AEA	Atomic Energy Act
AEC	U.S. Atomic Energy Commission
AHD	American Heritage Dictionary
agl	above ground level
ALA	American Lifelines Alliance
ALARA	as low as reasonably achievable
AMUD	Acton Municipal Utility District
ANL	Argonne National Laboratory
ANSI	American National Standards Institute
AOO	anticipated operational occurrences
APE	areas of potential effect
APWR	Advanced Pressurized Water Reactor

ACRONYMS AND ABBREVIATIONS

ARLIS	Alaska Resources Library and Information Services
ARRS	airborne radioactivity removal system
AS	ancillary services
ASCE	American Society of Civil Engineers
AVT	all volatile treatment
AWG	American wire gauge
BAT	best available technology
bbl	barrel
BC	Business Commercial
BDTF	Blowdown Treatment Facility
BEA	U.S. Bureau of Economic Analysis
BEG	U.S. Bureau of Economic Geology
bgs	below ground surface
BLS	U.S. Bureau of Labor Statistics
BMP	best management practice
BOD	Biologic Oxygen Demand
BOP	Federal Bureau of Prisons
BRA	Brazos River Authority
bre	below reference elevation
BRM	Brazos River Mile
BSII	Big Stone II
BTI	Breakthrough Technologies Institute
BTS	U.S. Bureau of Transportation Statistics
BTU	British thermal units
BUL	Balancing Up Load

ACRONYMS AND ABBREVIATIONS

BW	Business Week
BWR	boiling water reactor
CAA	Clean Air Act
CBA	cost-benefit analysis
CBD	Central Business District
CCI	Chambers County Incinerator
CCTV	closed-circuit television
CCW	component cooling water
CCWS	component cooling water system
CDC	Centers for Disease Control and Prevention
CDF	Core Damage Frequency
CDR	Capacity, Demand, and Reserves
CEC	California Energy Commission
CEDE	committed effective dose equivalent
CEED	Center for Energy and Economic Development
CEQ	Council on Environmental Quality
CESQG	conditionally exempt small quantity generator
CFC	chlorofluorocarbon
CFE	Comisin Federal de Electricidad
CFR	Code of Federal Regulations
cfs	cubic feet per second
CFS	chemical treatment system
CG	cloud-to-ground
CGT	Cogeneration Technologies
CHL	Central Hockey League

ACRONYMS AND ABBREVIATIONS

CO	carbon monoxide
CO_2	carbon dioxide
COD	Chemical Oxygen Demand
COL	combined construction and operating license
COLA	combined construction and operating license application
CORMIX	Cornell Mixing Zone Expert System
CPI	Consumer Price Index
CPP	continuing planning process
CPS	condensate polishing system
CPNPP	Comanche Peak Nuclear Power Plant
CPSES	Comanche Peak Steam Electric Station
CRDM	control rod drive mechanism cooling system
CRP	Clean Rivers Program
CS	containment spray
Cs-134	cesium-134
Cs-137	cesium 137
CST	Central Standard Time
CST	condensate storage tank
CT	completion times
CT	cooling tower
cu ft	cubic feet
C/V	containment vessel
CVCS	chemical and volume control system
CVDT	containment vessel reactor coolant drain tank
CWA	Clean Water Act

ACRONYMS AND ABBREVIATIONS

CWS	circulating water system
DAW	dry active waste
dBA	decibels
DBA	design basis accident
DBH	diameter at breast height
DC	direct current
DCD	Design Control Document
DDT	dichlorodiphenyltrichloroethane
DF	decontamination factor
DFPS	Department of Family and Protective Services
DFW	Dallas/Fort Worth
DO	dissolved oxygen
DOE	U.S. Department of Energy
DOL	Department of Labor
DOT	U.S. Department of Transportation
DPS	Department of Public Safety
D/Q	deposition
DSHS	Department of State Health Services
DSM	Demand Side Management
DSN	discharge serial numbers
DSWD	Demand Side Working Group
DVSP	Dinosaur Valley State Park
DWS	demineralized water system
DWST	demineralized water storage tank
E	Federally Endangered

ACRONYMS AND ABBREVIATIONS

EA	Environmental Assessment
EAB	exclusion area boundary
E. coli	Escherichia coli
EDC	Economic Development Corp.
EDE	effective dose equivalent
EEI	Edison Electric Institute
EERE	Energy Efficiency and Renewable Energy
EFH	Energy Future Holdings Corporation
EFW	energy from waste
EIA	Energy Information Administration
EIS	Environmental Impact Statement
EJ	environmental justice
ELCC	Effective Load-Carrying Capacity
EMFs	electromagnetic fields
EO	Executive Order
EOF	emergency operation facility
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
EPZ	emergency planning zone
ER	Environmental Report
ERA	Environmental Resource Associates
ERCOT	Electric Reliability Council of Texas
ESA	Endangered Species Act
ESP	Early Site Permit
ESRP	Environmental Standard Review Plan

ACRONYMS AND ABBREVIATIONS

ESW	essential service cooling water
ESWS	essential service water system
F&N	Freese & Nicholas, Inc.
FAA	U.S. Federal Aviation Administration
FAC	flow-accelerated corrosion
FBC	fluidized bed combustion
FCT	Fuel Cell Today
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FFCA	Federal Facilities Compliance Act
FLMNH	Florida Museum of Natural History
FM	farm-to-market
FP	fire protection
FPL	Florida Power and Light
FPS	fire protection system
FPSC	Florida Public Service Commission
FR	Federal Register
FSAR	Final Safety Analysis Report
FSL	Forecast Systems Laboratory
ft	feet
FWAT	flow weighted average temperature
FWCOC	Fort Worth Chamber of Commerce
FWS	U.S. Fish and Wildlife Service
gal	gallon
GAM	General Area Monitoring

ACRONYMS AND ABBREVIATIONS

GAO	U.S. General Accountability Office
GDEM	Governor's Division of Emergency Management
GEA	Geothermal Energy Association
GEIS	Generic Environmental Impact Statement
GEOL	overall geological
GFD	ground flash density
GIS	gas-insulated switchgear
GIS	Geographic Information System
GMT	Greenwich Mean Time
gpd	gallons per day
gph	gallons per hour
gpm	gallons per minute
gps	gallons per second
GRCVB	Glen Rose, Texas Convention and Visitors Bureau
GST	gas surge tank
GTC	Gasification Technologies Conference
GTG	gas turbine generators
GWMS	gaseous waste management system
H-3	radioactive tritium
HC	Heavy Commercial
HCl	Hydrochloric Acid
HCP	Ham Creek Park
HEM	hexane extractable material
HEPA	high efficiency particulate air
HIC	high integrity container

ACRONYMS AND ABBREVIATIONS

HL	high-level
HNO_3	Nitric Acid
hr	hour(s)
HRCQ	highway route-controlled quantity
H_2SO_4	Sulfuric Acid
HT	holdup tank
HTC	Historic Texas Cemetery
HUC	hydrologic unit code
HUD	U.S. Department of Housing and Urban Development
HVAC	heating, ventilating, and air-conditioning
I	Industrial
I-131	iodine-131
IAEA	International Atomic Energy Agency
I&C	instrumentation and control
IEC	Iowa Energy Center
IGCC	Integrated Gasification Combined Cycle
IH	Interim Holding
in	inch
INEEL	Idaho National Engineering and Environmental Laboratory
IOUs	investor-owned electric utilities
IPE	individual plant examination
ISD	Independent School District
ISFSI	independent spent fuel storage installation
ISO	independent system operator
ISO rating	International Standards Organization rating

ACRONYMS AND ABBREVIATIONS

ISU	Idaho State University
JAMA	Journal of the American Medical Association
K-40	potassium-40
KC	Keystone Center
JRB	Joint Reserve Base
km	kilometer
kVA	kilovolt-ampere
kWh	kilowatt hour
L	LARGE
LaaR	Load Acting as a Resource
LANL	Los Alamos National Laboratory
lb	pounds
LC	Light Commercial
LG	Lake Granbury
LL	low-level
LLD	lower limits of detection
LLMW	low-level mixed waste
LNG	liquid natural gas
LOCA	loss of coolant accident
LPSD	low-power and shutdown
LPZ	low population zone
LQG	large-quantity hazardous waste generators
LRS	load research sampling
LTSA	long term system assessment
Luminant	Luminant Generation Company LLC

ACRONYMS AND ABBREVIATIONS

LVW	low volume waste
LWA	Limited Work Authorization
LWMS	liquid waste management system
LWPS	liquid waste processing system
LWR	light water reactor
M	MODERATE
ma	milliamperes
MACCS2	Melcor Accident Consequence Code System
MCES	Main Condenser Evacuation System
Mcf	thousand cubic feet
MCPE	Market Clearing Price for Energy
MCR	main control room
MD-1	Duplex
MDA	minimum detected activity
MDCT	mechanical draft cooling tower
MEIs	maximally exposed individuals
MF	Multi-Family
mG	milliGauss
mg/l	milligrams per liter
mg/m^3	milligrams per cubic meter
MH	Manufactured Housing
MHI	Mitsubishi Heavy Industries
mi	mile
mi^2	square miles
MIT	Massachusetts Institute of Technology

ACRONYMS AND ABBREVIATIONS

MMbbl	million barrels
MMBtu	million Btu
MNES	Mitsubishi Nuclear Energy Systems Inc.
MOU	municipally-owned utility
MOV	motor operated valve
MOX	mixed oxide fuel
mph	miles per hour
MSDS	Materials Safety Data Sheets
msl	mean sea level
MSR	maximum steaming rate
MSW	municipal solid waste
MT	Main Transformer
MTU	metric tons of uranium
MW	megawatts
MW	monitoring wells
MWd	megawatt-days
MWd/MTU	megawatt–days per metric ton uranium
MWe	megawatts electrical
MWh	megawatt hour
MWS	makeup water system
MWt	megawatts thermal
NAAQS	National Ambient Air Quality Standards
NAPA	Natural Areas Preserve Association
NAP	National Academies Press
NAR	National Association of Realtors

ACRONYMS AND ABBREVIATIONS

NARM	accelerator-produced radioactive material
NAS	Naval Air Station
NASS	National Agricultural Statistics Service
NCA	Noise Control Act
NCDC	National Climatic Data Center
NCDENR	North Carolina Department of Environmental and Natural Resources
NCES	National Center for Educational Statistics
NCI	National Cancer Institute
NCTCOG	North Central Texas Council of Governments
ND	no discharge
NDCT	natural draft cooling towers
NEI	Nuclear Energy Institute
NELAC	National Environmental Laboratory Accreditation Conference
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Corporation/Council
NESC	National Electrical Safety Code
NESDIS	National Environmental Satellite, Data, and Information Service
NESW	non-essential service water cooling system
NESWS	non-essential service water system
NETL	National Energy Technology Laboratory
NHPA	National Historic Preservation Act
NHS	National Hurricane Center
NINI	National Institute of Nuclear Investigations
NIOSH	National Institute for Occupational Safety and Health

ACRONYMS AND ABBREVIATIONS

NIST	U.S. National Institute of Standards and Technology
NJCEP	NJ Clean Energy Program
NLDN	National Lightning Detection Network
NOAA	National Oceanic and Atmospheric Administration
NOAEC	no observable adverse effects concentration
NOI	Notice of Intent
NOIE	non-opt-in entities
NO_x	oxides of nitrogen
NP	Nacogdoches Power
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NR	not required
NRC	U.S. Nuclear Regulatory Commission
NREL	U.S. National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NRRI	National Regulatory Research Institute
NSPS	New Source Performance Standards
NSSS	nuclear steam supply system
NTAD	National Transportation Atlas Database
NVLAP	National Voluntary Laboratory Accreditation Program
NWI	National Wetlands Inventory
NWS	National Weather Service
NWSRS	National Wild and Scenic Rivers System
O_2	Oxygen
O_3	Ozone

ACRONYMS AND ABBREVIATIONS

ODCM	Off-site Dose Calculation Manual
OECD	Organization for Economic Co-operation and Development
O&M	operations and maintenance
ORNL	Oak Ridge National Laboratory
ORP	oxidation-reduction potential
OSHA	Occupational Safety and Health Act
OW	observation well
P&A	plugging and abandonment
PAM	primary amoebic meningoencephalitis
PD	Planned Development
PDL	Proposed for Delisting
PE	probability of exceedances
percent g	percent of gravity
PET	Potential Evapotranspiration
PFBC	pressurized fluidized bed combustion
PFD	Process Flow Diagram
PGA	peak ground acceleration
PGC	power generation company
PH	Patio Home
P&ID	piping and instrumentation diagram
PM	particulate matter
PM_{10}	particulate matter less than 10 microns diameter
$PM_{2.5}$	particulate matter less than 2.5 microns diameter
PMF	probable maximum flood
PMH	probable maximum hurricane

ACRONYMS AND ABBREVIATIONS

PMP	probable maximum precipitation
PMWP	probable maximum winter precipitation
PMWS	probable maximum windstorm
PPE	plant parameter envelope
ppm	parts per million
PPS	preferred power supply
PRA	probabilistic risk assessment
PSD	Prevention of Significant Deterioration (permit)
PSWS	potable and sanitary water system
PUC	Public Utility Commission
PUCT	Public Utility Commission of Texas
PURA	Public Utilities Regulatory Act
PWR	pressurized water reactors
QA	quality assurance
QC	quality control
QSE	qualified scheduling entities
R10	Single-Family Residential
R12	Single-Family Residential
R7	Single-Family Residential
R8.4	Single-Family Residential
RAT	Reserve Auxiliary Transformer
RB	reactor building
R/B	reactor building
RCDS	reactor coolant drain system
RCDT	reactor coolant drain tank

ACRONYMS AND ABBREVIATIONS

RCRA	Resource Conservation and Recovery Act
RCS	reactor coolant system
RDA	Radiosonde Database Access
REC	renewable energy credit
REIRS	Radiation Exposure Information and Reporting System
RELFRC	release fractions
rem	roentgen equivalent man
REMP	radiological environmental monitoring program
REP	retail electric providers
REPP	Renewable Energy Policy Project
RFI	Request for Information
RG	Regulatory Guide
RHR	residual heat removal
RIMS II	regional input-output modeling system
RMR	Reliability Must-Run
Rn_{222}	Radon-222
RO	reverse osmosis
ROI	region of interest
ROW	right of way
RPG	regional planning group
RRY	reactor reference year
RTHL	Recorded Texas Historic Landmarks
RTO	regional transmission organization
Ru-103	ruthenium-103
RW	test well

ACRONYMS AND ABBREVIATIONS

RWSAT	refueling waste storage auxiliary tank
RWST	refueling water storage tank
RY	reactor-year
S	SMALL
SACTI	Seasonal/Annual Cooling Tower Impact Prediction Code
SAL	State Archaeological Landmark
SAMA	severe accident mitigation alternative
SAMDA	severe accident mitigation design alternative
SB	Senate Bill
SCR	Squaw Creek Reservoir
SCDC	Somervell County Development Commission
scf	standard cubic feet
SCWD	Somervell County Water District
SDS	sanitary drainage system
SECO	State Energy Conservation Office
SER	Safety Evaluation Report
SERC	SERC Reliability Corporation
SERI	System Energy Resources, Inc.
SFPC	spent fuel pool cooling and cleanup system
SG	steam generator
SGBD	steam generator blow-down
SGBDS	steam generator blow-down system
SGs	steam generators
SGTR	steam generator tube rupture
SH	State Highway

ACRONYMS AND ABBREVIATIONS

SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SMP	State Marketing Profiles
SMU	Southern Methodist University
SOP	Standard Operations Permit
SO_2	sulfur dioxide
SO_x	sulfur
SPCCP	Spill Prevention Control and Countermeasures Plan
SPP	Southwest Power Pool
SQG	small-quantity generators
sq mi	square miles
SRCC	Southern Regional Climate Center
SRP	Standard Review Plan
SRST	spent resin storage tank
SSAR	Site Safety Analysis Report
SSC	structures, systems, and components
SSI	Safe Shutdown Impoundment
SSURGO	Soil Survey Geographic
SWATS	Surface Water and Treatment System
SWMS	solid waste management system
SWPC	spent fuel pool cooling and cleanup system
SWP3	Storm Water Pollution Prevention Plan
SWS	service water system
SWWTS	sanitary wastewater treatment system
T	Federally Threatened

ACRONYMS AND ABBREVIATIONS

t	ton
TAC	technical advisory committee
TAC	Texas Administrative Code
TB	turbine building
Tc_{99}	Technetium-99
TCEQ	Texas Commission on Environmental Quality
TCPS	Texas Center for Policy Studies
TCR	transmission congestion rights
TCS	turbine component cooling water system
TCWC	Texas Cooperative Wildlife Collection
T&D	transmission and distribution utility
TDCJ	Texas Department of Criminal Justice
TDOH	Texas Department of Health
TDOT	Texas Department of Transportation
TDPS	Texas Department of Public Safety
TDS	total dissolved solids
TDSHS	Texas Department of State Health Services
TDSP	transmission and distribution service provider
TDWR	Texas Department of Water Resources
TEDE	total effective dose equivalent
TGLO	Texas General Land Office
TGPC	Texas Groundwater Protection Committee
TH	Townhome
THC	Texas Historical Commission
THPOs	tribal historic preservation officers

ACRONYMS AND ABBREVIATIONS

TIS	Texas Interconnected System
TLD	Thermoluminescence Dosemeter
TMDLs	total maximum daily loads
TMM	Texas Memorial Museum
TOs	Transmission Owners
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
tpy	tons per year
TRAGIS	Transportation Routing Analysis Geographic Information System
TRB	Transportation Research Board
TRC	total recordable cases
TRE	Trinity Railway Express
TSC	technical support center
TSD	thunderstorm days per year
TSD	treatment, storage, and disposal
TSDC	Texas State Data Center
TSHA	Texas State Historical Association
TSP	transmission service provider
TSWQS	Texas Surface Water Quality Standards
TSS	total suspended sediment
TTS	The Transit System (Glen Rose)
TUGC	Texas Utilities Generating Company
TUSI	Texas Utilities Services Inc.
TWC	Texas Workforce Commission
TWDB	Texas Water Development Board

ACRONYMS AND ABBREVIATIONS

TWR	Texas Weather Records
TWRI	Texas Water Resources Institute
TxDOT	Texas Department of Transportation
TXU	Texas Utilities Corporation
TXU DevCo	TXU Generation Development Company LLC
UC	University of Chicago
UFC	uranium fuel cycle
UHS	Ultimate Heat Sink
UIC	Uranium Information Center
UO_2	uranium dioxide
USACE	U.S. Army Corps of Engineers
US-APWR	(MHI) United States-advanced pressurized water reactor
USC	U.S. Census
USCA	United States Court of Appeals
USDA	U.S. Department of Agriculture
USDOT	U.S. Department of Transportation
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	U.S. Geological Survey
USHCN	United States Historical Climatology Network
USHR	U.S. House of Representatives
USNPS	U.S. National Park Service
UTC	Universal Time Coordinated
UV	ultra-violet
VCIS	Ventilation Climate Information System

ACRONYMS AND ABBREVIATIONS

VCT	volume control tank
VERA	Virtus Energy Research Associates
VFD	Volunteer Fire Department
VOC	volatile organic compound
VRB	variable
WB	Weather Bureau
WBR	Wheeler Branch Reservoir
WDA	work development area
WDFW	Washington Department of Fish and Wildlife
weight percent	wt. percent
WHT	waste holdup tank
WMT	waste monitor tank
WNA	World Nuclear Association
WPP	Watershed Protection Plan
WQMP	Water Quality Management Plan
WRE	Water Resource Engineers, Inc.
WWS	wastewater system
WWTP	wastewater treatment plant
yr	year

CHAPTER 5

ENVIRONMENTAL IMPACTS OF OPERATION

5.0 ENVIRONMENTAL IMPACTS OF OPERATION

Chapter 5 presents the potential effects from operation of the Comanche Peak Nuclear Power Plant (CPNPP) Units 3 and 4. In accordance with Title 10 Code of Federal Regulations (CFR) Part 51, effects are analyzed, and a single significance level of potential effect to each resource, i.e., SMALL, MODERATE, or LARGE, is assigned consistent with the criteria that the Nuclear Regulatory Commission (NRC) established in 10 CFR Part 51, Appendix B, Table B-1, Footnote 3. Unless the significance level is identified as beneficial, the effect is adverse, or in the case of SMALL, may be negligible. The definitions of significance are as follows:

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

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

LARGE Environmental impacts are clearly noticeable and are sufficient to destabilize any important attributes of the resource.

This chapter is divided into 13 sections in which the first 11 sections are concurrent with NRC NUREG 1555. Two supplemental sections have been added to provide additional information related to the evaluation of impacts from CPNPP plant operations:

- Land-Use Impacts (Section 5.1).
- Water-Related Impacts (Section 5.2).
- Cooling System Impacts (Section 5.3).
- Radiological Impacts of Normal Operations (Section 5.4).
- Environmental Impacts of Waste (Section 5.5).
- Transmission System Impacts (Section 5.6).
- Uranium Fuel Cycle and Transportation Impacts (Section 5.7).
- Socioeconomics Impacts (Section 5.8).
- Decommissioning (Section 5.9).

- Measures and Controls to Limit Adverse Impacts During Operation (Section 5.10).
- Cumulative Impacts Related to Station Operations (Section 5.11).
- Impacts of Transportation of Radioactive Materials (Section 5.12).
- Nonradiological Health Impacts During Operations (Section 5.13).

The following definitions and figures are provided as additional information related to the content of Chapter 5 sections:

- CPNPP region - The area within the 50-mile (mi) radius around the site from the center point of CPNPP Units 3 and 4 (Figure 1.1-1).
- CPNPP vicinity - The area within the 6-mi band from the site boundary (Figure 1.1-2).
- CPNPP site - The 7950-acre (ac) area identified by the site boundary (Figure 1.1-3).

5.1 LAND-USE IMPACTS

The following subsections describe potential land-use effects from operations at the Comanche Peak Nuclear Power Plant (CPNPP) Units 3 and 4. Subsection 5.1.1 describes effects to the site and vicinity. Subsection 5.1.2 describes effects that could occur along transmission line corridors and in off-site areas as a result of operations and maintenance activities. Subsection 5.1.3 describes potential effects on historic properties in the site and vicinity, along transmission line corridors, and in off-site areas.

5.1.1 THE SITE AND VICINITY

CPNPP Units 3 and 4 dissipate heat using four mechanical draft cooling towers. The cooling tower and reactor unit locations are shown in Figure 2.1-1. The heat dissipation system is described in Subsection 3.4.2.3.

Effects to the CPNPP site and its vicinity would primarily be limited to those experienced during construction, as documented in Section 4.1. Therefore, it is anticipated that operation of the station has SMALL effects on land use within the site boundary or in the vicinity of CPNPP as no additional land-use changes are anticipated once construction is completed. No mitigation is necessary.

5.1.1.1 The Site

Land use within the CPNPP site is discussed in Subsection 2.2.1. Figure 2.2-1 depicts land use on the site and in the adjacent areas. Land use on-site consists primarily of open water (41.5 percent) followed by evergreen forest (23.3 percent) and grassland (13.7 percent). Previously disturbed/developed land makes up 10.6 percent of the site land use. Operations at CPNPP Units 3 and 4 have minimal effects on forest, grassland, pasture, and developed land on the site. No agricultural production occurs on the CPNPP site; therefore, operations at CPNPP have SMALL effects on land located within the site boundary as no additional land-use changes are anticipated once construction is completed. No mitigation is necessary.

As described in Subsection 2.2.1, there are approximately 1064 ac of prime farmland located within the CPNPP site boundary; however, no additional prime farmland is disturbed by plant operations. None of the prime farmland on-site is currently being used for agricultural production and 7 ac of prime farmland has already been disturbed during construction activities of CPNPP Units 3 and 4. Luminant Generation Company LLC (Luminant) owns the site and uses it for industrial purposes; therefore, there is no significant land-use change associated with the prime farmland on-site. Detailed geological characteristics in the vicinity of and at the CPNPP site are discussed in Section 2.6.

The cooling tower plumes resemble cumulus clouds when viewed from a distance. While visible in the local area, they are expected to have negligible visual effects. The CPNPP Units 3 and 4 are similar in height to Units 1 and 2, though built on ground that is approximately 12 ft higher. Because CPNPP Units 1 and 2 have been in operation since the early 1990s, any effect on local area aesthetics has already occurred. Discussion on the effects of cooling tower operations, including plume height and drift distance, is in Subsection 5.3.3.1.1. Discussion of salts on the sensitivity of resident species is in Subsection 5.3.3.2.1. The locations of roads on the CPNPP site are illustrated in Figure 2.1-1.

5.1.1.2 The Vicinity

Land use in the vicinity of CPNPP is discussed in Subsection 2.2.1, acreages are shown in Table 2.2-1, and Figure 2.2-2 illustrates the land use in the vicinity of the site. The majority of operation workers are expected to reside in Somervell and Hood counties. The area is fairly rural, with utilities and amenities generally supplied by the cities and townships in the counties. It is likely that new employees who choose to settle near the CPNPP site purchase homes or acreage in the Granbury or Glen Rose areas. Given the extensive development of housing in the vicinity, the operation workers are expected to find residences in existing or planned developments and are not expected to result in further land use change. Housing impacts are discussed in Subsection 4.4.2.4. No new land is anticipated to be disturbed after the construction phase, and operational land-use effects are confined to the CPNPP site as well as the intake and discharge areas at Lake Granbury; therefore, operations at CPNPP are expected to have SMALL effects on forest, pasture, and farmland in the vicinity of the site. No mitigation is necessary. Geological features in the vicinity of CPNPP are discussed in FSAR Section 2.5.

The majority of the cooling tower plumes dissipate before leaving the site boundary, or resemble cumulus clouds when seen from a distance. The effects of cooling tower plumes and drift in the vicinity of CPNPP are evaluated and the results are discussed in Subsection 5.3.3.1.1. Discussion of salts on the sensitivity of resident species is in Subsection 5.3.3.2.1.

The location of roads in the vicinity of CPNPP are described in Subsection 2.5.2.2. Operation-related land-use effects involving social and economic impacts in the vicinity surrounding CPNPP are assessed in Section 5.8.

5.1.2 TRANSMISSION CORRIDORS AND OFF-SITE AREAS

Land use within and adjacent to the proposed transmission corridors is discussed in Subsection 2.2.2. The primary land use in the transmission corridors is grassland, as the corridors are cleared by the time plant operation begins. Figure 2.2-1 shows land use on the site and in the adjacent areas.

The operation of CPNPP Units 3 and 4 requires four 345-kV transmission lines. These lines are placed along existing ROWs with a width of 160 ft. The lines consist of a 45-mi line to Whitney Switching Station, a 17-mi line to DeCordova Switching Station, a 22-mi line to Johnson Switching Station, a 23-mi line from Johnson Switching Station to Everman Switching Station, and a 42-mi line to Parker Switching Station. The basic electrical and structural design parameters of the transmission system are described in Subsection 3.7.1.

The Texas General Land Office oversees land use in Texas. The proposed transmission corridors do not cross federal, state, or Native American tribal lands. The Parker line crosses Texas State Highway 377 (SH 377), SH 171, U.S. Highway 180 (US 180), and Interstate 20E (I-20E) in addition to a Ft. Worth and Western Railroad line in Hood County and a Union Pacific Railroad line in Parker County. The Johnson line crosses SH 144 and Farm to Market 4 (FM 4), while the Everman line crosses SH 171, I-35W, a Ft. Worth and Western Railroad line in Johnson County, a Burlington Northern Santa Fe Railroad line in Tarrant County, and a Union Pacific Railroad line in Tarrant County. The DeCordova line crosses SH 144 while the Whitney line crosses SH 144, SH 174, SH 22, US 67, and a Burlington Northern Santa Fe Railroad line in Bosque County.

Transmission system impacts on terrestrial ecosystems, aquatic ecosystems, and members of the public are discussed in Section 5.6. Plant operations has minimal to no effect on land use along the transmission corridors, as the transmission corridors are existing or have been cleared during construction. The land use along the transmission corridors during operations is maintained as early open grassland successional stage. Access roads are established during construction and maintained as described in Subsection 5.6.1, resulting in no new land use impact during operations. Transmission line easements restrict placement of permanent structures in the easement or plantings that may interfere with line maintenance. Otherwise, no restrictions are placed on land use. Operation of the transmission corridor for CPNPP is expected to have SMALL impact on land use and is not expected to require mitigation.

Transmission ROWs are managed to prevent disruptions in service related to overgrown woody vegetation. The vegetation maintenance occurs on a maintenance cycle dictated by the vigor of local vegetation and the local experience of Oncor Electric Delivery Company LLC (Oncor Electric delivery). Typically maintenance consists of cutting herbaceous and low woody growth on a relatively short cycle and cutting saplings, larger shrubs, and trees on a longer cycle. Access roads are allowed to grass over and are re-cut only as needed to permit occasional vehicular access.

5.1.3 HISTORIC PROPERTIES

This subsection focuses on the effects of CPNPP operations on existing historic properties on the CPNPP site and within a 10-mi radius of its boundary. Archaeological sites and aboveground historic properties are among the entities that can be considered for listing on the National Register of Historic Places (NRHP). They are the principal historic properties of concern, with regard to effects from operations, along with cemeteries and traditional cultural properties. Definitions of the terms “historic properties,” “site integrity,” and “significance” in relation to eligibility for the NRHP and related concerns about impacts are described in Subsection 4.1.3. Site numbers, locations, and NRHP status of relevant historic properties are discussed in Subsection 2.5.3, Tables 2.5-21 and 2.5-22.

5.1.3.1 Site and Vicinity

Direct impacts on existing historic properties from operations at CPNPP are possible only within the on-site and off-site areas of potential effect (APE) for the CPNPP site, which are described in Subsections 2.5.3. There are no NHRP listed or eligible properties within the on-site APE and continued operation of the facility is not expected to impact NRHP eligible or listed properties (Subsection 2.5.3.3). Indirect, i.e., noise-related and aesthetic/visual effects from station operations are possible on-site or within a 10-mi radius of its boundary. This 10-mi radius extends through portions of Hood and Somervell counties. Given the close proximity of CPNPP Units 3 and 4 and the cooling towers to the existing facility, and the installation of water pipelines in a pre-existing water line ROW, operational impacts largely resemble the current operational impacts, with maintenance activity largely confined to areas directly impacted by construction.

The effects of station operations on cultural resources on the CPNPP site, in its vicinity, and within a 10-mi radius of the site are expected to be SMALL.

5.1.3.1.1 Prehistoric Archaeological Sites

On or within a 1-mi radius of the CPNPP site, the 1972 survey of Squaw Creek Reservoir (SCR) by Southern Methodist University (SMU) identified 14 prehistoric archaeological sites and six archaeological sites containing both historic and prehistoric components; however, none of these sites are within the current on-site APE (Figure 2.5-7 and Table 2.5-23). Continued operation of CPNPP Units 3 and 4 may require future vegetation clearing and soil disturbance for upkeep and maintenance purposes. Table 5.10-1 outlines a plan to limit continued disturbance of vegetation to the area within the site designated for CPNPP construction. Because no sites were located within the on-site APE, the direct effects of continued operation of Units 3 and 4 on prehistoric sites are SMALL, no mitigation is warranted. No indirect effects on these sites are anticipated because noise-related and aesthetic/visual effects from operations are extraneous considerations for buried prehistoric sites.

Numerous prehistoric sites and components are located within a 10-mi radius of the CPNPP site. Operations within the on-site APE are not expected to have any direct effects on such distant archeological sites that lie at locations outside of the site boundary. No indirect effects on these sites are anticipated because noise-related and aesthetic/visual effects from operations are extraneous considerations for buried prehistoric sites.

The effects of station operations on prehistoric archaeological sites on the CPNPP site, in its vicinity, and within a 10-mi radius of it are expected to be SMALL. No mitigation is warranted.

5.1.3.1.2 Historical Period Archaeological Sites

One historic feature, a stone wall, was identified within the on-site APE at the CPNPP site (Subsection 2.5.3.1). This feature is not eligible for listing on the NRHP. This feature is located 878 ft northeast of the proposed cooling tower location. Because the wall is within the on-site APE, direct impacts are likely to take place during the construction phase of the project (Subsection 4.1.3.1.2). The plan to limit continued disturbance of vegetation to the area within the site designated for CPNPP construction should also minimize direct impacts on the feature (Table 5.10-1). A total of 14 historic period archaeological sites, eight historic and six multi-component, are located on or within a 1-mi radius of the CPNPP site but remain outside the on-site APE. The effects of plant operation on these historic sites are expected to be SMALL and no mitigation is warranted.

5.1.3.1.3 Historic Sites

There are no NRHP properties within the on-site APE. The nearest NRHP listed properties are located within the towns of Glen Rose and Granbury. The nearest town of Glen Rose is located 5.2 mi to the south of the CPNPP site. Indirect (noise-related or aesthetic/visual) effects are an intrinsic consideration in regard to the potential adverse effects of operations on aboveground historic properties within the vicinity of the CPNPP. The visual impact from the cooling towers and reactor containment buildings does not exceed the visual impact of the reactor domes and buildings, and all 56 of these properties are at least 5 mi from the on-site APE. In addition to the fact that the existing reactors and domes (CPNPP Units 1 and 2) are visible from particular areas outside the CPNPP site, this view is obscured from the downtown areas of Glen Rose and Granbury in which the NRHP properties are consolidated. The relative distance of the historic properties from the CPNPP site makes noise concerns negligible; therefore, the operational effects of the CPNPP site upon NRHP properties within a 10-mi radius of the facility are expected to be SMALL and no mitigation is warranted.

5.1.3.1.4 Historic Cemeteries

One small historic cemetery, the Hopewell Cemetery (SV-C004), is located within the CPNPP site (Subsection 2.5.3). The Hopewell Cemetery is accessible, fenced for protection, and receives periodic general upkeep. The cemetery is located just over 980 ft from the proposed water pipeline route. This water pipeline route is located within a pre-existing transmission line ROW. Thus, indirect impacts from ROW maintenance remain the same. Vegetation surrounding the cemetery is consistently thick and obscures any visual corridors to on-site activity making visual impacts to the cemetery negligible. Noise impacts from continued operation of CPNPP Units 3 and 4 upon the Hopewell Cemetery are SMALL, so no mitigation is warranted. Three other nearby cemeteries, Unknown Cemetery (SV-CO26), Post Oak Cemetery (SV-001), and Milam Chapel Cemetery (SV-C002), are located outside the CPNPP site, but within two mi of the property boundaries. All three of these cemeteries are at least one mi from the on-site APE. Indirect effects related to the ongoing operation of facilities at the CPNPP site are not anticipated for the cemeteries because such factors are not sufficient to physically disturb burials and grave-markers or prevent visitor access.

5.1.3.1.5 Traditional Cultural Properties

No known Traditional Cultural Properties exist on CPNPP property. Comanche Peak, a geological feature north of the property, may have some significance to the Comanche Tribe. Squaw Creek just south of the property may also have special significance to the Comanche Tribe (Subsection 2.5.3.4). Because neither of these properties is within the on-site APE, they are not expected to be directly impacted by ongoing facility operations. The potential for indirect, visual/aesthetic impacts from proposed construction is not planned to exceed the impact of the current facilities within CPNPP property. A written response from the Comanche Tribe dated February 12, 2007 stated that the Comanche Tribe has no immediate concerns or issues regarding this project. In the event human remains or archeological items are discovered in the process of the project, the tribe requests project work cease and appropriate disposition occur between Luminant and relative Tribal Nations. Because of the distance separating the Traditional Cultural Properties from the on-site APE, indirect noise impact on Traditional Cultural Properties is expected to be SMALL and no mitigation is warranted.

5.1.3.2 Transmission Corridors and Off-Site Areas

Construction of Units 3 and 4 at CPNPP includes the construction of transmission lines and water intake and water discharge pipelines. This subsection describes the effects of plant operations on historic properties within the proposed transmission corridors and water pipeline ROWs. Oncor Electric Delivery selects the transmission and distribution line corridors, constructs the lines, and owns and operates the lines from the CPNPP site to various new and existing end users in north Texas. Final routes and designs have not been prepared to date but are being prepared by Oncor Electric Delivery. Oncor Electric Delivery has been in contact with the THC about needs and requirements for the protection of cultural resources, including historical and prehistoric resources, places eligible for inclusion on the NRHP, Native American and minority population concerns and archeological inventory requirements as specified by state and federal guidelines. Oncor Electric Delivery would be contracting with one of the firms listed by the Council of Texas Archeologists as being certified to conduct such investigations in the State of Texas, once specific investigation plans have been approved by the THC. Research on pre-existing cultural resources, reconnaissance archeological surveying and, if necessary, more intensive site testing and examination of significant cultural resources are planned along transmission corridors as their routes are determined.

5.1.3.2.1 Water Pipeline Corridor

A portion of the off-site APE includes the installation of water pipelines (Figure 2.5-9). The corridor for proposed water pipelines is expected to run adjacent to an existing water pipeline. This installation is expected to result in a temporary expansion of the existing Water Pipeline Corridor as it runs from the CPNPP property boundary northeast to its terminus in Lake Granbury. The exact route of the proposed Water Pipeline Corridor as it is planned to run from the property boundary to the cooling towers is illustrated on Figure 1.1-4.

The ongoing operation of the water pipelines are anticipated to have negligible effects on cultural resources due to the water lines being buried. Indirect impacts such as noise and visual/aesthetic impacts on cultural resources are expected to be SMALL and no mitigation is warranted. The effects of water pipeline construction on cultural resources are discussed in Subsection 4.1.3.2.1.

5.1.4 REFERENCES

None.

5.2 WATER-RELATED IMPACTS

This section provides information that describes the hydrological alterations, plant water supply, and water-related impacts of plant operations. Water-use impacts from plant operations are addressed in the following subsections:

- Hydrologic Alterations and Plant Water Supply (Subsection 5.2.1).
- Water-Use Impacts (Subsection 5.2.2).
- Water Quality Impacts (Subsection 5.2.3).

Based upon an evaluation of present and future water use, water withdrawal and discharge from the CPNPP Units 3 and 4 are considered to be of SMALL impact, and mitigation is not warranted.

5.2.1 HYDROLOGIC ALTERATIONS AND PLANT WATER SUPPLY

Hydrological alterations were evaluated to assess waters affected directly and indirectly by CPNPP Units 3 and 4 operations. Waters integral to plant operations include Lake Granbury and SCR. Waters affected by plant operations include stormwater and surface water.

Water withdrawn from Lake Granbury is (1) discharged back to Lake Granbury as cooling tower blowdown released to control solids, (2) lost as evaporation, (3) lost as drift (entrained in water vapor from the cooling towers), or (4) discharged to SCR after use and treatment for other CPNPP ancillary purposes. Water withdrawn from Lake Granbury and not returned to Lake Granbury or SCR is considered consumptive use. This necessary consumptive use of water by CPNPP results from the transfer of heat and the emission of water vapor. Drift losses are also a consumptive use but very small compared to evaporative losses and minimized to the greatest possible extent by drift eliminators included in the design of the cooling towers. The combined drift and evaporation loss is approximately 36,584 gpm with two units in operation. The maximum consumption rate of Lake Granbury water, predominantly resulting from evaporation during plant operations, is expected to be approximately 36,914 gpm.

The CPNPP Units 3 and 4 plant water systems require makeup water to the cooling towers to replace water lost to evaporation, drift, and blowdown. The average withdrawal rate of Lake Granbury water to replace water losses from the plant water systems is approximately 63,550 gpm for the two-unit operation (Figure 3.3-1).

In addition to water demand, water returns were evaluated for hydrological alterations. Water returned to Lake Granbury and SCR is available as a water supply to the downstream Brazos River water users and to the aquatic communities. Water returns from plant operations include cooling tower blowdown, stormwater runoff, and treated wastewater from both the conventional and radiological waste streams. Maximum blowdown from the nonradioactive circulation water system (CWS) and the essential service water system (ESWS) is discharged into Lake Granbury at a rate of approximately 26,100 gpm with both units operating (Figure 3.3-1) (Subsection 3.4.2.2). Effluent from other plant systems such as stormwater and sanitary outflows is anticipated to be discharged to the existing wastewater treatment pond and SCR. The treated liquid effluent is discharged to SCR via the Units 1 or 2 circulating water discharge.

Radioactive liquid effluents have provision to divert a portion of the flow to a new evaporation pond. Based on an analysis to determine the impact of liquid effluent on the tritium concentration in SCR, the tritium concentration in SCR is anticipated to be within the tritium limit due to the local rainfall, evaporation, and spillover (control release) from SCR to Squaw Creek. However, during the maximum tritium generation condition (i.e., all four units operate at full power), the tritium concentration could be exceeded, a portion of the liquid effluent from CPNPP Units 3 and 4 discharge header can be diverted to an evaporation pond located within the site boundary. Under this maximum tritium generation condition, and maintaining a 20 percent margin below the Off-site Dose Calculation Manual (ODCM) limit, up to approximately 45 percent of the daily effluent is diverted into the evaporation pond. Additional information related to processing low level radioactive wastewater is presented in Subsection 3.5.1 and Subsection 5.2.3.4.

Wastewater and stormwater discharges from the site to SCR and on-site ponds could potentially cause hydrologic alterations. To minimize the potential of stormwater affecting surface water bodies, the site maintains a stormwater pollution prevention plan (SWP3) and a Texas Pollutant Discharge Elimination System (TPDES) permit.

5.2.1.1 Physical Characteristics of Surface Water and Groundwater

The CPNPP Units 3 and 4 are located in rural Somervell and Hood counties in north central Texas (Figure 1.1-1). The CPNPP site is situated on the western end of a peninsula formed by land between the southern shore of SCR and the CPNPP Units 1 and 2 Safe Shutdown Impoundment (SSI). The cooling water source for CPNPP Units 3 and 4 is Lake Granbury, an impoundment of the Brazos River, located 7.13 mi northeast of the CPNPP site. The CPNPP site and Lake Granbury are located within the Brazos River Basin, a portion of U.S. Geological Survey (USGS) Region 12 (Texas Gulf - Region) that is described as the drainage that discharges into the Gulf of Mexico from and including Sabine Pass to the Rio Grande Basin, and includes parts of Louisiana, Texas, and New Mexico (USGS 2007). Within USGS Region 12, the Brazos River Basin is divided into three sub-regions: the Brazos Headwaters, Middle Brazos, and Lower Brazos Basins (Figure 2.3-2). The CPNPP site is located in the Middle Brazos Basin. The Middle Brazos Basin watershed drains an area of approximately 15,500 sq mi (USGS 2007). Local surface-water features are discussed in detail in Subsection 2.3.1 and the Final Safety Analysis Report (FSAR) Subsection 2.4.1.

Most of the local groundwater in the vicinity of the CPNPP occurs in bedrock. In the order of increasing age, bedrock aquifers in the site vicinity include the Comanche series Cretaceous age Paluxy Formation, Glen Rose Formation, and Twin Mountains Formation (Figure 2.3-24). Locally, CPNPP and SCR are situated on the Glen Rose Formation outcrop, which in turn, is underlain by the Twin Mountains Formation. The Paluxy Formation is absent at the CPNPP site and adjacent SCR (CPSES 2007). Some groundwater does exist in the shallow floodplain alluvium along stream valleys but is not withdrawn for use. The physical characteristics of the groundwater aquifers are further discussed in Subsection 2.3.1.5.3 and FSAR Subsection 2.4.12.

5.2.1.2 Water Sources

The operational water source to be used for the CPNPP Units 3 and 4 is Lake Granbury. In addition, potable water is planned to be supplied from Wheeler Branch Reservoir, part of the Somervell County Water District. The De Cordova Bend Dam impounds water of the Brazos

River to form Lake Granbury. According to information from the Brazos River Authority (BRA), there is no required minimum flow release at De Cordova Bend Dam. The BRA voluntarily makes a minimum flow release of 28 cfs under normal operating conditions.

The daily flow rate of the Brazos River near the cooling water discharge lines for CPNPP Units 3 and 4 on Lake Granbury is regulated by releases through De Cordova Bend Dam. Historical release data from BRA for the years 1969 to 2006 indicate an average monthly discharge of 1031 cfs. Table 2.3-11 presents the average monthly discharge at De Cordova Bend Dam for the period of record. The maximum recorded discharge was 72,585 cfs, recorded on October 15, 1981. Table 2.3-12 presents the annual peak discharges at De Cordova Bend Dam for the period of record.

The minimum daily flow data that was reviewed indicated several days of zero or minimal releases, approximately 28 cfs, at De Cordova Bend Dam for the period of record. As mentioned previously, the BRA voluntarily makes a minimum flow release of 28 cfs under normal operating conditions. The BRA releases additional water during flood conditions and in circumstances where BRA customers downstream request additional water. When the reservoir is full, the BRA passes inflow as it comes into the lake by adjusting gate openings as frequently as every couple of hours. The BRA calculates inflow to the lake based on change in reservoir elevation (storage) over a given period of time. In cases where there is no local runoff, releases would be similar to the USGS Brazos River Dennis gauging station hydrograph, with some lag (Figure 2.3-8). The BRA does not always base release decisions on the Dennis gauge. There can also be significant inflow to Lake Granbury from rainfall downstream of the Dennis gauge; in which cases, releases can be significantly higher than the Dennis gauge readings.

To illustrate monthly flow variability, discharge data collected by the BRA at the De Cordova Bend Dam from 1969 to 2006 are provided in Table 2.3-11. Temperature measurements for Lake Granbury showing variability with depth were collected on May 2, 2007, during the bathymetry study (Table 2.3-22). Flow characteristics of the Brazos River are discussed in greater detail in Subsections 2.3.2.2 and 2.3.1.2.3.

Low lake levels are documented for Lake Granbury in FSAR Subsection 2.4.11.3. The normal pool elevation of Lake Granbury is 693 ft msl (TWDB 2005). Estimates of frequency and duration of water-supply shortages are also presented in FSAR Subsection 2.4.11. Additional flow conditions are discussed in Subsection 5.2.2.2. Further information regarding flow data for the Brazos River can be found in Subsection 2.3.1.

Groundwater is not used for operation of CPNPP. The groundwater characteristics are discussed in Subsection 2.3.1.5 and FSAR Subsection 2.4.12.

5.2.1.3 Plant Withdrawals and Returns

Water is pumped from Lake Granbury to CPNPP Units 3 and 4. The water withdrawal rate from Lake Granbury for the two units associated with plant water systems is approximately 65,400 gpm during maximum operations (Figure 3.3-1).

CPNPP Units 3 and 4 nonradioactive CWS and ESWS blowdown waters are returned to Lake Granbury at the discharge structure located near the De Cordova Bend Dam. The stormwater, treated liquid low-level radioactive process water, and treated sanitary outflows are discharged to SCR. Tables 2.3-38 and 2.3-39 present plant makeup water and discharge rates. The water discharge rate to Lake Granbury during normal operations from the CWS, including loss estimates from the conceptual blowdown treatment facility (BDTF) of 5,200 gpm is estimated at 20,900 gpm. Effluent from other CPNPP Units 3 and 4 systems are expected to be discharged to the wastewater treatment basins (Figure 3.3-1) (Subsection 3.4.2.2). Additional information related to the CPNPP water use and discharge is presented in Sections 3.3 and 3.4. Additional information about water withdrawal, consumption, and returns, including operational and shutdown modes, is presented in Sections 3.3, 3.4, and Table 3.4-2.

No operational water withdrawals are planned to be associated with the operation and maintenance of the transmission lines.

5.2.1.4 Present and Future Surface Water Use

Each year, the Texas Water Development Board (TWDB) conducts an annual survey of surface water (and groundwater) use by municipal and industrial entities within Texas for water resource planning purposes (TWDB 2007a). The TWDB consumptive water use estimates for municipal, manufacturing, and steam-electric power categories come from an annual survey of public water suppliers and major manufacturing and power entities.

Non-consumptive water uses, such as navigation, hydroelectric generation, environmental flows, and recreation, are not reported by the TWDB. The water use reported by the TWDB annual survey covers consumptive withdrawals only and does not include net use by category or water return information. The TWDB reports water use by category on an annual basis and monthly use rates are not provided in the data.

The TWDB publishes annual water use estimates as described in Subsection 2.3.2.2. The 2006 draft estimated water use for Somervell County is 16,100 acre-feet and 48,931 acre-feet for Hood County (TWDB 2009). TWDB annual water use estimates for year 2004 are not considered draft and contain water use estimates in terms of groundwater and surface water use (TWDB 2007a). The 2004 data estimated total water use in Hood County at 11,857 ac-ft, of which 62 percent was reported as surface water use (and 38 percent groundwater use). Somervell County estimated water use was reported at 46,611 ac-ft in 2004, of which 96 percent was reported as surface water use (and 4 percent groundwater use). Total water use for Hood and Somervell counties represents 1.65 percent of the total reported water use in the Brazos River Basin.

Surface water withdrawals for Hood County were estimated at 7306 ac-ft in 2004 (TWDB 2007a). Approximately 76 percent of this use was for irrigation use, 15 percent for municipal use, five percent for steam electric use, and four percent for livestock use. Surface water withdrawals for Somervell County were estimated at 44,693 ac-ft in 2004. Approximately 99 percent of this withdrawal was for steam electric use with less than one percent for irrigation, mining, and livestock uses. Table 2.3-35 provides annual water use estimates by use category for Hood and Somervell counties.

Some of the water withdrawn from the Brazos River Basin watershed is returned to the Brazos River. Water use information for the Brazos River Basin watershed area for 2004 is presented in Table 2.3-33. Total 2004 water withdrawals from Hood and Somervell counties are presented in

Table 2.3-35. In 2006, surface water withdrawals on the Brazos River from Possum Kingdom Lake to Lake Whitney (Figure 2.3-21) accounted for approximately 5044 cfs (3,601,774 ac-ft/yr) (Table 2.3-34). A significant part of this surface water withdrawal (3,367,805 ac-ft/yr) was for the once-through cooling of CPNPP Units 1 and 2.

Based on this minimal use and the fact that the majority of this water from surrounding users (DeCordova Bend electric power plant, Wolf Hollow electric power plant, Lake Granbury Surface Water and Treatment System [SWATS], and CPNPP Units 1 and 2) is returned in the form of effluent, water withdrawal is not expected to affect the available water for other water users nor for the natural aquatic ecological communities of the Brazos River. The current and future surface water uses are discussed further in Subsections 2.3.2.2, 2.3.2.2.1, 2.3.2.2.2, and 2.3.2.2.3. Based upon this limited anticipated future water use, impacts from the CPNPP water withdrawal and discharge are considered SMALL as discussed further in Subsection 5.2.2.3.1.

5.2.1.5 Hydrological Alterations Affecting Groundwater

Groundwater is not used for operations of CPNPP Units 3 and 4. A majority of Lake Granbury is situated on impermeable bedrock; however, drainage channels and embayment areas in the vicinity of Lake Granbury may contain residual soils washed from higher ground that have settled to form alluvial deposits. Due to the shallow depth to bedrock, groundwater present in the thin veneer of alluvial deposits at the CPNPP site has not been used for any purpose. Additionally, the BRA's agreement with Luminant is based upon the BRA's operation of Lake Granbury so that the water level in it will be maintained above 675 ft msl (18 ft below the normal pool elevation). This maximum drawdown would allow for gravity drainage from nearby alluvial deposits but would not affect any beneficial groundwater use. Because of the limited drawdown near alluvial deposits and the absence of any beneficial use, hydrological impacts to alluvial settings along the Brazos River are SMALL.

Shallow groundwater flow below the CPNPP site mimics the surface topography, with an apparent groundwater divide along the long axis of the site peninsula. On the northern portion of the peninsula, a northerly flow toward SCR is observed, and a southerly flow toward the SSI is observed on the south side of the site peninsula (Subsection 2.3.1.5.5). The slow rate of groundwater movement through the low permeability media would result in groundwater gradients only being affected locally. Because the effects are both local and relatively short term, the hydrological impact to groundwater is SMALL. Because the regolith/undifferentiated fill zone is expected to be removed during construction of Units 3 and 4, groundwater pathway Scenarios 3 and 4 (Subsection 2.3.1.5.6) provide the most accurate post-construction conditions as the groundwater pathway to SCR would be in the shallow bedrock.

The Twin Mountains Formation is the principal water-bearing unit in the vicinity of CPNPP site. The top of the Twin Mountains Formation is determined to be at approximately 238 ft below the Units 3 and 4 plant grade elevation. Luminant is not anticipating using groundwater as an operational or safety-related source of water for CPNPP Units 3 and 4, and has implemented a conservation plan for future groundwater withdrawals at the CPNPP site. The present use and future use of groundwater is further discussed in Subsections 2.3.2.3 and 2.3.2.4.

5.2.1.6 Operational Activities Causing Hydrologic Alterations

Maintenance de-silting is not expected to be required for sediment removal near the CPNPP Units 3 and 4 intake structure. The need for installation of rip rap, stemwalls, or other appropriate means to stabilize the banks of the lake during and following construction is not anticipated. Because the need for maintenance de-silting and stabilization of the bank are not expected, hydrological impacts from de-silting are SMALL.

The CPNPP Units 3 and 4 makeup water intake structure from which withdrawal is planned to occur is located northeast of CPNPP on Lake Granbury and is situated next to the western upstream side of the existing makeup water intake structure for SCR. The SCR makeup water intake structure is located on the southwest bank of Lake Granbury, 1.31 mi upstream from the De Cordova Bend Dam. The CPNPP Units 3 and 4 intake structure is designed as a concrete slab with concrete piers to rock and an access bridge similar to the existing access bridge with concrete valve vaults provided on the shore. The screens on the intake structure are expected to have a through screen velocity of 0.5 fps or less. The CPNPP Units 3 and 4 intake structure would be located immediately adjacent to the existing makeup water intake structure for SCR; local flow patterns in the vicinity of the intake structure would be preserved to the maximum extent practical without interference with the operation of the intake structure. Local flow patterns in the vicinity of the intake structure are also expected to prevent significant aggradation of sediment near the intake structure because dredging has not been required for the existing intake for CPNPP Units 1 and 2. Based on the above, hydrological impacts near the intake structure would be SMALL.

The discharge structure is located 0.17 mi upstream of the De Cordova Bend Dam. To minimize hydrologic alterations from the discharge, a multi-port diffuser is expected to be used. The CPNPP Units 3 and 4 CWS and UHS cooling tower blowdown combined discharges would flow through two 42-in diameter pipes (one pipe per unit). The final 82 ft 4 in of each discharge pipe would be a multi-port diffuser with eighteen 4-in diameter nozzles (Figure 5.3-1). The diffuser maximizes thermal and chemical dissolution. The diffuser pipes would be located approximately 1.14 mi downstream from the intake to prevent heated discharge water from recirculating back to the intake. Based on the location of the diffuser upstream of the dam, hydrological impacts near the discharge structure would be SMALL. Additional information related to the CPNPP Units 3 and 4 discharge characteristics is presented in Subsections 5.2.3.1 and 5.2.3.4 as well as Section 3.4.

Dewatering activities that could affect groundwater flow and quality are not required during the operation of CPNPP. Minimal dewatering may be needed during construction of CPNPP Units 3 and 4 as addressed in Subsections 4.2.1.1.1 and 4.2.1.1.6.

Based upon minimal impact from the discharge design, and no maintenance de-silting or dewatering during operation, operational activities at CPNPP are considered to be of SMALL impact and mitigation is not warranted.

5.2.1.7 Surface Water and Groundwater Users Affected by Hydrologic Alterations

All surface water diversions and returns associated with CPNPP Units 3 and 4 operations are expected to be in accordance with approved state and regional water plans. Surface water alterations resultant from CPNPP Units 3 and 4 water use include lower lake levels at Possum Kingdom Lake and Lake Granbury and decreased flows in the reach of the Brazos River between Lake Granbury and Lake Whitney. No hydrologic alterations or effects on groundwater water users from CPNPP Units 3 and 4 operations are anticipated.

Extensive third party water availability modeling has been performed for the Brazos River drainage basin and the Brazos Region G water plan, as well as the State Water Plan have been amended, to provide adequate net diversions to CPNPP Units 3 and 4, plus requirements of other facilities and down stream water rights which might also draw on Lake Granbury. In addition, the BRA's current agreement with Luminant is based upon the BRA's operation of Lake Granbury so that the water level will not fall below 675 ft msl during low flow conditions (18 ft below the normal pool elevation) (Subsection 5.2.1.5).

Third party modeling performed to determine hydrologic alterations resultant from CPNPP Units 3 and 4 water use utilized monthly hydrology data from 1940 to 2007 and year 2020 water use projections and sedimentation conditions (F&N 2009). The resulting model shows the hydrologic alterations to Possum Kingdom Lake, Lake Granbury, and the Brazos River had CPNPP Units 3 and 4 been operating during this period. The model shows baseline conditions and conditions expected with CPNPP Units 3 and 4 typical year demand (90,152 ac-ft/year) and high temperature year demand (103,717 ac-ft/year).

The modeling shows that the increased demands for Units 3 and 4 will cause both Lake Granbury and Possum Kingdom Lake to be lower during drier periods. At the 90,152 ac-ft/year demand level, which is the typical demand expected from the new units, the maximum change is 12.6 feet in Possum Kingdom Lake and 2.5 feet in Lake Granbury during the period of most severe drawdown. On average, elevations in Possum Kingdom under typical demand will be 1.3 feet lower and elevations in Lake Granbury will be 0.4 feet lower with Units 3 and 4 water use. At the 103,717 ac-ft/year demand level, which is the high temperature demand expected from the new units, the maximum change is 14.8 feet in Possum Kingdom Lake and 2.9 feet in Lake Granbury during the period of most severe drawdown. On average, elevations in Possum Kingdom under high temperature demand will be 1.5 feet lower and elevations in Lake Granbury will be 0.6 feet lower with Units 3 and 4 water use (F&N 2009). All but the highest outflows from Lake Granbury will be reduced as well, thus lowering flows in the Brazos downstream of Lake Granbury. With Units 3 and 4, the outflows from Possum Kingdom would increase during dry periods, and spills from Possum Kingdom at the end of these periods would be smaller. However, over time the outflows from Possum Kingdom, and thus stream flow between Possum Kingdom and Lake Granbury would be similar with and without Units 3 and 4.

As discussed in the previous Subsection 5.2.1.6, maintenance dredging (de-silting) of Lake Granbury is not expected to be conducted. Stormwater discharged from the site to the SCR is controlled by continued implementation of a SWP3 and compliance with the TPDES permit, when revised to include CPNPP Units 3 and 4.

Based on the available CWS information, consumptive water use for Units 3 and 4 is estimated at 55,690,560 gpd (171 ac-ft/day). At this rate, the expected time to drawdown Lake Granbury from a normal pool elevation of 693 ft msl to the minimum operating elevation of 675 ft msl is approximately 508 days (Table 2.3-38). The maximum consumption rate of Lake Granbury water, predominantly resulting from evaporation during plant operations, is expected to be approximately 37,154 gpm. Detailed information on water use for the area, including locations of diversions and maximum use rate, and CPNPP is presented in Subsections 2.3.2.2.3, 2.3.2.2.4, and Subsection 3.3.1.

Five municipal water systems obtain water from Lake Granbury through the Lake Granbury SWATS. The closest municipal user to the CPNPP discharge is SWATS, located approximately 3.45 mi upstream of the CPNPP intake structure area on Lake Granbury. There are currently no downstream municipal drinking water users between the CPNPP Lake Granbury discharge and the City of Waco, approximately 65 mi south-southwest. The closest industrial user is the Wolf Hollow electric power plant, with an intake located approximately 150 ft downstream from the CPNPP Lake Granbury intake. The closest upstream industrial user is the DeCordova Bend electric power plant, located approximately 1.56 mi from the CPNPP Lake Granbury intake.

The average monthly flow of the Brazos River at the De Cordova Bend Dam is around 1031 cfs (Table 2.3-11). The consumptive use of CPNPP is a small percentage of the river contribution at this point of water withdrawal. Any additional concentration of total dissolved solids (TDS) as a result of the cooling tower blowdown would be well diluted in Lake Granbury and the Brazos River before reaching the City of Waco. There are no downstream municipal users between the CPNPP Lake Granbury discharge and the City of Waco, Texas, approximately 65 mi south-southwest. Because a BRA contract with Luminant is being negotiated to provide adequate net diversions to CPNPP Units 3 and 4, plus requirements of other facilities and down stream water rights which might also draw on Lake Granbury, and the BRA's current agreement with Luminant is based upon the BRA's operation of Lake Granbury so that the water level in it will be maintained above 675 ft msl during low flow conditions (18 ft below the normal pool elevation), impacts from the CPNPP operations to downstream water users are SMALL. Additional information about municipality use and industrial use is provided in Subsections 2.3.2.2, 2.3.2.2.1, and 2.3.2.2.3. Based upon this provision for low flow conditions and the expected minimal hydrologic alterations, impacts to surface-water and groundwater users are considered to be SMALL. Detailed discussions of possible intake and discharge processes that could alter the aquatic ecosystem near CPNPP are presented in Subsections 5.3.1.2 and 5.3.2.2.

5.2.1.8 Legal Restrictions

The U.S. Environmental Protection Agency (EPA) has promulgated regulations that implement Section 316(b) of the Federal Water Pollution Control Act, also known as the Clean Water Act (CWA) for new and existing electric power producing facilities. For lakes and reservoirs, regulations indicate that intake flow may not disrupt natural thermal stratification or turnover patterns (where present) of the source water except in cases where the disruption is determined to be beneficial to the management of fisheries for fish and shellfish by any fishery management agency. Section 125.83 of the CWA defines a lake or reservoir as any inland body of open water with some minimum surface area free of rooted vegetation and with an average hydraulic retention time of more than seven days. Lakes or reservoirs might be natural water bodies or impounded streams, usually fresh, surrounded by land or by land and a man-made retainer (e.g., a dam). Lakes or reservoirs might be fed by rivers, streams, springs, or local precipitation. Flow-through reservoirs with an average hydraulic retention time of seven days or less should be considered a freshwater river or stream. By EPA definition, Lake Granbury is classified as a lake or reservoir as retention time has been estimated at 260 days (TPWD 2005) by the Texas Parks and Wildlife Department. Additional information is provided in Subsection 5.3.1.1.1 about how

CPNPP meets the performance standards specified in the EPA regulations implementing Section 316(b). CPNPP Units 3 and 4 is designed with a closed cycle wet cooling tower with the design features expected by the Phase I rule incorporated into the intake design.

Any facility that discharges into waters of the United States is required to obtain a valid National Pollution Discharge Elimination System (NPDES) permit. In Texas, the TCEQ has been delegated authority to issue a TPDES permit and renew the permit every five years of operation of CPNPP. Subsection 5.2.3.1 provides additional information on the site TPDES permit requirements. No Native American lands are present within 50 mi of CPNPP as discussed in Subsection 2.2.3.

5.2.2 WATER-USE IMPACTS

This subsection describes the results of the (1) analysis of operations that could have impacts on water use, including water availability, (2) analysis of water quality changes that could affect water use, (3) analysis and evaluation of impacts resulting from these alterations and changes, (4) analysis and evaluation of proposed practices to minimize or avoid potential impacts, and (5) evaluation of compliance with federal, state, regional, local, and affected Native American tribal regulations applicable to water use and water quality.

5.2.2.1 Plant Operational Activities Potentially Impacting Water Use

Possum Kingdom Lake, Lake Granbury, and the Brazos River could potentially be affected by operational activities for Units 3 and 4. These activities include (1) makeup water withdrawals from Lake Granbury (Brazos River) and consumptive use, (2) cooling tower blowdown discharges to Lake Granbury (Brazos River), and (3) radioactive and nonradioactive process water discharges to SCR. Preoperational baseline monitoring programs for surface water and groundwater are described in Subsection 6.3.3.

5.2.2.2 Surface Water - Makeup Water Withdrawal and Consumptive Use

A description of the Brazos River, hydrologic alterations and their related operational activities, and physical effects of hydrologic alterations are presented in Subsection 5.2.1. Discharge records collected by the BRA for the Brazos River were used to estimate the monthly, annual average, and low flows of Lake Granbury. Detailed reservoir flow and hydrology data are presented in Subsection 2.3.1.

The proposed CPNPP water intake structure is located north-northeast of the CPNPP site on Lake Granbury. An intake-hydrodynamic description is presented in Subsection 5.3.1.1.1.

Recreational boating and fishing in the summer, when lake use is at highest, is not expected to be significantly affected by lake level reduction associated with CPNPP Units 3 and 4 water use except in times of severe drought. Hydrologic modeling performed has shown average decreases in Possum Kingdom Lake of 1.3 to 1.5 ft and maximum decreases of 12.6 to 14.8 ft below the level expected without the Units 3 and 4 water demand. Similarly, average decreases in Lake Granbury of 0.4 to 0.6 ft and maximum decreases of 2.5 to 2.9 ft below the level expected without the Units 3 and 4 water demand were determined (F&N 2009). Consumptive water use for Units 3 and 4 is estimated at 55,690,560 gpd (171 ac-ft/day). At this rate, the expected time to drawdown Lake Granbury from a normal pool elevation of 693 ft msl to the minimum operating elevation of 675 ft msl is approximately 508 days (Table 2.3-38). At the conservation pool elevation of 693 ft above msl, Lake Granbury has a storage volume of 129,011 ac-ft. Based on published elevation storage relationships (TWDB 2005), the 171 ac-ft/day consumptive water use for CPNPP Units 3 and 4 would result in a negligible (less than 0.1 ft) decrease in water level elevation on Lake Granbury. These withdrawals would not reduce the depth of water for boat or fishing upstream of the dam. Although flows in the Brazos River downstream of Lake Granbury will be reduced with Units 3 and 4 water use, the withdrawal of water for use by CPNPP Units 3 and 4 should have minimal impact on boating and fishing downstream of the dam. Luminant is negotiating a contract with the BRA that provides for minimum flow conditions so that downstream water users should not be impacted. The 27,447 ac-ft/yr from Possum Kingdom Lake already under contract to Luminant is expected to be reallocated to CPNPP for normal use by CPNPP Units 3 and 4, while the remaining 76,270 ac-ft/yr needed for CPNPP Units 3 and 4 is being negotiated. Based on the results of the third party modeling performed to determine hydrological alterations resultant from CPNPP Units 3 and 4 water demands, potential impacts from consumptive water use are expected to be SMALL, except during extreme drought conditions when the impact is expected to be MODERATE. Lake water level and stream flow changes resultant from CPNPP Units 3 and 4 water demand are not expected to be destabilizing to important attributes of the river and reservoirs resources.

5.2.2.3 Potential Impacts on Water Use

The following subsections discuss impacts on water use from the operation of Units 3 and 4.

5.2.2.3.1 Downstream Water Availability Impacts

Current Surface Water Use

Information about existing water users, including locations of diversions and maximum use rate, is presented in Subsection 2.3.2. Table 2.3-35 provides information about water consumption for Hood and Somervell counties, and Table 2.3-36 provides information about surface water use for Lake Granbury including information about CPNPP Units 1 and 2, Wolf Hollow electric power plant, and DeCordova Bend electric power plant. Upstream users have minimal impact on the water availability for Units 3 and 4 or downstream water users. However, as mentioned in Subsection 5.2.2.2, the BRA maintains Lake Granbury's water level by releases from Possum Kingdom located upstream from CPNPP. As part of this process, hydrologic modeling has been conducted to demonstrate that CPNPP does not have an impact on downstream users including recreational, navigational, and water consumers. The consumptive use of water for CPNPP is described in Subsection 5.2.2.2. The minimum flow released voluntarily by the BRA is expected to be maintained (Subsection 5.2.1.2). The pending System Operations Permit (SOP) should address impacts to water availability for users downstream from the CPNPP intake structures on Lake Granbury. Therefore, the impacts are considered SMALL.

Groundwater is not planned for use for operation of Units 3 and 4. Past and current hydrogeologic information for the CPNPP site is presented in Subsection 2.3.1 and FSAR Subsection 2.4.12.

Future Surface Water Use

Future consumptive water use information was obtained from the 2006 Brazos Region G Water Plan, which forecasts water demands by category for the years 2010 to 2060 (Brazos G 2006). The water demand estimates compiled for each type of water use do not specify future ground or surface water demand. Estimated demand surpluses or shortages are based on projected surface and groundwater supplies. Projections for non-consumptive water uses, such as navigation, hydroelectric generation, environmental flows, and recreation are not presented. As shown in Table 2.3-43, total water use for the region is projected to increase from 835,691 ac-ft in 2010 to 1,150,973 ac-ft in 2060, a 38 percent increase. The projections indicate that municipal, manufacturing, and steam-electric water use as percentages of the total water use increase from 2000 to 2060, while mining, irrigation, and livestock water use are projected to decrease or remain constant as percentages of the total.

As shown in Table 2.3-44, water demands in Hood and Somervell counties are projected to increase from 44,939 ac-ft in 2010 to 62,600 ac-ft in 2060, a 39 percent increase (Brazos G 2006). It should be noted that the Somervell County steam-electric water user group demands identified in the 2006 Brazos Region G Water Plan do not account for CPNPP Units 3 and 4 water demands, subsequently the additional demands for CPNPP Units 3 and 4 are not included in the regional water demand projections provided in Table 2.3-43 nor the county water demands provided in Table 2.3-44. The revised projected regional and county water demands are to be included in the 2011 Brazos G Water Plan.

The 2006 Brazos Region G Water Plan identifies 10 water user groups within Hood County and seven water user groups within Somervell County (Brazos G 2006). Table 2.3-45 identifies each water user group and their corresponding water surplus or shortage in the years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed to mitigate the shortage. Projected shortages for the Somervell County steam-electric water user group were identified for the years 2030 and 2060 in a July 2008 amendment to the 2006 Brazos Region G Water Plan. The Somervell County steam-electric water user group obtains its water supply from SCR and from the BRA from Lake Granbury. The July 2008 amendment, which has been approved by the Brazos Region G Board and is awaiting approval by the TWDB, identifies the purchase of surface water from the BRA as a planning strategy to overcome the identified shortages and provide adequate net diversions to CPNPP Units 3 and 4. The additional supply is expected to be available upon the approval of the BRA System Operations Permit (SOP), which is currently being considered by the TCEQ. Extensive third party water availability modeling has been performed for the Brazos River drainage basin and the modeling supports the availability of sufficient unallocated water for CPNPP Units 3 and 4, without impacting other users.

Average annual surface water withdrawal (diversion) from Lake Granbury to SCR for CPNPP Units 1 and 2 operations is estimated at 34,128 ac-ft/yr from 1994 to 2006. Average forced evaporation from Units 1 and 2 operation is 17,391 ac-ft/yr, and average reservoir discharge flow through Squaw Creek Dam is 21,678 ac-ft/yr for the same time period (TCEQ 2006). Considering the average gain from Lake Granbury with the average losses from forced evaporation and releases to Squaw Creek, an average loss of 4941 ac-ft/yr from SCR is realized. As discussed in Subsection 2.3.2.2.4, water use records for 2006 indicate that more water was diverted from Lake Granbury than was lost through forced evaporation and spillage through the SCR dam spillway. This hypothetical water loss or gain is driven by the variability of environmental in-flows and natural evaporation, which are not accounted for in the water use reports submitted to the TCEQ. An existing agreement between Luminant and the BRA provides 48,300 ac-ft/yr of make-up water from Lake Granbury to SCR for Units 1 and 2 operation. Consequently, adequate water is available to compensate for possible net losses and adverse environmental variability.

Projected maximum water use estimates are outlined in the previously mentioned amendment to the 2006 Region G Water Plan. These water use estimates include a maximum annual water withdrawal from Lake Granbury of 103,717 ac-ft/yr for the operation of CPNPP Units 3 and 4, with a maximum return flow of 42,100 ac-ft/yr. Net consumptive water use for the operation of Units 3 and 4 is estimated at 61,617 ac-ft/yr; however, an in-line water treatment system for CPNPP Units 3 and 4 blowdown currently in the design phase would decrease the annual discharge into Lake Granbury. Additional information about this Blowdown Treatment Facility (BDTF) is provided in Subsection 3.6.1.4. Figure 2.3-30 provides a simplified water use diagram for CPNPP Units 1 and 2 and Units 3 and 4 showing all inputs and outputs of the system.

An existing agreement between Luminant and the BRA identifies 27,447 ac-ft/yr of water from Possum Kingdom Lake currently under contract to Luminant. This water is expected to be reallocated to CPNPP for normal use by CPNPP Units 3 and 4, while the remaining 76,270 ac-ft/yr needed for CPNPP Units 3 and 4 is pending approval. Any new contract with the BRA is expected to provide for minimum flow conditions so that downstream water users should not be impacted. The dependable yield of Lake Granbury has been evaluated as at least 64,712 ac-ft/yr, exclusive of the additional yield, which could be made available by releases from Possum Kingdom Lake (Brazos G 2006). Yield analysis for Possum Kingdom Lake indicates a firm yield of 230,750 ac-ft in 2000 and 2060 (Brazos G 2006). Additional information related to future water use in the Brazos River Basin is presented in Subsection 2.3.2.2.4.

As mentioned previously, Luminant plans to reallocate the 27,447 ac-ft/yr from Possum Kingdom Lake provided by current Luminant and BRA agreements in addition to the 76,270 ac-ft/yr that is being negotiated with the BRA for CPNPP Units 3 and 4. The impact to downstream future water availability is considered in determining the amount of water available for use by CPNPP Units 3 and 4, consequently the impact is SMALL.

5.2.3 WATER QUALITY IMPACTS

The following subsections describe potential water quality impacts from plant operations, receiving water bodies, and the types of water discharges. In addition, potential impacts to groundwater quality and regulatory compliance requirements are also discussed. Additional information related to surface and groundwater quality is presented in Subsection 2.3.3.

5.2.3.1 Thermal Impacts

Discharges from the additional units are permitted under the TCEQ TPDES program, which regulates the discharge of pollutants into the waters of the state. Under TPDES regulations, waste heat is regarded as thermal pollution and is regulated in the same way as chemical pollutants. A computer program, the Cornell Mixing Zone Expert System (CORMIX, Version 5.0), was used to simulate the thermal plume that is anticipated in Lake Granbury by the discharge of the cooling tower blowdown from CPNPP Units 3 and 4. The CORMIX is widely used (Jirka, Doneker, and Hinton 1996) and recognized as a state-of-the-art tool for discharge mixing-zone analyses (CORMIX 2008a). The model has been validated in numerous applications (CORMIX 2008b).

For the CORMIX model water temperature, data collected from 1997 to 2007 at the Brazos River were used to establish low, mean, and high ambient temperatures (Table 2.3-23). Long-term monthly release records at the De Cordova Bend Dam were obtained from the Brazos River Authority (Table 2.3-11).

While in the normal intake/discharge mode, the CWS is expected to operate at 2.4 cycles of concentration. Blowdown discharge flow rates and temperatures were provided as input to CORMIX for two and a half-cycle operation. As discussed in more detail below, results of these simulations predict a small thermal plume that dissipates quickly. As discussed under discharge design below, placing the discharge structure in Lake Granbury upstream of the dam should facilitate enhanced mixing. Impacts from Units 3 and 4 discharge temperature are SMALL and do not warrant mitigation. In addition, Luminant plans to comply with TCEQ effluent limits imposed in the plant's TPDES permit, further ensuring this impact is SMALL. Additional information from the simulation is provided in the discharge design discussion below and in Subsection 5.3.2.1.

5.2.3.2 Operational Limitations

The TCEQ regulations for issuing TPDES permits give the agency the authority to allow a mixing zone for surface waters. A mixing zone defines a limited area or volume of the receiving water where the initial dilution of a discharge is allowed to occur. In practice, discharge dilution may occur close to (e.g., near-field) or far from (e.g., far-field) the actual location of a hydrodynamic mixing process; therefore, the definition of a specific mixing zone depends on source, ambient conditions, and regulatory constraints (CORMIX 2008c). For lakes and reservoirs, a typical mixing zone radius does not exceed one-half the width of the receiving water at the discharge point.

5.2.3.3 Discharge Design

An analysis of discharge before the De Cordova Bend Dam was used in evaluating the thermal plume. The analysis was performed for conditions of (1) low reservoir temperature at minimum downstream flow, (2) mean reservoir temperature at minimum downstream flow, and (3) high reservoir temperature at minimum downstream flow. (Subsection 5.3.2.1).

The CWS and UHS cooling tower blowdown flow rate was assumed constant at approximately 58 cfs. This 58 cfs flow rate represents the total of maximum blowdown, plus other miscellaneous effluents, from CPNPP Units 3 and 4. A plume model was developed for each case to determine the plume characteristics for the low reservoir flow and the high, median, and low reservoir temperatures.

The discharge design was modeled as two 74-ft long multiport diffusers with 17 openings each (Subsection 5.3.2.1). To preclude bottom-scour problems, the discharge ports for these oblique diffusers are positioned to discharge at an angle of 30 degrees from the vertical. Additional information about the oblique diffuser is presented in Subsection 3.4.2.2.

CORMIX Modeling

The CORMIX results show the 3°F isotherm of the thermal plume, under minimum lake flows, is less than 300 ft. The plume is small for all water temperatures under bounding lake-flow and discharge characteristics. The impact of the thermal discharge is anticipated to be SMALL.

TCEQ mixing-zone regulations limit the temperature increase at the edge of the near-field region of the thermal plume to less than 3°F greater than the ambient water temperature. The near-field region is a term used by CORMIX for describing the zone of strong initial mixing where the near-field processes occur. It is the region of the receiving water where outfall design conditions are most likely to have an impact on in-stream concentrations (CORMIX 2008c). In addition, the TCEQ lists 93ºF as a water quality criteria for Lake Granbury (TCEQ 2008). The CORMIX results for the low, mean, and high surface water temperatures show the temperature of the thermal plume at the edge of the near-field region to be slightly above the ambient water temperature. The mixing-zone regulations are easily met for water temperatures with the worst-case water-flow and discharge characteristics. Temperature of the discharge from Units 3 and 4 is considered to be of SMALL impact. In addition, placing the multiport diffuser upstream of the dam should facilitate mixing. Directional flow of reservoir water toward the dam would pull the plume toward the dam where it can mix with ambient water from the lake. The use of the CORMIX data provides a good assumption that the proposed multi-port diffuser located upstream of the dam would adequately meet the needs for the Units 3 and 4 outfall, and the temperature increase at this outfall would be SMALL and would not warrant mitigation. See Subsection 5.3.2 for further details regarding the thermal plume's mixing zone. Additional details related to the plant discharge system are presented in Subsection 3.4.2.2.

Discharge Mixing Zone

As described previously, the mixing zone is conservatively defined in terms of the 3°F maximum temperature increase above ambient and the 93°F maximum water temperature. For modeling, the reservoir centerline temperature increase resulting from the discharge was added in each case to the ambient water temperature prior to simulating the discharge effects. The mixing-zone temperature excess for the discharge was then re-defined by decreasing the maximum allowable 3°F difference by the water temperature increase due to the discharge component; the discharge 93°F isotherm (only applicable for the max-T case) was defined based on the discharge-blowdown temperature and the ambient temperature incremented as described.

The two and a half-cycle (i.e., cycles of concentration) low-reservoir-temperature modeling scenario results in the largest mixing zone. Even for this case, the mixing zone is demonstrably small. Allowing for a maximum cross-stream diffuser extent of approximately 74 ft, less than four percent of the lake width is impacted by the mixing zone and discharge structure. See Subsection 5.3.2 for further details regarding the thermal plume's mixing zone.

5.2.3.4 Wastewater Discharge

Cooling Tower Blowdown

Maximum blowdown from the cooling towers is discharged into Lake Granbury at a rate of approximately 26,076 gpm for the site total (Table 3.4-2) (Subsection 3.4.2.2).

Details related to water quality of Lake Granbury are presented in Subsection 2.3.3. Three conditions were evaluated for concentration levels: at 2.4 cycles of concentration, diluted effluent at low flow, and diluted effluent at annual mean flow. Within each of these three conditions there are two evaluations: mean and maximum. Most of the mean and maximum trace metals concentrations are below the TCEQ Criteria for Specific Metals in Water for Protection of Aquatic Life.

The copper concentration is expected to be below the screening criteria for the mean concentration of 2.4 cycles of concentration and below the criteria for mean concentration when diluted at low flow. In addition, copper concentration is expected to be below the screening criteria for both maximum and mean concentrations at the annual mean flow. However, copper has the potential to exceed the TCEQ Criteria for Specific Metals in Water for the Protection of Aquatic Life as a result of the 2.4 cycle cooling tower operation for the maximum concentration. In addition, copper could exceed the screening level for maximum concentrations when mixed with Lake Granbury at low flow (based upon a very conservative projection.) The occurrences during which the screening level for copper may be exceeded are expected to be infrequent and brief and have no lasting effect.

Selenium was not detected above the detection limit for the TCEQ Criteria for Specific Metals in Water for Protection of Aquatic Life (0.005 mg/L). When half the detection limit was used to estimate concentrations that would result from CPNPP Units 3 and 4 2.4-cycle cooling tower operation, selenium was estimated to exceed the TCEQ Criteria for Specific Metals in Water for Protection of Aquatic Life and also for both the mean and maximum concentrations when mixed with Lake Granbury at low flow. However, selenium is expected to be reduced to concentrations less than the TCEQ standards for Specific Metals in Water for Protection of Aquatic Life at the edge of the mixing zone in Lake Granbury during the annual mean flow for both mean and maximum concentrations.

When the BDTF is operational, the blended discharge concentrations were assessed by factoring in the R/O treatment process (Subsection 3.6.1.4) and it was found that the analyte concentrations in the blended discharge will be less than the analyte concentrations in the untreated discharge.

As mentioned in Subsection 2.3.3.1.9, Lake Granbury, the cooling water system (CWS) supply and blowdown discharge reservoir for CPNPP Units 3 and 4 was identified as a candidate on the Draft 2008 303(d) List as being impaired by naturally occurring chloride concentrations (TCEQ 2008). Prior to this, concerns for screening levels were listed on Lake Granbury for naturally occurring chloride, sulfate, and TDS concentrations (BRA 2007). Chlorides are not estimated to exceed the Texas Surface Water Quality Standards (TSWQS) for Lake Granbury as a result of the 2.4-cycle cooling tower operation for the mean concentration but are estimated to exceed the TSWQS for the maximum concentration, and the maximum concentrations when diluted by Lake Granbury at low flow. However, chlorides are expected to be reduced to concentrations less than the TSWQS when mixed with Lake Granbury during the annual mean flow for both mean and maximum concentrations. TDS is estimated to exceed the TSWQS for Lake Granbury for maximum concentrations as a result of the 2.4-cycle cooling tower operation and when mixed with Lake Granbury at low flow for both mean and maximum concentrations and maximum concentration at annual mean flow. Sulfates are only estimated to exceed the TSWQS for Lake Granbury at maximum concentration when diluted by Lake Granbury at low flow. Based on these estimations of projected chemical concentrations in cooling tower blowdown, a BDTF is in the design phase so that water quality standards and TPDES permit limits can be met.

Because cooling towers concentrate solids (minerals and salts) and organics that enter the system in makeup water, cooling tower water chemistry must be maintained within a specific pH range to minimize scaling. Similarly, an oxidizing biocide is added to the cooling water systems to prevent the growth of fouling bacteria and algae. Water treatment chemicals that are planned for use with Units 3 and 4 are divided into six categories based upon function:

- Biocide
- Algaecide
- pH adjuster
- Corrosion inhibitor
- Scale inhibitor
- Silt dispersant

Water treatment for the CWS and ESWS is provided by the turbine island chemical feed system. The pH adjuster, corrosion inhibitor, scale inhibitor, and dispersant are metered into the system continuously or as required to maintain proper concentrations. The biocide application frequency may vary with seasons. The algaecide is applied, as necessary, to control algae formation in the cooling tower. Additional information is provided in Subsections 3.3.2.1 and 3.6.1.

The water treatment chemicals are designed to be consumed by the system, with residual concentrations remaining in the effluent at trace to non-detectable levels. Once the discharge is treated and mixed back into Lake Granbury, the constituents are diluted by the volume of water present in the lake at the time of discharge. Based on the minimal concentration of cooling tower chemicals in the discharge, impact to water quality is anticipated to be SMALL.

The blowdown temperature is related to the ambient air wet bulb temperature. The average blowdown temperature is 91°F, and the expected maximum blowdown temperature is 93°F. The details of the potential impacts of this thermal release to Lake Granbury are discussed in Subsection 5.2.3.1. However, the slight increase in water temperature of Lake Granbury associated with this discharge would not impact any current or future water users downstream as the mixed reservoir temperature is almost negligible.

Discharges to Lake Granbury

Current design plans for Units 3 and 4 show the nonradioactive CWS and ESWS blowdown discharging to Lake Granbury. Additional mixing with receiving water is facilitated by placing the discharge structure in Lake Granbury before the De Cordova Bend Dam, coupled with the use of a multi-port diffuser. The constant flow of water toward the De Cordova Bend Dam would pull the effluent plume toward the dam and into the Brazos River. Directing the water through the dam is assumed to cause complete mixing of the effluent plume with raw water, resulting in fullyhomogenous water. Based upon treatment of the CPNPP discharge and the homogeneous mixing at the discharge point, impacts of residual chemicals on water quality are expected to be SMALL and do not warrant mitigation.

Discharges to Squaw Creek Reservoir

Wastewater generated from the floor and equipment drains, and nonradioactive laboratory wastewater, would be processed through a wastewater treatment system then discharged to SCR. Chemicals used in plant water treatment systems are discussed in Subsection 3.6.1. Plant discharges containing concentrations of these chemicals are treated in the wastewater treatment system. Materials used in the wastewater treatment system are compatible with the cooling water chemistry, and the chemicals used to control long-term corrosion and organic fouling. Treatment of the discharge is expected to reduce concentrations to levels that are within TPDES discharge limits and are environmentally acceptable. Sanitary wastes would be treated separately through a new or existing sewage treatment system and discharged to SCR. Stormwater is routed to holding ponds and then discharged to SCR. Additional wastewater discharge details are provided in Section 3.6. Because processed wastewater would be treated prior to discharge into SCR as needed to comply with TPDES wastewater discharge requirements, the impacts of residual chemicals on water quality are expected to be SMALL and do not warrant mitigation.

Low Level Radioactive Process Water Discharges

For Units 3 and 4, a liquid waste management system (LWMS) is designed to safely monitor, control, collect, process, handle, store, and dispose of liquid radioactive waste generated as a result of normal operation, including anticipated operational occurrences (AOOs). The AOOs are events in which the reactor plant conditions are disturbed beyond the normal operating range and are expected to occur one or more times during the lifetime of the plant. The LWMS is broadly classified into the liquid waste processing system (LWPS) and the reactor coolant drain system (RCDS). Additional information on the LWMS system is presented in Subsection 3.5.1.

Low-level radioactive wastewater meeting applicable discharge limits is expected to be discharged to SCR, with a possible diversion to a new evaporation pond. During normal operations, the release of liquid radioactive effluents to the environment would be such that the doses to individuals off-site are maintained within the limits of 10 CFR Part 20 and 10 CFR Part 50, Appendix I for pertinent thresholds. Information related to the process and discharge of low-level radioactive wastewater is presented in Subsection 3.5.1.

The LWMS and LWPS process and control the release of liquid radioactive effluents. Impacts from radioactive discharges are considered SMALL.

5.2.3.5 Impacts to Groundwater

The present use and future uses of groundwater are further discussed in Subsection 2.3.2.4. As discussed in Subsection 2.3.1.5.5, groundwater contours illustrate that shallow groundwater on the CPNPP Unit 3 and 4 site flows toward SCR and the SSI. Consequently, any plant impacts to groundwater are not anticipated to impact off-site groundwater.

There are two sources for radiological impacts to groundwater: (1) leaks from radioactive waste tanks, ponds, and piping, and (2) leaks from the spent fuel pit. To minimize the potential for contact of radioactive material with groundwater, the cells/cubicles housing tanks that contain significant quantities of radioactive material are coated with an epoxy coating to a height that is sufficient to hold the tank contents in the event of tank failure. The epoxy coating acts as a barrier to minimize the contamination of the groundwater system, and to minimize decontamination in the event of an overflow or break. Overflow from tanks or standpipe is directed to a near-by sump. The sump has liquid level detection. At high liquid levels, the level switch automatically activates the sump pump to forward the liquid to the waste holding tank for processing. This design minimizes the potential for contamination of the facility and the environment, facilitates decommissioning, and minimizes the generation of radioactive waste. In addition, radiological groundwater sampling is currently conducted at CPNPP as part of the monitoring program for CPNPP Units 1 and 2. The radiological analyses of groundwater samples include tritium and radioactive gamma spectroscopy. Ponds are lined with clay and polyethylene liners to prevent leaching.

Non-radioactive contamination of groundwater may result from leaks of petroleum storage tanks or spills. Luminant is expected to develop, implement, and maintain an SWP3 and a Spill Prevention Control and Countermeasures Control (SPCC) plan for Units 3 and 4 that address (1) spill management and control for operations, (2) storage and management of chemicals, and (3) oil storage and management. Based upon the implementation of best management practices and low permeability soils, impact from Units 3 and 4 operations on groundwater are considered SMALL.

5.2.3.6 Regulatory Compliance

The TCEQ requires industrial facilities that discharge into waters of the United States to obtain a valid TPDES permit for wastewater discharges and secure coverage under a valid TPDES general permit for stormwater. The TPDES permit for CPNPP Units 1 and 2 is expected to be amended to include discharge from Units 3 and 4 to Lake Granbury and SCR. The TPDES permit specifies maximum discharge limits. In addition, federal/state regulations require the development of SPCC and SWP3 plans.

As mentioned in Subsection 5.2.1.8, there are no Native American lands within 50 mi of the CPNPP site based upon a review of the National Atlas.

5.2.4 REFERENCES

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5.3 COOLING SYSTEM IMPACTS

The proposed project, CPNPP Units 3 and 4, is designed with three cooling systems that transfer heat to the environment during normal modes of plant operation. These systems are the essential service water cooling system (ESW), the non-essential service water system (NESW), and the circulating water system (CWS) (Section 3.4). Subsection 5.3.1 presents the impacts of the intake system, including impacts on physical and biological systems in Lake Granbury. Subsection 5.3.2 presents impacts of the discharge system, including physical impacts as well as those impacts affecting aquatic ecosystems. Subsection 5.3.3 presents the aesthetic and physical impacts of the heat-discharge system during station operation on the atmosphere and terrestrial ecosystems. Subsection 5.3.4 describes the potential health impacts of members of the public.

5.3.1 INTAKE SYSTEM

This subsection describes the impact of the intake system on the aquatic ecology and the physical impacts such as scouring, silt build up and shoreline erosion caused by the flow field induced by the intake system during station operation. Impacts associated with operation of the intake system on the environment are considered SMALL.

The CWS, ESW, and NESW systems are supplied with water from the raw water system (RWS) intake to the cooling towers in order to makeup for cooling tower losses due to evaporation, drift and blowdown, as well as provide intake screen washing flow and strainer backwash flow. Subsection 5.3.1.1 examines site hydrodynamic alterations as a result of operating a functional nuclear power plant. Subsection 5.3.1.2 explores possible impacts to aquatic life that could be affected by subsequent habitat modification. Specifications for intake structure and surrounding environment can be found in Subsection 3.4.2.1.

5.3.1.1 Hydrodynamic Description and Physical Impacts

This subsection describes the intake hydrodynamics and predicted spatial and temporal alterations in the ambient flow field and physical hydrological effects (e.g., bottom scouring, induced turbidity, silt buildup) induced by the reservoir intake system operation. In addition, design considerations and descriptions of practices or procedures to mitigate or minimize predicted adverse impacts are identified and evaluated.

5.3.1.1.1 Intake-Hydrodynamic Description

The proposed reservoir intake structure is located 7.13 mi northeast of the site on Lake Granbury. The intake structure is expected to be located on the southwest bank of Lake Granbury, adjacent to the current makeup water intake for SCR, and approximately 1.3 mi upstream from the De Cordova Bend Dam. Outlet works at De Cordova Bend Dam consist of two motor-controlled sluice gates with invert elevations at 652.0 ft and 640.0 ft msl (TWDB 2005). At conservation pool elevation of 693.0 ft, water depth in the intake area is approximately 50 ft. During reservoir inflow conditions of approximately 60 cfs and outflow of approximately 28 cfs, there is no measurable flow or current in Lake Granbury. Movement of water in the lake is dictated more by the wind. The Brazos River Authority (BRA) voluntarily makes a minimum flow release of 28 cfs under normal operating conditions. When the reservoir is full, the BRA passes inflow as it comes into the lake by adjusting gate openings as frequently as every couple of hours. The BRA calculates inflow to the lake based on change in reservoir elevation (storage) over a given period of time. In cases where there is no local runoff, releases would be similar to the U.S. Geological Survey (USGS) Brazos River Dennis gauging station hydrograph, with some lag (Figure 2.3-8). The BRA does not always base release decisions on the Dennis gauge. There can also be significant inflow to Lake Granbury from rainfall downstream of the Dennis gauge; in which cases, releases can be significantly higher than the Dennis gauge readings. During periods of increased inflow and discharge through the dam, water is passed through the reservoir resulting in a southeasterly flow in the vicinity of the intake structure, and the intake water flow direction is perpendicular to the flow direction of the reservoir.

The intake, which would be constructed on an off-bank platform approximately 90 ft from the bank of the reservoir, would draw approximately 65,400 gpm for two unit operation. Withdrawal would be through an intake that has a low through screen velocity, less than 0.5 fps through the screens on the intake structure. Because there is no regular flow pattern within Lake Granbury, the off-bank platform location combined with the low intake velocity is unlikely to lead to scouring of the lake bottom or alterations in the general flow regime of the reservoir. During normal conditions, water would be pumped from Lake Granbury and transported to the CWS via an underground pipeline. None of this water would be used as potable water supply for the station.

The reservoir intake structure with respect to water surface and cross section of the intake system is illustrated in Figure 3.4-2 and discussed in Subsection 3.4.2.1. Lake Granbury in the vicinity of the proposed project cooling water system intake-and-discharge structures includes approximately 507 ac. The proposed project discharge structure is anticipated to be located approximately 1.14 mi downstream from the intake structure.

During the bathymetric survey of Lake Granbury, reservoir bottom elevations were surveyed from one bank to the other from well upstream of the proposed project intake structure location to the floating dam safety barriers downstream of the proposed discharge location (Figure 2.3-13). The former main channel of the Brazos River as well as several well-developed river terraces along the point bar comprising the northern shore of this area of the lake are visible on the final bathymetric map of lower Lake Granbury. A bathymetric anomaly near the De Cordova Bend Dam (southeastern edge of mapped area) abruptly truncates the main Brazos River channel. This bathymetric anomaly appears to be a man-made structure of unknown history or origin. It is known that there was an extensive attempt to establish a lock and dam system along the Brazos River during the early 20th Century for the purpose of promoting river commerce (Boss 2007). It is not known if one of these sites existed within the mapped area. Alternatively, the bathymetric anomaly could represent remains of a temporary coffer dam that may have diverted the Brazos River during construction of the De Cordova Bend Dam during the 1960s.

As discussed in Section 3.4, intake water taken from Lake Granbury passes through passive submerged screens designed to minimize uptake of aquatic biota and debris. The screens are composed of three-eighths-mm mesh and are sized for a maximum through-screen velocity of less than 0.5 fps.

During normal conditions, water is pumped from Lake Granbury via pipeline into the CWS. The net water withdrawal rate from Lake Granbury for two units and associated with plant water systems is approximately 65,400 gpm during maximum operations (Figure 3.3-1).

The EPA has promulgated regulations that implement Section 316(b) of the Federal Water Pollution Control Act, also known as the Clean Water Act (CWA) for new and existing electric power producing facilities. For lakes and reservoirs, these regulations include the requirement that intake flow may not disrupt natural thermal stratification or turnover patterns (where present) of the source water except in cases where the disruption is determined to be beneficial to the management of fisheries for fish and shellfish by any fishery management agency. Section 125.83 of the CWA defines a lake or reservoir as any inland body of open water with some minimum surface area free of rooted vegetation and with an average hydraulic retention time of more than seven days. Lakes or reservoirs might be natural water bodies or impounded streams, usually fresh, surrounded by land or by land and a man-made retainer (e.g., a dam). Lakes or reservoirs might be fed by rivers, streams, springs, or local precipitation. By EPA definition, Lake Granbury is classified as a lake or reservoir because retention time has been estimated at 260 days (TPWD 2005) by the Texas Parks and Wildlife Department (TPWD).

A study performed in the vicinity of the cooling water intake and discharge structures for Units 3 and 4 indicated that Lake Granbury is thermally stratified during the summer and early fall months, and unstratified during the late fall and winter. During the spring and for certain periods during the winter, the lake is weakly stratified, with the weak stratification during the winter resulting from extended warm periods (WRE 1973). Field temperature measurements were collected at sample locations (Figure 2.3-20) in the main channel of the Brazos River on the lower portion of Lake Granbury during surface water sampling events in April, July, and October 2007, and January 2008. As shown on Table 2.3-26, water temperature differences between the surface and bottom measurements varied approximately 5°F in April, approximately 3°F in July, less than 1°F in October, and approximately 1°F in January. As shown on Table 2.3-22, temperature measurements collected in May 2007 (Figure 2.3-12) during the bathymetric survey of Lake Granbury indicated an approximate 8°F difference in water temperature between surface and bottom measurements. Based on the low intake velocity and localized area of influence at the intake structure, intake flow is not expected to disrupt natural thermal stratification or turnover patterns on Lake Granbury.

The intake structure design is planned to allow for a maximum through-screen velocity of less than 0.5 fps as required by 40 CFR 125.84 to limit organism mortality from impingement and entrainment. Detailed system description, and operation modes for the intake system are described in Section 3.4. The above evaluation indicates that the design of the proposed project intake cooling water system has the following features:

- The intake water flow direction is perpendicular to the flow direction of Lake Granbury.
- The average and maximum withdrawal of the intake cooling water does not affect thermal stratification within the reservoir.
- There are extremely low current approach velocities to the intake structure.

Based on the above assessment, the induced flow fields result in SMALL impacts on aquatic biota.

5.3.1.1.2 Physical Impacts of Intake

To minimize erosion and protect the integrity of the intake structure, it is anticipated that the intake structure design would provide for stabilization of the banks near the intake structure. Because the proposed project's intake structure would be located immediately adjacent to the existing intake structure (water supply to maintain the pool elevation of SCR, local flow patterns in the vicinity of the intake structure would be preserved to the maximum extent and the operation of the intake system is not expected to cause any significant changes in shoreline erosion, bottom scouring, induced turbidity, or silt buildup. Local flow patterns in the vicinity of the intake structure are also expected to prevent significant aggradation of sediment near the intake structure because maintenance de-silting has not been required for the existing intake for water supply to SCR for CPNPP Units 1 and 2 operations. Based on the above, physical impacts near the intake structure are SMALL.

No published information pertaining to sediment transport or erosional characteristics of lower Lake Granbury was identified during this study. The results of the 2003 TWDB Volumetric Survey indicate Lake Granbury has a volume of 129,011 ac-ft, and extends across 7945 surface ac at the conservation pool elevation of 693 ft msl. The revised TWDB 1994 survey report (1993 field survey) found 7949 surface ac and a total volume of 131,593 ac-ft. Comparison of the 1993 survey to the current 2003 survey of Lake Granbury shows little or no change in surface area and a two percent reduction in total volume at the top of the conservation pool. Most of this reduction appears to be in the area of continued deltaic accretion in the upper reaches of Lake Granbury where the Brazos River enters the main body of the reservoir. (TWDB 2005).

The BRA collected a total of 176 water samples from 2001 to 2006 at three locations in the main body of Lake Granbury to estimate the suspended sediment load. The mean total suspended sediment (TSS) concentration was 24 milligrams per liter (mg/l), with a range of results from 2 to 164 mg/l at the north end of the lake; 24 mg/l, with a range of results from 2 to 255 mg/l near the center of the lake; and 11.21 mg/l, with a range of results from 2 to 120 mg/l near De Cordova Bend Dam at the south end of the lake. The BRA sample locations are shown on Figure 2.3-10 and TSS concentrations are provided in Table 2.3-25.

Analytical results from five surface (0.3 ft) sample locations collected quarterly in 2007 – 2008 (Subsection 2.3.3.1.2) on the lower portion of Lake Granbury near De Cordova Bend Dam are similar to the BRA results in the same area, with an average TSS concentration of 10.6 mg/l. TSS concentrations in the surface sample locations ranged from 5.3 to 26.0 mg/l, with a standard deviation of 6.3 mg/l. Analytical results from four deep (10.0 – 55.0 ft) sample locations collected during the same time frame indicated an average TSS concentration of 109.8 mg/l. TSS concentrations in the deep water samples ranged from 5.0 to 672.0 mg/l, with a standard deviation of 217.8 mg/l. Elevated TSS concentrations from the deep sample locations were attributed to bottom interference with the sampling equipment and/or increased flow within the reservoir from rainfall in the area. The surface water sample locations are shown on Figure 2.3-20 and TSS concentrations are provided in Table 2.3-26.

Bathymetric survey and water quality sample analyses indicate the highest sediment accretion in the upper reaches of Lake Granbury, with declining TSS concentrations downstream in the vicinity of the intake structure. Based on the available data and the low intake velocity, any bedload carried within the reservoir would be unchanged by the operation of the intake.

5.3.1.2 Aquatic Ecosystems

In considering the effects of the intake structure for closed-loop cooling systems on aquatic ecology, the NRC evaluates (1) impingement or trapping of fish and shellfish on the intake structure screens, (2) entrainment, or drawing into the cooling water stream, of fish (eggs and larvae) and veligers (mollusk larvae), and (3) entrainment of phytoplankton and zooplankton. Studies of intake effects of closed-loop cooling systems have generally judged these impacts to be not significant because a closed-loop, re-circulating cooling system has significantly lower water intake than a once-through cooling system.

5.3.1.2.1 Fish Impingement and Entrainment

Utilizing closed-loop technology and cooling towers rather than a once through system reduces entrainment and impingement losses of fish primarily because of the relatively small volumes of makeup water needed for the evaporative loss of water from the cooling towers (CEC 2002). However, even low rates of entrainment and impingement may be of concern when an unusually important resource is affected. Important aquatic resources include threatened, endangered and other species of special interest, and critical habitat for these and other species. Table 2.4-14 lists fishes identified seasonally in Lake Granbury that are common to the region and sparse in the lower portion of the lake (Subsection 2.4.2).

Based on reviews of literature and operational monitoring reports, Subsection 5.3.1.1.1 concludes that water intake is expected to have little physical impact to the reservoir. Seasonal temperature stratification is not expected to be influenced except for a localized area immediately adjacent to the intake structure. Because the intake is expected to have little effect on the aquatic environment of Lake Granbury, the proposed project is expected to have minimal impact on the resident population of fish. Subsection 3.4.2 indicates through-screen water velocity during operational mode is below the 0.5 fps flow requirements of the CWA Section 316(b). Impingement of organisms on the intake screens is not likely to be a problem due to minimal water use and low intake velocities.

The intake structure is located on the southeastern bank of the lower section of Lake Granbury (Figure 2.3-13). Banks in this area tend to be steep, and rocky and littoral areas minimal. Aquatic surveys revealed few individuals of common fish and invertebrate species (Subsection 2.4.2). Pelagic habitat in the lower portion of Lake Granbury is not conducive to developing a diverse aquatic community. Water depth at the intake, as reported in Subsection 5.3.1.1.1, is estimated to be 50 feet at the conservation pool, depth of 693 feet. Subsection 3.4.2.1 describes the location and surroundings of the intake structure. With the sole exception of the existing intake structure, there is no cover for fish in that area and the only fish expected to be found in that pelagic zone are transient. Gill net studies from 2007 and 2008 in that area revealed a very low density of game fish. The habitat is not degraded by operational water intake.

5.3.1.2.2 Important Species

One state listed protected aquatic species, one federally listed candidate, and one state listed species of concern identified by agency contacts are of concern in Somervell County (Table 2.4-10). Pistol grip mussels (state listed species of concern) and sharpnose shiners (federally listed candidate species) are listed but not expected to reside in Lake Granbury. Neither species are associated with lentic habitat.

Brazos water snakes (state listed threatened) are associated with rocky shorelines and shallow water (Subsection 2.4.2). The lower portion of Lake Granbury near the intake structure is over one m deep and not considered ideal habitat for Brazos water snakes. Because listed aquatic species are not anticipated in proximity of the intake structure, impacts from the intake system to listed species are expected to be SMALL.

Historically, Lake Granbury supported a thriving bass fishery. Sport fish such as largemouth bass, striped bass, and channel catfish found in Lake Granbury are common to most stocked lakes in Texas. However, the fishery has been subject to golden algae blooms in recent years. Measures to mitigate the losses include stocking the lake with striped and largemouth bass. Although fish numbers are increasing, as of 2005, densities had not reached those recorded prior to golden algae infestation (Subsection 2.4.2). Studies performed in 2007 and 2008 using gill nets in the vicinity of the intake, revealed a very low density of game fish in the area.

A 1978 larval fish study was performed in Lake Granbury near the intake structure to determine impacts associated with the makeup water carried to the existing units. The study was designed to encompass the peak period of larval abundance in the reservoir. Nine genera of larval fish common to *lentic* habitat were identified; however, *Dorsoma spp* were found to be most abundant comprising 85 percent of total fish collected. *Menidia audens*, *pomoxis spp*. and *Aplodinotus grunniens* were also identified in most samples. The study concluded that the intake structure, as located, is not in an area which provides unique spawning and nursery habitat for fishes in Lake Granbury.

The 1978 larval fish study did not result in the collection of any species of special interest. Larval fish species represented in the 1978 survey were also represented in recent (2007 – 2008) gill net captures of older fish. Although ichthyoplankton was not evaluated, it is reasonable to assume ichthyoplankton assemblages would mimic adult assemblages.

Entrained ichthyoplankton are fish eggs and larvae that are small enough to be carried through the initial screens with cooling water. Entrainment of organisms carries a 100 percent mortality rate. Egg characteristics of many fish species are such that they would not be entrained. Some *Catostomidae* species lay heavy eggs in open water, which sink to the bottom leaving them less vulnerable to current patterns (Kraft, Carlson, and Carlson 2006). Species from families *Catostomidae*, *a*nd *Percidae* lay eggs with adhesive properties that stick to substrate such as logs or emergent vegetation and are not susceptible to directional flow (Kraft, Carlson, and Carlson 2006). Some species of families *Centrarchidae*, *Ictaluridae*, and *Cyprinidae* display parental care by laying eggs in nests in backwater areas and guarding them until they hatch (Kraft, Carlson, and Carlson 2006).

In an aquatic community setting, natural egg mortality estimates are between 50 percent and 99 percent predominately due to predation (WDFW 1997). Because 50 – 99 percent mortality is expected, small percentages of egg mortality caused by entrainment can be considered compensatory (FLMNH 2005).

5.3.2 DISCHARGE SYSTEM

This subsection describes the impact of the discharge system on the aquatic ecology and the physical impacts such as scouring, silt build up, and shore line erosion caused by the flow field induced by the discharge system during station operation.

Heat generated during each operational mode is released to the atmosphere and to Lake Granbury from the CWS, ESW, and NESW (Section 3.4).

Subsection 5.3.2.1 describes the physical impacts associated with thermal discharges to Lake Granbury. Subsection 5.3.2.2 describes the impacts of the thermal discharges on the aquatic ecosystems. Overall, as discussed in the following subsections, the impacts associated with the operation of the discharge system are SMALL.

5.3.2.1 Thermal Description and Physical Impacts

Effluent discharged from the new facility is treated by an in line system to lower TDS (Subsection 3.6.1.1) before being installed directly into the lower portion of Lake Granbury (Figure 2.1-1). A complete description of Lake Granbury including elevation and capacity curves is provided in Subsection 2.3.1. On-site meteorological information is described in Section 2.7 and Section 6.4. The station discharge has been analyzed using CORMIX, version 5.0 as discussed in the next paragraphs.

The mathematical modeling tool, Cornell Mixing Zone Expert System (CORMIX) (Jirka, Doneker, Hinton 1996) is a computer code for the analysis, prediction, and design of aqueous toxic or conventional pollutant discharges into diverse water bodies. The CORMIX is an EPA recommended analysis tool for the permitting of industrial, municipal, thermal, and other point source discharges to receiving waters. The CORMIX2 system, which is used for prediction of subsurface multi-port discharges, was used exclusively for this analysis.

The subprogram CORMIX2, within CORMIX, analyzes unidirectional, staged, and alternation designs of multi-port diffusers and allows for arbitrary alignment of the diffuser structure within the ambient water body, and for arbitrary arrangement and orientation of the individual ports. For complex hydrodynamic cases, CORMIX2 uses the “equivalent slot diffuser” concept and thus neglects the details of the individual jets issuing from each diffuser port and their merging process, but rather assumes that the flow arises from a long slot discharge with equivalent dynamic characteristics.

Dilution and distribution of the discharge heat as well as other effluent constituents are affected by both the design of the discharge structure and the flow characteristics of the receiving water. Table 2.3-39 denotes projected average discharge parameters and maximum expected discharge rates for the proposed project. CPNPP Units 3 and 4 would use a blowdown discharge, which consists of a submerged multiport diffuser that discharges into Lake Granbury, as shown in Figure 5.3-1. The diffuser system is composed of two diffuser sections each with a length of 74 ft. Both diffusers are expected to lay on Lake Granbury sediments, which are characterized with regard to erosion characteristics and transport in Subsection 2.3.1.2.4. Bathymetry of the area is found in Subsection 5.3.1.1.

Historical temperature data collected for Lake Granbury from 1998 through 2007 are provided in Table 2.3-23 and include maximum, average-maximum, average, average-minimum, and minimum monthly temperatures. An analysis of thermal plumes resulting from plant effluent discharges (Table 5.3-1) was done for conditions of low lake temperature, mean water temperature, and high reservoir temperature (Figures 5.3-2, 5.3-3, and 5.3-4). The effluent flow rate was assumed constant at approximately 58 cfs and was used for the CORMIX2. This flow represents the total of maximum expected blowdown, plus other miscellaneous effluents, from CPNPP Units 3 and 4. For the low flow, and the high, median, and low reservoir temperatures, a plume model was developed for each case to determine the plume characteristics.

Summaries of the predicted plume analysis data are provided in Table 5.3-2. Maximum delta-T conditions occur at the lowest reservoir temperature at which the surface area within a 3°F temperature isotherm is estimated to be 1562 ft^2. These isotherms extend approximately 682 ft in length from the discharge diffuser. The maximum width of the 3°F isotherm is about 358 ft. The plume width is approximately 19 percent of the reservoir width, which is approximately 1950 ft at normal reservoir pool condition. Because the plume does not cross the entire reservoir, analysis of a thermal barrier is precluded.

Under low temperature operating conditions, the greatest temperature difference (delta-T) of 44.4°F exists between the reservoir water at 48.6°F and the effluent discharge, which is conservatively assumed to be at a temperature of 93°F for this analysis. Actual mixed effluent discharge temperatures would be lower than 93°F.

The predicted thermal plume resulting from the proposed discharge system was modeled for the combined discharge using the CORMIX2. Thermal predictions for the low temperature conditions assumed plant discharge conditions as above, and an ambient reservoir flow velocity of 27.8 ft^3/s. Results of this model indicate a thermal plume that dissipates quickly. The plumes have no attachment or interface with reservoir banks and do not adversely affect water temperature. Dimensions of the predicted plumes are provided in Table 5.3-2.

5.3.2.2 Aquatic Ecosystems

Potential effects of discharging heated water are minimized by using a closed-loop cooling system and cooling towers (CEC 2002). The cooling towers dissipate approximately 99 percent of the waste heat to the atmosphere while a once through cooling system would dissipate 99 percent of the waste heat to the reservoir. The majority of waste heat associated with CPNPP Units 3 and 4 would be discharged to the atmosphere through evaporation, and only about one percent goes to Lake Granbury from blowdown flows. In using a closed-loop evaporation system, cooling towers build up mineral concentrations in the circulating water. Through blowdown and makeup, total dissolved solids and surface water contaminants are kept within design parameters and state discharge standards. Limited thermal effects are associated with the discharge of heated blowdown water to the discharge waters; therefore impacts to local aquatic organisms are SMALL.

In Subsection 4.2.1 of NUREG-1437, the NRC evaluated the potential impacts of discharging heated water associated with nuclear power plants to an aquatic system including (1) thermal discharge effects, (2) cold shock, (3) effects on movement and distribution of aquatic biota, (4) premature emergence of aquatic insects, (5) stimulation of nuisance organisms, (6) losses from predation, (7) parasitism and disease, (8) gas supersaturation of low dissolved oxygen in the discharge, and (9) accumulation of contaminants in sediments or biota. In general, for plants employing cooling tower systems, the impacts were found to be minor.

The average of the reported mean monthly discharges at De Cordova Bend Dam is 1031 cfs (Subsection 2.3.1.2.2), and a normal discharge of 55.43 cfs is anticipated during operation of CPNPP Units 3 and 4. Given the location of the proposed blowdown diffuser, a thermal plume may build just upstream along the face of De Cordova Bend Dam. The thermal plume was calculated in Subsection 5.3.2.1 under minimum flow conditions and varying temperatures. Maximum plume size occurs when ambient temperature is lowest and has been calculated to extend approximately 682 ft long and 358 ft across the reservoir. The plume is not associated with either bank, and spans 19 percent of the reservoir width. A thermal barrier across the reservoir therefore does not exist (Subsection 5.3.2.1).

One state listed protected aquatic species (Brazos water snake), one federally listed candidate (sharpnose shiner), and one state listed species of concern (pistolgrip mussel) identified by agency contacts are of concern near CPNPP. (Table 2.4-10). None are likely to reside in the lower portion of Lake Granbury. Gill net surveys performed in the summer of 2007 and winter 2008 revealed a limited number of game fish in the section of Lake Granbury near the dam. Game fish caught in four experimental varying mesh gill nets set for over 15 hr include two white bass, a single stripped bass, one crappie, and four channel catfish during the summer sampling event. Winter sampling efforts in Lake Granbury revealed four species of game fish including white bass (8), largemouth bass (1), channel catfish (31), and white crappie (4). Golden algae cause annual fish kills in several Lake Granbury locations but waters near the dam are particularly affected. Game fish populations near the dam are so blighted by golden algae in recent years that most do not currently reside in this portion of the lake.

Golden algae may not persist and a viable population of fish may return to waters near the dam. In winter months, some fish may be affected by the elevated temperature, with some species possibly residing in the plume for extended periods. Extended residence is not expected to affect the fish populations. Thermal blowdown associated with the CPNPP Units 3 and 4 would be diffused directly into Lake Granbury and not to any wetlands in the floodplain. No impacts to wetlands, shallow centrarchid nesting areas, or the bottomland floodplain are expected from a discharge located in this area. The additional flow during a flood event would minimize the time for mixing of the effluent with reservoir water, which further reduces the possibility of significant impact.

Second to thermal impacts to aquatic organisms in potential significance are toxic effects due to chemicals present in blowdown water from the cooling towers. Common to industrial cooling water systems are chemicals to prevent the buildup of bacteria, algae, scale, and non-native mollusks at some point from intake to discharge. Chemical additives intended to disperse silt, inhibit corrosion, and adjust pH to acceptable discharge levels are also frequently used. Chemicals discharged from the plant are further discussed in Section 3.6.

Chemicals released in Units 3 and 4 blowdown (Table 3.6-1) after treatment (Subsection 3.6.1.1) are expected to be below no observable adverse effects concentration (NOAEC) values. Because chemicals within the blowdown are expected to be below the NOAEC, fish populations are not anticipated to be influenced by chemical alterations to the receiving waterbody.

Impacts associated with discharge to Lake Granbury are negligible. Chemicals are below NOAEC, the plume is localized at one end of the reservoir, and only a small pelagic area is calculated to be warmer than ambient. In some situations many small impacts could have an additive or synergistic effect on aquatic habitat and impact the environment to uninhabitable levels. Proposed reactors and support systems have been designed to minimally impact the environment. CORMIX was used to ensure the thermal plume would not affect aquatic organisms in the reservoir. An evaporation pond was designed to treat effluent prior to discharge and ensure total dissolved solid levels would not degrade water quality. Because impacts to Lake Granbury are negligible, cumulative impacts associated with CPNPP would not affect aquatic organism populations within the reservoir.

5.3.2.3 Terrestrial Ecosystems

The mister system is designed to evaporate the waste reject water from treatment system and the design is provided in the response to GEN-03/HYD-23/LU-03.

Misting units are anticipated to be used to increase evaporation at the BDTF ponds. One hundred eighty two misters used simultaneously have the ability to evaporate 5200 gpm. Each unit discharges approximately 80 gpm and, based on an average evaporation efficiency of 0.357, 28.6 gpm will evaporate. Salt drift from the misters is a consideration for terrestrial ecology. When a 90 micron droplet of process water is sprayed into the air, a portion of the water droplet evaporates. Some droplets will completely evaporate leaving the solid portion suspended in the air. Meteorological conditions will determine the distance suspended solids are carried by wind currents.

According to a 2004 study performed by the Department of the Interior, it was found that salt drift from misting units was deposited up to 1300 ft from the source with a wind speed of 10 mph. The ER indicates the average wind speed is 10 mph with the predominant wind direction being from the south or southeast. No sensitive areas exist within 1300 ft of the BDTF. Salt drift could be maintained within the 128 ac evaporation pond with judicious placement of the misting units. NUREG 1555 indicates maintaining a deposition rate below 1 – 2 kg/ha/month is expected to prevent damage to vegetation. Salt concentrations leaving the misters are approximately 576 kg/minute. Mitigative measures such as salt fences or wind velocity sensors that halt misting could be employed to contain salt drift when wind speeds exceed 10 mph. If mitigative measures are employed to maintain salt concentrations within the 400 acres BDTF, ecological impacts due to salt drift will be SMALL.

Additional considerations when developing the BDTF are the location of power lines over the evaporation pond, localized fogging associated with the misting units, and salt concentrations of the pond water. Wings of birds swimming on brine ponds collect salt crystals, which eventually prevent birds from flying. Noise and violent spray action from the misting units will act as a deterrent, discouraging birds from flying near the lines or lighting on the pond. Potential impacts on birds will be monitored and bird deterrent procedures and equipment will be utilized as needed (e.g., noise cannons, netting, artificial predators, periodic patrols, and minimizing periods of time in which standing water is present). Possible localized fogging associated with the misting units will not affect transient birds as they will likely avoid the noise and violent spray. Any localized affect is expected to be less than what has historically occurred at and around the site, and would probably be temporary. Therefore, impacts to birds due to fogging are expected to be SMALL.

5.3.3 HEAT-DISCHARGE SYSTEM

This subsection describes the impact of the heat-discharge system on the aquatic ecology and the physical impacts such as scouring, silt build up and shore line erosion caused by the flow field induced by the discharge system during station operation. The CWS, ESW, and NESW systems (Section 3.4), use cooling towers to dissipate heat to the atmosphere.

Subsection 5.3.3.1 describes the impacts associated with heat dissipation to the atmosphere. Subsection 5.3.3.2 describes the impacts of the operation of heat dissipation systems on terrestrial ecosystems. Overall, as discussed in the following subsections, the impacts associated with the heat dissipation system on the atmosphere and terrestrial ecosystems are SMALL.

5.3.3.1 Heat Dissipation to the Atmosphere

Cooling systems that depend on evaporation of water for a major portion of the heat dissipation can be expected to create visible vapor plumes. These vapor plumes cause shadowing of nearby lands, salt deposition, and can increase the potential for fogging or icing. Physical and expected performance characteristics of the cooling system are provided in the FSAR Subsection 10.4.5.

Topography of the CPNPP site is virtually flat and has been graded to support four back-to-back mechanical draft cooling towers (MDCT) oriented in a staggered parallel arrangement. Two back to back MDCT arrangements per unit are selected for the proposed project in order to utilize the available areas. Cooling tower dimensions, layout, and airflow rates, are provided in Table 5.3-3. Physical characteristics of the heat discharge system are provided in Subsection 3.4.2.3. Typical drift rates for cooling towers of these types, and average Lake Granbury water dissolved solids and salt concentrations were used to support deposition calculations.

In addition to the CWS, an ultimate heat sink (UHS) is included in the design for CPNPP Units 3 and 4, and each has an associated cooling tower. The UHS heat load dissipated during normal plant operation is included in the CWS heat load utilized in the analysis. The heat dissipated by the UHS cooling tower during plant shutdown/cooldown would be orders of magnitude less than the heat dissipated by the CWS cooling towers. The heat dissipated by the CWS cooling towers would decrease as the plant shuts down and would be zero when the plant is shutdown. The environmental impact that would be associated with UHS system cooling tower operating in conjunction with the CWS cooling tower, or alone, is bounded by the CWS cooling tower analysis.

The NRC has identified several plume-related codes as acceptable methodologies. A model endorsed by NUREG-1555 was Carhart and Policastro. In NUREG-1555, the NRC accepted Carhart and Policastro’s conclusion that their code predicts the plume rise within a factor of 2 about 75 percent of the time and visible plume length within a factor of 2.5 about 70 percent of the time. This model was embedded into the Electric Power Research Institute (EPRI) Seasonal/Annual Cooling Tower Impact Prediction Code (SACTI) in 1991.

As discussed earlier, the heat dissipation system for the CWS for the proposed project would use MDCTs. The height of the discharge for the MDCTs is 55.4 ft above site grade, and this height was used in the SACTI model.

Seasonal mixing height values used for the cooling tower assessment are from Stephenville, TX, the nearest upper air observation location. Further meteorological information is provided in Section 2.7.

To determine potential impact of solid deposition due to cooling tower plumes, the concentrations of salts and dissolved solids in the CWS circulating water must be input into the plume model. The source of circulating water makeup for the CWS is Lake Granbury. Table 5.3-3 indicates that a sodium concentration of 288 ppm was used for the CWS cooling tower assessment.

Six years of meteorological data from 2001 through 2006 were obtained from Mineral Wells airport, the closest first order station. Other inputs used in the analysis can be found in Table 5.3-3. Six years of site meteorological data (2001-2006) were also used in the analysis.

The cooling tower assessment gives specific information on assumptions and how the input data were utilized to generate the plume model.

5.3.3.1.1 Length and Frequency of Elevated Plumes

Table 5.3-4 describes the expected plume lengths by season and direction for the four MDCTs. The longest average plume lengths are predicted to occur during the winter months, and the shortest are predicted to occur during the summer months.

5.3.3.1.2 Frequency and Extent of Ground Level Fogging and Icing in the Site Vicinity

The cooling tower assessment performed for the proposed project shows that there are occurrences of ground level fogging and Rime icing in the north and south directions that are contained within a mile of the cooling tower. Fogging and icing are predicted to occur almost exclusively in the areas of shore line or lake surface. See Table 5.3-5 for annual by hour fogging or icing rates.

5.3.3.1.3 Solids Deposition (i.e., Drift Deposition) in the Site Vicinity

The MDCTs would use drift eliminators to minimize the amount of water lost from the towers via drift. Some droplets are, nevertheless, swept out of the tops of the cooling towers in the moving air stream. The drift droplets containing dissolved salt and particulates are swept out of the tops of the cooling towers. Initially, these droplets rise in the plume's updraft, but due to their high settling velocity, they eventually break away from the plume, then evaporate, settle downward, and are dispersed by atmospheric turbulence. This drift essentially has the same concentrations of dissolved and suspended solids as the water in the cooling tower basin. The dispersion and deposition of drift from cooling towers are influenced by:

- Factors associated with the design and operation of the cooling tower.
    - Volume of water circulating in the tower per unit time (circulating water flow rate).

- Salt or particulates concentrations in the water.
- Drift rate.
- Mass size distribution of drift droplets.
- Plume rise influenced by tower diameter, height and mass flux.

- Factors related to atmospheric conditions.
  - Humidity.
  - Wind speed.
  - Wind direction.
  - Temperature.
  - Pasquill's stability class.

The salt drift deposition pattern shown in Table 5.3-6 indicates that there is negligible salt deposition at a distance of 1.5 miles from the site. The highest amount of salt deposition was found to be 137.3 kg/km^2/month occurring 100 meters from the site. The SCR is adjacent to the cooling towers and is likely to receive cooling tower drift that would add to TDS of the reservoir. However, TDS measured in SCR in 2007 exceeded 2600 mg/L at all sampling locations across all seasons, which is likely due to the reservoir acting as the UHS for two once-through units. Increases in SCR TDS measurements due to cooling tower drift are anticipated to be negligible.

The maximum predicted annual water deposition rate, from the cooling tower assessment is 4.9 x 10^4 kg/km^2/month at a downwind distance of 100 meters from the cooling towers. This deposition rate is the rainfall equivalent of 0.002 inches per month. This amount is trivial compared to the normal precipitation at CPNPP of 30 in annually. The National Weather Service (NWS) considers precipitation of less than 0.01 to be a trace amount.

Drift deposition results are indicative of the performance of the state-of-the-art drift eliminators, minimizing the size of the drift droplets. Small drift droplets tend to evaporate or remain suspended in air. Trivial drift deposition that does occur is most likely the result of meteorological conditions conducive to reduced plume rise; i.e., stronger wind speeds. The use of fresh water as makeup also contributes to the trivial deposition impacts as this use minimizes the total dissolved solids content of the circulating water.

5.3.3.1.4 Cloud Formation, Cloud Shadowing, and Additional Precipitation

In NUREG-1073 (Final Environmental Statement Related to the Operation of River Bend Station), the NRC indicates that even though plumes from natural draft cooling towers at several power plants have been observed to increase cloud cover several thousand feet aboveground, mechanical draft cooling towers are not known to produce such effects. Table 5.3-7 provides the downwind distances at which plume shadowing effects were predicted.

One potential environmental impact resulting from the discharge of cooling tower moisture is regional augmentation of natural precipitation. Estimates of the total contribution to surface precipitation from cooling towers, based on a 2200-MWe station, would be only 0.4 in for each tower, or a total of 0.8 in for two units annually (Huff 1972). The analysis for the proposed project indicates that there would be maximum contribution of only 78 x 10^3 kg/km^2/month to surface precipitation from operation of the MDCTs. This amount is inconsequential compared to the total annual rainfall (30 in) experienced in this region.

Induced snowfall due to operating cooling towers has been observed. Other documented induced-snowfall occurrences generally preceded actual snowfall occurrences. An investigation into the climatic conditions conducive to induced snowfall indicated that a very cold (less than 11°F) plume height (4900 ft) and stable atmosphere with moderate winds (15 ft/sec or 10.2 mph) optimized this situation (Sauvageot 1987). This type of meteorological condition occurs infrequently based on the CPNPP site meteorological data. There is no reason to expect that the cooling towers for the proposed project would significantly alter snowfall amounts or frequency.

5.3.3.1.5 Vapor Plume Interactions With Existing Pollution Sources

No industrial/commercial sources of vapor plumes are located within 1.25 mi (2km) of the site. Therefore, plume interaction between the CPNPP and existing pollution sources are not anticipated.

5.3.3.1.6 Ground Level Humidity Increase in the Site Vicinity

In the vicinity of the vapor plumes, both the absolute and relative humidity aloft is increased as evidenced by calculated frequency of visible plume occurrence. Absolute humidity at the surface is increased only slightly. Relative humidity near the proposed project towers may be increased during the colder months due to relatively low moisture-bearing capacities of cold air.

5.3.3.2 Terrestrial Ecosystems

Important terrestrial species are listed in Subsection 2.4.1. The cooling system for CPNPP is a closed-loop system that would employ MDCT as discussed in Subsection 5.3.3.1. Rejected heat is manifested in the form of atmospheric water vapor plumes. This subsection describes the potential impacts of the cooling tower plume drift regarding exposure of vegetation near nuclear power plants to salts, icing, or other effects (e.g., fogging and increased humidity) caused by standard operation of cooling towers. A benefit of closed-loop systems is that water is recycled through the plant leading to decreased overall water intake when compared to a once-through cooling system design. Because cooling water is cycled through the system up to a maximum of 2.4 times and evaporation rates are high, dissolved and suspended solids evident in cooling water are potentially concentrated up to 2.4 times that found in intake water. The proposed project would use cooling water drawn directly from Lake Granbury. Additional cooling ponds and lakes have not been proposed.

5.3.3.2.1 Salt Drift

Although the cooling towers are equipped with drift eliminators to reduce the amount of liquid particle loss, some droplets containing dissolved particles are ejected from the cooling tower.

Potential impacts of salt exposure due to cooling tower operation on native vegetation are similar to those for agricultural crops, including salt-induced leaf damage, growth, and seed yield reduction if salt deposition rates are high. NUREG-1555 Subsection 5.3.3.2 indicates that maintaining a deposition rate below 1 – 2 kg/ha/month is expected to prevent damage to vegetation. Subsection 5.3.3.1.3 indicates the highest deposition rate is 137.3 kg/km^2/month, which is below the threshold that is anticipated to prevent damage.

Maximum MDCT salt deposition rates predicted would be approximately 1.373 kg/ha/month, occurring 100 meters north of the cooling towers. NUREG-1555 Subsection 5.3.3.2 indicates that maintaining a deposition rate below 1 – 2 kg/ha/month is expected to prevent damage to vegetation. Impact to terrestrial ecosystems associated with salt deposition stemming from cooling tower operation is expected to be SMALL.

5.3.3.2.2 Increased Precipitation

Increased precipitation is discussed in Subsection 5.3.3.1.4. Impacts on terrestrial ecosystems are considered to be SMALL.

5.3.3.2.3 Fogging and Icing

Subsection 5.3.3.1.2 indicates surface fogging and icing at the CPNPP are expected. Ground icing and fogging events are predicted to occur primarily in the areas of wetlands or lake surface, thus impact on terrestrial ecology is considered to be SMALL and does not warrant mitigation.

5.3.3.2.4 Noise

The potential for noise effects from CPNPP Units 3 and 4 has been analyzed by projecting noise levels at the site and vicinity from various sources (Subsection 5.8.1.5). Resident wildlife species quickly adapt to constant background noise (Live Science 2005). Noise is expected to have a small impact on terrestrial ecology.

5.3.3.2.5 Bird collisions

Collisions between birds and the cooling towers are expected to be minimal. Most authors only report collisions on objects four to ten times taller than the proposed cooling towers for CPNPP (CEC 1995) (Kerlinger 2000). The low profile of the proposed towers is expected to prevent many collisions. Because much of this peninsula is expected to be cleared for construction of Units 3 and 4 and the cooling towers, there are no topographic or ecological features that would attract birds to this location or “funnel” them into the vicinity of exhaust stacks or other elevated features of the project. Night lighting is suspected as a contributing factor to many collisions. The combination of low profile and night time lighting at CPNPP is expected to keep the risk of bird collisions with the cooling towers SMALL.

5.3.4 IMPACTS TO MEMBERS OF THE PUBLIC

This subsection describes the potential health impacts associated with the cooling system for the proposed project. Impacts to human health from thermophilic microorganisms and from noise resulting from operation of the cooling system are addressed.

5.3.4.1 Thermophilic Microorganisms

The NRC designated impacts to public health from thermophilic microorganisms a Category 2 issue requiring plant-specific attention due to possible public health impacts associated with pathogen contact. The plant ultimately discharges into a reservoir system, but a portion is diverted into the BDTF. It is necessary to determine whether discharge characteristics promote survival and reproduction of pathogenic thermophilic microorganisms in either location. Organisms of concern include enteric pathogens *Salmonella* and *Shigella*, the *Pseudomonas aeruginosa* bacterium, thermophilic *Actinomycetes* (fungi), the many species of *Legionella* bacteria, and pathogenic strains of the free-living *Naegleria* amoeba.

Bacteria pathogenic to humans usually thrive at temperatures of 99°F, are ubiquitous in the environment, and only affect immunologically compromised individuals. Thermophilic microorganisms generally occur at temperatures ranging from 77°F to 176°F, but growth and reproduction is maximized at 122°F – 140°F. Two existing units at CPNPP with once-through cooling currently discharge into a cove on the south end of Squaw Creek Reservoir, where temperatures above 100ºF have been measured occasionally near the discharge. Even though this area was a favorite location for recreational fishing according to local blogs when the reservoir was open to the public, illness associated with thermophilic bacteria was never reported.

Recreational swimming in Texas reservoirs is generally considered a safe activity with regard to pathogen exposure. Although Texas reservoirs do not appear to have major problems due to high levels of pathogens, in 2007, the Texas Department of State Health Services confirmed a death attributed to primary amoebic meningoencephalitis (PAM). Thirty-five (35) PAM infections have been reported in Texas since 1972 and have involved children and adults who had been swimming in lakes (TDSHS 2007). The amoeba responsible for PAM thrives in warm, stagnant water and soil. A combination of lower water levels, high water temperature and stagnant or slow moving water produces higher concentrations of the amoeba in the water (BRA 2007).

The CPNPP Units 3 and 4 are planned to each utilize two banks of mechanical-draft cooling towers to employ a closed-loop cooling system and reduce heated discharge to Lake Granbury. Two gravity-drain 42-in discharge pipelines (one from Unit 3 and one from Unit 4) with multi-port diffusers are planned to be located approximately 600 ft upstream from De Cordova Bend Dam in the vicinity of the existing discharge pipe (Subsection 4.2.1.1.7). Average discharge through the dam is 28 cfs (Subsection 2.3.1.2.2). During low flow conditions, release may decrease to below 28 cfs. Constant flow provides continuous mixing and cooling of the blowdown discharge (Section 2.3).

The maximum temperature of water discharged into the reservoir is 93°F, at which point mixing and cooling begin immediately. Subsection 5.3.2.1 details the thermal plume expected from cooling tower blowdown in Lake Granbury. In theory, thermal additions to these water bodies could support thermophilic microorganisms. Thermophilic microorganisms thrive and reproduce at temperatures ranging from 122°F to 140°F. Although thermophilic microorganisms may be present in the thermal plume, expected temperatures are well below optimal temperature ranges for growth and reproduction. Impacts to public health from thermophilic microorganisms are not expected.

The BDTF is anticipated to carry a moderate heat load during winter months, but during summer months temperatures in the BDTF are near or cooler than ambient. Water temperatures from the cooling tower basin are designed at a maximum of 88.5ºF; therefore, growth of thermophilic bacteria growth is not expected. Additionally, the salt concentration in the BDTF has been calculated at 29,500 ppm. Even the salinity tolerant Acanthamoeba amoeba has an upper salt tolerance level of 12 ppt. However, Vibrio cholerae, the bacteria responsible for cholera outbreaks, does grow in moderate temperatures and high salinity. Singleton et al. (1982) indicates V. cholerae thrives at salinity concentrations of 25-35 ppt and temperatures of 20-25ºC (68-77ºF). Twenty five degrees Celsius was the highest temperature tested in this study. V. cholerae can probably withstand higher temperatures. It is possible the BDTF would provide suitable habitat for V. cholerae for much if not the entire year.

V. cholerae has not been identified in the Lake Granbury source water. It has been hypothesized the bacteria is an autochthonous constituent of brackish water and estuaries. Although CPNPP is not located near the ocean, and inoculation of the BDTF with V. cholerae is unlikely, monitoring for the bacteria will be performed if required by Texas State authorities.

Human disease resulting from any potential thermophilic pathogens in the lake will require an exposure pathway that is not reasonable given the environment surrounding the discharge pipe and the characteristics of the heat plume. The water will not be warm long enough to support a reproducing pathogen community, and swimmers and boaters are barred from the dam area, which includes the area surrounding the discharge pipe. Exposure risks are not present beyond those found in background conditions.

5.3.4.2 Noise

The proposed units are anticipated to produce noise from the operation of pumps, mechanical draft cooling towers, transformers, turbines, generators, switchyard equipment, and loudspeakers. In NUREG-1555, the NRC states that the principal sources of noise include cooling towers and pumps that supply the cooling water. The U.S. Department of Housing and Urban Development (HUD) has established noise impact guidelines for residential areas based on day-night average sound levels (Ldn). For the purpose of this document, noise impacts are assessed using the Ldn of 60 – 65 dBA A-weighted decibels (dBA) as the level below which noise levels would be considered acceptable for residential and outdoor recreational uses.

Impacts of operational noise on the public are expected to be small. Operational noise including distance to the nearest residence is further discussed in Section 5.8.

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TABLE 5.3-1
SUMMARY OF FACILITY DISCHARGE PLUME CASES ANALYZED

Case	Ambient Temperature (°F)	Low Flow (cfs)	Discharge Rate (cfs)	Discharge Temperature (°F)
Min Temperature	48.56	28	58	93
Mean Temperature	73.29	28	58	93
Max Temperature	89.24	28	58	93

TABLE 5.3-2
SUMMARY OF PLUME ANALYSIS

Case	Ambient Temperature	Isotherm Considered (°F)	Plume Length (ft)	Plume Width (ft)	Plume Area (ft^2)
Thermal Plume	Min	3 °F	682.38	357.94	1561.84
	Mean	3 °F	120.77	34.25	342.72
	Max	3 °F	0.89	15.03	15.28

TABLE 5.3-3
COOLING TOWER AND CIRCULATING WATER DATA

	Per Unit
Tower type	Back-to-back mechanical draft
Number of towers	2
Tower arrangement	parallel
Tower height above plant grade	55.4 ft
Tower dimensions	122 ft x 811ft
Heat dissipation rate	2922 MW
Air mass flow rate	29,000 kg/sec
Circulating water flow	1,317,720 gpm
Drift rate	6.6 gpm

TABLE 5.3-4
AVERAGE PLUME LENGTH IN MILES

	Winter	Spring	Summer	Fall	Annual
Plume from MDCT moving in the indicated direction					
S	3.77	2.27	1.37	2.2	2.71
SSW	3.47	1.83	1.04	1.7	1.99
SW	3.86	1.86	0.87	1.55	1.86
WSW	3.62	2.23	0.72	1.72	1.82
W	3.82	2.13	0.73	2.32	2.09
WNW	3.82	1.93	0.91	1.63	1.9
NW	3.8	1.94	1.07	1.76	1.94
NNW	3.09	1.47	0.66	1.49	1.5
N	2.57	1.3	0.58	1.4	1.36
NNE	2.3	1.43	0.65	1.67	1.5
NE	2.53	1.95	0.93	2.62	2.03
ENE	3.08	2.41	1.27	3.08	2.62
E	3.04	1.86	1.28	2.47	2.34
ESE	3.38	2.37	1.81	2.88	2.86
SE	2.87	2.11	1.4	2.45	2.5
SSE	3.05	1.98	1.16	2.29	2.46
All	3.14	1.73	0.83	1.9	1.9

TABLE 5.3-5 (Sheet 1 of 2)
ANNUAL HR/YR OF FOGGING OR ICING
DIRECTIONS ARE FROM THE TOWER

Fogging

(mi)	(m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
0.06	100	22	1.1	6.5	1.1	0.4	2.8	24.3	49.7	6.5	1.6	9.8	2.8	0	8.8	82.6	152.7
0.12	200	90.8	31.4	7.4	2.2	2	5.9	31	94.5	76.7	30.6	10.2	4.4	1.4	11.2	137.5	290.1
0.19	300	61.2	11	5.9	2.1	1	3.1	24.1	77.4	53	11.4	8.9	4.3	0.5	3.5	129.4	350.3
0.25	400	45.1	5.2	4.4	1	1	0.7	12.4	50.9	26.6	5.7	6.3	2.5	0.4	2.3	100.6	313.4
0.31	500	90	9.4	4.1	1	1.9	2.3	0	15.4	60.9	8.2	6.3	2.5	0.4	4.8	37.4	157.9
0.37	600	60.8	4.1	4.1	0.5	1.7	0.7	0	7.6	27.3	3.3	6.3	1.7	0.3	2.5	13.8	63.5
0.43	700	50.5	2.0	4	0	1.5	0	0	4.1	19	1	6.3	1	0.3	2	2	17.4
0.5	800	42.3	2.0	4	0	1.1	0	0	1	19	1	6.3	1	0.3	2	0.2	2.8
0.56	900	33.7	1.6	4	0	0.7	0	0	0	16.3	1	6	1	0	2	0	0
0.62	1000	28.5	1.5	2	0	0.5	0	0	0	15.5	1	3	1	0	2	0	0
0.68	1100	27.9	1.1	2	0	0.5	0	0	0	12.8	1	3	1	0	2	0	0
0.75	1200	20.5	1	2	0	0.5	0	0	0	7.5	0.5	3	1	0	1.5	0	0
0.81	1300	20.5	1	0	0	0.5	0	0	0	7.5	0.5	0	1	0	1.5	0	0
0.87	1400	20.5	1	0	0	0.5	0	0	0	7.5	0.5	0	1	0	1.5	0	0
0.93	1500	19.4	0.6	0	0	0.5	0	0	0	6.4	0.5	0	1	0	1.1	0	0
0.99	1600	19	0.5	0	0	0.5	0	0	0	6.0	0.5	0	0.6	0	1	0	0

TABLE 5.3-5 (Sheet 2 of 2)
ANNUAL HR/YR OF FOGGING OR ICING
DIRECTIONS ARE FROM THE TOWER

Icing

(mi)	(m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
0.06	100	9	1.1	6.5	1.1	0	2.8	24.2	45.2	6.4	1.6	9.8	2.8	0	7.5	57.2	77.2
0.12	200	52.7	21.6	7	1.9	1.2	5.6	30.6	84.5	66.9	28.5	10.2	4.4	1.2	5.2	80.4	133.2
0.19	300	36	7.5	5.7	2	0	3	24.1	63.4	43	10	8.9	4.3	0.4	2.5	67.2	125
0.25	400	19.7	2.2	4	1	0	0.7	12.4	38.2	16.6	3.8	6.3	2.5	0.3	1.3	36.4	84.8
0.31	500	42.9	5.2	4	1	0	2.3	0	7.1	42.1	7.9	6.3	2.5	0.3	2.9	2.4	27.4
0.37	600	20.5	1.8	4	0.5	0	0.7	0	2.6	16.9	3.1	6.3	1.7	0.3	1.3	0.9	10
0.43	700	15.5	0	4	0	0	0	0	1.5	9	1	6.3	1	0.3	1	0.5	5.5
0.5	800	15	0	4	0	0	0	0	0	9	1	6.3	1	0.3	1	0	0.4
0.56	900	14.5	0	4	0	0	0	0	0	9	1	6	1	0	1	0	0
0.62	1000	14.5	0	2	0	0	0	0	0	9	1	3	1	0	1	0	0
0.68	1100	14.5	0	2	0	0	0	0	0	9	1	3	1	0	1	0	0
0.75	1200	7.5	0	2	0	0	0	0	0	4.5	0.5	3	1	0	0.5	0	0
0.81	1300	7.5	0	0	0	0	0	0	0	4.5	0.5	0	1	0	0.5	0	0
0.87	1400	7.5	0	0	0	0	0	0	0	4.5	0.5	0	1	0	0.5	0	0
0.93	1500	7.5	0	0	0	0	0	0	0	4.5	0.5	0	1	0	0.5	0	0
0.99	1600	7.5	0	0	0	0	0	0	0	4.5	0.5	0	0.6	0	0.5	0	0

TABLE 5.3-6 (Sheet 1 of 2)
COOLING TOWER SALT DEPOSITION IN KG/KM^2/MONTH

(mi)	(m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
0.06	100	24.41	23.80	49.39	41.11	26.96	30.99	66.47	86.01	137.3	30.79	64.35	42.38	10.97	10.24	19.96	31.85
0.12	200	20.60	18.04	28.58	24.38	17.19	20.56	42.02	61.28	127.2	25.41	34.31	23.97	7.70	8.26	14.18	19.06
0.19	300	7.20	5.41	16.70	12.60	3.65	4.94	33.28	52.17	49.19	8.60	22.56	15.76	2.07	2.54	11.45	15.01
0.25	400	6.25	4.69	7.09	5.42	3.26	4.43	25.57	40.43	42.50	7.51	9.34	6.36	1.84	2.21	9.02	11.50
0.31	500	6.28	4.69	0.23	0.17	3.46	4.74	10.67	13.03	42.80	7.61	0.44	0.37	1.79	2.22	4.05	4.65
0.37	600	6.17	4.59	0.15	0.13	3.35	4.57	8.79	10.91	42.08	7.42	0.26	0.22	1.67	2.18	3.19	3.90
0.43	700	5.55	4.12	0.10	0.10	2.97	3.85	5.98	8.05	37.63	6.42	0.17	0.15	1.41	1.98	2.04	2.80
0.50	800	3.77	2.78	0.08	0.07	1.84	2.33	4.55	6.52	24.97	4.25	0.14	0.13	0.97	1.36	1.42	2.02
0.56	900	0.33	0.19	0.07	0.06	0.25	0.28	4.54	6.51	0.76	0.27	0.14	0.13	0.14	0.17	1.42	2.02
0.62	1000	0.31	0.18	0.07	0.06	0.24	0.27	4.58	6.57	0.74	0.26	0.14	0.13	0.14	0.17	1.43	2.03
0.68	1100	0.31	0.18	0.07	0.06	0.24	0.27	5.33	7.62	0.73	0.26	0.14	0.13	0.14	0.17	1.66	2.25
0.75	1200	0.31	0.18	0.07	0.06	0.24	0.27	5.85	8.44	0.73	0.26	0.14	0.13	0.14	0.17	1.87	2.48
0.81	1300	0.31	0.18	0.07	0.06	0.24	0.27	6.04	8.65	0.73	0.26	0.14	0.13	0.14	0.17	1.92	2.53
0.87	1400	0.31	0.18	0.07	0.06	0.24	0.27	6.04	8.65	0.73	0.26	0.14	0.13	0.14	0.17	1.92	2.53
0.93	1500	0.31	0.18	0.07	0.06	0.24	0.27	5.94	8.58	0.73	0.26	0.14	0.13	0.14	0.17	1.90	2.45
0.99	1600	0.31	0.18	0.07	0.06	0.24	0.27	5.75	8.43	0.73	0.26	0.14	0.13	0.14	0.17	1.86	2.27
1.06	1700	0.31	0.18	0.06	0.05	0.24	0.27	5.75	8.43	0.73	0.26	0.12	0.12	0.14	0.17	1.86	2.27
1.12	1800	0.31	0.18	0.05	0.05	0.24	0.27	5.75	8.43	0.73	0.26	0.10	0.10	0.14	0.17	1.86	2.27
1.18	1900	0.31	0.18	0.05	0.04	0.24	0.27	5.75	8.43	0.73	0.26	0.09	0.09	0.14	0.17	1.86	2.27
1.24	2000	0.31	0.18	0.05	0.04	0.24	0.27	5.56	8.18	0.73	0.26	0.09	0.09	0.14	0.17	1.78	2.21
1.30	2100	0.30	0.17	0.04	0.04	0.23	0.25	5.28	7.83	0.71	0.25	0.08	0.08	0.14	0.16	1.68	2.13
1.37	2200	0.27	0.15	0.04	0.03	0.20	0.22	5.10	7.58	0.64	0.23	0.06	0.07	0.13	0.15	1.59	2.05
1.43	2300	0.19	0.10	0.03	0.02	0.12	0.13	4.49	6.62	0.41	0.14	0.05	0.05	0.09	0.11	1.35	1.79

TABLE 5.3-6 (Sheet 2 of 2)
COOLING TOWER SALT DEPOSITION IN KG/KM^2/MONTH

(mi)	(m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
1.49	2400	0.12	0.05	0.02	0.02	0.07	0.07	2.29	2.91	0.22	0.08	0.04	0.04	0.05	0.07	0.93	0.78
1.55	2500	0.10	0.05	0.02	0.02	0.05	0.06	2.28	2.89	0.18	0.06	0.03	0.03	0.04	0.06	0.93	0.78
1.62	2600	0.08	0.04	0.02	0.02	0.05	0.05	2.28	2.89	0.15	0.05	0.03	0.03	0.03	0.04	0.93	0.78
1.68	2700	0.08	0.04	0.02	0.02	0.05	0.05	2.28	2.89	0.15	0.05	0.03	0.03	0.03	0.04	0.93	0.78
1.74	2800	0.06	0.03	0.02	0.02	0.04	0.04	2.28	2.89	0.11	0.04	0.03	0.03	0.02	0.03	0.93	0.78
1.80	2900	0.05	0.02	0.02	0.02	0.03	0.03	2.28	2.89	0.09	0.03	0.03	0.03	0.02	0.03	0.93	0.78
1.86	3000	0.05	0.02	0.02	0.02	0.03	0.03	2.13	2.71	0.09	0.03	0.03	0.03	0.02	0.03	0.87	0.73
1.93	3100	0.05	0.02	0.02	0.01	0.03	0.03	1.80	2.28	0.09	0.03	0.03	0.03	0.02	0.03	0.75	0.63
1.99	3200	0.05	0.02	0.01	0.01	0.03	0.03	1.88	2.31	0.09	0.03	0.03	0.02	0.02	0.03	0.77	0.66
2.05	3300	0.04	0.02	0.01	0.01	0.03	0.03	1.93	2.34	0.08	0.03	0.03	0.02	0.02	0.02	0.79	0.67
2.11	3400	0.04	0.02	0.01	0.01	0.02	0.03	1.93	2.34	0.07	0.02	0.03	0.02	0.01	0.02	0.79	0.67
2.17	3500	0.04	0.02	0.01	0.01	0.02	0.03	1.93	2.34	0.07	0.02	0.03	0.02	0.01	0.02	0.79	0.67
2.24	3600	0.04	0.02	0.01	0.01	0.02	0.03	1.54	1.76	0.07	0.02	0.03	0.02	0.01	0.02	0.58	0.51
2.3	3700	0.19	0.10	0.03	0.02	0.12	0.13	4.49	6.62	0.41	0.14	0.05	0.05	0.09	0.11	1.35	1.79
2.36	3800	0.12	0.05	0.02	0.02	0.07	0.07	2.29	2.91	0.22	0.08	0.04	0.04	0.05	0.07	0.93	0.78
2.42	3900	0.10	0.05	0.02	0.02	0.05	0.06	2.28	2.89	0.18	0.06	0.03	0.03	0.04	0.06	0.93	0.78
2.49	4000	0.08	0.04	0.02	0.02	0.05	0.05	2.28	2.89	0.15	0.05	0.03	0.03	0.03	0.04	0.93	0.78
2.55	4100	0.08	0.04	0.02	0.02	0.05	0.05	2.28	2.89	0.15	0.05	0.03	0.03	0.03	0.04	0.93	0.78
2.61	4200	0.06	0.03	0.02	0.02	0.04	0.04	2.28	2.89	0.11	0.04	0.03	0.03	0.02	0.03	0.93	0.78

NOTE:

Directions are directions that the plume is headed.

TABLE 5.3-7 (Sheet 1 of 2)
ANNUAL HR/YR OF PLUME SHADOW
DIRECTIONS ARE FROM THE TOWER

(mi)	(m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
0.25	400	2037.8	2271.1	2897.1	3825.1	4616.9	4171.6	3598.3	3186.5	3036.8	3109.5	3782	4279.2	3424.3	2424.5	1952.8	1915.9
0.37	600	1501.2	1511.8	1612.4	2233.5	2864.5	2790	2733.7	2534.9	2208.9	1968.6	2026.1	2180.6	1979.3	1652.6	1500.5	1539.3
0.5	800	1221	1122.5	1107.3	1611.9	1977.3	2306.2	2260.2	2041.8	1686	1424.9	1284.1	1523.8	1312.1	1243.7	1222.4	1231.2
0.62	1000	1077.4	952	871.5	1267	1593.5	1968.6	1967.9	1725.1	1421.6	1112.5	971.2	1149.1	995.4	976.9	1002.2	1085.5
0.75	1200	924.7	831.4	736.5	1047.7	1328	1687.6	1755.7	1486	1247.3	910.8	717.1	845	766.7	835.9	854.2	962.4
0.99	1600	616.8	585.9	580.6	793.4	969.9	1280.1	1446.4	1179.1	908.9	604.2	483.6	546.2	488.7	619.3	621	748.4
1.12	1800	495.9	515.3	535.3	728	861.7	1133	1338.5	1054.8	782.6	485.6	429.7	474	410.5	550.7	560.3	688.4
1.24	2000	437.3	456.3	497	657.2	740.8	997.2	1222.3	949.3	690.9	404	376.5	416.6	355	487.7	500.4	612.9
1.37	2200	382.3	408.1	464.3	607.8	659.6	906	1130	827.5	613	351.3	320.1	373	310.1	447.4	458.4	529.6
1.49	2400	336.7	378.3	436.9	578	607.2	842.5	1017.6	749.4	559.2	317.2	275.7	335	274.5	403.2	388.7	480
1.62	2600	307.1	340.2	416.5	538.2	549.6	792.2	947.9	670.3	518.6	294.1	236.7	307	244.2	363.9	362.5	432.4
1.74	2800	276.9	320.5	387.3	505.7	518	735.6	886.8	616.1	486.7	279.8	216.6	274	227.1	329	346.4	394.2
1.86	3000	257.5	298	362.5	474.4	489	685.6	818.6	575.2	452.8	268.8	191.6	247.5	209.5	312.2	330.6	355.5
1.99	3200	246.9	284.7	342.4	452.7	449.3	654.6	778.8	531.9	432	252.6	175.4	219.6	196.4	285	313.5	331.3
2.24	3600	219.3	252.8	318.4	375.7	411.1	573.5	695.8	486.7	388.7	235.7	154.6	183.1	171.3	260.5	279.9	285.6
2.36	3800	210.1	243	308.6	339.1	392.8	556.7	653.3	466.8	367.8	227.8	142.1	171.5	159.7	245	270.2	266.7
2.49	4000	201.2	228	301.6	314.5	383.1	542.6	631.1	444.7	347.5	213.1	137.6	157	152.1	231.9	258.5	257.4
2.73	4400	178.4	204.2	283.1	280.3	371.3	495.4	579.5	404.4	323.6	201.2	126.5	128.2	140.7	214.6	238	242.7
2.86	4600	166.1	195.4	269	264.6	361.6	470.8	560.8	389	317.6	196	120.6	124.2	139.4	206.6	227.8	236.7
2.98	4800	152.1	181.1	259.6	257.7	354.2	457	550.2	374.4	298	191.3	116.1	114.3	130	196.3	218.9	220.7
3.23	5200	134.5	158.8	236.5	239	338.2	427.9	517.8	350.5	280.5	182.3	106.2	102.3	122.4	181.9	196.3	187.9
3.36	5400	120	149.5	219.6	227.6	332.3	409.8	500.1	341.5	268.3	174.6	101.3	93.3	118.9	176.7	183.8	176.7
3.48	5600	114	141.5	211.9	223.8	324.1	400.5	487.3	328.2	254.5	171.6	100.3	88.4	117.8	172	179.7	167.7
3.6	5800	104.3	128.7	198.4	213.8	317.5	375.5	476.5	319.2	249.3	167.3	95.7	86	116.1	163.8	163.7	155.7

TABLE 5.3-7 (Sheet 2 of 2)
ANNUAL HR/YR OF PLUME SHADOW
DIRECTIONS ARE FROM THE TOWER

(mi)	(m)	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
3.73	6000	98.3	125.8	189.9	206.6	311.6	362.2	460.5	309.8	243	156.6	92.4	82.8	111.9	158.3	160.6	145.7
3.98	6400	89.3	111.3	174.7	189.3	307.3	344.2	432.5	295.7	227.4	144.5	86.1	73.1	101.5	150.1	141.9	134.9
4.35	7000	67	92.9	156.4	161.8	289	309.8	395.6	275.2	201.9	127.2	79	63	97.9	134.4	128.4	116.9
4.47	7200	58.9	90.9	147.6	157.4	287	301.8	385.4	262	188.4	121.3	74.8	59.9	93.6	127.1	124.4	114.9
4.6	7400	53.4	86.6	141.2	150.2	282.2	294.5	368.2	254.9	176.1	115.3	71.8	54.9	92.6	120.1	119.8	105.5
4.72	7600	44.4	83.9	135.1	146.1	277.2	287.3	360	246	168.7	110.3	68.7	52.5	87.7	113.7	109.6	97.2
4.85	7800	39.4	70.8	128.9	138.9	275.2	275.7	343	236.6	158.6	106.3	65.1	49.7	85.8	111.9	106.7	91.2
4.97	8000	35.4	60	118.4	134	270.6	266.5	333.1	225.4	151.4	101.8	62.8	48.6	79.9	110.9	99.8	81.2

5.4 RADIOLOGICAL IMPACTS OF NORMAL OPERATIONS

This section identifies and describes the environmental pathways and impacts by which radiation and radiological effluents associated with normal operation can be transmitted to living organisms in and around the Comanche Peak Nuclear Power Plant (CPNPP). The operational exposure to living organisms in and around the station from increased ambient radiation levels is also discussed.

5.4.1 EXPOSURE PATHWAYS

A radiological exposure pathway is the vehicle by which a receptor may become exposed to radiological releases from nuclear facilities. The major pathways of concern are those that could cause the highest calculated radiological dose. These pathways are determined from the type and amount of radioactivity released, the environmental transport mechanism, and how the station environs are used (e.g., residences, gardens). The environmental transport mechanisms include the meteorological characteristics of the area that are defined by wind speed and wind direction, and the parameters that define the aquatic (liquid) pathway. The most important factor in evaluating the exposure pathway is the use of the environment by the residents in the area around CPNPP. Factors such as location of homes in the area, irrigation of crops, drinking water locations, use of livestock for milk or meat, and the growing of gardens for vegetable consumption are considerations when evaluating exposure pathways.

Routine radiological effluent releases from the CPNPP are a potential source of radiological exposure to man and biota other than man. The potential exposure pathways include liquid and gaseous effluents. The radioactive gaseous effluent exposure pathways include direct radiation, air submersion, deposition on plants and soil, and inhalation by animals and humans. The radioactive liquid effluent exposure pathways include fish consumption and direct exposure from deposited or liquid borne radionuclides. An additional exposure pathway is the direct radiation from contained sources at the plant during normal operations.

The description of the exposure pathways and the calculation methods used to estimate doses to the maximally exposed individual and to the population surrounding the CPNPP site are based on Regulatory Guides 1.109 and 1.111. The computer codes LADTAP II (NUREG/CR-4013) and GASPAR II (NUREG/CR-4653) are used to evaluate doses from liquid effluent releases and gaseous effluent releases, respectively. The source terms used in estimating exposure pathway doses are based on the bounding values provided in the US-APWR Design Control Document (DCD) Chapter 11.

5.4.1.1 Liquid Pathways

Small amounts of liquid radioactive effluents (below regulatory limits) may be mixed with the cooling water and discharged to SCR. It is expected that the CPNPP Units 3 and 4 would operate similarly to CPNPP Units 1 and 2. The release of small amounts of radioactive liquid effluents is permitted for CPNPP Units 1 and 2 and is expected to be permitted for CPNPP Units 3 and 4 as long as the releases comply with the requirements specified in Title 10 of the Code of Federal Regulations (10 CFR) Part 20. The following analyses are provided in order to bound the doses from liquid pathways. The important exposure pathways include:

- Internal exposure from ingestion of water or contaminated food chain components.
- External exposure from the surface of contaminated water or from shoreline sediment.
- External exposure from immersion in contaminated water.

Water from SCR is not utilized in any way for public consumption. Access to SCR is through Squaw Creek Park for recreational activity and is limited and controlled by Luminant. Boating, fishing and shoreline activities are allowed. Normally, a maximum of 100 boats will be allowed on the lake at any given time. More than 100 boats may be allowed for special occasions.

The discharge from SCR is Squaw Creek, a freshwater stream that converges with the Paluxy and Brazos Rivers approximately 4.3 mi south of the reservoir (Figure 5.4-1). There are no other sources of dilution in Squaw Creek; therefore, the most limiting location for aquatic food and recreation for an individual in an unrestricted area is along Squaw Creek. From its confluence with the Paluxy River, the Brazos River flows approximately 60 stream mi south to Whitney Reservoir. Whitney Dam impounds Whitney Reservoir, a lake with a capacity of 554,203 ac-ft and a length of approximately 30 stream mi. Below Whitney Dam, the Brazos River continues to flow south for many miles; however, only approximately 16 stream mi are considered in this evaluation because at this point the river flows outside the 50 mi radius from CPNPP. Figure 5.4-2 shows the Brazos River system within 50 mi of CPNPP.

NUREG-1555 states that the population distribution for 80 km (50 mi) around the site for five years after the time of the licensing action should be considered in the assessment of effluent doses. The projected permanent and transient population for the year 2058, 3,493,553 persons, conservatively bounds this requirement. Default population fractions of 0.71 (adult), 0.11 (teen), and 0.18 (child) are assumed.

The LADTAP II computer program (NUREG/CR-4013) was developed by the U.S. Nuclear Regulatory Commission (NRC) to estimate radiation doses to individuals, population groups, and biota from radionuclide releases as liquid effluents from lightwater nuclear reactors (LWRs) during routine operation. The LADTAP II hydrologic model used to represent mixing of the CPNPP Units 3 and 4 liquid effluent in SCR is the completely mixed impoundment (reservoir) model. The LADTAP II completely mixed impoundment model assumptions are consistent with Regulatory Guide 1.113. For calculation of the shoreline dose, a width factor is input to define the shoreline geometry of Squaw Creek. A shore-width factor for rivers of 0.2 is used.

Because SCR is represented as a completely mixed tank, the circulating water system flowrate from CPNPP Units 1 and 2 to SCR does not affect the reconcentration in the impoundment or the resulting doses. The liquid effluent from Units 3 and 4 is discharged into and mixed with the Unit 1 or 2 circulating water flow.

Another important hydrological parameter associated with the completely mixed model is the flushing of the reservoir by releases from SCR to Squaw Creek. Lower effluent releases from SCR result in higher reconcentration in the impoundment; therefore, it is conservative to use a low flowrate when evaluating compliance with 10 CFR 50 Appendix I limits. The minimum discharge flowrate from SCR is 1.5 ft^3/s. This minimum flowrate is based on the current contract with the Brazos River Authority (BRA) for water allocation rights. The contract stipulates that the owner make sufficient releases to maintain a minimum flow of 1.5 ft^3/s at the Highway 144 crossing over Squaw Creek. U.S. Geological Survey (USGS) data for Squaw Creek are consistent with a release rate of 1.5 ft^3/s. USGS data give an average mean minimum flow of 2 ft^3/s for the time period from 1977 to 2006. Case 1 of the LADTAP II evaluation considers an effluent release rate of 1.5 ft^3/s.

The expected average release rate from SCR, once Units 3 and 4 are operational, is anticipated to be approximately 45.4 ft^3/s (32,900 ac-ft/yr). Therefore, Case 2 determines more realistic doses using this value for comparison with the Appendix I case. Effluent concentrations are estimated at the midpoint of plant life for the US-APWR, 30 year.

Aquatic food and recreation pathways are evaluated for an individual located approximately two miles (10,560 ft) south of the Squaw Creek Dam. Given the size and access to Squaw Creek, usage by the maximally exposed individual at two miles is judged to be reasonable and conservative. Using the mean stream flow velocity in the reach of Squaw Creek, 0.4 ft/sec, a transit time of 7.3 hr is obtained. Because there are no other sources of dilution along Squaw Creek, a dilution factor of one is applied.

The Texas Commission on Environmental Quality (TCEQ) is the environmental agency for the state of Texas. The TCEQ is the regulatory agency responsible for water rights. Information provided by the TCEQ demonstrated that the Brazos River Authority (BRA) holds the majority of water rights within the Brazos River basin and sells water to various individuals, municipalities, and industries. A review of water rights granted by these agencies showed that drinking water and irrigation water are not obtained from surface water in close proximity to CPNPP. The nearest possible drinking water usage location is associated with the City of Cleburne. The BRA has a municipal/domestic use water contract with the City of Cleburne for 5000 ac-ft/yr. However, according to the BRA, there is no diversion infrastructure in place, and no water has ever been diverted for irrigation or public consumption. The shoreline distance from the Squaw Creek Dam to the assumed drinking water diversion location is approximately 48.8 mi. Since NUREG-1555, Section 5.4 guidance indicates that present and known future drinking water intake locations be considered; the location of the Cleburne water right is conservatively used for evaluation of the drinking water pathway for the maximally exposed individual. The assumed drinking water location is along the Brazos River whereas the proposed diversion location for the City of Cleburne is from Lake Whitney. The proposed diversion location is shown on Figure 5.4-3. The analyzed drinking water location is very conservative because additional dilution in the Lake Whitney volume is not considered.

Given the distance from the confluence of Squaw Creek, the Paluxy River and the Brazos River to the City of Cleburne water right, complete mixing is assumed. The Brazos River monthly average stream flow is 1,234 ft^3/sec. Two cases are evaluated for public doses. The first case, Case 1, uses a minimum discharge from SCR to determine the dose to the maximum exposed individual and the second case, Case 2 uses the expected discharge from SCR to evaluate the population dose. A ratio of the Brazos River monthly average streamflow and the minimum Squaw Creek stream flow, 1.5 ft^3/sec, is used to determine the Case 1 dilution factor of 822.7 for the drinking water pathway for the maximally exposed individual. The dilution factor determined for the more realistic case, Case 2, is 27.2 (ratio of 1,234 ft^3/sec and 45.4 ft^3/sec).

The Squaw Creek and Brazos River stream velocities at mean flow are 0.4 and 1.3 ft/sec, respectively. The shoreline distance from the Squaw Creek Dam to the confluence with the Paluxy River is approximately 4.3 mi (22,704 ft). The shoreline distance from the Squaw Creek confluence of the Paluxy River to the drinking water diversion on the Brazos River is approximately 235,046 ft. These values are used to determine the transit time (66 hr) for the drinking water pathway for the maximally exposed individual. Note that the Brazos River stream velocity is used for the approximately 400 ft along the Paluxy River to the Brazos River (Figure 5.4-1).

Other than the City of Cleburne, located just above Whitney Reservoir, all of the other municipal water rights are approximately 359,057 ft below Squaw Creek Dam immediately below Whitney Reservoir. However, because there is no infrastructure, the actual future use location for these other water rights might be anywhere along Whitney Reservoir; therefore, for the purpose of conservatively calculating transit time, a location at the midpoint of the reservoir is assumed. The transit time for the midpoint of Whitney Reservoir, an additional 50,654 ft downstream, is determined to be 77 hr assuming the average Brazos River stream velocity of 1.3 ft/sec. The dilution factor for the City of Cleburne drinking water diversion location was determined to be 822.7 for Case 1 and 27.2 for Case 2. The dilution factor for the remaining water use locations, which are primarily associated with the City of Whitney, is determined by assuming an additional dilution factor of two (2) due to mixing in the volume of Whitney Reservoir. The resulting dilution factor is 1645.4 for Case 1 and 54.4 for Case 2.

The populations of Cleburne and Whitney from U.S. Census Bureau 2006 data are 29,689 and 2068, respectively. These populations are conservatively increased by 80 percent to 53,440 and 3722 to project the populations to the year 2058.

There is no commercial fish harvest in Squaw Creek, the Brazos River below the Paluxy River, or Whitney Reservoir. In addition, as is typical of freshwater sites, there is no sport or commercial harvest of invertebrates. Aquatic vegetation is not normally consumed in the vicinity surrounding CPNPP; therefore, this pathway is not evaluated.

Current sport fish harvest data is not available for the Brazos River Basin in the vicinity of CPNPP. In addition, outbreaks of golden alga, a microscopic organism that produces toxins causing massive fish kills, were experienced in Lake Granbury, the Brazos River and Whitney Reservoir as recently as March of 2003. Sport species require considerable stocking effort and years to recover naturally from a golden alga outbreak; therefore, creel data for Whitney Reservoir from 1999 – 2000, prior to the golden alga outbreaks, which have impacted fishing and the number of anglers on the reservoir, are used in evaluation of the aquatic foods pathway.

The total number of sport fish harvested by species in Whitney Reservoir from December 1, 1999, through November 29, 2000, was obtained from the Texas Parks and Wildlife Department. Conservative weights of each species were used to estimate the total weight of each species harvested. To account for the lack of creel data for the Brazos River and the future increase in the quantity of sport fish harvested, the total weight of sport fish harvested in 1999 – 2000 is increased by 25 percent. This increase is reasonable because there is no public access to the Brazos River above Whitney Reservoir, and harvest data predates recent fish kills associated with golden alga. See Table 5.4-1 for the Whitney Reservoir sport fish harvest data used in the LADTAP II analysis. The total annual fish harvest of 715,125 lb/yr (324,375 kg/yr) was used in the analysis. Because the annual sport fish harvest is assumed to be caught in both the Brazos River and Whitney Reservoir, the location of the City of Cleburne municipal water diversion above Lake Whitney is conservatively assumed for the determination of the transit time (66 hr) and dilution factor (822.7 Case 1 and 27.2 Case 2) for aquatic foods.

Shoreline usage is evaluated at the mid-point of Lake Whitney Reservoir. The transit time and dilution factor used for the shoreline pathway for Case 1 (minimum discharge from SCR) are 77 hr and 1645.4, respectively. The transit time and dilution factor used for the shoreline pathway for Case 2 (expected discharge from SCR) are 77 hr and 54.4, respectively. The population shoreline usage time for this location is 22,358,746 person-hr/yr. This value is based on Regulatory Guide 1.109 exposure times and age group fractions and 50 percent of the 2058 population within 50 miles of CPNPP. The same parameters used for shoreline use are conservatively applied to the boating and swimming pathways.

Surface water is not commonly used for irrigation in the vicinity of CPNPP Units 3 and 4. Some water is diverted from the Brazos River system downstream of the plant for the purpose of irrigation; however, a review of water rights granted by the TCEQ and BRA showed that it is not used for cultivation of farm products for human consumption. Identified uses are irrigation of grass, hay and oats. Although the acreage irrigated with surface water is normally used for the production of feed for livestock, the irrigated food pathways for vegetables and leafy vegetables will be considered in this evaluation for conservatism.

The total irrigation rate from the Brazos River system within 50 mi of CPNPP is 10,594 ac-ft/yr (1.09E+09 L/mo). The irrigated acreage from the Brazos River system within 50 mi of CPNPP that is used in determination of the irrigation rate is 3600 ac (1.46E+07 m^2). This value is based on TCEQ data conservatively increased by approximately 40 percent to include BRA water contracts that do not identify acreage. The irrigation rate and acreage are used to determine the irrigation rate in the units required for LADTAP II input, 74.6 L/m^2/mo. The total irrigated production of leafy vegetables and other vegetables is given in Table 5.4-1.

The total annual milk production from milk cows and milk goats raised along the Brazos River system within 50 mi of the site is given in Table 5.4-1. The total annual meat production is also given in this table.

The LADTAP II computer program, as described in NUREG/CR-4013, and the liquid pathway parameters presented in Table 5.4-1 and Table 5.4-2 were used to calculate the maximally exposed individual and population dose from this pathway. The LADTAP II program implements the radiological exposure models described in Regulatory Guide 1.109, Revision 1, for radioactivity releases in liquid effluent.

A discussion pertaining to doses calculated for liquid pathways is presented in Subsection 5.4.2.1.

5.4.1.2 Gaseous Pathways

Two release points are considered in the evaluation of off-site dose consequences due to gaseous releases. These release points are the plant vent and the evaporation pond (EP). The purpose of the EP is to prevent tritium concentration in the SCR from exceeding the limit described in the existing CPNPP Off-site Dose Calculation Manual (ODCM) , Revision 26, due to tritium discharge from Units 3 & 4. The EP decreases the level of tritium discharge into the SCR by accepting liquid wastes, including tritium, from the liquid waste management system (LWMS) and evaporating the liquid wastes by natural processes.

The methodology contained in the GASPAR II program (described in NUREG/CR-4653) was used to determine the doses for gaseous pathways. This program implements the radiological exposure models described in Regulatory Guide 1.109, Revision 1, for radioactivity releases in gaseous effluent. The code calculates the radiation exposure to man from:

- External exposure to airborne radioactivity.
- External exposure to deposited activity on the ground.
- Inhalation of airborne activity.
- Ingestion of contaminated agricultural products.

Tables 5.4-3, 5.4-4, and 5.4-5 present the gaseous pathway parameters used to calculate doses for both the maximally exposed individual and for the population. Pathway doses for the maximally exposed individual are determined at the receptor location with the highest atmospheric dispersion (χ/Q) and deposition (D/Q) values. Details of the χ/Q and D/Q calculations are given in Section 2.7. The nearest residence in the south-southwest (SSW) sector results in the highest χ/Q and D/Q values for releases from the plant vent or the evaporation pond. The maximum point of concentration at the EAB is used for evaluation of noble gas external doses. The maximum point of concentration at SCR is used for evaluation of noble gas, ground, and inhalation doses to an individual at SCR for recreational purposes.

Doses due to milk ingestion are determined assuming milk ingestion from both cows and goats. This assumption is conservative because it assumes the individual consumes twice the annual milk ingestion. This assumption is also conservative because, there are no identified milk animals (cows or goats) near the site (within five mi). Where there are no identified milk cows in counties within the 50-mi radius of the plant, or where the number of milk cows was withheld for the 2002 U.S. Department of Agriculture (USDA) agricultural census, data from the 1997 agricultural census were used and assumed to represent current values.

For counties within 50 mi of the Comanche Peak site where the number of milk goats was unavailable, it was assumed that the number of milk goats is equal to the number of milk cows in the county. The dose evaluation conservatively assumed that leafy vegetables are grown all year long and that the maximally exposed individual ingests 76 percent of his annual vegetable intake from his own contaminated garden. It is also assumed that cows and goats are on pasture all year long, and their entire food intake is from the pasture. The population within a 50-mi radius of the CPNPP site, projected to the year 2058, is 3,493,553 persons. Vegetable, milk and meat production data was determined from USDA county farm statistics.

A discussion pertaining to doses calculated for the gaseous pathway is presented in Subsection 5.4.2.2.

5.4.1.3 Direct Radiation from Station Operation

As stated in referenced DCD Subsection 12.4.2.1, the direct radiation from the containment and other plant buildings is negligible. The General Area Monitoring (GAM) program at CPNPP Units 1 and 2 gives an annual average dose rate of 0.001 mrad/hr at the protected area fence. Using this dose rate and assuming the maximum individual spends 134 hours per year at the worst-case location gives an annual dose of 0.134 person-mrad (0.001 mrad/hr * 134 hrs/yr). This is conservative because the nearest location a member of the public would occupy for an extended amount of time is SCR. As described in Section 5.4.3.2, the maximally exposed individual is assumed to use SCR 134 hours per year. Using the dose rate at the PA fence for an individual assumed to be at SCR is very conservative because the dose due to direct radiation decreases by the inverse square of the distance from the source.

5.4.2 RADIATION DOSES TO MEMBERS OF THE PUBLIC

5.4.2.1 Liquid Pathways Doses

Maximum dose rate estimates to man due to liquid effluent releases were determined for the following pathways:

- Eating fish or invertebrates.
- Using the shoreline for activities, such as sunbathing or fishing.
- Swimming and boating.
- Ingestion of contaminated drinking water.
- Consumption of food produced with contaminated water.

The concentrations of radioactive effluents in SCR are estimated using a completely mixed impoundment model (Regulatory Guide 1.113). Table 5.4-6 provides the expected annual liquid radionuclide releases to SCR. The impoundment receives plant effluents and allows additional time for radiological decay before release of effluents to the receiving water body (Squaw Creek). Dilution of the impoundment occurs due to precipitation, flow from tributaries of Squaw Creek, and make-up flow from Lake Granbury. Mixing is promoted by drawing water from the impoundment for Units 1 and 2 plant cooling and return of plant cooling water to SCR. Table 5.4-1 summarizes parameters used in the calculation of nuclide concentrations in SCR.

The estimates for the maximum individual whole-body and critical organ doses from these interactions are presented in Table 5.4-8. These doses would only occur under conditions that maximize the resultant dose. It is unlikely that any individual would receive doses of the magnitude calculated.

5.4.2.2 Gaseous Pathways Doses

Dose rate estimates were calculated for hypothetical individuals of various ages exposed to gaseous radioactive effluents through the following pathways:

- Direct radiation from immersion in the gaseous effluent cloud and from particulates deposited on the ground;
- Inhalation of gases and particulates;
- Ingestion of milk; and
- Ingestion of foods contaminated by gases and particulates.

Tables 5.4-3, 5.4-4 and 5.4-5 provide the parameters used in the gaseous effluents dose evaluation. Table 5.4-7 gives the expected annual gaseous releases for the plant vent and the evaporation pond. Table 5.4-12 provides the estimated whole-body and critical organ doses for the identified gaseous effluent pathways. These doses would only occur under conditions that maximize the resultant dose. It is unlikely that any individual would receive doses of the magnitude calculated. The doses to the maximally exposed individual at SCR due to normal effluent releases from the plant vent and the evaporation pond are also calculated. These doses are calculated at the point of maximum exposure at SCR, which occurs at a distance of 0.10 miles NNW of Units 3 and 4 for plant vent releases and at a distance of 0.41 miles NNW of the evaporation pond for evaporation pond releases.

5.4.3 IMPACTS TO MEMBERS OF THE PUBLIC

5.4.3.1 Impacts from Liquid Pathways

The most conservative maximum individual dose resulted from Case 1, which used the minimum flow from SCR to Squaw Creek. The maximally exposed individual dose calculated was compared to 10 CFR 50, Appendix I criteria and is presented in Table 5.4-8. The estimated maximum individual doses are compared to the 10 CFR 20.1301 criteria in Table 5.4-9. The maximally exposed individual dose calculated for all units at the site was also compared to 40 CFR 190 criteria and is presented in Table 5.4-10. The estimated population dose due to liquid effluent releases is given in Table 5.4-11. The most conservative population dose resulted from Case 2, which used a higher (more realistic) flow from SCR to Squaw Creek.

5.4.3.2 Impacts from Gaseous Pathways

The gaseous effluent release pathway dose to maximally exposed individuals is given in Table 5.4-12. Table 5.4-13 gives a comparison between the calculated maximally exposed individual dose and 10 CFR 50, Appendix I criteria. In addition, the maximally exposed individual gaseous effluent dose calculated for all units at the site was also compared to 40 CFR 190 criteria (Table 5.4-14). The maximum doses to an individual using SCR for recreational activities are given in Table 5.4-27. The doses to the maximally exposed individual at SCR were calculated based on a person occupying the worst-case location for 134 hours per year. The number of hours was conservatively assumed to be twice the number of hours of shoreline exposure for the maximum age group from Table E-5 of RG 1.109. The doses to an individual at SCR were conservatively included in the maximum individual doses even though SCR is a restricted area per the definition provided in 10 CFR 20.1003 because CPNPP has control of access to the reservoir and has restricted public access in the past.

The population dose due to gaseous effluents from CPNPP Units 3 and 4 was also calculated. The population within a 50-mi radius of the CPNPP site was projected to the year 2058 using the cohort component method. The population dose for the various pathways (immersion, inhalation, ingestion, recreational use of SCR, and ground deposition) is provided in Table 5.4-15.

5.4.3.3 Direct Radiation Doses

As reported in the CPNPP Units 1 and 2 Annual Radiological Environmental Operating Report for 2006, the background radiation dose rate equivalent for the area surrounding Fort Worth, Texas is 0.22 mrad/day. This calculated value varies widely with changes in location but represents an appropriate reference value to compare with actual measured thermoluminescence dosemeter (TLD) readings. Using data from the pre-operational program for the two years prior to the startup of Unit 1, the quarterly TLDs averaged a calculated dose rate of 0.14 mrad/day while the yearly TLDs averaged a calculated dose rate of 0.16 mrad/day. The range of measured values from this same two-year period varied from a minimum of 0.11 mrad/day to a maximum of 0.22 mrad/day. For comparative purposes, a minimum dose rate of 0.11 mrad/day will be assumed for natural background radiation giving an annual background dose of 0.04 rad.

The dose due to direct radiation and skyshine from all units on-site is reported in Table 5.4-16. Population doses resulting from natural background radiation to individuals living within a 50-mi radius of the CPNPP site are also presented in this table for comparison.

Radioactive wastes stored inside the plant structures are shielded so that areas outside the structures meet Radiation Zone I criteria. If it becomes necessary to temporarily store radioactive wastes/materials outside the plant structures, radiation protection measures will be taken by the radiation protection staff to ensure compliance with 10 CFR 20 and to be consistent with the recommendations of RG 8.8.

5.4.4 IMPACTS TO BIOTA OTHER THAN MEMBERS OF THE PUBLIC

Radiation exposure pathways to biota other than man or members of the public are examined to determine if the pathways could result in doses to biota greater than those predicted for man. This assessment uses surrogate species that provide representative information on the various dose pathways potentially affecting broader classes of living organisms. Surrogates are used because important attributes are well defined and are accepted as a method for judging doses to biota. Important biota considered are state or federally listed species that are endangered, threatened, commercial, recreationally valuable, or important to the local ecosystem.

Table 5.4-17 identifies important biota from Section 2.4 and the assigned surrogates in this assessment. Surrogate biota used includes algae (also taken as aquatic plants), invertebrates (taken as fresh water mollusks and crayfish), fish, muskrat, raccoon, duck, and heron. The assessment uses dose pathway models adopted from Regulatory Guide 1.109. Pathways included are:

- Ingestion of aquatic foods including fish, invertebrates, and aquatic plants.
- Ingestion of water.

- External exposure water immersion or surface effect.
- External exposure to shoreline deposits.
- Inhalation of airborne nuclides.
- External exposure to immersion in gaseous effluent plumes.
- Surface exposure from deposition of iodine and particulates from gaseous effluents.

Internal exposures to biota from the accumulation of radionuclides from aquatic food pathways are determined using element-dependent bioaccumulation factors. The terrestrial doses are calculated as total body doses resulting from the consumption of aquatic plants, fish, and invertebrates. The terrestrial doses are the result of the amount of food ingested, and the previous uptake of radioisotopes by the food organism. The total body doses are calculated using the bioaccumulation factors corresponding to the food organisms and dose conversion factors for adult man modified for terrestrial animal body mass and size. The use of the adult factors is conservative because the full 50-year dose commitment predicted by the adult ingestion factors would not be received by biota due to their shorter life spans. The model in Regulatory Guide 1.109 shows that the largest contributions to biota doses are from liquid effluents via the food pathway.

5.4.4.1 Liquid Effluents

The model used for estimating nuclide concentrations is similar to that used in the analysis for doses to man (Subsection 5.4.2).

The calculation of biota doses was performed using LADTAP II (NUREG/CR-4013). Doses to biota are estimated at SCR, and no credit is taken for dilution or transit time from the outflow. Downstream of the SCR Dam, additional dilution and radioactive decay occur, resulting in lower nuclide concentrations and doses to biota. This assessment, however, is made for the higher doses occurring in or near SCR.

Food consumption, body mass, and effective body radii used in the dose calculations are shown in Table 5.4-18. Residence times for the surrogate species are shown in Table 5.4-19 (NUREG/CR-4013). Table 5.4-20 summarizes parameters and references used in the LADTAP II pathways dose models. Surrogate biota doses from liquid effluents for all units on-site are shown in Table 5.4-21.

5.4.4.2 Gaseous Effluents

Doses from gaseous effluents also contribute to terrestrial total body doses. External doses occur due to immersion in a plume of noble gases and deposition of radionuclides on the ground. The inhalation of radionuclides followed by the subsequent transfer from the lung to the rest of the body also contributes to total body doses. Inhaled noble gases are poorly absorbed into the blood and do not contribute significantly to the total body dose. The noble gases do contribute to a lung organ dose, but do not make a contribution via this path to the total body dose.

Immersion and ground deposition doses are largely independent of organism size and the doses for the maximally exposed individual (Subsection 5.4.2) can be applied. The external ground doses (Subsection 5.4.2) calculated by GASPAR II are increased to account for the closer proximity to ground of terrestrials (NUREG/CR-4653). This approach is similar to the adjustments made for biota exposures to shoreline sediment performed in LADTAP II. Doses from gaseous effluents to terrestrials are also adjusted for site residency times and are based on Table 5.4-19. The inhalation pathway doses for biota are the internal total body doses calculated by GASPAR II for man (Subsection 5.4.2). The total body inhalation dose (rather than organ specific doses) is used because the biota doses are assessed on a total body basis. Table 5.4-20 summarizes the parameters and references used in the GASPAR II gaseous effluent dose models. The dose to biota on a per unit basis is given in Table 5.4-22.

5.4.4.3 Biota Doses

The following discussion is based on the cumulative impacts from all units on-site. Doses to biota from liquid and gaseous effluents are shown in Table 5.4-23. Table 5.4-23 shows those doses compared with the whole body dose equivalent criterion in 40 CFR 190. Dose criteria are applicable to man and are considered conservative when applied to biota. The criteria in 40 CFR 190 for thyroid and next highest organ doses are not used in this analysis because doses are based on total body doses. The total body dose is taken as the sum of the internal and external dose. In man, the internal dose from individual organs is weighted by factors less than unity to arrive at the whole body dose equivalent. Thus, a unity factor is assumed for the entire internal dose. Table 5.4-23 shows that annual doses to the seven surrogates exceed the requirements of 40 CFR 190 for all units at a site.

Use of exposure guidelines, such as 40 CFR 190, which apply to members of the public in unrestricted areas, is considered very conservative when evaluating calculated doses to biota. The International Council on Radiation Protection states that “...if man is adequately protected then other living things are also likely to be sufficiently protected,” and uses human protection to infer environmental protection from the effects of ionizing radiation (ORNL 1995). This assumption is appropriate in cases where humans and other biota inhabit the same environment and have common routes of exposure. It is less appropriate in cases where human access is restricted or pathways exist that are much more important for biota than for humans. Conversely, it is also known that biota with the same environment and exposure pathways as man can experience higher doses without adverse effects.

Species in most ecosystems experience dramatically higher mortality rates from natural causes than man. From an ecological viewpoint, population stability is considered more important to the survival of the species than the survival of individual organisms. Thus, higher dose limits could be permitted. In addition, no biota has been discovered that show significant changes in morbidity or mortality to radiation exposures predicted for nuclear power plants.

An international consensus has been developing with respect to permissible dose exposures to biota. The International Atomic Energy Agency (IAEA) evaluated available evidence (ORNL 1995) including the Recommendations of the International Commission on Radiological Protection. The IAEA found that appreciable effects in aquatic populations would not be expected at doses lower than one unit of absorbed dose (100 ergs/gm) per day (1 rad/day) and that limiting the dose to the maximally exposed individual organisms to less than 1 rad/day would provide adequate protection of the population. The IAEA also concluded that chronic dose rates of 0.1 rad/day or less do not appear to cause observable changes in terrestrial animal populations. The assumed lower threshold occurs for terrestrials rather than for aquatic animals primarily because some species of mammals and reptiles are considered more radiosensitive than aquatic organisms. The permissible dose rates are considered screening levels and higher species-specific dose rates could be acceptable with additional study or data.

The calculated total body doses for biota are compared in Table 5.4-24 to the dose criteria evaluated in the Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards (ORNL 1995). The biota doses meet the dose guidelines except for the dose to the Heron, which is approximately twice the guideline dose. This result is acceptable due to the very conservative nature of the evaluation and fact that the guideline dose is only intended for screening purposes. Conservatisms incorporated into the biota doses include use of adult dose factors, conservative isotopic releases source terms, conservative treatment of the radionuclide transport mechanisms, and conservative dose criteria. As presented above, population stability is considered more important to the survival of the species than the survival of individual organisms. Thus, higher dose limits could be permitted.

5.4.5 OCCUPATIONAL RADIATION EXPOSURES

This subsection provides a discussion of the anticipated occupational radiation exposure to CPNPP Units 3 and 4 operating personnel. Estimates of these radiation doses are intended to provide a quantitative basis for the regulatory assessment of the potential risks and health impact to operating personnel.

Similar to current plant designs, occupational exposure from the operation of advanced reactor designs will continue to result from exposure to direct radiation from contained sources of radioactivity and from the small amounts of airborne sources typically resulting from equipment leakages. Past experience demonstrates that, for commercial nuclear power reactors, the dose to operating personnel from airborne activity is not a significant contributor to the total occupational dose. This experience is expected to apply to CPNPP Units 3 and 4.

As indicated in NUREG-1437, for the purpose of assessing radiological impacts to workers, the Commission has concluded that impacts are of small significance if doses and releases do not exceed permissible levels in the Commission’s regulations. The standards for acceptable dose limits are given in 10 CFR Part 20. For CPNPP, the radiation exposures to operating personnel will be maintained within the limits of 10 CFR 20 and will also satisfy the as low as reasonably achievable (ALARA) guidance contained in Standard Review Plan 12.1 and Regulatory Guide 8.8.

Administrative programs and procedures governing Radiation Protection and Health Physics in conjunction with the radiation protection design features of the US-APWR will be developed with the intent to maintain occupational radiation exposures ALARA. Consequently, for environmental impact assessment purposes, it is reasonable to expect and conclude that the annual operator exposures for CPNPP Units 3 and 4 would be bounded by the operating experience exhibited by existing operating light water reactors.

The average annual collective occupational dose information for LWR plants operating in the United States between 1973 and 2006 is given in Table 5.4-25, based on data provided in NUREG-0713. The more recent dose data presented in this report are based on 69 operating pressurized water reactors (PWRs). The data show that, historically (since 1973), the average collective dose and average number of workers for PWRs, in general, continued to rise until 1983. Thereafter (data through 2006), the average collective dose per LWR dropped by approximately 85 percent. The overall decreasing trend in average reactor collective doses since 1983 is indicative of successful implementation of ALARA dose reduction measures at commercial power reactor facilities.

The variation in annual collective dose at operating reactors results from a number of factors such as the amount of required maintenance, the amount of reactor operations, and required in-plant surveillances. These factors have varied in the past, but are expected to improve with the US-APWR design.

The 3-year average collective dose per reactor is one of the metrics that the NRC uses in the Reactor Oversight Program to evaluate the effectiveness of a licensee's ALARA program. Table 5.4-26 shows that PWR commercial reactor sites in operation for at least 3 year as of December 31, 2006, and detail the occupational exposure statistics. As presented in Table 5.4-26, the average annual collective total effective dose equivalent (TEDE) per reactor is 79 person-rem.

Using this metric, an estimate of the average annual collective TEDE dose for CPNPP Units 3 and 4 is 160 person-rem. The average annual individual worker dose of about 0.13 rem at operating PWRs is well within the limits of 10 CFR 20. These exposures are considered to be of small significance and pose a risk that is comparable to the risks associated with other industrial occupations.

5.4.6 REFERENCES

(ORNL 1995) Oak Ridge National Laboratory (ORNL). “EFFECTS OF IONIZING RADIATION ON TERRESTRIAL PLANTS AND ANIMALS: A WORKSHOP REPORT”, ORNL/TM-13141,Oak Ridge National Laboratory. 1995.

TABLE 5.4-1 (Sheet 1 of 2)
LIQUID EFFLUENT PATHWAY PARAMETERS

Description	Parameter
Completely Mixed Impoundment Model	
SCR Volume[(a)]	144,700 ac-ft (6.3E+09 ft^3)
Effluent Discharge Flow rate	247,500 gpm
SCR minimum discharge flow rate (Case 1)	1.5 ft^3/s
SCR expected average discharge flow rate (Case 2)	45.4 ft^3/s (32,900 ac-ft/year)
Midpoint of plant life	30 yr
Maximally Exposed Individual	
Shoreline and fishing use location	On SCR
Shore-width factor (Squaw Creek)	0.2
Shore-width factor (SCR)	0.3
Squaw Creek stream velocity	0.4 ft/sec
Transit time to location of maximum individual dose	7.3 hr
Transit time (SCR)	0.0
Dilution factor for Squaw Creek	1
Dilution factor for SCR	1
Downstream distance to first potential drinking water location (City of Cleburne diversion)	
Along Squaw Creek	4.3 mi (22,704 ft)
Along Paluxy and Brazos Rivers	44.5 mi (235,046 ft)
Brazos River stream velocity	1.3 ft/sec
Transit time to first potential drinking water location	66 hr
Brazos River monthly average stream flow	1,234 ft^3/sec
Dilution factor for drinking closest drinking water (Case 1) (complete mixing of Squaw Creek and Brazos River)	822.7
Dilution factor for drinking closest drinking water (Case 2) (complete mixing of Squaw Creek and Brazos River)	27.2
Population Dose	
2058 projected 50-mile population including transients	3,493,553 persons
Location of potential drinking water location	
City of Cleburne diversion	given above
City of Whitney diversions	9.6 mi (50,654 ft) downstream of Cleburne
Transit time to assumed City of Whitney diversion	77 hr
Dilution factor for drinking water, multiplied by a factor of two for dilution in Whitney Reservoir (Case 1)	1645.4 (822.7*2)

TABLE 5.4-1 (Sheet 2 of 2)
LIQUID EFFLUENT PATHWAY PARAMETERS

Description	Parameter
Dilution factor for drinking water, multiplied by a factor of two for dilution in Whitney Reservoir (Case 2)	54.4 (27.2*2)
Projected population of Cleburne	53,440
Projected population of Whitney	3,722
Distance to assumed location of fish harvest (above Whitney Reservoir, City of Cleburne diversion)	given above
Total annual fish harvest, Whitney Reservoir and the Brazos River	715,125 lb/yr (324,375 kg/yr)
Transit time for aquatic food	66 hrs
Dilution factor for aquatic foods (Case 1 / Case 2)	822.7 / 27.2
Downstream distance of shoreline, boating and swimming use (midpoint of Whitney Reservoir)	9.6 mi (50,654 ft) downstream of Cleburne
Shore-width factor for shoreline use (Whitney Reservoir)	0.3
Transit time for recreational usage	77 hr
Dilution factor for recreational usage (Case 1 / Case 2)	1645.4 / 54.2
Shoreline, boating and swimming usage based on RG 1.109 exposure times and age group fractions and 50 percent of the 50 mile population (population dose due to public use of SCR is estimated to be 250 times the maximum SCR individual dose based on an estimated maximum usage of 250 people)	22,358,746 person-hr/yr (each activity)
Location of assumed irrigation diversion (City of Cleburne)	given above
Transit time for irrigation usage	66 hr
Dilution factor (Case 1 / Case 2)	822.7 / 27.2
Irrigation rate	74.6 $L/m^2/mo$
Total Meat Production along the Brazos River	281,000 (kg/yr)
Total Milk Production along the Brazos River	943,000 (l/yr)
Irrigated Agricultural Products along the Brazos River	
Total Leafy Vegetables	54,038 lb/yr (25,000 kg/yr)
Total All Other Vegetables	11,619,279 lb/yr (5,270,000 kg/yr)

a) Based on USGS minimum pool elevation of 772.98 ft

Note: Default values from RG 1.109 used for all input values not listed above.

TABLE 5.4-2
LIQUID PATHWAY CONSUMPTION FACTORS FOR THE MAXIMUM EXPOSED INDIVIDUAL

Pathway	Adult	Teen	Children	Infant
Fish consumption	21 kg/yr	16 kg/yr	6.9 kg/yr	NA
Shoreline usage	12 hr/yr	67 hr/yr	14 hr/yr	NA
Swimming exposure (assumed same as shoreline)	12 hr/yr	67 hr/yr	14 hr/yr	NA
Boating	12 hr/yr	67 hr/yr	14 hr/yr	NA

Source: Regulatory Guide 1.109
Consumption factors from Regulatory Guide 1.109 Table E-5 used in lieu of site specific values.

TABLE 5.4-3 (Sheet 1 of 2)
GASEOUS EFFLUENT PATHWAY PARAMETERS

Description	Value
Population Data	Table 5.4-5
Milk Production	908,000,000 l/yr
Vegetable Production	481,000,000 kg/yr
Meat Production	42,500,000 kg/yr
Source Term	Table 5.4-7
Nearest Residence (for plant vent release)	0.79 mi SSW
Point of Maximum Concentration at the EAB (for plant vent release)	0.37 mi NNW
Nearest Residence (for evaporation pond release)	0.31 mi SSW
Midpoint of plant life	30 yrs
Nearest Residence χ/Q and D/Q values for plant vent release	
No decay, undepleted	$4.4x10^{-7}$ s/m^3
2.26 day decay, undepleted	$4.4x10^{-7}$ s/m^3
8 day decay, depleted	$3.9x10^{-7}$ m^{-2}
D/Q for maximum individual dose calculation	$4.5x10^{-9}$ m^{-2}
EAB χ/Q and D/Q values for plant vent release	
No decay, undepleted	$5.5x10^{-6}$ s/m^3
2.26 day decay, undepleted	$5.5x10^{-6}$ s/m^3
8 day decay, depleted	$5.1x10^{-6}$ s/m^3
D/Q for maximum individual dose calculation	$5.5x10^{-8}$ m^{-2}
Nearest Residence χ/Q and D/Q values for evaporation pond release	
No decay, undepleted	$3.10x10^{-6}$ s/m^3
2.26 day decay, undepleted	$3.10x10^{-6}$ s/m^3
8 day decay, depleted	$2.90x10^{-6}$ s/m^3
D/Q for maximum individual dose calculation	$2.10x10^{-8}$ m^{-2}
Annual Average χ/Q (worst location)	$4.4x10^{-7}$ s/m^3
Annual Average D/Q (worst location)	$4.5x10^{-9}$ m^{-2}
Annual Average Decayed χ/Q (worst location)	$3.9x10^{-7}$ s/m^3 for 8.00 day decay (depleted)

TABLE 5.4-3 (Sheet 2 of 2)
GASEOUS EFFLUENT PATHWAY PARAMETERS

Description	Value
SCR χ/Q and D/Q values for plant vent release	
No decay, undepleted	6.0×10^{-5} s/m^3
2.26 day decay, undepleted	6.0×10^{-5} s/m^3
8.00 day decay, depleted	5.6×10^{-5} s/m^3
D/Q for maximum individual dose calculation	3.9×10^{-7} m^{-2}
SCR χ/Q and D/Q values for evaporation pond release	
No decay, undepleted	7.9×10^{-6} s/m^3
2.26 day decay, undepleted	7.9×10^{-6} s/m^3
8.00 day decay, depleted	7.3×10^{-6} s/m^3
D/Q for maximum individual dose calculation	4.8×10^{-8} m^{-2}
Fraction of the year that leafy vegetables are grown.	1
Fraction of the year that milk cows are on pasture.	1
Fraction of the maximum individual's vegetable intake that is from his own garden.	0.76
Fraction of milk-cow feed intake that is from pasture while on pasture.	1
Average absolute humidity over the growing season	8 g/m^3
Fraction of the year that goats are on pasture.	1
Fraction of milk-goats feed intake that is from pasture while on pasture.	1
Fraction of the year that beef cattle are on pasture.	1
Fraction of beef-cattle feed intake that is from pasture while the cattle are on pasture	1

Note: Default values from RG 1.109 used for all input values not listed above.

TABLE 5.4-4
GASEOUS PATHWAYS CONSUMPTION FACTORS FOR THE MAXIMUM EXPOSED INDIVIDUAL

Pathway	Adult	Teen	Children	Infant
Leafy Vegetables	64 kg/yr	42kg/yr	26 kg/yr	NA
Meat	110 kg/yr	65 kg/yr	41 kg/yr	NA
Milk	310 L/yr	400 L/yr	330 L/yr	330 L/yr
Vegetable	520 kg/yr	630 kg/yr	520 kg/yr	NA

Source: Regulatory Guide 1.109

Note: Consumption factors from Regulatory Guide 1.109 Table E-5 in lieu of site specific values.

TABLE 5.4-5 (Sheet 1 of 6)
POPULATION DISTRIBUTION

Direction	Distance	2058 Permanent Population	2058 Transient Population	2058 Total Population
N	0-1 mi	0	0	0
NNE	0-1 mi	0	0	0
NE	0-1 mi	0	0	0
ENE	0-1 mi	0	0	0
E	0-1 mi	0	0	0
ESE	0-1 mi	0	0	0
SE	0-1 mi	0	0	0
SSE	0-1 mi	0	0	0
S	0-1 mi	0	0	0
SSW	0-1 mi	16	0	16
SW	0-1 mi	15	0	15
WSW	0-1 mi	33	0	33
W	0-1 mi	13	0	13
WNW	0-1 mi	1	0	1
NW	0-1 mi	1	0	1
NNW	0-1 mi	0	0	0
N	1-2 mi	13	0	13
NNE	1-2 mi	17	0	17
NE	1-2 mi	11	0	11
ENE	1-2 mi	0	0	0
E	1-2 mi	0	0	0
ESE	1-2 mi	4	0	4
SE	1-2 mi	25	0	25
SSE	1-2 mi	40	0	40
S	1-2 mi	114	0	114
SSW	1-2 mi	126	0	126
SW	1-2 mi	95	0	95
WSW	1-2 mi	63	46	109
W	1-2 mi	17	0	17

TABLE 5.4-5 (Sheet 2 of 6)
POPULATION DISTRIBUTION

Direction	Distance	2058 Permanent Population	2058 Transient Population	2058 Total Population
WNW	1-2 mi	5	0	5
NW	1-2 mi	3	0	3
NNW	1-2 mi	1	0	1
N	2-3 mi	39	0	39
NNE	2-3 mi	39	0	39
NE	2-3 mi	37	0	37
ENE	2-3 mi	25	0	25
E	2-3 mi	84	0	84
ESE	2-3 mi	74	0	74
SE	2-3 mi	151	0	151
SSE	2-3 mi	265	0	265
S	2-3 mi	40	0	40
SSW	2-3 mi	19	0	19
SW	2-3 mi	33	0	33
WSW	2-3 mi	31	0	31
W	2-3 mi	31	0	31
WNW	2-3 mi	12	0	12
NW	2-3 mi	7	0	7
NNW	2-3 mi	17	0	17
N	3-4 mi	111	0	111
NNE	3-4 mi	92	0	92
NE	3-4 mi	228	0	228
ENE	3-4 mi	46	0	46
E	3-4 mi	141	0	141
ESE	3-4 mi	82	0	82
SE	3-4 mi	96	4548	4644
SSE	3-4 mi	136	0	136
S	3-4 mi	29	0	29
SSW	3-4 mi	29	1106	1135

TABLE 5.4-5 (Sheet 3 of 6)
POPULATION DISTRIBUTION

Direction	Distance	2058 Permanent Population	2058 Transient Population	2058 Total Population
SW	3-4 mi	35	0	35
WSW	3-4 mi	62	0	62
W	3-4 mi	105	0	105
WNW	3-4 mi	57	0	57
NW	3-4 mi	8	0	8
NNW	3-4 mi	32	0	32
N	4-5 mi	266	0	266
NNE	4-5 mi	180	0	180
NE	4-5 mi	282	0	282
ENE	4-5 mi	146	0	146
E	4-5 mi	37	0	37
ESE	4-5 mi	145	0	145
SE	4-5 mi	242	3436	3679
SSE	4-5 mi	1314	0	1314
S	4-5 mi	191	397	588
SSW	4-5 mi	32	0	32
SW	4-5 mi	70	0	70
WSW	4-5 mi	29	0	29
W	4-5 mi	161	0	161
WNW	4-5 mi	110	0	110
NW	4-5 mi	6	0	6
NNW	4-5 mi	114	0	114
N	5-10 mi	18,648	56,273	74,921
NNE	5-10 mi	12,807	113	12,920
NE	5-10 mi	5077	396	5473
ENE	5-10 mi	5377	0	5377
E	5-10 mi	340	0	340
ESE	5-10 mi	1162	0	1162
SE	5-10 mi	928	991	1920

TABLE 5.4-5 (Sheet 4 of 6)
POPULATION DISTRIBUTION

Direction	Distance	2058 Permanent Population	2058 Transient Population	2058 Total Population
SSE	5-10 mi	3217	2701	5917
S	5-10 mi	683	471	1153
SSW	5-10 mi	369	0	369
SW	5-10 mi	206	0	206
WSW	5-10 mi	204	0	204
W	5-10 mi	313	0	313
WNW	5-10 mi	560	0	560
NW	5-10 mi	1974	321	2295
NNW	5-10 mi	1949	0	1949
N	10-20 mi	16,062	256	16,318
NNE	10-20 mi	12,609	203	12,812
NE	10-20 mi	6788	162	6950
ENE	10-20 mi	4410	0	4410
E	10-20 mi	2119	539	2658
ESE	10-20 mi	836	0	836
SE	10-20 mi	500	0	500
SSE	10-20 mi	382	0	382
S	10-20 mi	1650	0	1650
SSW	10-20 mi	360	419	780
SW	10-20 mi	903	2	905
WSW	10-20 mi	888	0	888
W	10-20 mi	645	0	645
WNW	10-20 mi	925	0	925
NW	10-20 mi	1201	42	1243
NNW	10-20 mi	6649	11	6660
N	20-30 mi	14,807	10,622	25,429
NNE	20-30 mi	12,527	0	12,527
NE	20-30 mi	17,815	0	17,815
ENE	20-30 mi	67,032	0	67,032

TABLE 5.4-5 (Sheet 5 of 6)
POPULATION DISTRIBUTION

Direction	Distance	2058 Permanent Population	2058 Transient Population	2058 Total Population
E	20-30 mi	71,297	23,687	94,985
ESE	20-30 mi	3528	0	3528
SE	20-30 mi	2778	0	2778
SSE	20-30 mi	4130	1034	5164
S	20-30 mi	1003	0	1003
SSW	20-30 mi	2903	0	2903
SW	20-30 mi	1528	0	1528
WSW	20-30 mi	31,690	8810	40,500
W	20-30 mi	5302	0	5302
WNW	20-30 mi	1675	0	1675
NW	20-30 mi	2789	0	2789
NNW	20-30 mi	5089	0	5089
N	30-40 mi	64,275	74,352	138,627
NNE	30-40 mi	125,265	169	125,434
NE	30-40 mi	579,473	114,717	694,190
ENE	30-40 mi	122,405	11,617	134,023
E	30-40 mi	16,681	0	16,681
ESE	30-40 mi	7779	0	7779
SE	30-40 mi	16,749	17,411	34,161
SSE	30-40 mi	7157	7671	14,827
S	30-40 mi	1320	0	1320
SSW	30-40 mi	451	0	451
SW	30-40 mi	1488	0	1488
WSW	30-40 mi	10,651	0	10,651
W	30-40 mi	2108	0	2108
WNW	30-40 mi	1691	0	1691
NW	30-40 mi	2885	0	2885
NNW	30-40 mi	38,695	19,917	58,611
N	40-50 mi	30,146	215	30,361

TABLE 5.4-5 (Sheet 6 of 6)
POPULATION DISTRIBUTION

Direction	Distance	2058 Permanent Population	2058 Transient Population	2058 Total Population
NNE	40-50 mi	143,955	1631	145,586
NE	40-50 mi	978,773	267,143	1,245,916
ENE	40-50 mi	270,180	0	270,180
E	40-50 mi	17,747	0	17,747
ESE	40-50 mi	18,881	0	18,881
SE	40-50 mi	4755	0	4755
SSE	40-50 mi	4559	12	4572
S	40-50 mi	3655	0	3655
SSW	40-50 mi	4957	1974	6930
SW	40-50 mi	1424	0	1424
WSW	40-50 mi	5304	0	5304
W	40-50 mi	923	0	923
WNW	40-50 mi	1495	0	1495
NW	40-50 mi	1440	0	1440
NNW	40-50 mi	10,106	0	10,106
		2,860,136	633,417	3,493,553

TABLE 5.4-6
ESTIMATED LIQUID RADIONUCLIDE RELEASES

Released Activity (one unit, Ci/yr)

Na-24	4.70E-03	Ru-106	3.81E-02
P-32	0.00E+00	Ag-110m	6.00E-04
Cr-51	1.30E-03	Sb-124	0.00E+00
Mn-54	7.00E-04	Te-129m	7.80E-05
Fe-55	5.00E-04	Te-129	3.10E-04
Fe-59	1.00E-04	Te-131m	2.50E-04
Co-58	1.90E-03	Te-131	7.60E-05
Co-60	0.00E+00	I-131	4.00E-04
Ni-63	0.00E+00	Te-132	4.70E-04
Zn-65	2.20E-04	I-132	3.10E-04
W-187	3.50E-04	I-133	8.10E-04
Np-239	5.30E-04	I-134	8.90E-05
Rb-88	2.80E-02	Cs-134	1.00E-03
Sr-89	6.00E-05	I-135	7.80E-04
Sr-90	8.00E-06	Cs-136	2.16E-02
Sr-91	6.80E-05	Cs-137	2.00E-03
Y-91m	4.40E-05	Ba-140	4.89E-03
Y-91	1.00E-05	La-140	8.00E-03
Y-93	3.10E-04	Ce-141	6.00E-05
Zr-95	2.00E-04	Ce-143	5.00E-04
Nb-95	1.00E-04	Pr-143	7.90E-05
Mo-99	1.64E-03	Ce-144	1.70E-03
Tc-99m	1.70E-03	Pr-144	1.70E-03
Ru-103	3.11E-03	Total (except H-3)	1.29E-01
		H-3	1.60E+03

Notes:

1. CPNPP Units 3 and 4 will not have an on-site laundry therefore detergent wastes listed in the DCD source term are not included in the above listing.

2. LADTAP II calculations can only be performed for radionuclides that are included in the LADTAP dose conversion factor library. As a result, releases of Rh-103m, Rh-106, AG-110, and Ba-137m are not used in this analysis. Given the relatively short half-lives of these radionuclides, 56.12 minutes, 29.92 seconds, 24.57 seconds and 2.55 minutes, respectively, the effect of this omission is considered negligible.

TABLE 5.4-7 (Sheet 1 of 2)
ESTIMATED GASEOUS RADIONUCLIDE RELEASES

Plant Vent
(per unit)

Isotope	Annual Release (Ci)
I131	4.20E-03
I133	6.40E-02
KR85	1.40E+03
XE131M	2.60E+02
XE133M	2.00E+00
XE135M	4.00E+00
XE135	2.00E+00
XE137	4.00E+00
XE138	1.00E+00
H3	1.80E+02
C14	7.30E+00
AR41	3.40E+01
CR51	6.10E-04
MN54	4.30E-04
CO57	8.20E-06
CO58	2.30E-02
CO60	8.80E-03
FE59	7.90E-05
SR89	3.00E-03
SR90	1.20E-03
ZR95	1.00E-03
NB95	2.50E-03
RU103	8.00E-05
RU106	7.80E-05
SB125	6.10E-05
CS134	2.30E-03
CS136	8.50E-05
CS137	3.60E-03
BA140	4.20E-04
CE141	4.20E-05

TABLE 5.4-7 (Sheet 2 of 2)
ESTIMATED GASEOUS RADIONUCLIDE RELEASES

Evaporation Pond

Nuclide	(Ci/yr)	Nuclide	(Ci/yr)
NA 24	2.35E-03	AG110	3.60E-05
P 32	0.00E+00	SB124	0.00E+00
CR 51	6.50E-04	RH106	1.95E-02
MN 54	3.50E-04	AG110M	3.00E-04
FE 55	2.50E-04	TE129M	3.90E-05
FE 59	5.00E-05	TE129	1.55E-04
CO 58	9.50E-04	TE131M	1.25E-05
CO 60	0.00E+00	TE131	3.80E-05
NI 63	0.00E+00	I131	2.00E-04
ZN 65	1.10E-04	TE132	2.35E-04
W187	1.75E-04	I132	1.55E-04
NP239	2.65E-04	I133	4.05E-04
RB 88	1.40E-02	I134	4.45E-05
SR 89	3.00E-05	CS134	5.00E-04
SR 90	4.00E-06	I135	3.90E-04
SR 91	3.40E-05	CS136	1.08E-02
Y 91M	2.20E-05	CS137	1.00E-03
Y 91	5.00E-06	BA137M	2.30E-04
Y 93	1.45E-04	BA140	2.45E-03
ZR 95	1.00E-04	LA140	4.00E-03
NB 95	5.00E-05	CE141	3.00E-05
MO 99	8.20E-04	CE143	2.50E-04
TC 99M	8.50E-04	PR143	3.95E-05
RU103	1.56E-03	CE144	8.50E-04
RH103M	1.55E-03	PR144	8.50E-04
RU106	1.91E-02	H-3	8.00E+02
Total	4.34E-02		8.00E+02

TABLE 5.4-8
ESTIMATED MAXIMUM INDIVIDUAL DOSE FROM LIQUID EFFLUENTS
(MREM/YR, PER UNIT)

Dose	Appendix I Objective	CPNPP Unit 3 or 4 Assessment
Total Body		
Shoreline Use		1.95E-03
Water Ingestion		6.39E-03
Fish Ingestion		8.83E-01
Irrigated Foods		8.91E-03
Total	**3**	**9.00E-01**[(a)]
Maximum Organ		
Shoreline Use[(c)]		1.09E-02
Water Ingestion		4.51E-03
Fish Ingestion		1.26E+00
Irrigated Foods		1.04E-02
Total	**10**	**1.29E-00** [(b)]

Notes:

(a) An adult receives the maximum individual total body dose.

(b) A teenager receives the maximum individual organ dose, which is to the liver.

(c) SCR provides the maximum individual exposure.

TABLE 5.4-9
10 CFR 20.1301 COMPARISON ESTIMATED MAXIMUM INDIVIDUAL DOSE FROM LIQUID EFFLUENTS (MREM/YR, PER UNIT)

Dose	10 CFR 20.1301 Objective	CPNPP Unit 3 or 4 Assessment
Total Body	-	9.00E-01[(a)]
Thyroid Dose	-	1.53E-01
TEDE	100	9.05E-01[(b)]
Dose in any hour (mrem/hr)	2	1.03E-04

a) An adult receives the maximum individual total body dose.

b) The total effective dose equivalent (TEDE) is approximated by the sum of the whole body dose and 3 percent of the thyroid dose. (Regulatory Guide 1.183)

TABLE 5.4-10
DOSE EQUIVALENT FROM LIQUID EFFLUENTS TO ANY MEMBER OF THE PUBLIC (MREM/YR, PER SITE)

Dose	40 CFR 190 Requirements	CPNPP Assessment of all Units
Whole Body Dose Equivalent[(c)]	25	7.79E+00
Thyroid Dose	75	9.18E+00[(a)]
Dose to Another Organ[(b)]	25	1.14E+01

a) Note that the collective thyroid dose includes the maximum organ dose due to liquid effluents from Units 1 and 2. This value bounds the thyroid dose.

b) A teenager receives the maximum individual organ dose, which is to the liver.

c) An adult receives the maximum individual total body dose.

TABLE 5.4-11
ESTIMATED POPULATION DOSE FROM LIQUID EFFLUENTS
(PERSON-REM/YR, PER UNIT)

Dose	CPNPP Unit 3 or 4 Assessment
Total Body	2.36E+00
GI-LLI (Max. organ)	2.27E+00
Thyroid	2.07E+00

TABLE 5.4-12 (Sheet 1 of 6)
GASEOUS PATHWAYS - MAXIMUM EXPOSED INDIVIDUAL DOSE SUMMARY

PLANT VENT

Pathway/Age Group	Total Body	GI-Tract	Bone (max organ)	Liver	Kidney	Thyroid	Lung	Skin
Plume	5.38E-02	5.38E-02	5.38E-02	5.38E-02	5.38E-02	5.38E-02	5.99E-02	5.03E-01
Ground	1.01E-01	1.01E-01	1.01E-01	1.01E-01	1.01E-01	1.01E-01	1.01E-01	1.19E-01
Vegetables								
Adult	3.20E-02	3.44E-02	2.50E-01	3.09E-02	2.48E-02	5.70E-02	2.27E-02	2.17E-02
Teen	4.44E-02	4.75E-02	3.62E-01	4.76E-02	3.83E-02	7.71E-02	3.53E-02	3.36E-02
Child	9.28E-02	8.77E-02	7.99E-01	1.01E-01	8.53E-02	1.59E-01	8.04E-02	7.78E-02
Meat								
Adult	8.31E-03	1.42E-02	3.70E-02	8.36E-03	7.68E-03	8.79E-03	7.42E-03	7.31E-03
Teen	6.61E-03	9.96E-03	3.09E-02	6.90E-03	6.35E-03	7.13E-03	6.16E-03	6.06E-03
Child	1.18E-02	1.33E-02	5.77E-02	1.23E-02	1.16E-02	1.28E-02	1.13E-02	1.12E-02
Cow Milk[a]								
Adult	1.46E-02	9.72E-03	5.06E-02	1.65E-02	1.14E-02	5.40E-02	9.43E-03	8.57E-03
Teen	2.12E-02	1.66E-02	9.04E-02	2.91E-02	2.02E-02	8.75E-02	1.69E-02	1.52E-02
Child	4.12E-02	3.72E-02	2.17E-01	5.95E-02	4.42E-02	1.82E-01	3.87E-02	3.61E-02
Infant	7.94E-02	7.52E-02	3.96E-01	1.19E-01	8.71E-02	4.28E-01	7.89E-02	7.42E-02

TABLE 5.4-12 (Sheet 2 of 6)
GASEOUS PATHWAYS - MAXIMUM EXPOSED INDIVIDUAL DOSE SUMMARY

PLANT VENT

Pathway/Age Group	Total Body	GI-Tract	Bone (max organ)	Liver	Kidney	Thyroid	Lung	Skin
Goat Milk								
Adult	2.72E-02	1.09E-02	6.92E-02	3.33E-02	1.78E-02	6.42E-02	1.23E-02	9.72E-03
Teen	3.37E-02	1.83E-02	1.21E-01	5.78E-02	3.07E-02	1.03E-01	2.19E-02	1.67E-02
Child	5.20E-02	3.97E-02	2.86E-01	1.07E-01	6.13E-02	2.13E-01	4.63E-02	3.85E-02
Infant	9.08E-02	7.90E-02	4.95E-01	2.09E-01	1.14E-01	5.03E-01	9.18E-02	7.78E-02
Inhalation								
Adult	5.75E-03	5.89E-03	1.53E-03	5.79E-03	5.70E-03	1.33E-02	9.33E-03	5.56E-03
Teen	5.77E-03	5.93E-03	1.81E-03	5.90E-03	5.81E-03	1.59E-02	1.13E-02	5.61E-03
Child	5.07E-03	5.09E-03	2.15E-03	5.25E-03	5.13E-03	1.79E-02	9.67E-03	4.96E-03
Infant	2.92E-03	2.90E-03	9.47E-04	3.07E-03	2.96E-03	1.48E-02	6.13E-03	2.85E-03

a) The nearest milking cow for human consumption is located beyond 5 mi.

TABLE 5.4-12 (Sheet 3 of 6)
GASEOUS PATHWAYS - MAXIMUM EXPOSED INDIVIDUAL DOSE SUMMARY

EVAPORATION POND

Pathway/Age Group	Total Body	GI-Tract	Bone (max organ)	Liver	Kidney	Thyroid	Lung	Skin
Plume	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ground	2.27E-02	2.27E-02	2.27E-02	2.27E-02	2.27E-02	2.27E-02	2.27E-02	2.66E-02
Vegetables								
Adult	1.13E-01	2.87E-01	1.33E-02	1.16E-01	1.13E-01	1.10E-01	1.04E-01	1.02E-01
Teen	1.28E-01	3.38E-01	2.04E-02	1.38E-01	1.34E-01	1.26E-01	1.19E-01	1.17E-01
Child	1.94E-01	3.54E-01	4.68E-02	2.17E-01	2.09E-01	1.99E-01	1.85E-01	1.82E-01
Meat								
Adult	1.94E-02	1.89E+00	2.97E-02	1.62E-02	7.12E-02	1.50E-02	1.48E-02	1.47E-02
Teen	1.24E-02	1.18E+00	2.50E-02	9.98E-03	5.62E-02	9.01E-03	8.91E-03	8.76E-03
Child	1.68E-02	7.22E-01	4.69E-02	1.21E-02	7.31E-02	1.10E-02	1.08E-02	1.06E-02
Cow Milk								
Adult	4.64E-02	3.97E-02	7.69E-03	5.11E-02	4.18E-02	4.38E-02	3.61E-02	3.45E-02
Teen	5.96E-02	5.10E-02	1.36E-02	7.35E-02	5.73E-02	5.95E-02	4.80E-02	4.49E-02
Child	8.86E-02	7.53E-02	3.18E-02	1.18E-01	9.07E-02	1.00E-01	7.58E-02	7.12E-02
Infant	1.28E-01	1.13E-01	5.32E-02	2.00E-01	1.39E-01	1.78E-01	1.17E-01	1.08E-01

TABLE 5.4-12 (Sheet 4 of 6)
GASEOUS PATHWAYS - MAXIMUM EXPOSED INDIVIDUAL DOSE SUMMARY

EVAPORATION POND

Pathway/Age Group	Total Body	GI-Tract	Bone (max organ)	Liver	Kidney	Thyroid	Lung	Skin
Goat Milk								
Adult	1.05E-01	7.39E-02	2.24E-02	1.19E-01	9.15E-02	8.15E-02	7.51E-02	7.05E-02
Teen	1.35E-01	9.59E-02	3.97E-02	1.76E-01	1.27E-01	1.09E-01	1.01E-01	9.17E-02
Child	1.96E-01	1.48E-01	9.33E-02	2.83E-01	2.02E-01	1.80E-01	1.59E-01	1.45E-01
Infant	2.78E-01	2.23E-01	1.56E-01	4.93E-01	3.09E-01	3.05E-01	2.47E-01	2.20E-01
Inhalation								
Adult	5.89E-02	6.08E-02	5.36E-04	5.90E-02	5.92E-02	5.90E-02	7.72E-02	5.87E-02
Teen	5.95E-02	6.14E-02	7.53E-04	5.97E-02	5.98E-02	5.96E-02	9.08E-02	5.92E-02
Child	5.25E-02	5.33E-02	1.03E-03	5.28E-02	5.29E-02	5.28E-02	8.04E-02	5.23E-02
Infant	3.02E-02	3.04E-02	5.65E-04	3.04E-02	3.04E-02	3.05E-02	5.28E-02	3.00E-02

TABLE 5.4-12 (Sheet 5 of 6)
GASEOUS PATHWAYS - MAXIMUM EXPOSED INDIVIDUAL DOSE SUMMARY

(PLANT VENT AND EVAPORATION POND)

Pathway/Age Group	Total Body	GI-Tract	Bone (max organ)	Liver	Kidney	Thyroid	Lung	Skin
Plume	5.38E-02	5.38E-02	5.38E-02	5.38E-02	5.38E-02	5.38E-02	5.99E-02	5.03E-01
Ground	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.45E-01
Vegetables								
Adult	1.45E-01	3.21E-01	2.63E-01	1.47E-01	1.38E-01	1.67E-01	1.27E-01	1.24E-01
Teen	1.72E-01	3.86E-01	3.82E-01	1.86E-01	1.72E-01	2.03E-01	1.54E-01	1.51E-01
Child	2.87E-01	4.42E-01	8.46E-01	3.18E-01	2.95E-01	3.58E-01	2.65E-01	2.60E-01
Meat								
Adult	2.78E-02	1.90E+00	6.67E-02	2.46E-02	7.89E-02	2.38E-02	2.22E-02	2.20E-02
Teen	1.90E-02	1.19E+00	5.59E-02	1.69E-02	6.25E-02	1.61E-02	1.51E-02	1.48E-02
Child	2.86E-02	7.35E-01	1.05E-01	2.44E-02	8.47E-02	2.38E-02	2.21E-02	2.18E-02
Cow Milk								
Adult	6.10E-02	4.94E-02	5.83E-02	6.76E-02	5.32E-02	9.78E-02	4.55E-02	4.31E-02
Teen	8.08E-02	6.76E-02	1.04E-01	1.03E-01	7.75E-02	1.47E-01	6.49E-02	6.01E-02
Child	1.30E-01	1.12E-01	2.49E-01	1.77E-01	1.35E-01	2.82E-01	1.15E-01	1.07E-01
Infant	2.07E-01	1.88E-01	4.49E-01	3.19E-01	2.26E-01	6.06E-01	1.96E-01	1.82E-01

TABLE 5.4-12 (Sheet 6 of 6)
GASEOUS PATHWAYS - MAXIMUM EXPOSED INDIVIDUAL DOSE SUMMARY

(PLANT VENT AND EVAPORATION POND)

Pathway/Age Group	Total Body	GI-Tract	Bone (max organ)	Liver	Kidney	Thyroid	Lung	Skin
Goat Milk								
Adult	1.32E-01	8.48E-02	9.16E-02	1.52E-01	1.09E-01	1.46E-01	8.74E-02	8.02E-02
Teen	1.69E-01	1.14E-01	1.61E-01	2.34E-01	1.58E-01	2.12E-01	1.23E-01	1.08E-01
Child	2.48E-01	1.88E-01	3.79E-01	3.90E-01	2.63E-01	3.93E-01	2.05E-01	1.84E-01
Infant	3.69E-01	3.02E-01	6.51E-01	7.02E-01	4.23E-01	8.08E-01	3.39E-01	2.98E-01
Inhalation								
Adult	6.47E-02	6.66E-02	2.07E-03	6.48E-02	6.49E-02	7.23E-02	8.65E-02	6.43E-02
Teen	6.52E-02	6.73E-02	2.56E-03	6.56E-02	6.56E-02	7.55E-02	1.02E-01	6.48E-02
Child	5.76E-02	5.84E-02	3.18E-03	5.80E-02	5.80E-02	7.07E-02	9.01E-02	5.72E-02
Infant	3.31E-02	3.33E-02	1.51E-03	3.35E-02	3.34E-02	4.54E-02	5.89E-02	3.29E-02

TABLE 5.4-13
GASEOUS PATHWAYS - COMPARISON OF MAXIMUM INDIVIDUAL DOSE COMPARED TO 10 CFR 50, APPENDIX I CRITERIA (PER UNIT)

Type of Dose	10 CFR 50 Design Objective	Calculated Dose
Gaseous Effluents (Noble Gases)		
Gamma Air Dose	10 mrad	8.42E-02 mrad
Beta Air Dose	20 mrad	6.50E-01 mrad
Total Body Dose	5 mrem	5.38E-02 mrem
Skin Dose	15 mrem	5.03E-01 mrem
Radioiodines and Particulates		
Maximum to any organ	15 mrem	2.55 mrem

Notes:

Doses were calculated at the locations resulting in the highest pathway doses to the public.

mrad = millirad

TABLE 5.4-14
GASEOUS PATHWAYS COMPARISON OF MAXIMUM INDIVIDUAL DOSE COMPARED TO 40 CFR 190 CRITERIA (MREM/YR, PER SITE)

Type of Dose (Annual)	40 CFR 190 Design Objective	Calculated Doses
Whole Body	25 mrem	2.01
Thyroid	75 mrem	5.47
Max to any organ	25 mrem	7.40

Note that the collective thyroid dose includes the maximum organ dose due to gaseous effluents from Units 1 and 2. This value bounds the thyroid dose.

TABLE 5.4-15
GASEOUS PATHWAYS – ANNUAL POPULATION DOSE RESULTS

Pathway	Calculated Dose (Person rem) per unit
Whole Body	3.77
Thyroid	4.29
TEDE	3.89

Note:

The population doses in this table include gaseous doses due to effluents from the evaporation pond and plant vent.

TABLE 5.4-16
DIRECT RADIATION DOSE

	Location	Estimated Annual Dose
Direct radiation from site	Maximum Individual at site boundary	1.34E-01 mrad

TABLE 5.4-17
IDENTIFIED IMPORTANT SPECIES AND ANALYTICAL SURROGATES

Basis	Identified Species	Remarks	Surrogate Species
Aquatic Ecology			
Federally threatened	None identified Sharpnose shiner (*Notropis oxyrhynchus)*, candidate		
State threatened	Pistol grip Mussel (*Tritogonia verrucosa)* (species of concern)		Freshwater invertebrae
Commercial or recreation	Channel catfish Hybrid striped bass Largemouth bass	Sport fishing. Hybrid striped bass restocked between 1979 and 1996	Freshwater fish; comparable size
Terrestrial Ecology			
Federally endangered	Black-capped vireo (*Vireo atricapillus)* Golden-cheeked warbler (*Dendroica chrysoparia)*		
State threatened	Bald eagle (*Haliaeetus leucocephalus)* Texas horned lizard (*Phrynosoma cornutum)* Timber (Canebreak) Rattlesnake (*Crotalus horridus)* Brazos water snake (*Nerodia harteri)*		
Commercial or recreation	Whitetail deer and small game incl. turkey, rabbit, squirrel, raccoon	Hunted near CPNPP site	Raccoon, muskrat
	Waterfowl, including ducks (various species), coot, Canada goose, etc.	Hunted near CPNPP site	Duck
	Migratory shorebirds incl. sandpipers and heron	Not hunted	Heron

Note: See Section 2.4, Ecology

TABLE 5.4-18
TERRESTRIAL BIOTA PARAMETERS

Terrestrial Biota	Food Intake (g/d)	Body Mass (g)	Effective Body Radius (cm)	Food Organism
Muskrat	100	1,000	6	Aquatic Plants
Raccoon	200	12,000	14	Invertebrates
Heron	600	4,600	11	Fish
Duck	100	1,000	5	Aquatic Plants

Source: NUREG/CR-4013

TABLE 5.4-19
SHORELINE (SEDIMENT) AND SWIMMING EXPOSURES

Biota	Shoreline Exposure (hr/yr)	Swimming Exposure (hr/yr)
Fish	4,380	8,760
Invertebrates	8,760	8,760
Algae	NA	8,760
Muskrat	2,922	2,922
Raccoon	2,191	NA
Heron	2,922	2,920
Duck	4,383	4,383

Source: NUREG/CR-4013

TABLE 5.4-20
PARAMETERS USED IN BIOTA DOSE ASSESSMENTS

Parameter	Source or Bases
Freshwater aquatic plant elemental bioaccumulation factors	NUREG/CR-4013, Table 3.1.
Freshwater fish and invertebrate bioaccumulation factors	Regulatory Guide 1.109, Table A-1
Committed total body dose factors from ingestion of biota	Regulatory Guide 1.109, Table E-11
Tritium dose factor	NUREG/CR-4013, Table 3.8
Effective absorbed energies for internal doses.	NUREG/CR-4013, Appendix B
Total body water immersion dose factors	NUREG/CR-4013, Appendix B
Shoreline and sediment external dose factors	Regulatory Guide 1.109, Table E-6
Increase factor (2) for ground exposure	NUREG/CR-4013, Section 3.2.5
Noble gas total body immersion dose factors	Regulatory Guide 1.109, Table B-1
Total body inhalation dose factors	Regulatory Guide 1.109, Table E-7

TABLE 5.4-21
CPNPP UNITS 3 AND 4 LIQUID PATHWAY DOSES TO PRIMARY AND SECONDARY ORGANISMS (BIOTA) (MRAD/YR)

Organism	Internal Dose	External Dose	Total Dose	Dose Limit[(a)] (per site)
Fish	9.10E+00	9.48E+00	1.86E+01	
Invertebrate	1.29E+01	1.90E+01	3.18E+01	
Algae	4.08E+01	7.82E-03	4.08E+01	Total Body: 25
Muskrat	6.10E+01	6.32E+00	6.73E+01	Thyroid: 75
Raccoon	1.56E+01	4.74E+00	2.03E+01	Another organ:25
Heron	1.97E+02	6.32E+00	2.04E+02	
Duck	5.84E+01	9.48E+00	6.79E+01	

a) 40 CFR 190

TABLE 5.4-22
DOSES TO PRIMARY AND SECONDARY ORGANISMS (BIOTA) (MRAD/YR)
GASEOUS PATHWAY (PER UNIT 3 OR 4)

Biota	External Dose	Internal Dose	Total Dose
Muskrat	2.64E+00	1.18E-02	2.65E+00
Raccoon	1.79E+00	1.18E-02	1.80E+00
Heron	1.72E+00	1.18E-02	1.73E+00
Duck	2.37E+00	1.18E-02	2.38E+00

*Plant Vent releases only

TABLE 5.4-23
DOSES TO PRIMARY AND SECONDARY ORGANISMS FROM ALL UNITS
(BIOTA) (MRAD/YR)

Biota	Liquid Effluents Total Dose[a]	Gaseous Effluents[b] Total Dose[c]	Dose Limit[d] (per site)
Fish	1.33E+02	NA	
Invertebrate[e]	3.18E+01[e]	NA	
Algae[e]	4.08E+01[e]	NA	Total Body: 25
Muskrat	7.32E+01	5.3	Thyroid: 75
Raccoon	2.62E+01	3.60	Another organ:25
Heron	2.10E+02	3.46	
Duck	7.37E+01	4.76	

a) Units 1 and 2 biota doses obtained from CPSES ER, Section 5.2. Note that Units 1 and 2 liquid doses include contributions from both liquid and gaseous pathways.

b) Plant vent releases only

c) Included a whole body dose of 0.2 mrem/year per unit for Units 1 and 2

d) 40 CFR 190 criteria

e) Units 1 and 2 dose contributions unavailable

TABLE 5.4-24
COMPARISON OF BIOTA DOSES TO ORNL 1995 EVALUATED DAILY LIMITS

Aquatic Biota 1,000 mrad/day[(a)]	Terrestrial Biota 100 mrad/day
Fish – 133 mrad/yr	Muskrat – 78.5 mrad/yr
Invertebrate – 31.8 mrad/yr	Raccoon – 29.8 mrad/yr
Algae – 40.8 mrad/yr	Heron – 213.5 mrad/yr
Duck – 78.5 mrad/yr	

a) A dose equivalent of 1 mrem is approximately the same as 1 mrad of absorbed dose in tissue (man).

TABLE 5.4-25 (Sheet 1 of 2)
SUMMARY OF INFORMATION REPORTED BY COMMERCIAL LIGHT WATER REACTORS (1973 - 2006)

Year	Number of Reactors Included[(a)]	Annual Collective Dose (person-rem)	No. of Workers With Measurable Dose[(b)]	Electricity Generated (MW-yrs)	Average Measurable Dose per Worker (rem)	Average Collective dose per Reactor (person-rem)	Average No. Personnel With Measurable Doses Per Reactor[(c)]
1973	24	13,962	14,780	7,164.1	0.95	582	616
1974	33	13,650	18,139	10,590.9	0.75	414	550
1975	44	20,901	28,234	17,768.9	0.74	475	642
1976	52	26,105	34,515	21,462.9	0.76	502	664
1977	57	32,521	42,393	26,448.3	0.77	571	744
1978	64	31,785	46,081	31,696.5	0.69	497	720
1979	67	39,908	64,253	29,926.0	0.62	596	959
1980	68	53,739	80,457	29,157.5	0.67	790	1,183
1981	70	54,163	82,224	31,452.9	0.66	774	1,175
1982	74	52,201	84,467	32,755.2	0.62	705	1,141
1983	75	56,484	85,751	32,925.6	0.66	753	1,143
1984	78	55,251	98,309	36,497.6	0.56	708	1,260
1985	82	43,048	92,968	41,754.7	0.46	525	1,134
1986	90	42,386	100,997	45,695.1	0.42	471	1,122
1987	96	40,406	104,403	52,116.3	0.39	421	1,088
1988	102	40,772	103,294	59,595.1	0.40	400	1,013
1989	107	35,931	108,278	62,223.0	0.33	336	1,012
1990	110	36,602	108,667	68,291.7	0.34	333	988
1991	111	28,519	98,782	73,448.4	0.29	257	890
1992	110	29,297	103,155	74,012.0	0.28	266	938
1993	106	25,597	93,749	70,704.9	0.27	241	884
1994	107	21,672	83,454	74,536.6	0.26	203	780
1995	107	21,233	85,671	78,875.2	0.25	198	801

TABLE 5.4-25 (Sheet 2 of 2)
SUMMARY OF INFORMATION REPORTED BY COMMERCIAL LIGHT WATER REACTORS (1973 - 2006)

Year	Number of Reactors Included[(a)]	Annual Collective Dose (person-rem)	No. of Workers With Measurable Dose[(b)]	Electricity Generated (MW-yrs)	Average Measurable Dose per Worker (rem)	Average Collective dose per Reactor (person-rem)	Average No. Personnel With Measurable Doses Per Reactor[(c)]
1996	109	18,883	84,644	79,660.0	0.22	173	777
1997	109	17,149	84,711	71,851.4	0.20	157	777
1998	105	13,187	71,485	77,069.9	0.18	126	681
1999	104	13,666	75,420	83,197.6	0.18	131	725
2000	104	12,652	74,108	86,006.8	0.17	122	713
2001	104	11,109	67,570	87,552.8	0.16	107	650
2002	104	12,126	73,242	88,829.70	0.17	117	704
2003	104	11,956	74,813	87,015.00	0.16	115	719
2004	104	10,368	69,849	89,823.50	0.15	100	672
2005	104	11,456	78,127	89,177.70	0.15	110	751
2006	104	11,021	80,265	89,989.70	0.14	106	772
Average	88	28,227	76,390	57,037	0.41	364	864

a) Includes only those reactors that had been in commercial operation for at least one full year as of December 31 of each of the indicated years.

b) Figures are not adjusted for the multiple reporting of transient individuals.

c) Electricity Generated reflects the gross electricity generated for the years 1973 – 1996. Beginning in 1997, it reflects the net.

Source: NUREG-0713, Vol. 28

TABLE 5.4-26 (Sheet 1 of 2)
THREE YEAR TOTALS AND AVERAGES LISTED IN ASCENDING ORDER OF COLLECTIVE TEDE PER PWR (2004-2006)

Site Name	Reactor Years	Collective TEDE per Reactor	Collective TEDE per Site	Number of Workers with Measurable TEDE	Average TEDE per Worker	Total MW-Year	Average TEDE per MW-Year
CRYSTAL RIVER 3	3	44	131	1,208	0.11	2,348.20	0.06
SEABROOK	3	45	135	2,571	0.05	3,307.80	0.04
NORTH ANNA 1, 2	6	45	271	2,400	0.11	5,160.10	0.05
POINT BEACH 1, 2	6	46	278	1,931	0.14	2672.0	0.10
SUMMER 1	3	48	144	1,610	0.09	2,647.30	0.05
HARRIS	3	51	153	1,828	0.08	2,503.20	0.06
KEWAUNEE	3	57	170	1,201	0.14	1,206.80	0.14
VOGTLE 1, 2	6	58	347	2,756	0.13	6,277.40	0.06
PRAIRIE ISLAND 1, 2	6	61	365	3,071	0.12	2,819.30	0.13
PALO VERDE 1, 2, 3	9	61	551	4,923	0.11	8,880.10	0.06
ROBINSON 2	3	62	186	1,829	0.10	2,046.10	0.09
TURKEY POINT 3,4	6	63	377	3,546	0.11	3,625.80	0.10
BRAIDWOOD 1, 2	6	64	382	3,536	0.11	6,765.60	0.06
WOLF CREEK 1	3	69	207	1,738	0.12	3,225.10	0.06
CATAWBA 1, 2	6	70	419	3,934	0.11	6,234.50	0.07
SEQUOYAH 1, 2	6	71	423	4,038	0.10	6353.0	0.07
BYRON 1, 2	6	71	423	3,611	0.12	6,676.30	0.06
COMANCHE PEAK 1, 2	6	73	438	2,915	0.15	6,540.40	0.07
SURRY 1, 2	6	74	442	3,132	0.14	4,471.60	0.10
DIABLO CANYON 1, 2	6	77	461	3,271	0.14	5,867.70	0.08
MCGUIRE 1, 2	6	80	478	3,735	0.13	6,169.80	0.08
SALEM 1, 2	6	80	480	6,104	0.08	6,148.40	0.08
OCONEE 1, 2, 3	9	82	738	5,670	0.13	6,749.50	0.11
WATERFORD 3	3	83	249	2,153	0.12	3,059.30	0.08

TABLE 5.4-26 (Sheet 2 of 2)
THREE YEAR TOTALS AND AVERAGES LISTED IN ASCENDING ORDER OF COLLECTIVE TEDE PER PWR (2004-2006)

Site Name	Reactor Years	Collective TEDE per Reactor	Collective TEDE per Site	Number of Workers with Measurable TEDE	Average TEDE per Worker	Total MW-Year	Average TEDE per MW-Year
MILLSTONE 2, 3	6	86	513	3,293	0.16	5,563.10	0.09
CALVERT CLIFFS 1, 2	6	86	516	3,362	0.15	4,913.60	0.11
SOUTH TEXAS 1, 2	6	86	518	3,188	0.16	7,135.20	0.07
DAVIS-BESSE	3	87	262	2,069	0.13	2,202.70	0.12
COOK 1, 2	6	93	560	3,647	0.15	5,688.70	0.10
BEAVER VALLEY 1, 2	6	101	606	4,422	0.14	4,569.10	0.13
ST. LUCIE 1, 2	6	114	686	4,645	0.15	4,442.80	0.15
CALLAWAY 1	3	117	350	2,949	0.12	2,958.80	0.12
ARKANSAS 1, 2	6	121	725	4,746	0.15	5,059.30	0.14
SAN ONOFRE 2, 3	6	122	733	3,698	0.20	5,360.70	0.14
WATTS BAR 1	3	157	472	3,534	0.13	2,890.30	0.16
INDIAN POINT 2	3	165	494	2,933	0.17	2774.0	0.18
FORT CALHOUN	3	195	584	2,875	0.20	1,149.80	0.51
PALISADES	3	207	621	2,012	0.31	2,040.70	0.30
Totals and Averages	207		16,408	126,590	0.13	179,940.90	0.09
Average per Reactor-Year		79		612		869.3	

Sites where not all reactors had completed 3 full years of commercial operation as of 12/31/2006 are not included.

Source: NUREG-0713, Vol. 28

TABLE 5.4-27
TOTAL GASEOUS DOSES TO THE MAXIMALLY EXPOSED INDIVIDUAL AT SQUAW CREEK RESERVOIR

Pathway	Calculated Dose (mrem) per unit
Whole Body	7.22E-02
Thyroid	8.02E-02
TEDE	7.46E-02

5.5 ENVIRONMENTAL IMPACTS OF WASTE

This section describes the environmental impacts that could result from the operation of the nonradioactive waste system, and from storage and disposal of solid and mixed wastes.

Construction and operation activities at the Luminant Generating Company (Luminant) Comanche Peak Nuclear Power Plant (CPNPP) result in the generation of several identifiable waste streams. These facility wastes are regulated by the Texas Commission on Environmental Quality (TCEQ), which has the regulatory oversight of air, water, solid, and hazardous wastes that may be generated at CPNPP. As demonstrated in the following subsections, the environmental impacts from operational wastes are expected to be SMALL because of regulatory controls and the limited quantities that are generated.

Hazardous wastes are disposed at an off-site facility permitted under the Resource Conservation and Recovery Act (RCRA) to accept hazardous wastes. The TCEQ has regulatory authority for the State of Texas waste programs. Petroleum and hazardous waste streams are regulated under the RCRA; while both Nuclear Regulatory Commission (NRC) and EPA regulate mixed waste. Non-hazardous wastes including solid and asbestos waste streams are regulated by TCEQ. A facility generating these wastes is required to have a EPA RCRA facility identification number, and in Texas, a solid waste notice of registration (NOR) number assigned by the TCEQ. The EPA RCRA identification number for CPNPP is TXD020332078 (EPA), and the TCEQ NOR number is 33036.

Aqueous waste discharges are regulated by the TCEQ through the Texas Pollutant Discharge Elimination System (TPDES) permit program for stormwater and operational wastewater streams, and incorporates chemical monitoring requirements. In the TPDES permit, point-source discharge outfalls are assigned discharge serial numbers (DSNs), constituents to be monitored or sampled, and concentration limits based on water quality standards. In 2008, an amendment of the current CPNPP TPDES permit (TCEQ 2004) is planned that would include the anticipated operations of Units 3 and 4. Aquatic ecology for the receiving water bodies (Lake Granbury and SCR) is discussed in Subsections 2.4.2 and 5.3.2.2.

Air emissions are regulated through the Clean Air Act (CAA) by the EPA, or authorized state, which in the case of CPNPP, is the TCEQ. Texas has regulatory authority from the EPA for the air program, and Units 1 and 2 currently maintain an air permit. It is anticipated that construction air permit from TCEQ would be required prior to the commencement of construction activities. In addition, the existing operational air permit for Units 1 and 2 would have to be amended prior to commencement of operations of Units 3 and 4. The extent of permit modification is typically dependent on the final design of the emergency power generation system and its projected emissions.

5.5.1 NONRADIOACTIVE WASTE SYSTEM IMPACTS

This subsection describes the potential environmental impacts from the nonradioactive solid, liquid, and gaseous waste streams associated with the construction and operation of CPNPP Units 3 and 4. Descriptions of the various streams that generate nonradioactive wastes are presented in Section 3.6. Thermal and chemical monitoring programs are discussed in Sections 6.1 and 6.6.

5.5.1.1 Impacts of Discharges to Water

The nonradioactive wastewater streams making up plant discharge may include, but are not limited to the cooling water blowdown, auxiliary boiler blowdown, water treatment waste, floor and equipment drains and nonradioactive laboratory waste. The dominant component of this discharge is the cooling tower blowdown with the contribution of other streams typically amounting to less than 10 percent of the flow (Section 3.3 and Figure 3.3-1). Current design plans for Units 3 and 4 show the circulating water system blowdown and service water system discharging to Lake Granbury. Wastewater generated from the floor and equipment drains, and nonradioactive laboratory wastewater would be processed through a wastewater treatment system then discharged to SCR. Sanitary wastes would be treated separately through a new and existing sewage system and discharged to SCR. Wastewater discharge details are provided in Section 3.6.

The chemical discharge concentration limitations are based on established federal and state water quality standards to assure that the receiving water body is not degraded. The CPNPP Units 1 and 2 have a current TPDES permit for the discharge of wastewaters, and the impacts on the environment are SMALL. The TPDES permit would be modified for the operations of Units 3 and 4. This amended permit would likely require additional monitoring requirements set by the TCEQ to ensure that the impact from wastewater discharges from Units 3 and 4 does not adversely impact the receiving waterbodies. No further mitigation actions would be required over those in the permit. Water uses for Lake Granbury is discussed in Subsection 2.3.2. Impacts from radiological exposures is discussed in Section 5.4.

5.5.1.1.1 Liquid Effluents Containing Biocides or Chemicals

Description of the anticipated nonradioactive waste chemical and biocide discharge (to Lake Granbury) concentrations is provided in Section 3.6 and Table 3.6-1. Details on the chemical monitoring program are presented in Section 6.6. Chemical and biocide usage, and discharge information is based on the plant design. Biocides are added and are effective in parts per million concentrations. Except for cooling tower blowdown water all low volume waste is planned to be processed through the low volume waste (LVW) treatment system and then discharged to SCR as permitted. Cooling tower blowdown water is planned to be discharged to Lake Granbury with a partial (46%) blowdown treatment prior to leaving the site. Because the wastewater associated with these chemicals and biocides would be either diluted or treated, then the impact should be SMALL, and no additional mitigation would be warranted.

5.5.1.1.2 Demineralized Water-Treatment Wastes

The plant design demineralized process water is produced using a microfiltration system with reverse osmosis (RO) units. The microfiltration system removes suspended solids and would produce a small waste stream of solids. The RO units produce high quality water that is vital to maintaining the chemistry of the plant but there are wastes associated with using the RO process. RO unit reject water is discharged to the waste management system.

The demineralized water treatment wastes consist of spent RO membranes, salts, minerals and, solids removed from the raw water source. The wastes are handled in accordance with the TCEQ regulations and disposed of at an appropriate land-fill. Water treatment wastes and purification waste RO filters would be containerized and disposed of at a permitted industrial waste landfill.

Using a process similar to the demineralization system, it is anticipated that cooling water system blowdown will require treatment to remove salts, minerals, and solids prior to discharge into Lake Granbury. Any wastes generated from the treatment of blowdown will be disposed in accordance with all applicable federal and state regulations.

Chemicals such as sulfuric acid and caustic soda may be used to adjust the pH to between six and nine prior to release of any nonradioactive waste stream to the combined wastewater stream discharge or to the collection ponds, such as the wastewater treatment and evaporation ponds. In addition, certain biocides may be necessary when operating the RO system. Additional information related to the demineralized water treatment system for Units 3 and 4 is presented in Section 3.6. Because the wastes associated with these RO units are disposed of in compliance with the TCEQ, then the impact should be SMALL, and no additional mitigation would be warranted.

5.5.1.1.3 Floor Drain Systems

Discharges from the nonradioactive floor drains would be routed to the wastewater treatment facility that is currently used for Units 1 and 2. Site modification of the capacity of the wastewater treatment ponds (part of the wastewater treatment facility) may be required to handle the additional waste water from Units 3 and 4. Because this wastewater would be sampled, monitored, and treated if necessary prior to discharge to SCR in accordance with the facility's TDPES wastewater permit limitations, then the impact should be SMALL, and no additional mitigation would be warranted.

5.5.1.1.4 Surface Drainage and Roof Drains

During and after precipitation events, water from the roof drains and impervious surfaces, such as parking lots and sidewalks, typically sheet flows overland to drainage ways and are planned to be directed to stormwater drains or drainage ditches and discharged to SCR. This wastewater is currently not regulated under the facility's stormwater pollution prevention plan (SWP3) and no treatment of this wastewater is expected to be necessary prior to discharge; therefore, the impact should be SMALL, and no additional mitigation would be warranted.

5.5.1.2 Impacts of Discharges to Land

This subsection discusses the environmental impacts from waste discharges to land at an off-site permitted facility. Waste types include non-hazardous, hazardous, and petroleum solid wastes. CPNPP maintains a waste minimization plan to attempt to reduce the amount of waste generated and disposed of each year. This waste minimization plan is described in Subsection 5.5.3 and serves as the mitigation process for limiting the generation of non-hazardous and hazardous waste.

5.5.1.2.1 Nonradioactive Solid Waste

Solid nonradioactive industrial waste including non-hazardous industrial and office waste streams are not burned or disposed of on-site. Private, municipal, or county solid waste transporters typically collect this waste for recycling or disposal in an appropriately permitted landfill. Therefore, these wastes do not affect the site terrestrial ecology, soil, or groundwater; thus there impact is considered SMALL.

Water treatment and purification waste RO filters are containerized and disposed of at a permitted non-hazardous waste landfill. Solid waste generated from the Blowdown Treatment Facility (BDTF) is planned to be disposed of at an off-site permitted non-hazardous waste landfill. Additional information on waste generated from the BDTF is presented in Subsection 3.6.1.4.

Construction and demolition wastes are transported off-site for disposal at an industrial waste landfill. Some excavated clean soils may be placed at certain areas on-site where some fill is needed for other activities; e. g., leveling for parking lot surfaces. Impacts from nonradioactive solid industrial waste have been reduced because of the CPNPP waste reduction program, which is expected to be implemented for the operations of Units 3 and 4; therefore, additional mitigation is not required.

5.5.1.2.2 Hazardous Wastes

Hazardous waste is managed and disposed of by CPNPP in accordance with federal and state regulations as per RCRA and TCEQ requirements. The CPNPP has an assigned site-specific EPA RCRA (TXD020332078) and TCEQ NOR (33036) identification numbers for waste disposal. The current generation of hazardous waste at CPNPP is less than 220 pounds per month. Based on this volume of waste the facility is classified as a Small Quantity Generator (SQG) under TCEQ criteria. In addition, CPNPP has a waste reduction program in place that has reduced the volume of hazardous waste generated from approximately 90 tons per year in 1994 to less than one in 2006. Waste volumes generated by operating the new CPNPP Units 3 and 4 are projected to be similar or less than the quantities generated from Units 1 and 2. The site is projected to remain a SQG, therefore having a SMALL impact and no additional mitigation would be required.

The majority of the hazardous wastes generated from the operations of Units 1 and 2 is Freon contaminated waste oil. This waste stream would likely be generated from Unit 3 and 4 operations. Hazardous waste streams generated by the operations of Units 1 and 2 are collected and stored in a designated, enclosed hazardous waste storage building. Wastes generated from the operations of Units 3 and 4 are expected to be stored in this building. Periodically (within in 90 days after being generated) these wastes would be manifested then transported and disposed of at an off-site RCRA-permitted Treatment, Storage, and Disposal (TSD) facility. As mentioned above, a limited amount of hazardous waste is generated by the operations of Units 3 and 4. Impacts on the local environment from hazardous waste management are SMALL, and additional mitigation would not be required.

5.5.1.2.3 Petroleum Waste

Petroleum wastes may include fuels such as gasoline and diesel oil, and used oil and greases from equipment maintenance. For Units 1 and 2, used liquid petroleum materials are recycled for fuel blending while petroleum residue wastes; e.g., oil rags, are disposed of at an off-site TCEQ permitted industrial waste disposal facility. These waste disposal practices are expected to be used during the operations of Units 3 and 4.

5.5.1.3 Impacts of Discharges to Air

The operation of auxiliary boilers, as well as the testing and operation of the emergency generators and fire pumps generate nonradioactive gaseous effluents. Constituents of the gaseous effluents from these systems are typical of releases from the combustion of the fuel used. CPNPP maintains air permits for emissions as required by the TCEQ. These permits are expected to be amended before commencement of Units 3 and 4 construction activities.

Annual air emissions for the standby generators and the fire pumps are provided in Section 3.6. The emissions are expected to comply with applicable federal, state, and local regulations. Emissions result when equipment is tested on a routine schedule. Careful planning of equipment run time allows for the limiting of air emissions released to the atmosphere. Because these air emission sources are not continuously operated, their impact is expected to be SMALL and would not warrant additional mitigation.

5.5.1.4 Impacts of Sanitary Waste

Sanitary waste is treated at an on-site sanitary wastewater treatment facility. Initial sanitary wastes generated from Units 3 and 4 would be treated at the existing treatment facility that is used to treat sanitary waste generated from Units 1 and 2. After operations commence for Unit 4 CPNPP plans to construct and permit a new sanitary waste water treatment facility for all four units. The treated wastewater would be discharged to SCR through the current TPDES permitted outfall for Units 1 and 2. Because sanitary waste is treated in accordance with regulatory requirements prior to discharge, the impact to SCR would be SMALL and would not warrant additional mitigation.

5.5.2 MIXED WASTE IMPACTS

In October of 1992, Congress enacted the Federal Facilities Compliance Act (FFCA), which added a definition of mixed waste to RCRA. Mixed waste contains both hazardous waste and source, special nuclear, or byproduct radioactive materials as defined in the Atomic Energy Act (AEA) of 1954 (42 USC 2011 et seq.).

The EPA's Mixed Waste Rule, finalized on May 16, 2001, provides increased flexibility to generators and facilities that manage low-level mixed waste (LLMW) and technologically-enhanced, naturally-occurring, and/or accelerator-produced radioactive material (NARM) containing hazardous waste. The LLMW is exempt from some RCRA storage and treatment regulations, and LLMW or eligible NARM from RCRA hazardous waste transportation and disposal regulations. These wastes are exempt from RCRA Subtitle C requirements, including permitting, provided they meet specific conditions. The exempt wastes must then be managed as radioactive waste in accordance with NRC or NRC Agreement State Regulations.

Mixed waste may be generated during routine maintenance activities, refueling outages, health physics activities, and radiochemical laboratory activities. Nuclear power plants, in general, are not significant generators of mixed waste. The vast majority of mixed waste that is stored at nuclear power plants is chlorinated fluorocarbons (CFCs), solvents, and used oil. Other sources may include liquid scintillation fluids, other types of organic materials, and metals such as lead and chromium, and aqueous corrosives.

Luminant operating procedures and practices instruct plant operators to segregate wastes so as to not create mixed wastes. The specific types and quantities of mixed waste generated by the Mitsubishi design are anticipated to be similar to Units 1 and 2. Based on experience from operating Units 1 and 2, the mixed waste generation is projected to be approximately one cubic-meter per year, which would be less than typical of operating stations and would be approximately three percent of the LLW volumes; i.e., NUREG-1437, Section 2.3.7.3. The volumes generated by Units 3 and 4 are expected to be less than the experience from other, older design units, and the impacts of this waste type would be SMALL; therefore, no additional mitigation would be warranted.

In addition, nuclear power plants do not generate significant volumes of mixed waste because of continuing progresses being made in reducing mixed waste generation. Mixed waste minimization assures that the chemical and radiological exposures are reduced both by the As Low As Reasonably Achievable (ALARA) and chemical awareness training programs as well as personnel good practices. Regular inspections are conducted and documented, and preventive maintenance measures are taken when needed.

Currently at CPNPP, mixed waste is maintained in a designated storage area and monitored on a standard inspection schedule. To date, no mixed waste has been transported off-site for final disposition since operations of Unit 1 commenced in 1990. If mixed waste is removed from CPNPP in the future, the transportation of this waste would be done by licensed hazardous/ mixed waste carriers. The material would be manifested and traced from point of generation, to transport, and disposal. Records of disposals would be maintained by the generating facility and EPA, or authorized state. The CPNPP maintains detailed records of waste generation on-site as well as where the material is stored and its final disposition.

5.5.3 WASTE MINIMIZATION PLAN

Pursuant to the EPA solid waste regulations, 40 CFR 260 through 265, regarding hazardous waste management and the TCEQ, a waste minimization plan was developed for the operations of Units 1 and 2 (CPSES 1999). The plan includes addressing waste generation, waste storage areas, and waste management oversight requirements. Elements of the waste minimization plan include, as a minimum, (1) inventory identification and control, (2) work planning to reduce hazardous waste generation, (3) hazardous waste reduction methods and processes, and (4) key assumptions critical to the successful implementation of waste management.

In 2005, CPNPP was recognized as a National Environmental Leader by EPA and TCEQ for meeting several environmental related goals including hazardous and non-hazardous waste reduction. Since 1994, CPNPP has reduced the amount of hazardous waste generated from over 90 tons per year to less than one ton.

The environmental impacts from hazardous waste generation and on-site storage are SMALL. Waste is stored in monitored, secure storage, transported by licensed transporters, and treated or disposed of at an authorized and permitted facility. No additional mitigation beyond current practice is required, and impacts are SMALL.

5.5.4 REFERENCES

(CPSES 1999) Comanche Peak Steam Electric Station. Waste Minimization Plan.

(TCEQ 2004) Texas Commission on Environmental Quality. Texas Pollutant Discharge Elimination System Permit 1854. TXU Energy Company LLC. Comanche Peak Nuclear Power Plant.

5.6 TRANSMISSION SYSTEM IMPACTS

This section discusses the environmental impact of operating the transmission lines associated with the proposed project, Comanche Peak Nuclear Power Plant (CPNPP) Units 3 and 4. As noted in Section 5.0, impacts are classified as SMALL, MODERATE, or LARGE.

As discussed further in Subsection 9.4.3.1, operating the proposed project requires expanding four electrical transmission lines that connect the proposed project to switching stations in the area, and expanding the connection between two switching stations located off-site. These expansions would consist of either single or double 345-kV circuits. Three single circuit expansions would be installed on existing structures. Two double circuit expansions may require constructing new towers on new or expanded transmission line right-of-way (ROW) 160 ft wide.

The transmission lines are owned, operated, and maintained by Oncor Electric Delivery Company LLC (Oncor Electric Delivery), a separate company. Oncor would construct and operate the system expansions working with the Electric Reliability Council of Texas (ERCOT) and under the supervision and regulation of the Public Utility Commission of Texas (PUC). Oncor Electric Delivery has a history of working closely with these groups and other regulatory agencies as needed to protect ecological resources along its existing transmission lines. The effects on terrestrial (Subsection 5.6.1) and aquatic (Subsection 5.6.2) resources and members of the public (Subsection 5.6.3) from installing and operating new circuitry associated with the proposed project are expected to be SMALL. The effects do not warrant mitigation beyond the best management practices (BMPs) used by Oncor Electric Delivery along its existing lines.

5.6.1 TERRESTRIAL ECOSYSTEMS

According to Subsection 4.5.6 of NUREG-1437, the effects on the terrestrial environment from operating electrical transmission systems result mainly from system repair and maintenance activities and maintenance of the ROW. These conclusions are supported by Oncor Electric Delivery's operating experience and procedures. Transmission lines pose a potential threat of physical injury to migrating and foraging bird species that might collide with the power lines, or of electrocution to raptors and large perching species while attempting to nest or perch on the towers.

Once placed into service, transmission lines are scheduled for inspection several times per year following an inspection protocol developed on the basis of Oncor Electric Delivery's operating experience with its overall transmission system. The purpose of the inspections is to identify any deterioration or damage to the transmission towers or power lines that require repair. The inspections also seek to identify any man-made encroachment onto the ROW or the growth of woody vegetation that might interfere with operation of the system.

Inspections can be performed from the ground, but are most often performed using light aircraft or helicopters. Ground and aerial inspections generate noise. Maintenance and repair also require persons on the ground to use trucks and other vehicles in the ROW. The noise and human presence startle and displace wildlife locally. This effect is temporary and has no lasting effect on wildlife populations.

Transmission ROWs are managed to prevent disruptions in service resulting from overgrown or diseased woody vegetation falling or encroaching on the power lines. Transmission ROW management also prevents overhead vegetation from falling on employees and members of the public. Vegetation management occurs on a maintenance cycle dictated by the vigor of local vegetation and Oncor Electric Delivery's local experience. This maintenance typically requires cutting herbaceous and low woody growth on a relative short cycle and cutting saplings, larger shrubs, and small trees on a longer cycle that varies within the service area from west to east. The cycle may also vary depending on public concerns, local ordinances, line maintenance, and environmental considerations. ROW maintenance typically involves use of herbicides in addition to light power equipment such as saws, mowers, and hand tools.

Application of herbicides is one of the primary methods used by Oncor Electric Delivery for maintaining ROWs once they have been cleared of woody vegetation or reclaimed. After initial clearing by cutting, herbicides are often applied to stumps to limit re-sprouting of woody species. Foliar application of herbicides is used afterwards if re-sprouting occurs or if the ROW is invaded by noxious weeds or other undesirable species. Undesirable species are controlled as required by local management plans usually established at the county level. Hand cutting and mowing are used in areas where herbicides may not be effective, difficult to apply, or undesirable. Herbicides are handled and applied only by qualified personnel in accordance with manufacturer specifications and guidance from regulatory agencies that license appropriately trained personnel to perform the work.

Using vehicles such as pick-up trucks or tractors with mower attachments and small powered tools like chainsaws along the ROW during repair or maintenance requires periodic refueling that could result in incidental spills of fuel and lubricants. Personnel using fuel or lubricants in the field are trained to respond to, clean up, and report spills. Adequate spill response materials are always available. Contaminated materials are managed and disposed in accordance with federal and state laws and regulations to prevent any adverse effects of these materials on the environment. This potential impact is negligible to SMALL.

Access roads for construction and subsequent maintenance are stabilized wherever necessary with gravel to prevent formation of ruts and gullies in the exposed soil. These road surfaces are allowed to grass-over and are re-cut only as needed to permit occasional vehicular access.

Clearing dense vegetation such as trees and large shrubs from a ROW removes the canopy, exposes the ground layer to sunlight, and usually results in fairly rapid growth of grasses, forbs, saplings, and low shrubs. If treated at intervals longer than one or two years after initial clearing, removing trees and shrubs creates habitat that mimics early stages of plant succession. Treatment increases the amount of ecotone or edge within what might otherwise be a spatially homogeneous woodland or shrub habitat. Increasing edge benefits species like ground-nesting birds, small mammals, and browsers like white-tailed deer that inhabit or use openings at the expense of species that might inhabit or use later successional stages such as woodlands. With the exception of creating openings in woodland or shrub habitat, no specific wildlife management practices such as planting food plots are included in normal ROW maintenance activities.

To the extent that habitat diversity increases and species in adjacent habitats fail to decline in diversity or density even though they might avoid the edge habitat separating a forest stand, for example, from the ROW, the effect results in a generally positive but SMALL benefit to local wildlife populations. Maintenance of a newly cleared segment through woodland might provide new opportunity for nest parasites such as the brown-headed cowbird to penetrate the woodland edge and impair the nesting success of woodland species. Nest parasitism is a generally negative but SMALL adverse impact on local populations.

With the possible exception of wetlands and floodplains, Oncor Electric Delivery's existing ROWs avoid wildlife sanctuaries, refuges, preserves, and the other "important" habitats identified in NUREG-1555. These ROWs do not adversely affect state- or federally-listed species or any of the other "important" species identified in that document. As reported in NUREG-1437 for operating plants, the potential effects associated with maintenance and system repair within established ROWs on "important" habitats and species are SMALL. (Subsection 4.5.6.1)

Although not necessarily defined as "important" species, NUREG-1437 states that avian mortality resulting from collisions with transmission lines and other man-made structures is of concern if the stability of a local population of any bird species is threatened or if the reduction in the numbers within any bird population significantly impairs its function within the ecosystem. Collision potential typically is dependent on site-specific variables such as the line location in relation to high use habitats (e.g., nesting, foraging, and roosting), line orientation to flight patterns and movement corridors, species composition, visibility, and line design.

Avian mortality resulting from collisions with transmission lines is considered to be of SMALL significance if there is no threat to the stability of local populations and if there is no noticeable impairment of its functioning within the ecosystem. None of the studies reviewed in NUREG-1437 suggest that collision mortality is a significant factor in reducing the populations of common bird species.

Based on (1) existing literature showing no significant effects of collision mortality on overall population levels and (2) the lack of known instances where nuclear power plant transmission lines affect large numbers of individuals in local areas, NUREG-1437 (Subsection 4.5.6.1) concluded that mortality resulting from bird collisions with existing transmission lines does not cause long-term reductions in bird populations. It is, therefore, a SMALL effect.

Electrocution is primarily a threat to species whose long wingspans make them susceptible to touching two energized conductors or an energized conductor and a ground simultaneously. This threat is higher in areas where towers in treeless terrain such as prairies and rangeland make attractive perches and nest sites. Electrocution in forested areas offering numerous natural perches and nest sites is a lesser threat. Potential electrocution is mitigated on a case-by-case basis by using fiberglass pole-top pin extensions, pole-top caps to exclude perching, nonconductive cross arms, insulating material, and other raptor-safe designs and features. This threat is a SMALL potential impact associated with existing ROWs in the area surrounding the proposed project.

Section 4.5 of NUREG-1437 evaluated the effects of transmission line maintenance and vegetation management on floodplains and wetlands. Control of trees and large shrubs is normally required only in forested areas where trees grow tall enough to physically interfere with operation of the power lines. Marshes, ponds, and other types of emergent wetlands lacking trees are generally not subjected to vegetation control and should not be affected. Effects in wetland and floodplain areas were found to be SMALL at operating nuclear power plants. Based on that analysis and Oncor Electric Delivery's operating experience in the area, the effects on floodplains and wetlands associated with the transmission system expansions to serve the proposed project are also expected to be SMALL.

NUREG-1437 (Subsection 4.5.6.3) also evaluated the effects of electromagnetic fields (EMFs) on plants, agricultural crops, honeybees, wildlife, and livestock. The potential impacts of EMFs to members of the public are discussed in Subsection 5.6.3.2, below.

These effects are considered to be of SMALL significance to plants and animals if the overall health, productivity, and reproduction of individual species are unaffected. According to studies cited in NUREG-1437, EMFs produced by transmission lines up to 1100 kV have no significant biological or economical impact on plants, wildlife, agricultural crops, or livestock with the possible exception of the following.

Plants. Studies reviewed in NUREG-1437 (Subsection 4.5.6.3.1) show that minor damage to plant foliage and buds can occur in the vicinity of strong electric fields. The damage is similar to that caused by drought or other environmental stresses. The damage is thought to result from heating caused by induced corona at the leaf tips and margins. The electric field is greatly focused by leaf points or marginal teeth, thus increasing its strength to the point that corona occurs. Transmission lines designed for voltage levels less than 765-kV, like the 345-kV circuits proposed for CPNPP Units 3 and 4, reduce adverse effects from corona discharge and ozone formation. See Subsection 5.6.3.3, below, for additional explanation of corona discharge.

Damage does not extend to lower levels of the plant because the electric field weakens with distance from the lines and because the upper plant parts shield the lower parts from the electric field. Corona discharge generally does not interfere with overall plant growth and the impact is SMALL.

Honeybees. Several studies cited in NUREG-1437 (Subsection 4.5.6.3.2) show that honeybees in hives under transmission lines are affected by EMF. These effects can be greatly reduced by shielding the hives with a grounded metal screen or by moving the hives away from the lines. The impacts are not caused by direct effects of the electric fields on the bees but by voltage buildup and electric currents within the hives, and the resultant shocks to bees. Bees kept in moisture-free nonconductive conditions were not adversely affected, even in strong electric fields. This effect can be eliminated by simply moving the hives. The effects of EMFs on honeybees are a SMALL impact.

The adverse effects of operating electrical transmission lines on terrestrial ecological resources are expected to be SMALL, as discussed in NUREG-1437. Oncor Electric Delivery's experience also reinforces the conclusion that these impacts are SMALL. Through extensive experience operating transmission lines, Oncor Electric Delivery is unaware of any new and significant information that would alter the conclusions presented in NUREG-1437 regarding the SMALL impacts of operating transmission lines and maintaining the ROWs.

These impacts warrant no special mitigation beyond Oncor Electric Delivery's standard operating procedures and best management practices discussed earlier in Section 5.6. Installing new circuitry underground would be the only potentially meaningful mitigation. This option is explored only for densely populated areas such as large cities because of the high cost of construction and maintenance, and power losses that increase substantially compared to overhead installation.

5.6.2 AQUATIC ECOSYSTEMS

The effects of ROW and service road maintenance activities on nearby aquatic ecosystems are a concern in this subsection. These effects are considered to be of SMALL significance in Subsection 4.5.5 of NUREG-1437, if there is no measurable change in species diversity, abundance, or health within the aquatic ecosystem.

The potential effects of transmission lines on aquatic resources arise mainly from water quality effects associated with maintaining ROWs and service roads, and from possible trespassing on the ROWs. Trespassing is minimized by fencing and installing gates that are normally locked.

Where roads cross or border on surface waters, soil erosion could cause elevated turbidity and sedimentation. Appropriate erosion control techniques (e.g., grassed or wooded buffer strips between the road and the body of water) minimize these potential effects.

Power line ROWs are normally maintained by mowing and selective application of herbicides that do not increase soil erosion. There are potential toxic effects of herbicides applied to power line ROWs that are subsequently transported to surface waters. These effects are mitigated in the maintenance program by consulting appropriate authorities and applying herbicides properly. By properly using approved herbicides, significant adverse effects are avoided. Mowing and other activities needed to maintain ROWs are readily controllable to minimize effects to aquatic resources resulting in a SMALL impact.

Best construction and management practices (BMPs) required of personnel engaged in operating or maintaining transmission lines that cross waterways are discussed in Subsection 4.3.1.4. Adding circuitry to existing transmission line ROWs and implementation of BMPs (Subsection 4.3.1.4) avoid any significant impact to aquatic habitats. By minimizing impact to habitat, ROWs are not expected to adversely affect state- or federally-listed species, or any of the other “important” aquatic species identified in NUREG-1555. The effect of transmission lines on surface water quality and aquatic ecology is of SMALL significance.

Oncor Electric Delivery’s experience reinforces this conclusion. Because of extensive experience operating transmission lines, Oncor Electric Delivery is also unaware of any new and significant information that would alter the conclusions presented in NUREG-1437 regarding the SMALL impacts on aquatic ecology of operating transmission lines and maintaining the ROWs. The continued use of proper management practices with respect to soil erosion and application of herbicides is expected on the CPNPP site and elsewhere off-site.

5.6.3 IMPACTS TO MEMBERS OF THE PUBLIC

The possible effects from electrical transmission systems on members of the general public include electrical shock, exposure to electromagnetic fields (EMF), exposure to noise and ozone, radio and television interference, visual effects, and potential interference with local aviation. Each of these effects is individually evaluated in the following subsections.

5.6.3.1 Electrical Shock

Objects located near transmission lines can become electrically charged because of their immersion in the lines' electrical field. The charge results in a current that flows through the object to the ground. The current is "induced" because there is no direct connection between the power line and the object. The induced current can also flow to the ground through the body of a person (or animal) that touches the object. An object that is insulated from the ground can actually store an electrical charge, thereby becoming "capacitively charged." A person (or animal) standing on the ground and touching a vehicle or fence receives an electrical shock as a result of the sudden discharge of the capacitive charge through the body to the ground.

The National Electrical Safety Code describes establishing minimum vertical clearances to the ground for power lines exceeding 98-kV. The clearance must limit the induced current to 5 milliamperes (ma) if the largest anticipated truck, vehicle, or equipment item is short-circuited to ground. The 5-ma limit compares to a limit of 4 – 6 ma for ground fault circuit interrupters used in residential applications outside or around water sources such as bathrooms. A 500-kV transmission line, for example, requires a minimum of 45 ft of clearance at which height induced currents are below 5-ma for tall vehicles such as tractor trailers and busses. Adding circuitry to existing transmission lines high enough to comply with the 5-ma standard eliminates the possibility of dangerous electrical shocks and continues Oncor Electric Delivery's long-standing commitment to operate and maintain facilities that ensure public and worker safety.

Induced current can also be prevented by grounding metal objects such as vehicles, tractors, and fences within the ROW. Grounding chains can be easily installed on mobile equipment. Metal fences can be connected to a simple ground rod with an insulated lead and wire clamp. Consequently, the potential effects on members of the public and workers in the ROW are SMALL.

5.6.3.2 Exposure to Electromagnetic Fields

The EMFs exist anywhere electricity is produced, distributed, or consumed. These fields are created by power lines; residential, commercial, and industrial wiring; and even the use of consumer appliances.

In 1992, the U.S. Congress established a research and education program designed to determine if exposure to extremely low frequency EMF is harmful to humans. The National Institute of Environmental Health concluded that human exposure could not be ruled entirely safe, but evidence warranting aggressive regulatory concern was lacking.

Oncor Electric Delivery's existing transmission system was routed to avoid occupied buildings and other environmentally sensitive sites. In addition, new transmission lines are routed in accordance with the PUC's "policy of prudent avoidance" whereby Oncor Electric Delivery is tasked with reasonably avoiding population centers and other locations where people gather in order to limit exposure to EMF. The EMF also diminishes rapidly with distance. For example, readings on the strength of EMF directly under existing 230-kV and 525-kV lines typically range from 15 – 25 milliGauss (mG). At 75 ft from the ROW fence, these levels decrease to a range of 3 – 7 mG.

The normal background magnetic field strength away from electrical devices is 0.6 – 1.5 mG. In homes, typical EMF strength levels around common electrical devices range from 2 to 20 mG for computers and from 800 to 1100 mG for electrical can openers. In addition to land-use conflicts and visual effects, avoiding existing buildings minimizes potential EMF exposure. Until human exposure findings occur that are contrary to those discussed above, the potential effects from exposure to EMF are considered SMALL.

5.6.3.3 Noise and Ozone

Transmission lines operating at 345-kV and higher can emit noise when the electric field strength surrounding them is greater than the breakdown threshold of the surrounding air, creating a discharge of energy. The energy and heat loss, termed corona discharge, is also affected by ambient weather factors such as humidity, air density, wind, and precipitation, as well as irregularities on the energized surface.

Conductors on high-voltage lines are designed to be corona-free under ideal conditions. Slight irregularities and variations on the surfaces of the conductors can cause higher electrical fields near the surfaces and the occurrence of corona. The most common sources are water droplets, either on the conductor or dripping from it. Thus, noise often occurs during wet weather. During fair weather, insects and dust on a conductor replace water as sources of corona.

Corona discharge may also result in the production of small amounts of ozone. Ozone is an allotrope of the element oxygen. An allotrope is a structurally different form of a common element. Ozone consists of three oxygen atoms (O_3); whereas, oxygen consists of two oxygen atoms (O_2). Ground-level ozone is, like oxygen, a gas but is considered to be an air pollutant that can harmfully affect the respiratory systems of animals.

Corona discharge causes ozone formation by breaking apart oxygen molecules in the atmosphere. The freed oxygen atom then re-bonds with an oxygen molecule, forming ozone. NUREG-1437 (Subsection 4.5.2) found that the amount of ozone produced by even large transmission lines was insignificant and undetectable by monitoring a prototype 1200-kV line. There are no known links between the level of ozone produced by high-voltage transmission lines and any adverse effects on plants, animals or humans.

Modern power lines are designed and constructed with features to eliminate corona discharge. The potential for corona loss increases during wet weather, and nuisance noise occurs if insulators and other hardware have any defects.

Corona noise along transmission lines is usually of low volume, about 10 decibels (dB) or less, or even inaudible except directly below power lines when one may perceive a “hum” of 50 – 60 dB on a quiet, humid day. Normal human speech has a sound level of about 60 dB. While it can be annoying, the noise poses no known risk to humans or animals. The effects from corona discharge are SMALL.

5.6.3.4 Radio and Television Interference

Corona can also generate EMF noise at frequencies used for radio and television signals. Radio and television interference is most often linked to defective hardware or to an oxidized film that forms where two pieces of hardware come into direct contact. This condition arises because lines receive insufficient routine maintenance.

Once reported by members of the public, replacement of the defective part normally corrects the problem. Oncor Electric Delivery's standard maintenance practices seek to ensure proper connections between all current-carrying components for their operational life. This effect is temporary and SMALL.

5.6.3.5 Visual Effects

Oncor Electric Delivery selected its existing transmission lines to avoid environmentally sensitive areas. Oncor Electric Delivery also works to maintain important viewsheds. Low-growing natural vegetation that does not pose a threat to the overhead lines may be retained at road and river crossings for its screening effect during construction to help minimize ground-level visual effects, unless engineering requirements dictate otherwise. Visual effects to members of the public from transmission lines are SMALL.

5.6.3.6 Aviation

Federal Aviation Administration (FAA) regulations establish standards for constructing objects in navigable airspace and require notification of the FAA regarding any such proposed construction. Notification is required if the object under construction exceeds 200 ft in height above ground level. Notification is also required if the tall object is located within 3.3 nautical mi (20,000 ft) of runways longer than 3200 ft, within 1.7 nautical mi (10,000 ft) of runways 3200 ft long or less, or within 0.8 nautical mi (5000 ft) of heliports. Oncor Electric Delivery complies with these regulations. There are no commercial airports within 20,000 ft of the existing transmission lines that are expected to be utilized for CPNPP Units 3 and 4.

5.7 URANIUM FUEL CYCLE AND TRANSPORTATION IMPACTS

This section is divided into two subsections. Subsection 5.7.1 discusses the impacts on the environment from the processes and hazards associated with the Uranium Fuel Cycle (UFC) while Subsection 5.7.2 discusses the impacts of the transportation of radioactive materials as found in this and other relevant sections of the Environmental Report.

5.7.1 URANIUM FUEL CYCLE IMPACTS

This subsection discusses the impacts on the environment from the processes and hazards associated with the UFC. The UFC, for purposes of this subsection, is defined as the total of those options and processes associated with the provision, utilization, and ultimate disposition of fuel for nuclear power reactors. It should be noted that until a federal permanent high-level disposal repository becomes a reality, the nuclear fuel cycle is incomplete (LANL 1982).

Table S-3 of 10 CFR 51.51 provides estimates of the environmental impacts due to the UFC. The impacts are calculated for a reference 1000-MWe (3400-MWt) light water reactor (LWR) operating at an annual capacity factor of 80 percent for an effective electric output of 800 MWe. The reference reactor used a 3.2 percent U_{235} enrichment and a 33,000 MWd/MTU burnup. This reference reactor is referred to throughout this subsection.

Nuclear Regulatory Commission (NRC) regulation 10 CFR 51.51 requires that the data in Table S-3 be used as the basis for evaluation of newly proposed projects. Baseline data are calculated and presented in Table S-3 for (1) natural resource use of land and water, (2) fossil fuel, (3) chemical effluents including gases, liquids, and solids, (4) radiological effluents including gases, liquids, and solids, and (5) transportation including dose to the public and workers.

Two Mitsubishi Heavy Industries (MHI) US-Advanced Pressurized Water Reactors (US-APWR) are proposed for CPNPP Units 3 and 4. Nuclear fuel suppliers use manufacturers of nuclear fuel from around the world and therefore not every item covered by U.S. Federal Regulations and Table S-3 will directly apply to this proposed fuel cycle (Table S-3 is based on total domestic production). Differences will be noted as the process is explained. Different stages of the UFC can be provided from various sources, both foreign and domestic. Regardless of any differences noted, the tables supplied for this subsection are based on the 10 CFR 51.51, Table S-3, guidance.

Subsection 1.1.3, states that each unit’s gross electrical power available to the grid is approximately 1600 MWe. The projected summertime production is expected to be approximately 1625 MWe. For conservatism in this evaluation, the optimum 1700 MWe is used for the comparison to the reference plant. An annual capacity factor of 95 percent (approximately 36 days off-line in a two-year period) is used for the US-APWR while the reference reactor used an 80 percent capacity factor. These two reactors operating at 1700 MWe each, with a projected annual capacity factor of 95 percent, yields an effective electric output of 3230 MWe. A ratio of the generation values of 3230 MWe for the two US-APWR units and 800 MWe for the reference reactor provides a scaling factor of 4.04 to convert reference reactor values to CPNPP Units 3 and 4 specific values (Table 5.7-1). CPNPP Units 3 and 4 values are presented in the text and tables of this subsection after applying the calculated scaling factor given above.

In developing the reference reactor data, the NRC staff considered two UFC options. The first option, no-recycle, and the second, uranium-only recycle, differ only in the treatment of spent fuel removed from a reactor. No-recycle means all spent fuel is waste to be stored at a federal waste repository. Uranium-only recycle involves reprocessing spent fuel to recover unused uranium and return it to the UFC. The reference reactor values that are provided for reprocessing, waste management, and transportation are from the UFC option resulting in the larger environmental impact.

The Nuclear Nonproliferation Act of 1978 effectively banned any reprocessing or recycling of spent fuel from U.S. commercial nuclear power generation. The ban on reprocessing spent fuel was lifted in 1981 but the combination of economics, increased uranium ore stockpiles, and nuclear industry stagnation provided little incentive for the industry to resume reprocessing. The Energy Policy Act of 2005 authorized the U.S. Department of Energy (DOE) to research and develop proliferation-resistant fuel recycling and transmutation technologies that minimize environmental or public health and safety effects. Federal policy does not prohibit reprocessing, but additional DOE efforts are required before commercial reprocessing and recycling of spent fuel produced in the U.S. commercial nuclear power plants can commence.

The stages of the UFC include:

- Uranium mining and milling;
- Uranium hexafluoride conversion;
- Isotopic enrichment of uranium;
- Fabrication of nuclear fuel;
- Use of the fuel in the reactor; and
- Disposal of the spent (used) fuel or reprocessing.

Figure 5.7-1 illustrates processes in the UFC.

Natural uranium is mined in either open-pit, underground mines, leaching or solution mining, or by an in-situ leaching process. In-situ leaching involves injecting a solvent solution into the underground uranium ore zone to dissolve uranium, and then pumping the solution to the surface for further processing. In-situ leaching is currently the most used method to mine uranium. In-situ mining produces the least environmental impact and is cost effective (CSIRO 2004).

The ore or leaching solution is moved to mills located in places such as in the USA, Canada, and Australia where it is processed to recover the uranium as uranium oxide (U_3O_8). Most uranium mills use an acid or alkaline leach solution to extract and concentrate the U_3O_8. The uranium oxide is converted to uranium hexafluoride (UF_6), which is then injected into the enrichment process. A “dry” or “wet” conversion process can be used to produce UF_6. (LANL 1982)

The UF_6 is transported in 10- or 14-ton shipping cylinders to an enrichment facility located at facilities in places such as in the USA, France, England, Japan or Russia. The process of enrichment increases the percentage of the more fissile isotope uranium-235 (U_{235}) and decreases the percentage of uranium-238 (U_{238}). Natural uranium is approximately 0.7 percent U_{235}. All production methods of enrichment exploit the slight differences in atomic weights of the two isotopes. A feature common to all large-scale enrichment schemes is that they employ a number of identical stages, which produce successively higher concentrations of U_{235}. Each stage concentrates the product of the previous stage further before being sent to the next stage. Similarly, the tailings from each stage are returned to the previous stage for further processing. This sequential enriching system is called a cascade.

At a fuel-fabrication facility, the enriched uranium is then converted from UF_6 to uranium dioxide (UO_2). The UO_2 is formed into pellets, inserted into tubes, and loaded into fuel assemblies ready to be transported to the reactor site. Supplied fuel can include a partial load of reactor-grade mixed oxide fuel (MOX). The MOX fuel fabrication takes place in such places as France, England, the USA, or Japan. MOX fuel pellets contain some plutonium and are usually fabricated by mechanically blending UO_2 and PuO_2 powders, then pressing and sintering them (NRC 1999).

The fuel assemblies are placed in the reactor to produce heat by fission. At the fuel assembly end of life, the fissle concentration reaches a point where the nuclear fission process becomes inefficient. The fuel assemblies are now ”spent fuel” assemblies and are removed from the reactor and placed in on-site storage.

After on-site storage for sufficient time to allow for short-lived fission product decay and to reduce the heat generation rate, the fuel assemblies may be transferred to a “dry cask” in preparation for shipment to a high-level waste repository for interment. Storing the spent fuel elements in a repository constitutes the final step in the no-recycle option. In the current situation at commercial nuclear reactors, spent fuel storage in a federal repository has not been approved. Spent fuel is stored on-site in spent fuel pools immersed in water or in dry cask storage units, all awaiting final disposition. As an alternative for plants no longer having sufficient wet or dry on-site storage capacity, spent fuel may be transferred off-site to another plant where adequate storage is available.

The environmental effects of the UFC from operation of CPNPP Units 3 and 4 are assessed in the following subsections. This assessment is based on the CPNPP Units 3 and 4 values calculated and reported in Table 5.7-2, and an analysis of the potential radiological effects from Radon-222 (Rn_{222}) and Technetium-99 (Tc_{99}).

In NUREG-1437, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants”, the NRC staff provides a detailed analysis of the environmental impacts from the UFC. Although NUREG-1437 is specific to license renewal, the information is relevant because the LWR design considered in this application uses the same basic type of fuel. The analyses in Subsection 6.2.3 of NUREG-1437, “Sensitivity to Recent Changes in the Fuel Cycle,” are summarized and presented in this subsection as they relate to this proposed action.

Recent changes in the UFC may have some bearing on environmental impacts. The CPNPP concludes that the impacts of the current UFC are less than those identified for the reference reactor, and are noted below. The reference reactor values were calculated from industry averages for each type of facility or operation within the UFC. Recognizing that this approach would result in a range of values for each estimate, the NRC staff chose the assumptions or factors to be applied so the calculated values would not be underestimated. This approach is adopted to ensure that the actual environmental impacts would be less than the quantities shown for the reference reactor and would envelope the widest range of operating conditions for light water reactors. Some UFC parameters and interactions were recognized by the NRC staff as being less precise than the estimates and were not considered, or were considered but had no effect on the reference reactor calculations.

To determine the annual fuel requirement, the NRC staff defined the model reactor as a 1000-MWe light water cooled reactor. They assumed an 80 percent capacity factor, a 12-month fuel reloading cycle, and an average fuel burnup of 33,000 megawatt-days (MWd) per metric ton (t) of uranium. This is referred to as a “reactor reference year” (RRY). The current expected lifetime of a new nuclear plant is 60 years (the 40-year initial licensing plus one 20-year license renewal term). The sum of the initial fuel loading and the presumed reloads for the lifetime of the reactor is divided by the 60-year presumed lifetime to obtain an average annual fuel requirement. This quantity of fuel was determined for both boiling water reactors (BWRs) and pressurized water reactors; the higher annual requirement, a BWR using 35 t of uranium, was chosen in NUREG-1437 as the basis for the RRY.

A number of fuel management improvements have been adopted by nuclear power plants to achieve higher performance, and to reduce fuel and enrichment requirements. Since the reference reactor data was published, the improvements in reactor technology have resulted in an overall reduction of the annual fuel requirement.

Another important factor is the elimination of the U.S. restrictions on importation of foreign uranium. The economic conditions of the uranium market currently favor utilization of foreign uranium rather than domestic uranium. These market conditions have led to the closing and decommissioning of most domestic uranium mines and mills, substantially reducing the environmental effects in the U.S. from these activities. These changes to the UFC indicate that the environmental impacts of mining and milling have dropped to levels below those given for the reference reactor. For the purposes of this analysis, the reference reactor conservative estimates have not been reduced. Based on advanced reactor designs, current and future practices in each phase of the UFC has becomes more environmentally friendly, particularly mining, milling and enrichment.

Because plutonium is a strong alpha emitter, and its specific activity is much higher than uranium, a minute quantity of plutonium, if inhaled, could present a health hazard. Therefore, a MOX fuel fabrication facility has remote handling requirements not found in uranium fabrication facilities. A MOX fabrication facility is subject to more stringent requirements than a uranium fuel fabrication facility (NRC 1999). Operating practices have become more environmentally friendly as processing technology improves, particularly with higher load factors and longer burnup. Environmental regulations and practices are more stringent and thus more environmentally friendly (INEEL 2004).

Section 6.2 of NUREG-1437 discusses the sensitivity to recent changes in the UFC on the environmental impacts in detail. Where relevant in the following discussions, a single significance level of the potential impact, i.e., SMALL, MODERATE, or LARGE, is assigned to each analysis. This significance level is consistent with the criteria that the NRC established in 10 CFR 51, Appendix B, Table B-1, Footnote 3, as follows: SMALL environmental impacts are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. MODERATE environmental impacts are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource. LARGE environmental impacts are clearly noticeable and are sufficient to destabilize any important attributes of the resource.

5.7.1.1 Land Use

The total annual land requirement for the UFC supporting CPNPP Units 3 and 4 is presented in Table 5.7-2. This table includes values for both permanently and temporarily committed land. A “temporary” land commitment is a commitment for the life of the specific UFC plant; e.g., a mill, enrichment plant, or succeeding plants. Following completion of decommissioning, such land can be released for unrestricted use. “Permanent” commitments represent land that may not be released for use after plant shutdown or decommissioning. A permanent commitment example is the stabilization of mill tailings impoundments, because decommissioning activities on the pertinent land cannot remove sufficient radioactive material to meet the limits in 10 CFR 20, Subpart E, for release of land for unrestricted use. The division of temporarily committed land into undisturbed and disturbed land as shown in Table 5.7-2 is compared to the land disturbed to provide fuel for a coal-fired power plant using strip-mined coal with power generation equivalent to the CPNPP Units 3 and 4 values. Portions of the UFC now occur in foreign countries as well as domestically; therefore, based on this analysis, CPNPP concludes that the impacts on land use to support CPNPP Units 3 and 4 would be SMALL.

5.7.1.2 Water Use

Power stations supply electrical energy to the enrichment stage of the UFC. The primary water requirement of the UFC is waste heat removal from these power stations. For the UFC supporting the proposed project, over 97 percent of the annual water requirement is used in this manner. Values for the various water uses required are presented in Table 5.7-2. On a thermal effluent basis, annual discharges from the UFC are equal to about four percent of the thermal effluent from the reference reactor using once-through cooling. The consumptive water use is about 2 percent of the consumptive water use of the reference reactor using cooling towers. The expected thermal effluent values for CPNPP Units 3 and 4 are presented in Table 5.7-2. Portions of the UFC now occur in foreign countries as well as domestically; therefore, based on this analysis, CPNPP concludes that the impacts on water use for these combinations of thermal loadings and water consumption would be SMALL relative to the water use and thermal discharges of the proposed project.

5.7.1.3 Fossil Fuel Effects

Electrical energy and process heat are required during various phases of the UFC process. The electrical energy is usually produced by combustion of fossil fuels at power plants. Electrical energy needs associated with the UFC represents about five percent of the annual electrical power production of the reference reactor. Process heat is primarily generated by the combustion of natural gas. This gas consumption, if used to generate electricity, would be less than 0.4 percent of the electrical output from the reference reactor. If the electrical energy and heat are produced by burning coal, there are direct environmental impacts to the air, water, and land along with fly ash disposal as a secondary impact. Electrical energy needs for CPNPP Units 3 and 4 associated with the UFC are presented in Table 5.7-2. Portions of the UFC now occur in foreign countries as well as domestically; therefore, based on this analysis, CPNPP concludes that the fossil fuel impacts from the consumption of electrical energy for UFC operations would be SMALL relative to the net power production of CPNPP Units 3 and 4.

5.7.1.4 Chemical Effluents

The quantities of chemical effluents, both gaseous and particulate, due to the UFC processes to support CPNPP Units 3 and 4 are presented in Table 5.7-2. The principal effluents are oxides of sulfur (SO_x), oxides of nitrogen (NO_x), and particulates. Based on data in the 1997 Annual Report of the Council on Environmental Quality, these emissions constitute a SMALL additional atmospheric loading in comparison with these emissions from the stationary fuel combustion and transportation sectors in the United States.

Liquid chemical effluents produced in the UFC processes are related to fuel enrichment and fabrication, and may be released to receiving waters. In these effluents, the chemicals are usually present in such small concentrations that only small amounts of dilution water are required to reach levels of concentration that are within established water quality standards. Table 5.7-2 presents the amount of dilution water required for specific constituents. Additionally, any liquid discharges into the navigable waters of the United States from plants associated with UFC operations are subject to requirements and limitations set in an National Pollution Discharge Elimination System (NPDES) permit issued by an appropriate federal, state, regional, local, or affected Native American tribal regulatory agency. International standards apply to those processes that take place in foreign countries. Tailings solutions and solids are generated during the milling process. These materials are impounded, treated, and not released in quantities sufficient to have a significant impact on the environment. Portions of the UFC occur in foreign countries as well as domestically; therefore, based on this analysis, CPNPP determined that the impacts of these chemical effluents would be SMALL.

5.7.1.5 Radioactive Effluents

The estimates of radioactive effluent releases to the environment are presented in Table 5.7-2. These estimates are from waste management activities and certain other phases of the UFC process. The 100-year involuntary environmental dose commitment to the U.S. population is calculated in several parts.

The portion of the 100-year dose commitment to the U.S. population from radioactive gaseous effluents due to the UFC during reactor operation is presented in Table 5.7-4 per year of operation of the proposed project. This portion of the estimate excludes reactor releases and any dose commitment from Rn-222. The portion of the 100-year dose commitment to the U.S. population due to the UFC from radioactive liquid effluents other than reactor operation is presented in Table 5.7-4 per year of operation of the proposed project. Thus, the total 100-year environmental dose commitment to the U.S. population from radioactive gaseous and liquid releases resulting from these operations in the UFC is presented in Table 5.7-4 per year of operation of the proposed project. Table 5.7-4 goes one step further, adding the Rn-222 and Tc-99 committed doses (Table 5.7-3) to the values described above to provide a total committed dose.

Currently, the radiological effects associated with Rn-222 and Tc-99 release are not addressed in the reference reactor data of Table S-3. Principal Rn-222 releases occur during mining and milling operations and as emissions from mill tailings; whereas, principal Tc-99 releases occur from gaseous diffusion enrichment facilities. The CPNPP performed an assessment of Rn-222 and Tc-99 based on information in NUREG-1437. In Subsection 6.2.2.1 of NUREG-1437, the NRC staff estimated the Rn-222 releases from the mining and milling operation, and from mill tailings required to support each year of operations of the reference reactor. Of the total radiological effects expected, about 77 percent would be from mining, 15 percent from milling operations, and 7 percent from inactive tailings prior to stabilization.

The major risks from Rn-222 are bone and lung exposure; although there is a small risk from whole body exposure. The organ-specific dose weighting factors from 10 CFR Part 20 are applied to the bone and lung doses to estimate the 100-year dose commitment from Rn-222 to the whole body. The estimated population dose commitment from mining, milling, and tailings before stabilization for each year of operation of CPNPP Units 3 and 4 is presented in Table 5.7-3. From stabilized tailings piles, the estimated 100-year environmental dose commitment is presented in Table 5.7-3. Additional insights regarding routine Rn-222 exposure and risk, and long-term releases from stabilized tailings piles, are discussed in NUREG-1437.

As shown in NUREG-1437, the NRC staff also considered the potential health effects associated with the release of Tc-99 whose source is from spent fuel re-processing. Using that evaluation method, the releases of Tc-99 per year of CPNPP Units 3 and 4 operation are chemical reprocessing of recycled UF_6 before it enters the isotope enrichment cascade, and released into the groundwater from a federal repository. These values are presented in Table 5.7-3.

The major risks from Tc-99 are from gastrointestinal tract and kidney exposure; although, there is a small risk from whole-body exposure. Using organ-specific risk estimators, these individual organ risks can be converted to a whole-body 100-year dose commitment per year of CPNPP Units 3 and 4 operations. This value is presented in Table 5.7-3.

Although radiation may cause cancers at high doses and high dose rates, currently there is no data that unequivocally establishes the occurrence of cancer following exposure to low doses and dose rates below about 10,000 mrem. However, radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response model is used to describe the relationship between radiation dose and risk such as cancer induction. A report by the National Research Council (NAP 2006) supports the linear, no-threshold dose response model. Simply stated, any increase in dose, no matter how small, results in an incremental increase in health risk. This theory is accepted by the NRC as a conservative model for estimating health risks from radiation exposure, recognizing that the model probably overestimates those risks.

Based on this model, the NRC staff estimated the risk to the public from radiation exposure. The sum of the estimated whole body population doses from radioactive gaseous effluents, liquid effluents, Rn-222, and Tc-99 discussed above can be used to estimate the number of fatal cancers, nonfatal cancers, and severe hereditary effects that the U.S. population would incur annually; this estimate is conservative because much of the process occurs outside the U.S. This risk is small compared to the number of fatal cancers, nonfatal cancers, and severe hereditary effects that would be estimated to occur in the U.S. population annually from exposure to natural sources of radiation using the same risk estimation method.

The radiation levels from airborne Rn-222 released from tailing piles are indistinguishable from background radiation levels at a few kilometers from the tailings pile, at less than one km in some cases. The public dose limit specified by EPA regulation in 40 CFR Part 190 is 25 mrem/yr to the whole body from the entire UFC, but most NRC licensees have airborne effluents resulting in doses of less than one mrem/yr.

In addition, at the request of the U.S. Congress, the National Cancer Institute (NCI) conducted a study and published "Cancer in Populations Living Near Nuclear Facilities, A Survey of Mortality Nationwide and Incidence in Two States" in 1990 (JAMA 1991). The report concluded that if any excess cancer risk was present in U.S. counties with nuclear facilities, it was too small to be detected with the methods employed. The contribution to the annual average dose received by an individual from the UFC related to radiation received from other sources is presented in Table 5.7-5 (NRC 2003). Portions of the UFC occur in foreign countries as well as domestically; therefore, based on the analyses presented, CPNPP concludes that the environmental impacts of radioactive effluents from the UFC are SMALL.

5.7.1.6 Radioactive Wastes

The quantities of buried radioactive waste material (low-level, high-level, and transuranic wastes) are specified in Table 5.7-2. For low-level waste disposal at land burial facilities, the NRC notes in the reference reactor data that there will be no significant radioactive releases to the environment. For high-level and transuranic wastes, the NRC notes that these wastes are expected to be buried at a repository and that no release to the environment is expected to be associated with such disposal. The gaseous and volatile radionuclides contained in the spent fuel would have been released and monitored before disposal.

The federal government has recommended Yucca Mountain site for the development of a repository for the geologic disposal of spent nuclear fuel and high-level nuclear waste. The EPA developed Yucca Mountain-specific repository standards, which were subsequently adopted by the NRC in 10 CFR Part 63. In an opinion issued on July 9, 2004, the U.S. Court of Appeals for the District of Columbia Circuit Court vacated EPA’s radiation protection standards for the candidate repository that required compliance with certain dose limits over a 10,000-year period (USCA 2004).

The Court’s decision also vacated the compliance period in NRC’s licensing criteria for the candidate repository in 10 CFR Part 63. In response to the Court’s decision, EPA issued proposed revised standards on August 22, 2005. The proposed standard would revise the radiation protection standards for the candidate repository (EPA 2005). As required by the Nuclear Waste Policy Act of 1982, and in order to be consistent with EPA’s revised standards, NRC proposed revisions to 10 CFR Part 63 on September 8, 2005. The proposed standards are

15 mrem/yr for the first 10,000 years following disposal and 350 mrem/yr after 10,000 years through one million years after disposal (NRC 2005).

For the reasons stated above, CPNPP concludes that the environmental impacts of radioactive waste disposal from the UFC are SMALL.

5.7.1.7 Occupational Dose

In the review and evaluation of the environmental effects of the UFC, the 100-year overall involuntary whole-body dose commitment to the U. S. population attributable to all phases of the UFC for CPNPP Units 3 and 4 is presented in Table 5.7-4. The total projected 100-year dose without Rn-222 and Tc-99 is 2,424 person-rem/yr. Based on the population of the U. S.of approximately 300 million people, the individual dose to a single person would be extremely small (less than 0.0081 mrem/yr). Occupational doses for operational workers would be maintained at each licensed facility to meet the dose limits in 10 CFR Part 20, which is five rem/yr while ALARA principals can significantly reduce exposures, and in most cases by greater than 90 percent of the occupational limit, with such a small contribution from the UFC the impact to occupational workers is minimal. On this basis, CPNPP concludes that environmental impacts from this occupational dose would be SMALL.

5.7.1.8 Summary

Using an evaluation process as provided by NUREG-1437 (NRC 1996), CPNPP has evaluated the environmental impacts of the UFC, considered the effects of Rn-222 and Tc-99, and appropriately scaled the data for the proposed project. Portions of the UFC occur in foreign countries as well as domestically, and based on this comparison, CPNPP concludes that the environmental impacts of the UFC are SMALL, and mitigation is not warranted.

5.7.2 TRANSPORTATION OF RADIOACTIVE MATERIALS

The transportation dose to workers and the general public is presented in Table 5.7-2 for the proposed project. The table indicates the total exposure of workers and the general public is equal to 10.1 person-rem total dose. For comparative purposes, the estimated collective dose from natural background radiation to the population within 50 mi of CPNPP Units 3 and 4 is 4,500,000 person-rem/yr based on a population of approximately 1,500,000 people (Subsection 2.5.1.2) and a natural background dose rate of 0.3 rem/yr per person (Table 5.7-5). Addressing the MOX issue in transportation, this assessment included the analysis of particle sizes of MOX fuel following a transportation accident and the determination that the particles would be too large to be inhaled. Thus, it was concluded that transportation accidents would not increase the threat of plutonium toxicity from inhalation (NRC 1999). From the NRC website, key topics section, the following is presented "Over the last 30 years, thousands of shipments of commercially generated spent nuclear fuel has been made throughout the United States without causing any radiological releases to the environment or harm to the public." On this basis, CPNPP concludes that environmental impacts of transportation would be SMALL.

The preceeding Subsection 5.7.1.6 discussed radioactive waste; low, high, and transuranic and the methods of disposal. Transportation supporting information as required by NUREG-1555 Subsection 5.7.2, July 2007 are included in the following sections:

- Reactor type and rated core thermal power - Section 3.2 and Subsection 3.8.1.
- Fuel assembly description - Section 3.2.
- Average irradiation level of irradiated fuel - Subsection 3.8.1.5.
- Capacity of on-site storage facilities and minimum fuel storage time - Subsection 3.8.1.6.
- Treatment and packaging procedures for radioactive waste other than irradiated fuel - Subsections 3.8.1.8 and 3.8.1.11.
- Transportation packaging systems used for fresh fuel, spent fuel, and other radioactive waste - Subsections 3.8.2.1, 3.8.2.2, 3.8.1.8 and 3.8.1.10.
- Transportation distances - Subsections 3.8.2.1, and 3.8.2.2.

The US-APWR does not meet the conditions for power level, average fuel enrichment, or average fuel burnup. Therefore, Subsection 3.8.2 and Section 7.4 present additional analysis of fuel transportation effects for normal conditions and accidents, respectively. Transportation of radioactive waste meets the applicable conditions in 10CFR 51.52 and no further analysis is required (Subsection 3.8.1.12).

5.7.3 REFERENCES

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(INEEL 2004) Idaho National Engineering and Environmental Laboratory. Updated Uranium Fuel Cycle Impacts for Advanced Reactor Designs. Author Robert Nitschke. Senior Consulting Scientist. October 4, 2004.

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(NRC 1999) U.S. Nuclear Regulatory Commission. Mixed-Oxide Fuel Use In Commercial Light Water Reactors. Memorandum. William D. Travers, Executive Director for Operations.

(NRC 2003) U.S. Nuclear Regulatory Commission. Natural and Man-Made Radiation Sources. Reactor Concepts Manual. www.nrc.gov/reading-rm/basic-ref/teachers/06.pdf. July 2003. Accessed September 2007.

(NRC 2005) U.S. Nuclear Regulatory Commission. Proposed Rule Changes to 10 CFR 63. Disposal of High-Level Radioactive Wastes In A Geologic Repository At Yucca Mountain, Nevada. Federal Register. Volume 70. No. 173. page 53319.

(USCA 2004) United States Court of Appeals for the District of Columbia Circuit. Nuclear Energy Institute, Inc. Petitioner, v. Environmental Protection Agency. Respondent. January 14, 2004. No. 01-1258.

TABLE 5.7-1
SCALING FACTOR BETWEEN REFERENCE REACTOR AND THE PROPOSED US-APWRS

	Reference Reactor Data (10 CFR 51.51- Model 1000 MWe- LWR)	CPNPP Units 3 and 4 Data (two US-APWR Units)
Gross Electrical Output	**1000 MWe**	**3400 MWe** (2 Units *1700 MWe = 3400 MWe)
Capacity Factor	**80 Percent** (0.80)	**95 Percent** (0.95)
Effective Electric Output	**800 MWe** (1000 MWe *0.80 = 800 MWe)	**3230 MWe** (3400 MWe * 0.95 = 3230 MWe)
Ratio of Effective Electric Output Values		**4.04**[(a)] (3230 MWe / 800 MWe = 4.0375)

a) This scaling factor (4.04) is used to calculate the CPNPP Units 3 and 4 values in the remaining tables for ER Section 5.7. The number of significant digits used is based on standard practice.

TABLE 5.7-2 (Sheet 1 of 5)
URANIUM FUEL CYCLE ENVIRONMENTAL DATA - REFERENCE REACTOR AND CPNPP UNITS 3 AND 4[(a)]

10 CFR 51.51 Table S-3
(Normalized to model LWR annual fuel requirements [WASH-1248] or RRY [NUREG-0116])

Environmental Considerations	Reference Reactor Data (10 CFR 51.51 values)	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year (RRY) of model 1,000 MWe LWR	US-APWR Data CPNPP Units 3 & 4 (Reference Reactor Data multiplied by scaling factor = 4.04[(b)])
Natural Resource Use			
Land (acres)			
Temporarily committed[(c)]	**100**		404
Undisturbed area	**79**		319
Disturbed area	**22**	This is equivalent to a 110 MWe coal-fired power plant	89
Permanently committed	**13**		53
Overburden moved, (millions of MT)	**2.8**	This is equivalent to a 95 MWe coal-fired power plant	11.3
Water (millions of gallons)			
Discharged to air	**160**	This equals two percent of the model 1000 MWe LWR with cooling tower	646
Discharged to water bodies	**11,090**		44,804
Discharged to ground	**127**		513
Total	**11,377**	This equals < four percent of the model 1000 MWe LWR with once-through cooling	45,963
Fossil Fuel			
Electrical energy (thousands of MW-hour)	**323**	< 5 percent of model 1,000 MWe output	1305
Equivalent coal (thousands of MT)	**118**	Equivalent to the consumption of a 45 MWe coal-fired plant	477
Natural gas (millions of scf)	**135**	< 0.4 percent of model 1,000 MWe energy output	545

TABLE 5.7-2 (Sheet 2 of 5)
URANIUM FUEL CYCLE ENVIRONMENTAL DATA - REFERENCE REACTOR AND CPNPP UNITS 3 AND 4[(a)]

	10 CFR 51.51 Table S-3 (Normalized to model LWR annual fuel requirements [WASH-1248] or RRY [NUREG-0116])		
Environmental Considerations	Reference Reactor Data (10 CFR 51.51 values)	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year (RRY) of model 1,000 MWe LWR	US-APWR Data CPNPP Units 3 & 4 (Reference Reactor Data multiplied by scaling factor = 4.04[(b)])
Effluents - Chemical (MT)			
Gases (including entrainment)[(d)]			
SO_x	**4,400**		17,776
NO_x[(e)]	**1,190**	Equivalent to emissions from 45 MWe coal-fired plant for a year	4,808
Hydrocarbons	**14**		57
CO	**29.6**		119.6
Particulates	**1,154**		4,662
Other gases			
F	**0.67**	Principally from UF_6 production, enrichment, and reprocessing. Concentration within range of state standards–below level that has effects on human health.	2.71
HCL[(f)]	**0.014**		0.057
Liquids			
SO_{-4}	**9.9**	From enrichment, fuel fabrication, and reprocessing steps.	40.0
NO_{-3}	**25.8**	Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water levels below permissible standards	104.2

TABLE 5.7-2 (Sheet 3 of 5)
URANIUM FUEL CYCLE ENVIRONMENTAL DATA - REFERENCE REACTOR AND CPNPP UNITS 3 AND 4[(a)]

	10 CFR 51.51 Table S-3 (Normalized to model LWR annual fuel requirements [WASH-1248] or RRY [NUREG-0116])		
Environmental Considerations	Reference Reactor Data (10 CFR 51.51 values)	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year (RRY) of model 1,000 MWe LWR	US-APWR Data CPNPP Units 3 & 4 (Reference Reactor Data multiplied by scaling factor = 4.04[(b)])
Fluoride	**12.9**	The constituents that require dilution and flow of dilution water are: NH_3–600 cfs, NO_3–20 cfs, Fluoride–70 cfs	52.1
Ca^{++}	**5.4**		21.8
Cl^-	**8.5**		34.3
NA^+	**12.1**		48.9
NH_3	**10.0**		40.0
Fe	**0.4**		1.6
Tailings Solutions (thousands of MT)	**240**	From mills only–no significant effluents to the environment	970
Solids	**91,000**	Principally from mills–no significant effluents to the environment	367,640
Effluents - Radiological (curies)			
Gases (including entrainment)			
Rn-222	*****	Presently under consideration by the NRC*****	
Ra-226	**0.02**		0.08
Th-230	**0.02**		0.08
Uranium	**0.034**		0.137
Tritium (thousands)	**18.1**		73.1
C-14	**24**		97
Kr-85 (thousands)	**400**		1616
Ru-106	**0.14**	Principally from fuel reprocessing plants	0.57
I-129	**1.3**		5.3

TABLE 5.7-2 (Sheet 4 of 5)
URANIUM FUEL CYCLE ENVIRONMENTAL DATA - REFERENCE REACTOR AND CPNPP UNITS 3 AND 4[(a)]

	10 CFR 51.51 Table S-3 (Normalized to model LWR annual fuel requirements [WASH-1248] or RRY [NUREG-0116])		
Environmental Considerations	Reference Reactor Data (10 CFR 51.51 values)	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year (RRY) of model 1,000 MWe LWR	US-APWR Data CPNPP Units 3 & 4 (Reference Reactor Data multiplied by scaling factor = 4.04[(b)])
I-131	**0.83**		3.35
Tc-99	*****	Presently under consideration by the NRC*****	
Fission products and transuranics	**0.203**		0.820
Liquids			
Uranium and daughters	**2.1**	Principally from milling–included tailings liquor and returned to ground–no effluents: therefore, no effect on environment.	8.5
Ra-226	**0.0034**	From UF_6	0.0137
Th-230	**0.0015**		0.0061
Th-234	**0.01**	From fuel fabrication plants–concentration 10 percent of 10CFR20 for total processing 26 annual fuel requirements for model LWR.	0.04
Fission and activation products	**5.9E-6**		2.4E-5
Solids (buried on-site)			
Other than high level (shallow)	**11,300**	9,100 Ci comes from low level reactor wastes and 1,500 Ci comes from reactor decontamination and decommissioning–buried at land burial facilities. 600 Ci come from mills–included in tailings returned to ground. Approximately 60 Ci comes from conservation and spent fuel storage. No significant effluent to the environment.	45,652
TRU and HLW (deep)	**1.1E+7**	Buried at Federal Repository.	4.4E+7

TABLE 5.7-2 (Sheet 5 of 5)
URANIUM FUEL CYCLE ENVIRONMENTAL DATA - REFERENCE REACTOR AND CPNPP UNITS 3 AND 4[(a)]

	10 CFR 51.51 Table S-3 (Normalized to model LWR annual fuel requirements [WASH-1248] or RRY [NUREG-0116])		
Environmental Considerations	Reference Reactor Data (10 CFR 51.51 values)	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year (RRY) of model 1,000 MWe LWR	US-APWR Data CPNPP Units 3 & 4 (Reference Reactor Data multiplied by scaling factor = 4.04[(b)])
Effluents-thermal (billions of British Thermal Units)	**4,063**	< 5 percent of model 1,000 MWe LWR	16,415
Transportation (person-rem)			
Exposure of workers and general public	**2.5**		10.1
Occupational exposure	**22.6**	From reprocessing and waste management	91.3

a) In some cases where no entry appears, it is clear from the background documents that the matter was addressed and that, in effect, the Table should be read as if a specific zero entry had been made. However, other areas are not addressed at all in the Table. Table S-3 does not include health effects from the effluents described in the Table, or estimates of releases of Radon-222 from the UFC or estimates of Technetium-99 released from waste management or reprocessing activities. These issues may be the subject of litigation in the individual licensing proceedings. Data supporting this table are given in the "Environmental Survey of the UFC," WASH-1248, April 1974; the "Environmental Survey of Reprocessing and Waste Management Portion of the LWR Fuel Cycle," NUREG-0116 (Supp. 1 to WASH-1248); the "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0216 (Sup. 2 to WASH-1248): and in the record of final rulemaking pertaining to UFC Effects from Spent Fuel Reprocessing and Radioactive Waste Management, Docket RM-50-3. The contributions from reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and fuel recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor, which are considered in Table S-4 of § 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A-E of Table S-3A of WASH-1248.

b) Differences may exist due to rounding and significant figure uncertainties. Values expressed in same format as Reference Reactor values. Values rounded up for conservative estimations.

c) The contributions to temporarily committed land from reprocessing are not prorated over 30 years, because the complete temporary impact accrues regardless of whether the plant services 1 reactor for 1 year or 57 reactors for 30 years.

d) Estimated effluents based upon combustion of equivalent coal for power generation.

e) 1.2% from natural gas use and process.

f) NUREG 1555 shows the HCl value as 0.14 t.

TABLE 5.7-3
WHOLE-BODY 100-YEAR DOSE COMMITMENT ESTIMATE OF RN-222 AND TC-99

Values for Rn-222	Released Curies (Ci) Per Reference Reactor Year (RRY)	Percent of Tailings (with stabilized tailings)	Whole-body 100-year dose commitment, 100-year person-rem per RRY	Released Ci per CPNPP operation year, both units (scaling factor = 4.04)	Whole-body 100-year dose commitment, 100-year person-rem per CPNPP year
Mining	4060	77	110	16,402	444
Milling and tailings (during active milling)	780	15	20	3,151	81
Inactive tailings	350	7	9	1,414	36
Stabilized tailings, Ci/year	1	<1	1	4	4
Total for Rn-222	5191	100	140	20,971	565

Values for Tc-99	Released Ci. Per RRY	Percent of Tailings (with stabilized tailings)	Whole-body 100-year dose commitment, 100-year person-rem per RRY	Released Ci. per CPNPP operation year, both units(scaling factor = 4.04)	Whole-body 100-year dose commitment, 100-year person-rem per CPNPP year
Chemical reprocess	0.007	58	58	0.028	234
Groundwater	0.005	42	42	0.020	170
Total for Tc-99	0.012	100	100	0.048	404

TABLE 5.7-4
WHOLE-BODY 100-YEAR DOSE COMMITMENT TO THE U.S. POPULATION FROM THE UFC

100-year overall involuntary whole-body dose commitment to the U.S. population from the UFC, excluding Rn-222 or Tc-99, person-rem/yr	Reference Reactor, per Reference Reactor Year (RRY)	CPNPP both units, per CPNPP operation year (scaling factor=4.04)
From radioactive gaseous effluents (excluding reactor releases and the dose commitment due to Rn-222), person-rem/yr	400	1616
From radioactive liquid effluents (all fuel-cycle operations excluding reactor operations), person-rem/yr	200	808
Total dose commitment to the U.S. population without Rn-222 and Tc-99, person-rem/yr	600	2424
Total Rn-222 (from Table 5.7-3), person-rem/yr	140	566
Total Tc-99 (from Table 5.7-3), person-rem/yr	100	404
Total dose commitment to the U.S. population with Rn-222 and Tc-99, person-rem/yr	840	3394

TABLE 5.7-5
RADIATION EXPOSURE TO A MEMBER OF THE U.S. POPULATION FROM VARIOUS SOURCES

Exposure Source	Average Dose Equivalent to U.S. Population, mrem/yr
Natural:	
Radon	200
Other	100
Occupational:	0.9
Nuclear Fuel Cycle[(a)]:	0.05
Consumer Products:	
Tobacco[(b)]	-----
Other	5 - 13
Medical:	
Diagnostic X-rays[(c)]	39
Nuclear Medicine[(d)]	14
Approximate Total:	360

(NRC 2003)

a) Collective dose to regional population within 50 mi of each facility

b) Difficult to determine a whole body dose equivalent, however the dose to a portion of the lungs is estimated to be 16,000 mrem/yr.

c) Number of persons unknown, however 180 million examinations performed with an average dose of 50 mrem per examination.

d) Number of persons unknown, however 7.4 million examinations performed with an average dose of 430 mrem per examination.

5.8 SOCIOECONOMIC IMPACTS

The following subsections describe the potential socioeconomic impacts from operating CPNPP Units 3 and 4. Subsection 5.8.1 describes physical impacts of plant operation to the site and vicinity. Subsection 5.8.2 describes social and economic impacts on the region. Subsection 5.8.3 describes environmental justice impacts as a result of plant operation.

5.8.1 PHYSICAL IMPACTS OF STATION OPERATION

This subsection assesses the potential physical impacts due to operation of Units 3 and 4 on the nearby communities or residences. Potential impacts include noise, odors, exhausts, thermal emissions, and visual intrusions. These physical impacts are managed to comply with applicable federal, state, and local environmental regulations and do not significantly affect the CPNPP site and vicinity. For the purpose of this analysis, plant operations workers and local communities, buildings, and roads are described below.

5.8.1.1 Workers and Local Public

There are no residential areas located within the site boundary. Beyond the immediate site boundary, the area is rural with woods and farmland. The nearest community to the CPNPP site is the city of Glen Rose, located 5.2 mi south. The largest community whose border lies within the vicinity of the site is the city of Granbury, located 9.2 mi north. The locations of surrounding communities within the vicinity are further described in Section 2.1. Population distribution is described in Section 2.5. Because of Glen Rose and Granbury's distance from the CPNPP site, residents would not experience any physical impact from operation of Units 3 and 4.

The CPNPP is expected to employ approximately 1494 operations workers in 2018, with 1000 workers for Units 1 and 2, and 494 workers for Units 3 and 4. After a year, the number of operations workers decreases to the long-term operations worker level of 412 workers. In addition, 800-1200 temporary workers are required during outages. The impacts from these workers on the local and regional areas are discussed in Subsection 5.8.2.

The effect of heat dissipation to the atmosphere from operations of the cooling towers is described in Subsection 5.3.3.1. Noise and air quality impacts from the plant are discussed in Subsection 5.8.1.5. Because there are no residents within the site boundary, there are no impacts due to atmospheric heat dissipation on nearby communities. As noted in Subsection 5.8.1.4, the nearest residence is approximately 0.9 mi to the southwest of the site center point.

5.8.1.2 Buildings

The plant layout including new and existing structures is shown in Figure 2.1-1. Operations activities are not expected to affect any off-site buildings, including industrial, commercial, and residential structures. Current on-site buildings from CPNPP Units 1 and 2 have been constructed to comply with applicable safety standards, which include considerations for shock and vibration from operations activities.

5.8.1.3 Roads

Impacts of new units' operations on transportation and traffic in the region are the greatest on the rural roads of Hood and Somervell counties. Impacts on traffic are determined by four elements: (1) the number of operations workers and their vehicles on the roads; (2) the number of shift changes for the operations workforce; (3) the projected population growth rate in the region; and (4) the capacity of the roads. The largest impacts to roads are expected to be during shift changes.

Figure 2.5-5 illustrates the road and highway systems of both Hood and Somervell counties. Operation workers access the site via Farm to Market 56 (FM 56),(Subsection 2.5.2.2). FM 56 passes to the west of the site, connecting FM 51 to U.S. Highway 67 (US 67), while Texas State Highway 144 (SH144) passes to the east of the site and connects US 67 to US 377. Both are 2-lane highways, and FM 56 has turn lanes near the plant entrance. Improvements, such as widening, turn lanes and traffic lighting are currently being made to SH 144.

For plant operation, it is expected that CPNPP operates with five crews of approximately 30 workers each. The crews follow a five-week rotation, with one crew in training, one crew off, and the other three crews covering the operational shifts. The operations shifts are 12 hours long. The remaining support personnel, including security, administration, and technicians, work a variety of shifts. The CPNPP is expected to employ a peak total of 1494 operations workers at the plant for all units. Therefore, the maximum number of vehicles on the roadways from operations is approximately 1494 including workers from all four units. However, the impact at any given time is much less than 1494 vehicles as these vehicles travel on the roadways in different directions and at varying times based on shift schedules, vacations days, sick leave, day of the week, and other factors. Additional impacts may be present during outage periods for Units 1 and 2 (800 – 1200 additional workers) every 18 months as well as for Units 3 and 4 (800-1200 additional workers) every two years.

As discussed in Subsection 2.5.2.2.3, the averaged annual daily traffic (AADT) counts in 2007 on FM 56 indicate that 8500 vehicles use the road to the north of the plant entrance while 3500 vehicles use the road to the south of the entrance. The AADT counts indicate that approximately 13,400 vehicles travel on US 67 east of the intersection with FM 56, and 6500 vehicles travel on US 67 to the west of the intersection. The AADT counts indicate that 34,000 vehicles travel on US 377 east of the intersection with FM 56 while13,100 travel on US 377 to the west of the intersection (TxDOT 2007).

According to the Highway Capacity Manual, the capacity of a two-lane highway is 1700 vehicles per hour for each direction of travel. The capacity is nearly independent of the directional distribution of the traffic on the facility, except that for extended lengths of two-lane highway, the capacity does not exceed 3200 vehicles per hour for both directions of travel combined (TRB 2000).

During the 1980s, with the construction of CPNPP Units 1 and 2, a study was completed on the increase of traffic in the area surrounding the plant. Approximately 8694 persons were employed on-site with an estimated 3710 vehicles entering the site. After the completion of the traffic study, improvements in traffic signals, widened lanes, turn lanes, and additional signage were made to the immediate area to handle the large volume of traffic. Traffic flow for construction and operation of the new units is expected to be approximately 50 percent of that number. During outages, approximately 800-1200 temporary workers commute on-site, resulting in 400-600 additional vehicles assuming a similar ratio of two workers per vehicle. Thus traffic during outages does not exceed historical levels.

The impacts of plant operations are expected to have minimal effects on the interstate highways in the region. Because the increase in operation workers is below historic accounts of traffic volume as well as the improvements to the roads in the surrounding area, the impacts from operation workers on smaller two-lane state and county highways, as well as the local roads, are expected to be SMALL. Potential mitigation measures, if needed, include staggering shifts so they do not coincide with traditional traffic congestion, and encouraging carpools.

5.8.1.4 Aesthetics

As shown in Figure 2.2-1, the CPNPP site encompasses the SCR and is mainly woodland area along the northern, western, and eastern boundaries. The southeastern boundary contains the reservoir dam and has areas of grassland. The nearest residence is approximately 0.9 mi southwest of the center point.

As the viewshed analysis in Subsection 2.2.1 states, the CPNPP existing units have reactor domes that are 228 ft high. CPNPP Units 3 and 4 are similar in height to CPNPP Units 1 and 2, though built on ground 12 ft higher. With CPNPP Unit 1 and Unit 2 in operation since 1990 and 1993, respectively, any affect on local viewsheds has already occurred. The plumes from the cooling towers of CPNPP Units 3 and 4, while visible in the local area, are expected to have negligible visual effect. The size and duration of cooling tower plumes is detailed in Subsection 5.3.3.1.1 and detailed in Table 5.3-7.

Visual impacts of new transmission corridors are discussed in Subsection 5.6.3.5. Recreation impacts are discussed in Subsection 5.8.2.3.4.

5.8.1.5 Noise

The potential effects of noise from CPNPP site operation have been analyzed by projecting noise levels at the site and vicinity from various facility sources. Projected levels are compared to current on-site and off-site ambient measurements (Subsection 2.5.5), as well as to federal noise level guidelines. The results of these comparisons are then used to determine the magnitude of noise impacts at the various receptors identified in Subsection 2.5.5.

The U.S. Department of Housing and Urban Development (HUD) has established noise impact guidelines for residential areas based on day-night average sound levels (Ldn) (US HUD 1996). Some states and municipalities have established noise control regulations or zoning ordinances that specify acceptable noise levels. The state of Texas, and Hood and Somervell counties have not developed a noise regulation that specifies the community noise levels that are acceptable.

Instead of using continuous equivalent sound levels (Leq), a special version of the Leq, and the most common measure of environmental noise levels, is the day-night average level (Ldn). The Ldn is valid for a 24-hour period and is computed the same as a 24-hour Leq except that the prevailing sound level in the calculation has a 10-dB penalty added between the hours of 2000 and 0700. For the purpose of this document, noise impacts are assessed using the HUD Ldn of 60 - 65 dBA as the level below which noise levels would be considered acceptable for residential and outdoor recreational uses. As discussed in NUREG-1437, noise levels below 60 - 65 dBA are considered to be of small significance.

Additional noise sources from CPNPP plant operation are expected to include heating, ventilation and air-conditioning systems, vents, transformers and electrical equipment, transmission lines, water pumps, material-handling equipment, motors, public address systems, cooling towers, trucks and vehicular traffic. A fire arms shooting range is also located on-site, away from the main portion of the facility, but can create sporadic noise while firing weapons. Many of the noise sources are expected to be confined indoors, underground or used infrequently. The main source of continuous noise is anticipated to be the mechanical draft cooling towers. Per NUREG-1817, cooling towers generate approximately 85 dBA in close proximity and approximately 55 dBA at a distance of 1000 feet during operation.

Other noise generated on-site is from natural sources such as wind through foliage, wildlife, and insects. Noise generated outside of the fence line from nearby off-site sources include, residential activities (near locations 17 and 23), traffic along the western fence line (location 39, plant entrance) and aquatic vehicles (boats) around the reservoir and near the old swim beach (location 15) across the lake to the north of the site (Figure 2.5-20).

Nearby locations with potential sensitivity to noise were identified from the ambient noise survey as well as site reconnaissance conducted in 2007 and 2008. Receptors were reviewed within a 10-mi radius of the site and include the nearest residences (location 23 near the south fence line, location 1) and location 17 (near the east fence line), Post Oak Memorial Chapel and cemetery (location 25), Freedom Church (location 40) and Happy Hill Children's Home (location 30). Recreation locations within Squaw Creek Park were also selected such as the old swim beach on the north side of SCR (location 15). Squaw Creek Reservoir and Park, as well as the old swim beach are located on the CPNPP property therefore public access to SCR and its facilities are controlled and limited by CPNPP. Members of the public (receptors) that are allowed access to the reservoir for recreational activities are anticipated to follow site safety requirements that exist due to the industrial nature of the facility. As an industrial site, noise levels in certain areas of the reservoir may be slightly elevated during operational activities when compared with ambient noise levels located off site.

No sensitive receptors (species of importance) were located within the fence line of the facility. As stated in Subsection 5.3.3.2.4, resident wildlife species quickly adapt to constant background noise, therefore the impact to resident wildlife is anticipated to be small. The near-by residences are located east across SCR and to the south-southwest of the site. Because water is between the site and the residences to the east, potential noise from the site would not be attenuated past the fence line (location 2) with distance as it would be by natural insulators (trees with foliage, ground cover, earthen berms, etc.). These residences are located at a substantial distance and are antificapted not to be affected by proposed additional Comanche Peak noise. The nearest state park to the Comanche Peak site is Dinosaur Valley State Park, located 3.3 miles to the southwest of the site. Dinosaur Valley State Park is located at a substantial distance and is expected not to be affected by additional noise.

The ambient noise survey was conducted within a 5-mi radius of the site, along extant transmission lines and along the proposed water supply and return line route between Lake Granbury and the Comanche Peak Site. The survey indicated that the fence line (locations 1, 2, 3) and swim beach (location 15) and off-site noise levels measured in the range of values expected for ambient noise for a low density residential and rural location: ranging from 50 - 55 Ldn (2). Area noise levels ranged between 35 and 82 dBA (daytime traffic) and between 36 and 70 dBA (nighttime traffic). Average equivalent sound levels (Leq) measured between 53 and 58 dBA.

Ambient noise levels fluctuate during winter, spring, summer and fall seasons. The loudest potential for background noise is during the spring and summer months when the wind through foliage and a full array of wildlife (birds, insects, amphibians, etc) are the predominant noise sources. Monitoring positions were measured at a distance from the most likely (predominant) noise source during power plant operation (specifically the proposed cooling towers).

As shown in Table 5.8-1, background noise levels plus projected operational noise level impacts at the nearby receptor sites are similar to the original background noise level range.

None of the identified sensitive receptors is located within the fence line of the facility; therefore, none would be significantly impacted by operational noise.

Subsection 2.5.3 references historic properties within a 10-mi radius of the site boundaries. Historic properties are located within 1.2 mi of an extant transmission line. Historic properties should not be impacted by operational noise from the site, pipeline or extant transmission line noise. Historic properties are located at a sufficient distance from noise sources that noise levels would attenuate to levels that are inaudible (below background levels) or ambient noise levels at the historic sites. Historic properties and cemeteries located within one mile of the proposed water line route include the Hopewell and Nubbin Ridge Cemeteries.

The day-night noise levels that are anticipated from the plants' cooling towers at the site boundary are expected to be below the limit of 65 dBA recommended by HUD. In the GEIS, the staff discusses the environmental impacts of noise at existing nuclear power plants and common noise sources (cooling towers, transformers, loud speakers and intermittent noise from auxiliary equipment). As mentioned in the GEIS, at most sites employing cooling towers, transformer noise is masked by the broadband cooling tower noise. Also mentioned in the GEIS, these noise sources are generally sufficiently distant from the plant boundaries that the noise generated by the plant is attenuated to near ambient noise levels at the site boundaries. Therefore, noise would also be attenuated to ambient noise levels beyond the site boundaries at critical receptors. Loud speaker use continues to be utilized during emergencies; daylight hours, drills and system checks or personal communication devices should be used. The day-night noise levels from the CPNPP plant operations (specifically the cooling towers) are less than 65 dBA to the site boundary, which is considered to be of SMALL significance to the public. Thus no mitigation alternatives are necessary.

5.8.1.5.1 Transmission Line Noise Due to Operation

High-voltage transmission lines can emit noise when the electric field strength surrounding the lines is greater than the breakdown threshold of the encapsulating air, creating an energy discharge. This discharge is known as corona discharge, and is affected by ambient weather conditions such as wind, precipitation, air density, humidity, etc., and energized surface irregularities. The corona discharge can create a noise which can be heard near the base of the transmission lines. Noise from corona discharge along the transmission line is low (well below the 60 - 65 dBA threshold) and does not pose a noise induced risk to the surrounding community or habitat. As mentioned in NUREG 1555, electric field effects on terrestrial biota need not be considered for lines energized at less than 765 kV…voltages of 765 kV or above, consideration of the possible effects of electric fields and corona discharge, including resulting noise on terrestrial biota, may be warranted. The CPNPP transmission lines are to be energized at 345 kV or less. As stated in the GEIS, the term "corona" generally refers to the electrical discharges occurring in air subjected to the strong electric fields adjacent to phase conductors. Corona generally is not a problem at voltages below 345 kV. Corona results in audible noise, radio and TV interference, energy losses, and the production of ozone and oxides of nitrogen. As mentioned in Section 5.6 and Subsection 9.4.3.1, the expansion of four electrical transmission lines connect four switching stations and expand the connection between two switching stations. The expanded transmission lines are to be energized at 345 kV or less and the right of way (ROW) for each transmission line is approximately 160 feet wide, therefore noise impacts from operation of transmission lines are expected to be small.

5.8.1.5.2 Noise Due to Operation of Water Supply and Return Pipelines

The operation of Units 3 and 4 at CPNPP includes the operation of water intake pumps, water intake and water discharge pipelines (Figure 2.5-9). The corridor for proposed makeup water pipelines is expected to run adjacent to an existing water pipeline. The route of the proposed water supply pipeline corridor is planned to run from Lake Granbury to the cooling towers along the existing right of way utilized by CPNPP Units 1 and 2. Blowdown lines utilize existing right of way for transmission line corridors. No pumps or noise producing equipment is used along the pipelines. The ongoing operation of the water pipelines are anticipated to have negligible effects on cultural resources due to the water lines being buried. Indirect impacts such as noise and visual/ aesthetic impacts on cultural resources are expected to be SMALL and no mitigation is warranted.

Currently there are water intake pumps operating on Lake Granbury for Units 1 and 2. Five additional pumps are to be installed adjacent to the existing pump platforms, along with a Jockey pump. The pumps are enclosed in a concrete housing, but the pump motors are located on the roof of the housing. The noise levels generated by the new pumps were not known at the time of this writing. The existing pumps are located on the lake, therefore noise is anticipated not to be attenuated as with natural vegetation, berms, or hills. Reflectance of noise off the water could actually increase the noise levels emitting from the pumps. The operation of the additional pumps is anticipated to have a SMALL to LARGE impact on surrounding communities. Mitigation measures would include, but are not limited to: utilizing low noise producing pump motors, mounting the pump motors on sound dampening material, relocating the pump motors away from the water and/ or enclosing the pump motors in a sound absorbing structure.

5.8.1.5.3 Noise Due to Operation of Railroad Spur During Operation

An existing railroad spur is to be utilized at the CPNPP site frequently during construction activities but the tracks are expected to be removed during operation of the CPNPP site.

Therefore, railroad noise impact on the surrounding community is considered to be of SMALL significance and no mitigation measures are necessary.

5.8.1.5.4 Traffic Noise Due to Operation

Noise due to plant operations traffic depends on: the number of operations workers and their vehicles on the roads; the number of shift changes for the operations workforce; the projected population growth rate in the region; and the capacity of the roads. The largest impacts to roads are expected to be during shift changes. Figure 2.5-5 illustrates the road and highway systems of both Hood and Somervell counties.

Operation workers access the site via Farm to Market 56 (FM 56), or Texas State Highway 144 (SH 144) (Subsection 2.5.2.2). FM 56 passes to the west of the site, connecting FM 51 to U.S. Highway 67 (US 67), while SH 144 passes to the east of the site and connects US 67 to US 377. Both are two-lane highways, and FM 56 has turn lanes near the plant entrance. Improvements, such as widening, turn lanes and traffic lighting are currently being made to SH 144.

For plant operation, it is expected that CPNPP operates with five crews of 30 workers each. The crews follow a five-week rotation, with one crew in training, one crew off, and the other three crews covering the operational shifts. The operations shifts are 12 hours long. The remaining support personnel, including security, administration, and technicians, work a variety of shifts. The CPNPP is expected to employ a peak total of 1494 operations workers at the plant for all units. Therefore, the maximum number of vehicles on the roadways from operations is approximately 1494 including workers from all four units. However, the impact at any given time is much less than 1494 vehicles as these vehicles travel on the roadways in different directions and at varying times based on shift schedules, vacations days, sick leave, day of the week, and other factors.

Additional impacts may be present during outage periods for Units 1 and 2 (800 - 1200 additional workers) every 18 months as well as for Units 3 and 4 every two years. Additional information on transportation, including current traffic counts, is discussed in Subsection 2.5.2.

According to the Highway Capacity Manual, the capacity of a two-lane highway is 1700 vehicles per hour for each direction of travel. The capacity is nearly independent of the directional distribution of the traffic on the facility, except that for extended lengths of two-lane highway, the capacity does not exceed 3200 vehicles per hour for both directions of travel combined (TRB 2000).

During the 1980s, with the construction of CPNPP Units 1 and 2, a study was completed on the increase of traffic in the area surrounding the plant. Approximately 8694 persons were employed on-site, with an estimated 3710 vehicles entering the site. After the completion of the traffic study, improvements in traffic signals, widened lanes, turn lanes, and additional signage were made to the immediate area to handle the large volume of traffic.

During the ambient noise survey in 2007 and 2008, noise results along roadways ranged from 35 to 70 dBA (daytime traffic and as high as 82 dBA at times) and 36 to 70 dBA (nighttime). The impacts of plant operations are expected to have minimal effects on the interstate highways in the region. Because the increase in operation workers is below historic accounts of traffic volume as well as the improvements to the roads in the surrounding area, the impacts from operation workers on smaller two-lane state and county highways, as well as the local roads, the impacts of plant operations are expected to be SMALL.

5.8.1.6 Air Quality

Regional air quality is discussed in Section 2.7. Impacts to air quality from diesel emissions are discussed in Subsection 3.6.3.1 and shown in Tables 3.6-2, 3.6-3, 3.6-4, 3.6-5, 3.6-6, and 3.6-7. The largest sources of emissions are the two auxiliary boilers as shown in Table 3.6-6. As discussed in Subsection 5.5.1.3, the standby generators and fire pumps are not continuously operated, which reduces air emissions. Gaseous and particulate effluents due to UFC processes to support CPNPP Units 3 and 4 are shown in Table 5.7-2. As discussed in Subsection 5.7.1.4, the emissions constitute a SMALL additional atmospheric loading. Operations activities are expected to be conducted in accordance with the best management practices available during the time of operation. This would include performance of proper maintenance of operational vehicles and equipment to maximize efficiency and minimize emissions, in compliance with applicable federal, state, and local regulations. Actual operational-related emissions cannot be effectively quantified before the plant is completed. Air emissions are expected to be controlled as necessary, to meet requirements of applicable air regulations and permits in place at the time of operation.

Because air emissions from the operation of CPNPP Units 3 and 4 are considered a small atmospheric loading and comply with the applicable regulations, the impacts due to air emissions on the surrounding population as a result of operation of Units 3 and 4 are SMALL and do not warrant mitigation.

5.8.2 SOCIAL AND ECONOMIC IMPACTS OF STATION OPERATION

This subsection evaluates the demographic, economic, infrastructure, and community impacts to the region as a result of operating CPNPP. The evaluation assesses impacts of operations and of demands placed by the workforce on the region.

5.8.2.1 Demography

The 2007 estimated permanent population within the 50-mi region is 1,538,761. Population projections are discussed in Subsection 2.5.1. As stated in Subsection 5.8.1.1, the CPNPP employs approximately 494 operations workers at Units 3 and 4 in 2018 with the number decreasing to 412 after a year. In order to supply the needed workforce, Luminant has partnered with local and state education entities to train operations workers in the region. The Nuclear Power Institute is a statewide partnership with headquarters at Texas A&M University that is working to develop courses, curriculum, and programs to prepare students for careers in the nuclear workforce. A total of ten universities and colleges are participating (NPI 2009). Also, Luminant has created the Luminant Academy at Tyler Junior College to train students in generation, mining, and construction operations for their power plants (TJC 2008). These efforts allow workers for CPNPP Units 3 and 4 to be drawn from the region. Based on preliminary estimates, it is assumed that 50 percent of the new unit employees are hired locally and 50 percent migrate into the region and bring their families with them. The average family size in the United States was 3.18 in 2000. Therefore, the additional workforce that migrates to the region at peak conditions in 2018 (123) increases the population in the region by approximately 492 people.

The operational workforce for CPNPP Units 1 and 2 is distributed throughout the 50-mi region. Table 5.8-2 shows the cities with more than five workers in residence. The city with the largest numbers of workers is Granbury with 401 workers, followed by Glen Rose with 194 workers. It is assumed that the operations workers who migrate into the region settle in a pattern similar to the current workers for Units 1 and 2, with 42 percent in Hood County and 21 percent in Somervell County. The remaining workers settle in other counties in the region, with Johnson County and Tarrant County having the next largest numbers. As discussed in Subsection 4.4.2.1, the peak construction worker numbers occur in 2014. By the time of peak operations workers in 2018, the construction workforce has left the region. Therefore, the influx of operations workers and families represents a 4.8-percent decrease in Hood County, a 10.4-percent decrease in Somervell County, and a 24-percent decrease in Walnut Springs. The remaining areas in the economic region show increases, with Cleburne increasing by 4.2 percent, Fort Worth increasing by 4.8 percent, and Stephenville increasing by 1.6 percent.

Worker settlement patterns are also influenced by the available amenities, including recreation opportunities, convenient shopping, quality schooling, and affordable housing. The largest number of these amenities within a close distance is found in Granbury, with numerous golf courses, grocery stores, retail outlets, and schools. This helps explain why nearly twice as many current operations workers live in Hood County as compared to Somervell County. However, this also means that Hood County has a disproportionate impact. Hood County must provide health facilities, water, police and firemen, and housing while receiving less tax benefits than Somervell County.

The “bust effect” is defined as the effect experienced by the community that is the result of an abrupt loss of population. The population in Hood and Somervell counties peaks in the spring of 2015, a few months after the peak construction workforce and then declines until the beginning of 2017, when in-migrating operations workers and population growth begin replacing the population lost by the construction workers leaving the area. The population levels are also influenced by the 800 – 1200 temporary employees required for the scheduled refueling of Units 3 and 4 every two years. These workers are expected to work at the plant for an average of 26 days per outage. There are also refueling workers associated with Units 1 and 2. Refueling for those units occurs every 18 months and involves 800 – 1200 additional workers. It is possible with the number of outages that some temporary workers would remain in the region. Outages occur frequently and are not simultaneous, so a worker might find sufficient income. If any of the outage workers chose to retain in the region, it is likely they would find permanent housing and would reside in the same areas as the operation workers. The impacts of plant operations on local and regional demography are SMALL as the increase in population is offset by the departure of the 4953 construction workers that decreases the strain on community infrastructure.

5.8.2.2 Economy

The impacts of the new units’ operation on the local and regional economy depend on the economic region’s current and projected economy and population. As discussed in Subsection 2.5.2.1, the economic region consists of those counties most likely to be affected by the construction and operation of CPNPP Units 3 and 4. Based on the distribution of the operations workers for CPNPP Units 1 and 2, those counties are Bosque, Erath, Hood, Johnson, Somervell, and Tarrant, counties. During the time period when operational workers move into the economic region, CPNPP site construction is concluding. In this case, the “bust effect” is the result of construction workers leaving the economic region. Because these workers, even those who commute, partake to some degree in goods and services in the economic region, certain services experience loss of economic growth. The impact is caused by a decrease of use during the population recovery period. Sales, personal income, and tax revenues may experience a decline.

According to Subsection 5.8.2.1, the economic region as a whole does not experience the bust effect. However, the total population of Hood and Somervell counties decreases after the peak construction period. Hood County is projected to recover peak construction population levels by 2019 due to population growth and the operations workers. Somervell County is projected to recover peak construction levels by 2028.

Additional jobs in the region result from the multiplier effect attributable to the new operations workforce. In the multiplier effect, each dollar spent on goods and services by an operational worker becomes income to the recipient who saves some but re-spends the remainder. The recipients’ re-spending becomes income to others, who in turn save part and re-spend the remainder. The number of times the final increase in consumption exceeds the initial dollar spent is called the “multiplier.” The Regional Economic Analysis Division of the U.S. Department of Commerce Bureau of Economic Analysis (BEA) provides multipliers for industry jobs and earnings. The economic model, Regional Input-output Modeling System (RIMS II), incorporates buying and selling linkages among regional industries and was used to estimate the impact of new nuclear plant-related expenditure of money in the region of interest. The wages and salaries of the operating workforce have a multiplier effect that could result in an increase in business activity, particularly in the retail and service industries. Based on the power generation and supply multiplier of the RIMS II Table 1.5 , for every dollar of income for operational plant employees, an additional 0.32 cents is added to the regional economy (BEA 2005).

Using the same category, for every operations job at Units 3 and 4, an estimated 1.1 jobs are created in the economic region, which means that the 123 in-migrating workers at the start of operations result in an additional 135 indirect jobs for a total of approximately 258 new jobs in the economic region. Because most indirect jobs are service-related and not highly specialized, it is assumed that most, if not all, indirect jobs are filled by the existing workforce (Table 2.5-13).

In the year 2006, there were 48,965 people unemployed in the economic region. Some or all of the indirect jobs created by the operations workforce are expected to be filled by unemployed workers in these counties. The money spent in the local area by these new workers, their families, and the newly employed persons in the counties also add to the economy of the area.

Annual expenditures for operation and maintenance during operation of CPNPP are estimated as $65,000,000 per unit. The majority of annual expenditures would be spent in the economic region with a portion of the funds spent outside the economic region. Based on the power generation and supply multiplier of 1.32 from the RIMS II multiplier in Table 1.5, if the annual expenditures were made entirely within the economic region, a total of $41.6 million would be added to the area.

With the anticipated loss of 4953 construction workers, the impact from plant operation employees in the economic region is considered a LARGE beneficial impact due to their influence on the local economy. Because the operations workforce creates indirect jobs in the economic region and the operations expenditures also benefit the economy, the impact of plant operations on the economic region is SMALL and also beneficial, and also no mitigation is required.

5.8.2.2.1 Regional Taxes and Political Structure

Regional taxes and the political structure within the CPNPP region are discussed in Subsection 2.5.2.3. Somervell County is the tax district that is expected to be most directly affected by the operation of CPNPP.

Luminant is required by Hood and Somervell counties to pay ad valorem taxes based on the current and new units. Table 2.5-17 shows CPNPP ad valorem taxes for Units 1 and 2 for 2006. On the new units, Luminant is expecting to pay the ad valorem taxes to Somervell and Hood counties on a basis similar to the current requirements. By the time operations begin, Luminant is expected to be paying the entire amount of ad valorem taxes for Units 3 and 4. The majority of the ad valorem taxes go to Somervell County and its districts, while smaller amounts are paid to Hood County and its districts. Based on the ad valorem amounts for 2006 and the property tax revenues for the same time period, the ad valorem taxes may be the largest portion of total tax revenues for some districts in Somervell County once the new units are operational.

Several types of taxes are generated by operations activities and purchases, and by the workforce expenditures within the vicinity. The wages expected to be paid to operations workers are discussed in Subsection 2.5.2.3.1. Assuming an average annual salary of $72,548, approximately $29.9 million a year is paid in wages to the operations workers.Employees of the CPNPP pay federal personal income taxes on their wages and salaries. Texas residents do not pay a state personal income tax. The counties in the region experience an increase in the amount of sales and use taxes collected. Additional sales and use taxes are generated by retail expenditures of the operating workforce. As discussed in Subsection 2.5.2.3.1, the sales and use tax rate in populated areas in the economic region is 8.25 percent including local and state taxes. If the annual operations expenditures are spent within the economic region, the total sales and use tax revenue is approximately $5.4 million per year per unit for a total of $10.7 million. Of this total, $8.1 million per year goes to the state with the remaining $2.6 million in revenue going to cities, counties, and other local districts.

Property tax revenues should remain stable or growing as the increasing population occupies the houses vacated by the construction workforce. Sales and use taxes are expected to decrease as the construction workers leave the area and as the construction expenditures are finished. Operations expenditures are approximately $9.1 million a year less than the average construction expenditures. Countering this is the payment of the ad valorem taxes on the new units. Current revenues from CPNPP Units 1 and 2 exceed $24 million annually based on Table 2.5-17. Revenues from CPNPP Units 3 and 4 are expected to be similar. Thus total tax revenues for the economic region continue to increase during operations. The impact of plate operations is expected to be LARGE and beneficial for the economic region.

5.8.2.3 Infrastructure and Public Services

Local public services potentially affected by the operation of Units 3 and 4 including (1) public safety, (2) social services, (3) education, (4) tourism, and (5) recreation are described individually in Subsection 2.5.2. It is likely that operations workers and their families would concentrate in several communities with well-developed public services. Diversification of settlement would minimize the likelihood of any one community's services being overburdened.

5.8.2.3.1 Public Services

Public services types identified in this subsection include (1) water supply and wastewater facilities and (2) fire, police and medical services.

5.8.2.3.1.1 Water Supply and Wastewater Facilities

The CPNPP is not anticipating using groundwater as a safety-related or operational source of water. The CPNPP is using Lake Granbury for all operational water uses related to Units 3 and 4 cooling. Water for operation dust suppression and general use is obtained from SCR. An on-site wastewater facility provides sufficient capacity for wastewater treatment related to plant operation for all four units.

As stated in Subsection 5.8.2.1, the in-migrating workforce in 2018 increases the population in the 50-mi region by approximately 492 people. Water systems in the vicinity are generally not operating at or near capacity (Subsection 2.5.2.7.1). Therefore, the water supply and wastewater treatment facilities servicing the CPNPP vicinity are considered sufficient to provide adequate service. Additional information regarding wastewater facilities is discussed in Subsection 2.5.2.7.1.

5.8.2.3.1.2 Police and Fire Protection Services

The Somervell County Sheriff's Department has sole jurisdiction over Somervell County (TDPS 2006). As stated in Subsection 2.5.2.7.2, the total number of police officers in Somervell county is 19. The number of police officers per 1000 residents in Somervell County in 2006 is 2.4 and during the construction is 2.0. The departing construction workers and incoming operational workforce and families would increase the police ratio to 2.2. Hood County is served by the Hood County Sheriff's Department, Granbury Police Department, and Tolar Police Department (TDPS 2006). These departments combined employ 68 police officers, resulting in a ratio of 1.3 officers per 1000 residents during construction. The operational workforce and families increase the police ratio to 1.4. According to the U.S. military, the desired ratio of police officers to population is between 1 and 4 officers per 1000 citizens, with cities needing higher levels than other areas (Broemmel, Clark, and Nielsen 2007). As discussed in Subsection 4.4.2.3, the United States currently has approximately 2.5 police officers per 1000 residents. With the increase in residents in Somervell and Hood counties, the ratio of police officers to residents is still within the levels recommended by the U.S. military.

In Johnson County, the ratio of police officers per 1000 residents in Cleburne decreases from 1.6 during construction to 1.5 during operations. Fort Worth likewise decreases from 2.3 to 2.2 due to the rapid population growth of the city. In Stephenville, the ratio decreases from 2.2 in 2014 to 1.9

in 2018. The ratio of sheriff's officers per 1000 residents in Walnut Springs increases from 16 to 20. This leaves all the cities but Walnut Springs below the national average, but still within the levels recommended by the U.S. military. Also, it is reasonable to assume that by 2018 additional staffing is obtained for the cities in response to the population growth, which would increase the ratios.

Within Somervell County there is one fire department with 40 paid and volunteer firefighters. The ratio of firefighters per 1000 residents is 4.3 during construction and increases to 4.7 by 2018. In Hood County, there are nine fire departments with 250 volunteer firefighters for a ratio of 4.8 during construction that increases to 5.0 during operations. The ratio of firefighters per 1000 residents in Cleburne decreases from 1.5 during construction to 1.4 during operations. The ratio in Fort Worth drops from 1.4 to 1.3, while the ratio in Stephenville decreases from 2.4 in 2014 to 2.3 in 2018. The ratio in Walnut Springs increases form 8.8 to 11 as the population does not increase rapidly enough to replace the construction workers that left the area prior to 2018. Thus, Hood County, Somervell County, Stephenville, and Walnut Springs remain well above the national average discussed in Subsection 4.4.2.3 while Cleburne and Fort Worth remain just under it.

As discussed above, it is reasonable to assume that additional personnel are added to the fire departments in the economic region from 2006 to 2018 in response to the rapid population growth in the area. This would increase the ratios for the counties and cities, resulting in a lessened impact.

5.8.2.3.1.3 Medical Services

Somervell County also has one hospital, Glen Rose Medical Center. Located in Glen Rose, the medical center has 16 beds with 80 staff members, including staff members associated with the attached nursing home. Hood County is home to one hospital, Lake Granbury Medical Center, located in Granbury. The hospital contains 59 beds with 36 doctors on active duty (Lake Granbury Medical Center 2007). By the time construction is completed, both hospitals have finished their planned expansions, resulting in 142 available beds (Subsection 4.4.2.3). The number of beds is more than sufficient to meet the demands of the plant operations workers in addition to the increasing demand resulting from population growth in the region. Additional information on medical services is discussed in Subsections 2.5.2 and 4.4.2.3.

5.8.2.3.2 Housing

Housing information is discussed in Subsection 2.5.2.6. As stated in Subsection 5.8.2.1, the CPNPP employs approximately 494 people for operations of Units 3 and 4 with 123 in-migrating at the start of operations in 2018. Thus, assuming that the in-migrating workers relocate to the economic region, a conservative estimate of 123 housing units are needed for the new workers. Some employees may choose to build new homes, reducing the number of existing vacant housing units necessary. The amount of housing needed can be expected to vary during the operation of the plant as total operations workers decreases to 412 by 2019. Also, additional workers are required during refueling outages at the site. It would be expected that the majority of outage workers would stay in extended-stay hotels, trailers, or rent rooms in homes, and would not become permanent residents in the region. Refueling outages happen every 18 months for CPNPP Units 1 and 2 and every two years for CPNPP Units 3 and 4. Each outage requires 800 –

1200 temporary workers. Outages for CPNPP Units 1 and 2 last for a period of 17 - 24 days while outages for CPNPP Units 3 and 4 cycle between one 40 day outage, one 30 day outage, and two 16 day outages. Outages for the four units do not occur simultaneously.

As discussed in Subsection 2.5.2.6, based on 2000 Census data and American Community Survey data, there are 77,805 vacant housing units in the economic region. A number of these housing units are filled by the construction workforce, with a peak construction workforce of 4953 workers in 2014. From the peak construction plus outage population in 2014 to 2018 when the total number of operations workers has moved to the region, the population in Hood County decreases by 4.8 percent while the population in Somervell County decreases by 10.4 percent. This decline in population is expected to make available additional housing. However, as a majority of the construction workforce is expected to use temporary housing, the operation workforce may not find sufficient housing from the departure of the construction workforce alone. As discussed in Subsection 4.4.2.4, there are numerous housing developments being added in Hood County which, along with the existing housing, should serve to provide sufficient housing for the operations workforce that choose to settle in the vicinity.

Based on vacancy data from the 2000 Census, sufficient housing units are available. Therefore, the impacts of plant operation on housing are expected to be SMALL and do not require mitigation.

Land-use planning and zoning laws within the CPNPP site and vicinity are described in Section 2.2.1. Land-use effects from operation of the CPNPP are described in Subsection 5.1.1.

5.8.2.3.3 Education

It is assumed that 50 percent of the new workforce relocates to the region with their families, increasing the population by approximately 492 people at the start of operations, and that 21 percent settle in Somervell County and 42 percent settle in Hood County. During this time, the students from the in-migrating construction workers have left while the students of the operations workers who in-migrated during peak construction remain. According to the percent of school age children by county as discussed in Subsection 4.4.2.5, the in-migration of operations workers adds 37 students to Hood County. However, the students from peak construction who depart create a net loss of 431 students. Somervell County receives 23 students from operations workers for a net loss of 266 students. Johnson County receives 13 students for a net loss of 148. Tarrant County receives 9 students for a net loss of 104. Erath County receives 5 students for a net loss of 63, and Bosque County receives five students for a net loss of 54. These losses in students are expected to be replaced by population growth in the economic region.

As discussed in Subsection 4.4.2.5, the school districts in Hood and Somervell counties do not exceed their capacities during peak construction. The loss of students at the beginning of operations lowers the enrollment towards current levels. However, the population growth in the economic region acts to replace the students lost. Because the districts do not have to make substantial changes to accommodate the peak construction enrollment, the loss of that enrollment does not adversely affect the districts. Because population growth acts to augment student enrollment during operations the impact of plant operations on education is expected to be SMALL and does not require mitigation.

5.8.2.3.4 Recreation

Common recreational activities in the region include hunting, fishing, wildlife watching, and camping. Additional information regarding these activities is discussed in Section 2.5.1.3.

A new recreational site is planned for the Wheeler Branch Reservoir located 3.2 mi southeast of the CPNPP Units 3 and 4 center point. The proposed park includes a boat launch, fishing pier, swim area, and biking or walking trails. The reservoir itself is expected to be open to the public in 2010 and is restricted to non-powered water craft (SCWD 2008). SCR, located within the site boundary, will be open for recreational use with controlled access. Other recreation near the site occurs near the Brazos River, with biking, canoeing, and horseback riding, and at the Dinosaur Valley State Park, with walking trails and biking.

During outages up to 1200 additional workers are required at CPNPP. The outage workers are expected to stay in temporary housing such as hotels, RV parks, and rentals. This limits the available temporary housing for recreational transients. However, many RV parks have a limited number of long-term spots, with the rest reserved for short-term transients. This acts to mitigate the affect of the outage workers on recreational transients. Also, outages for CPNPP Units 1 and 2 are not simultaneous with outages for CPNPP Units 3 and 4. Thus the maximum number of temporary workers in the area for any outage does not exceed the current levels for CPNPP Units 1 and 2. Because the current outage workers are housed without displacing the recreational transients, it is expected that the temporary workers due to CPNPP Units 3 and 4 outages also do not displace recreational transients from the vicinity.

The impacts of plant operations on recreation are expected to be SMALL. No mitigation is expected to be required.

5.8.3 ENVIRONMENTAL JUSTICE IMPACTS

Executive Order 12898 (EO 1994) directs federal executive agencies to consider environmental justice under the National Environmental Policy Act. The underlying purpose of this Executive Order is to ensure that minority and/or low-income populations do not bear a disproportionate share of adverse health or environmental effects of a proposed project, such as the CPNPP.

Subsection 2.5.4 describes the evaluation process used to identify minority and low-income populations living within the region that meet the conditions associated with the NRC guidance. Tables 2.5-24, 2.5-25, and 2.5-26 as well as Figures 2.5-10, 2.5-11, 2.5-12, 2.5-13, 2.5-14, 2.5-15, 2.5-16, 2.5-17, 2.5-18, and 2.5-19 identify census blocks, block groups, and relative distances and spatial distributions of minorities and low-income populations around the CPNPP.

Figure 2.5-11 illustrates the distribution of all minority populations that were identified in Subsection 2.5.4. Locally, there are no minority populations identified adjacent to the site. The nearest minority populations are in the cities of Glen Rose and Granbury. The closest population is just over 5 mi away in Glen Rose. Because the effects of normal operations occur primarily on the site and adjacent properties, it is anticipated that there are no disproportionate impacts to minority populations. Because the minority population is distributed evenly among the majority population, regionally all of the physical impacts, regardless of what they are, are proportionate.

The nearest low-income population to the site is located southwest near the city of Dublin, approximately 32 mi away. Because of their distance from the site, it is anticipated that any impact to low-income populations is minimal and proportionate to the majority population.

5.8.3.1 Potential Environmental Impacts

For the purposes of this environmental justice assessment, environmental impacts under consideration due to plant operation include potential impacts due to land use, water, and ecology. As discussed in Sections 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, and 7.1, impacts resulting from the operation of CPNPP are SMALL with respect to the following resources:

- Land Use.
- Water Use.
- Aquatic and Terrestrial Ecology.
- Human Populations.

Because these impacts are determined to be SMALL, and given the distribution of minority and low-income populations, the potential for disproportionate impacts to those populations is considered to be SMALL. Specifically, Luminant did not identify any location-dependent disproportionate high and adverse impacts to minority and low-income populations.

Based on the analysis in Subsection 2.5.4.4, no significant natural resource dependencies in any population have been identified in the region.

5.8.3.2 Potential Socioeconomic Impacts

For the purposes of this environmental justice assessment, socioeconomic impacts due to plant operation include potential impacts due to transportation, housing, infrastructure and public services, education and recreation. As discussed in previous subsections of Section 5.8, impacts resulting from the operation of the CPNPP are SMALL with respect to the following resources:

- Housing.
- Education.
- Recreation.
- Infrastructure and Public Services.

Impacts resulting from the operation of the CPNPP are SMALL to MODERATE with respect to transportation. Because these impacts were determined to be SMALL to MODERATE, and given the distribution of minority and low-income populations, the potential for disproportionate impacts to those populations is considered to be SMALL. Specifically, Luminant did not identify any location-dependent disproportionate high and adverse impacts to minority and low income populations.

5.8.3.3 Benefits of Operation

Luminant is an equal-opportunity employer and expects the CPNPP workforce to reflect the surrounding demographic characteristics. Several beneficial impacts are experienced in the vicinity and region surrounding CPNPP. These include local economic impacts, including the addition of new jobs and tax increases paid by the plant and its workers, which benefit the local public services and the local education systems. However, such benefits would not be disproportionate to minority and low-income populations around the CPNPP.

5.8.3.4 Mitigative Measures

Because the potential impacts of plant operations on minority and low-income populations are expected to be SMALL, no mitigative efforts are required.

5.8.3.5 Environmental Justice Review for Alternative Sites

Review of the environmental justice for the alternative sites is provided in Subsection 9.3.4.3.3.

5.8.4 REFERENCES

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TABLE 5.8-1
PREDICTED NOISE LEVELS (DBA) EXPECTED DUE TO PLANT OPERATIONS

Receptor Position[a]	Approximate Distance from nearest Cooling Tower (feet)	Recorded Ambient Leq dBA Day – Night average 2006	CPNPP Units 3 and 4 Calculated Noise Emissions dBA[b]	Projected Average Noise Level[b]
1 - Approximate Southwest fence line along access road.	4,746	57	42	57
2 - Approximate east fence line between cooling tower and residential property located across SCR.	14, 794	56	33	56
3 - Approximate nearest western fence line	4,693	56	43	56
15 Swim beach north of site	4,482	56	42	56
23 Nearest residential neighborhood south-southwest of site	4,746	44-65[c]	42	44-65
25 Nearest Church and Cemetery	8,591	44-68[c]	36	44-68

a) Figure 2.5-20

b) Calculations were made using a noise level of 55 dBA at 1000 feet. The combination of cooling towers for units 3 and 4 would not have a significant impact due to distance and shielding from each cooling tower and other structures. Noise attenuation calculation. Secondary noise level (SPL_2, dBA) = Initial noise level (SPL_1, dBA) - 20 log (d^1/ d^2) where d^1 is the original distance from the source and d^2 is the measured distance from the source.

c) Area noise levels were collected at these locations utilizing a Quest Type 2 sound level meter with octave band analysis.

TABLE 5.8-2
PLACE OF RESIDENCE FOR CPNPP UNITS 1 & 2 WORKERS

Operations Workers	City/Town	County
401	Granbury	Hood
194	Glen Rose	Somervell
100	Cleburn	Johnson
60	Ft Worth	Tarrant
42	Stephenville	Erath
29	Tolar	Hood
27	Walnut Springs	Bosque
25	Hico	Hamilton
20	Benbrook	Tarrant
14	Rainbow	Somervell
13	Nemo	Somervell
13	Weatherford	Parker
11	Meridian	Bosque
8	Burleson	Johnson
5	Iredell	Bosque
5	Bluff Dale	Erath
5	Arlington	Tarrant
5	Crowley	Tarrant

5.9 DECOMMISSIONING

The Nuclear Regulatory Commission (NRC) defines decommissioning as the safe removal of a facility from service and the reduction of residual radioactivity to a level which permits termination of the license and release of the property for either restricted or unrestricted use. The NRC regulation 10 CFR 50.82, Termination of License, specifies actions that must be taken to decommission a nuclear power facility, and 10 CFR 20, Subpart E, Radiological Criteria for License Termination, identifies the radiological criteria that must be met for site release. NUREG-0586, Final Generic Environmental Impact Statement (GEIS) on Decommissioning of Nuclear Facilities, Supplement 1 identifies activities that can be bounded by a generic evaluation, and the decommissioning activities and associated environmental issues that are likely to require site-specific analysis before performing a decommissioning activity.

Luminant has included the specific decommissioning requirements necessary for initial licensing of Comanche Peak Nuclear Power Plant (CPNPP) Units 3 and 4 in "PART 1, General and Financial Information." Specifically, Part 1 includes the "Decommissioning Funding Assurance" necessary for the licensing requirements per 10 CFR 50.33(k) and 10 CFR 50.75(b)(1). Detail plans regarding decommissioning of the units are expected to be developed as required by the license and the NRC regulations prior to decommissioning the facilities. This subsection only provides an initial projection of expected future environmental impact based on current knowledge and experience. A detailed environmental assessment is expected to be included as part of the detail plan prior to decommissioning.

5.9.1 SITE-SPECIFIC POTENTIAL ENVIRONMENTAL IMPACTS OF DECOMMISSIONING

The impacts associated with the decommissioning of any light water reactor (LWR) before or at the end of an initial or renewed license are evaluated in the GEIS on Decommissioning of Nuclear Facilities, NUREG-0586, Supplement 1, regarding the decommissioning of nuclear power reactors. That report determined that the impacts associated with decommissioning under the stated decommissioning options were either SMALL or may require site-specific assessment. Table 5.9-1 provides a summation of the impact assessments as determined in NUREG-0586.

The site-specific assessment impact areas consist of off-site land-use activities, aquatic ecology activities beyond the operational area, terrestrial ecology activities beyond the operational area, threatened and endangered species, environmental justice, and cultural and historic resource impact activities beyond the operational area. Each of these impacts is expected to be SMALL when evaluated in the future to support decommissioning, just as they have been evaluated as SMALL for the construction and operational phases of the Combined Operating License (COL) Application (Section 2.5, 4.2, and 5.8).

The CPNPP Units 3 and 4 are contained almost entirely within the operational area. The few potentially affected areas off-site include the intake and return infrastructure for condenser cooling water and blowdown return lines involving Lake Granbury, the water pipeline corridors, and transmission corridors and lines that may be deactivated or removed in the future. Because the length of time is far into the future, it is not prudent to define what would be done as part of the decommissioning activities. If identified environmental impacts at the time of decommissioning were not considered in initial or subsequent environmental assessments, the licensee is expected to be required to request a license amendment regarding the activities and submit a supplement to the Environmental Report relating to the additional impacts as discussed above.

TABLE 5.9-1
ANTICIPATED ENVIRONMENTAL IMPACTS FROM DECOMMISSIONING CPNPP UNITS 3 AND 4[(a)]

Issue	Generic	Impact
On-site/Off-site Land Use		
- On-site land-use activities	Yes	SMALL
- Off-site land-use activities	No	Site-specific
Water Use	Yes	SMALL
Water Quality		
- Surface water	Yes	SMALL
- Groundwater	Yes	SMALL
Air Quality	Yes	SMALL
Aquatic Ecology		
- Activities within the operational area	Yes	SMALL
- Activities beyond the operational area	No	Site-specific
Terrestrial Ecology		
- Activities within the operational area	Yes	SMALL
- Activities beyond the operational area	No	Site-specific
Threatened and Endangered Species	No	Site-specific
Radiological		
- Activities resulting in occupational dose to workers	Yes	SMALL
- Activities resulting in dose to the public	Yes	SMALL
Radiological Accidents	Yes	SMALL
Occupational Issues	Yes	SMALL
Cost	NA	NA
Socioeconomic	Yes	SMALL
Environmental Justice	No	Site-specific
Cultural and Historic Resource Impacts		
- Activities within the operational area	Yes	SMALL
- Activities beyond the operational area	No	Site-specific
Aesthetics	Yes	SMALL
Noise	Yes	SMALL
Transportation	Yes	SMALL
Irretrievable Resources	Yes	SMALL

a) Data from NUREG-0586 Supplement 1

5.10 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATION

This section summarizes the principal adverse environmental impacts of operations and provides possible measures and controls to limit these impacts. A modified Leopold Matrix is presented in Table 5.10-1 that depicts the cause-and-effect relationships between operational environmental disturbances and the corresponding affected environmental receptors/resources. The horizontal axis on the matrix represents the principal environmental disturbances, and the vertical axis depicts the environmental receptors or resources that could be affected by those disturbances. The table also summarizes feasible measures and controls that have been identified for mitigating operational impacts.

The significance indicators provided in Table 5.10-1 are designated using the following descriptors: SMALL (S), MODERATE (M), or LARGE (L). The significance indicators are defined in Section 5.0. The assignment of significance levels (S, M, and L) is based on the assumption that for each impact, corresponding specific mitigation measures and controls, or equivalents, are implemented. If a SMALL (S) significance determination is made without the implementation of measures and controls, then no additional measures and controls are identified in Table 5.10-1. A blank cell in the elements “Potential Environmental Parameters and Significance Levels” column denotes “no impact” of that type on the environmental resource.

Each “Impact Description or Activity” attribute is assigned a number, and each “Specific Mitigation Measures and Controls “ attribute is assigned a number in parenthesis that corresponds to the respective “Impact Description or Activity.” In addition to the standard outline provided in Chapter 5 of NUREG-1555, the following additional environmental resources are explicitly called out in Table 5.10-1: Water Use Impacts (5.2.2) and Noise (5.8.1.5). These subsections have been specifically added to provide a more thorough consideration of the adverse impacts and their mitigation measures. The specific mitigation measures and controls described in Table 5.10-1 are considered reasonable from a practical, engineering, and economic view; many are based on statutes and regulatory requirements or are generally accepted practices within the utility industry. Therefore, these measures and controls are not expected to present an undue hardship on the applicant. Based on a review of the operational impacts described in this chapter, specific mitigation measures and controls for reducing adverse impacts at the Comanche Peak Nuclear Power Plant (CPNPP) include:

- An environmental, safety, and health plan is expected to be prepared for Units 3 and 4.
- Operational employees receive appropriate training in environmental compliance and safety procedures.
- Material Safety Data Sheets are required for use of applicable hazardous materials at CPNPP. Operational employees are trained in the appropriate use of hazardous materials.
- Hazardous materials are used in accordance with applicable federal, state, and local laws and regulations.
- Hazardous wastes are treated, stored, and disposed of in accordance with the Resource Conservation and Recovery Act (RCRA) and other applicable federal, state, and local

laws and regulations. Operational employees are trained in the appropriate handling and disposal of hazardous wastes.

- As appropriate, safety and/or environmental personnel are responsible to oversee and inspect operational activities.
- Operational activities are performed in accordance with applicable local, state, and federal ordinances, laws, and regulations intended to prevent or minimize adverse environmental effects of operational activities on air, water, land, occupational workers and the general public.
- Operational activities are performed in compliance with applicable CPNPP environmental, safety, and operational procedures that place controls on how activities are performed.

Specific mitigation measures and their associated controls are detailed in Table 5.10-1.

5.10.1 REFERENCES

None

TABLE 5.10-1 (Sheet 1 of 10)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATIONS

ER Chapter 5	Section Description	Potential Environmental Impact Parameters & Significance Level [a]									Impact Description or Activity	Specific Mitigation Measures and Controls
		Noise	Erosion	Effluents and wastes	Surface-water impacts	Groundwater impacts	Terrestrial ecosystem impacts	Aquatic ecosystem impacts	Socioeconomic impacts	other site-specific impacts		
5.1	**Land-Use Effects**											
5.1.1	Site and Vicinity		S	S	S		S	S			1. Maintenance of the plant during operations may necessitate continued removal or disturbance of vegetation. 2. Impacts to forest, grassland, pastureland and farmland in the vicinity are expected to be limited because the areas of proposed construction have already been disturbed previously. 3. Cooling tower plumes are expected to resemble cumulus clouds at a distance.	(1) Limit continued disturbance of vegetation to the area within the site designated for CPNPP construction. • No additional mitigation is required
5.1.2	Transmission Corridors and Off-site Areas			S	S		S	S			At this time, the land-use effects from operations in the transmission line corridors are unknown. When the desktop transmission line corridor study is complete (Dec. 2007), information pertaining to these corridors, off-site areas, and the effects associated with operations in them are to be discussed.	
5.1.3	Historic Properties										No impact to historical properties or cultural resources is expected by operating Units 3 and 4	
5.2	Water-Related Impacts										Water volumes are expected to change prior to COLA submission.	
5.2.1	Hydrologic Alteration and Plant Water Supply			S	M	S			S		1. Water loss primarily as a result of "consumptive" loses results in a net consumption of approximately 37,154 gallons per minute (gpm) of water. Net consumption includes makeup water withdrawn from Lake Granbury minus blowdown water returned to Lake Granbury. This large volume could adversely affect the Brazos River below Lake Granbury. 2. Stormwater contaminated discharges to Squaw Creek Reservoir (SCR). 3. The cooling water system may have a minor localized influence on river hydraulics. 4. Erosion of banks near intake structure.	(1) Cooling and Plant Water Systems are designed to minimize the amount of water needed. (1) Avoid usage of groundwater sources. (2) Prepare and maintain an SWP3 and TPDES permit to minimize releases. (3) Install multi-port diffuser pipes to maximize thermal and chemical dissolution. (4) Install erosional control devices to stabilize the banks if needed. • No additional mitigation is required.

TABLE 5.10-1 (Sheet 2 of 10)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATIONS

ER Chapter 5	Section Description	Potential Environmental Impact Parameters & Significance Level [(a)]: Noise	Erosion	Effluents and wastes	Surface-water impacts	Groundwater impacts	Terrestrial ecosystem impacts	Aquatic ecosystem impacts	Socioeconomic impacts	other site-specific impacts	Impact Description or Activity	Specific Mitigation Measures and Controls
5.2.2	Water-Use Impacts			S	M	S			S		1. Approximately 9 percent of the monthly average flow of 997 cubic feet per second (cfs), note: this volume is derived from USACE data from 1991 though 2006) through Lake Granbury is expected to be lost to water withdrawal and evaporation from the proposed Units 3 and 4 cooling-tower operations. The loss of this volume of water could potentially affect Lake Granbury under low flow conditions 2. Effluent discharges of small concentrations of residual chemicals priority pollutants, and thermal pollution into Lake Granbury. 3. Use of a chemical and thermal mixing zone (allocated impact zone). 4. An estimated 44% increase in future water consumption in the Brazos River basin (TWDB, Brazos Region G 2006). 5. By 2020, water demand levels in Somervell County would exceed 3% of their capacity (TWDB, Brazos Region G 2006).	(1) Cooling and Plant Water Systems are designed minimize the amount of water needed, SCR spillage for Brazos, and use of Luminant contracted water. (2) Treatment of blowdown (2) Planned effluent discharges are limited and in compliance with Clean Water Act (CWA) regulations (40 CFR 423). (2) Planned effluent discharges are limited and in compliance with the sites amended TPDES permit. (3) Compliance with TCEQ regulations. (4,5) Construct Wheelers Branch Reservoir and supply water from the Paluxy River, tributary to the Brazos River. SCR spillage for BRA use, and use of Luminant contracted water. • No additional mitigation is required.
5.3	**Cooling System Impacts**											
5.3.1	**Intake system**											
5.3.1.1	Hydrodynamic Descriptions and Physical Impacts	S	S		S			S			1. Noise associated with operations of water makeup pumps at the intake structure. 2. Erosion of Lake Granbury banks, bottom scouring and induced turbidity near intake structure. 3. Buildup of sediment deposits and littoral debris.	(1) As appropriate, protective hearing equipment is used by employees working near the water pumps and cooling towers. (2) Stabilize banks of the embayment and shoreline with erosional controls if needed. (3) Water intake design to avoid siltation. • No additional mitigation is required.
5.3.1.2	Aquatic Ecosystems				S			S			1. Impingement and entrainment may kill some aquatic species 2. Minor aquatic impact resulting from consumption of water from Lake Granbury.	(1) Utilization of closed cycle technology and cooling tower, sizing river intake structures to ensure minimum water velocity through screens that are designed to prevent fish from being draw into the intake structure. (2) Makeup water is expected to be supplied by the low-flow reservoir during low flow conditions. • No additional mitigation is required.

TABLE 5.10-1 (Sheet 3 of 10)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATIONS

ER Chapter 5	Section Description	Potential Environmental Impact Parameters & Significance Level [(a)]: Noise	Erosion	Effluents and wastes	Surface-water impacts	Groundwater impacts	Terrestrial ecosystem impacts	Aquatic ecosystem impacts	Socioeconomic impacts	other site-specific impacts	Impact Description or Activity	Specific Mitigation Measures and Controls
5.3.2	**Discharge System**											
5.3.2.2	Aquatic Ecosystems		S	S	S			S		S	1. Small turbidity effect and bottom scouring near the intake structure. 2. Potential for minor erosion or sedimentation near the discharge point. 3. Planned blowdown discharges of water containing concentrated salts and minerals. 4. Thermal plume has a minor impact on aquatic organisms. 5. Planned discharges of concentrated minerals and treated hazardous waste may have a small impact on aquatic organisms	(1, 2) To the extent practical, equipment is employed and positioned so as to reduce scouring and turbidity effects. (1-3) Intake structure constructed using Best Available Technology. (3) Blowdown treatment. (4) The reactors utilize cooling towers and a closed-loop cooling cycle that significantly reduces the thermal plume effects on aquatic organisms. (5) Hazardous effluents are treated according to RCRA, CWA, and TPDES permit requirements. • No additional mitigation is required.
5.3.3	**Heat Discharge System**											
5.3.3.1	Heat Dissipation to the Atmosphere			S	S					S	1. The cooling towers release visible vapor plumes into the atmosphere. 2. The cooling towers discharge small amounts of waste salts and other chemicals to the atmosphere that can contaminate soil and damage vegetation. 3. Vapor plumes cause a minor increase in heat and humidity near the site vicinity and aloft. 4. Vapor plumes cause a shadowing effect and are expected to induce less than 0.4 in precipitation annually.	(1-4) Utilization of drift eliminators in cooling towers to minimize the amount of water lost from the towers via drift. (2) Use of blowdown treatment to minimize total dissolved content of circulating water. • No additional mitigation is required.
5.3.3.2	Terrestrial Ecosystems	S		S	S					S	1. Operating noise has a minor effect on species near the cooling tower. 2. The cooling towers discharge small amounts of waste salts (drift deposition) and other chemicals to the atmosphere but are not in high enough concentrations to significantly damage leaves.	(1) Cooling towers are designed to minimize noise levels. (2) Blowdown is treated to remove some of the salts and other dissolved solids. • No additional mitigation is required.

TABLE 5.10-1 (Sheet 4 of 10)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATIONS

ER Chapter 5	Section Description	Potential Environmental Impact Parameters & Significance Level (a): Noise	Erosion	Effluents and wastes	Surface-water impacts	Groundwater impacts	Terrestrial ecosystem impacts	Aquatic ecosystem impacts	Socioeconomic impacts	other site-specific impacts	Impact Description or Activity	Specific Mitigation Measures and Controls
5.3.4	Impacts to Members of the Public	S			S				S	S	1. The discharge system results in a small increase in the background noise level. 2. Growth of thermophilic microorganisms in the cooling water system.	(1) As applicable, workers are trained in compliance with Noise Control Act (NCA), 42 USC 4901 et seq. and Occupational Safety and Health Act (OSHA). (1) As appropriate, protective hearing equipment is used by employees working near the cooling towers. (2) Water is periodically monitored and tested for thermophilic microorganisms according to the Centers for Disease Control's Surveillance for Waterborne-Disease Outbreaks-United States. (2) Workers are trained on safe work procedures. (2) As appropriate, workers are assigned and trained to use air respirators. • No additional mitigation is required.
5.4	**Radiological Impacts of Normal Operation**											
5.4.1	Exposure Pathways			S	S	S	S	S		S	1. Discharges of radioactive gases to the environment. 2. Potential exposure of humans to low doses of radiation. 3. Relatively small planned discharges of radioactive liquids to SCR. 4. Exposure of humans and biota to radioactive liquid through ingestion, immersion or contact of contaminated water or shoreline soil and ingestion of contaminated food chain components, immersion 5. Exposure to radioactive gases through airborne radioactivity, deposited activity, ingestion of contaminated agricultural products, and direct radiation from the facility during operation.	(1-5) Planned releases of radiation are within dose limits prescribed under 10 CFR 20. 1301 "Dose limits for individual members of the public." (3) Effluent discharges must comply with requirements specified in 10 CFR 20. (1-5) Although there are no acceptance criteria specifically for biota, there is no evidence that chronic doses below 100 mrad/day are harmful to plants or animals. The biota doses are less than 2 mrad/day). (1-5) Sensors monitor and warn of any unacceptable radiation levels under work plans and procedures are developed for hazardous assignment. (1-5) CPNPP has a comprehensive plan for routinely periodically monitored radiation pathways and releases on receptors. (1-5) Procedures are developed for treating and handling radioactive effluents. • No additional mitigation is required.
5.4.2	Radiation Doses to Members of the Public			S	S		S			S	1. Radiological exposure to individuals and the general public from release of radioactive materials in liquid effluents releases to SCR and gaseous releases to the atmosphere. 2. Direct radiation from the containment and other plant buildings is negligible.	1) Public access to SCR is controlled. Radiation doses to the public from gaseous releases to the atmosphere. Calculated doses are expected to be within limits given in 10 CFR 50 and Appendix I criteria within regulatory limits of 40 CFR 190; therefore no impact. (1,2) Releases and exposure to radiation are within all regulatory limits. • No additional mitigation is required.

TABLE 5.10-1 (Sheet 5 of 10)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATIONS

ER Chapter 5	Section Description	Potential Environmental Impact Parameters & Significance Level [(a)]									Impact Description or Activity	Specific Mitigation Measures and Controls
		Noise	Erosion	Effluents and wastes	Surface-water impacts	Groundwater impacts	Terrestrial ecosystem impacts	Aquatic ecosystem impacts	Socioeconomic impacts	other site-specific impacts		
5.4.3	Impacts to Members of the Public										1. Potential impacts to the public originate from liquid effluent releases to SCR and gaseous releases to the atmosphere. 2. Members of the public can receive radioactive doses from breathing, swimming, food, drinking water, and contact with contaminated soil.	(1,2) Procedures are developed for treating and handling radioactive effluents. (1,2) Calculated doses are expected to be within limits given in 10 CFR 50 and Appendix I criteria within regulatory limits of 40 CFR 190. • No additional mitigation is required.
5.4.4	Impacts to Biota other than Members of the Public			S	S		S	S		S	1. Potential doses to biota originate from liquid and gaseous effluents. 2. Biota can receive radioactive doses via contact with contaminated water or soil and through ingestion. Calculated doses for seven surrogated exceeded regulatory limits 40 CFR 190.	(1, 2) Although no international consensus has been developed with respect to dose exposures to biota, there is no convincing scientific evidence that chronic doses below 100 mrdad/day is harmful to plants or animals. The biota doses are less than 2 mrad/day. (1,2) Use of exposure guidelines, such as 40 CFR 190, which apply to members of the public in unrestricted areas, is considered very conservative when evaluating calculated doses to biota. The international Council on Radiation Protection states that "...if man is adequately protected then other living things are also likely to be sufficiently protected," and uses human protection to infer environmental protection from the effects of ionizing radiation (ORNL 1995). No mitigation is required. • No additional mitigation is required.
5.4.5	Occupational Radiation Doses										1. Impacts to workers from radiation exposure.	(1) Based on the available data on the APWR design, the maximum annual occupational dose is estimated to be 0.7263 person-Sv (72.63 person-rem). Impacts to workers from occupational radiation doses are SMALL and do not warrant additional mitigation.

TABLE 5.10-1 (Sheet 6 of 10)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATIONS

ER Chapter 5	Section Description	Potential Environmental Impact Parameters & Significance Level [(a)]: Noise	Erosion	Effluents and wastes	Surface-water impacts	Groundwater impacts	Terrestrial ecosystem impacts	Aquatic ecosystem impacts	Socioeconomic impacts	other site-specific impacts	Impact Description or Activity	Specific Mitigation Measures and Controls
5.5	**Environmental Impact of Wastes**											
5.5.1	Non-radioactive Waste-System Impacts			S	S		S	S		S	1. As part of routine operations, Hazardous non-radioactive emissions and effluents are discharged to the air, Lake Granbury, SCR, and soil. 2. Increased chemicals, biocides, caustics and other pollutants in discharge. 3. Increase in total volume of sanitary and hazardous waste generated. 4. Hazardous non-radioactive waste is generated and disposed of in accordance with RCRA regulations. 5. Non-hazardous waste is generated and disposed of in accordance with TCEQ regulations. 6. Increased stormwater discharge. 7. Increased air emissions.	(1-2) All discharges will comply with TCEQ NPDES permit (TCEQ 2004) and applicable water quality standards. (1,4) Hazardous waste is carefully monitored. (3) Use approved transporters and approved off-site disposal facilities for disposal of solid wastes. Create a waste program for waste minimization through reuse, recycling and product selection. (3) Sanitary waste is treated at an approved sewage treatment plant. (5) Non-hazardous non-radioactive waste is generated and disposed of according to applicable local, state, and federal regulations, including the Solid Waste Disposal Act, as amended, 42 USC 6901 et seq. (1-5) Inspections are performed to ensure that all waste is managed according to applicable laws and regulations. (1-5) Employees are trained to follow applicable procedures, waste regulations, and chemical awareness information. (1-5) Sewage treatment is performed by licensed operators. (1-5) Minor changes to CPNPP waste management, monitoring and minimization plans. (6) Monitor discharges from the sediment retention pond in accordance with the SWP3. (7) Operate minor air emissions sources in accordance with applicable federal, state, and local regulations. • No additional mitigation is required.
5.5.2	Mixed Waste Impacts			S	S		S	S		S	1. Projected annual generation of less than 1 cu yd mixed waste per year. 2. Potential chemical hazard and occupational exposure to radiological materials during handling and storage.	(1, 2) The inventory of mixed waste is maintained in a designated storage area and monitored prior to off-site disposal. (1, 2) Transport of mixed waste is done by licensed hazardous/ mixed waste carriers. (1, 2) Limit mixed waste generation though source reduction, recycling, and treatment options. (1, 2) Inspections are performed to ensure that all waste is managed according to applicable laws and regulations. (1,2) Mixed-waste storage assures that chemical and radiological exposures are minimized both by the As Low As Reasonably Achievable (ALARA) and chemical awareness training programs. • No additional mitigation is required.

TABLE 5.10-1 (Sheet 7 of 10)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATIONS

ER Chapter 5	Section Description	Potential Environmental Impact Parameters & Significance Level [(a)]									Impact Description or Activity	Specific Mitigation Measures and Controls
		Noise	Erosion	Effluents and wastes	Surface-water impacts	Groundwater impacts	Terrestrial ecosystem impacts	Aquatic ecosystem impacts	Socioeconomic impacts	other site-specific impacts		
5.5.3	Waste Minimization			S						S	1. Volume of mixed waste is projected to be less than 1 percent of the total low level waste (LLW) volume.	(1) Comply with current Waste Minimization Plan developed for existing Units 1 and 2 to address hazardous waste management, equipment maintenance, recycling and reuse, segregation, treatment (decay in storage), work planning, waste tracking, and awareness training. • No additional mitigation is required.
5.6	**Transmission System Impacts**											
5.6.1	Terrestrial Ecosystems	S	S	S	S		S			S	1. Continued maintenance involving clearing of vegetation along the corridor may impact terrestrial ecology. 2. Fatal avian collisions with transmission lines. 3. Exhaust and nuisance noise from aerial and ground inspections and maintenance of transmission corridors. 4. Potential for spills of hazardous materials during maintenance. 5. Application of herbicides.	(1) Employees are trained on how to perform work in a manner that reduces adverse environmental impacts. (1-6) Minimize potential impacts through compliance with permitting requirements and best management practices. (1, 2) To the extent feasible, avoid any additional disturbances on critical or sensitive terrestrial habitats/species. (3) As practical, vehicles/machinery use, noise suppression/ mufflers, and vehicles are maintained to reduce emissions. (4) Readily available spill response materials and personnel trained to respond to, clean-up and report spills. (4) Employees are trained in hazardous materials/waste procedures to minimize the risk of spills. (5) Herbicides are applied by trained employees licensed to apply herbicides. • No additional mitigation is required.
5.6.2	Aquatic Ecosystems		S	S	S			S			1. Continued maintenance involving clearing of vegetation along the corridor near water bodies may impact aquatic biota. 2. Potential for some erosion and subsequent runoff into water bodies. 3. Herbicides can migrate into water bodies. 4. Potential for spills of hazardous materials/waste that pollute the aquatic ecosystem. 5. Unauthorized encroachment.	(1-4) Minimize potential impacts through compliance with permitting requirements and best management practices. (1) To the extent feasible, avoid any additional disturbances on critical or sensitive aquatic habitats/species. (2) As practical, cleared areas are reseeded to limit erosion. (2) Apply appropriate erosion controls (grassed or wooded buffer strips, board roads, and removable mats). Obtain a permit before dredge or fill activities. (3) Herbicides are applied by using proper management practices by trained employees who possess an application permit. (4) Employees are trained in hazardous materials/waste procedures to minimize risk of spills. (5) Perform routine over-flights. • No additional mitigation is required.

TABLE 5.10-1 (Sheet 8 of 10)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATIONS

ER Chapter 5	Section Description	Potential Environmental Impact Parameters & Significance Level (a)									Impact Description or Activity	Specific Mitigation Measures and Controls
		Noise	Erosion	Effluents and wastes	Surface-water impacts	Groundwater impacts	Terrestrial ecosystem impacts	Aquatic ecosystem impacts	Socioeconomic impacts	other site-specific impacts		
5.6.3	Impacts to Members of the Public	S		S	S		S	S		S	1. Increased exposure to electromagnetic fields. 2. Increased noise from high voltage transmission lines. 3. Increased radio and television interference. 4. Visual effects of transmission lines by the public. 5. Impacts to aviation routes.	(1-2) Transmission lines built to standards. (3) Natural vegetation is retained at road and river crossings during construction to help minimize ground-level visual impacts unless engineering requirements dictate otherwise. (4) Transmission towers would be designed to reduce any impact to important scenic view areas. (5) In the case of CPNPP, no towers along the new transmission lines are expected to exceed 200 ft in height, nor are there any airports, airstrips, or heliports within 20,000 ft of the transmission line corridors currently under review by Luminant. • No additional mitigation is required.
5.7	**Uranium Fuel Cycle Effects**											
5.7	Uranium Fuel Cycle Effects	S							S	S	1. Open-pit, underground mining or leaching of uranium ore.	(1) Use mining techniques that minimize potential impacts. (1) Some uranium may be imported. • No additional mitigation is required.
5.7.1.1	Land Use	S							S	S	1. Commitment of land for uranium processing facilities.	(1) Use mining techniques that minimize potential impacts. (1) Some uranium may be imported. • No additional mitigation is required.
5.7.1.2	Water Use			S	S			S			1. Increased discharge of thermally heated waters into Lake Granbury.	(1) Use of new technologies with less fuel loading to reduce water usage. (1) Use closed loop cooling tower system. • No additional mitigation is required.
5.7.1.3	Fossil Fuel Effects									S	1. Natural gas consumption to generate electricity. 2. Air emissions from fossil fuel plants supplying the gaseous diffusion plant.	(1, 2) Use of new technologies with less fuel loading to reduce energy and emissions usage. (1, 2) Use of energy efficient equipment/processes (1, 2) Develop and maintain an energy conservation program. • No additional mitigation is required.
5.7.1.4	Chemical Effluents			S	S						1. Chemical, gaseous, and particulate effluents from fuel enrichment and fabrication. 2. Generation of tailings solutions and solids during the milling process.	(1) Water treatment systems would be designed meet requirements and limitations. (2) Use mining techniques that minimize potential impacts. (2) Some uranium may be imported. • No additional mitigation is required.

TABLE 5.10-1 (Sheet 9 of 10)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATIONS

ER Chapter 5	Section Description	Potential Environmental Impact Parameters & Significance Level [(a)]: Noise	Erosion	Effluents and wastes	Surface-water impacts	Groundwater impacts	Terrestrial ecosystem impacts	Aquatic ecosystem impacts	Socioeconomic impacts	other site-specific impacts	Impact Description or Activity	Specific Mitigation Measures and Controls
5.7.1.5	Radioactive Effluents									S	1. Impacts of radioactive effluent releases to the environment from waste activities. 2. Impacts of radioactive gaseous effluents during reactor operation. 3. Impacts of liquid radioactive effluent from sources other that operation.	(1-3) Based on data from the Nuclear Regulatory Commission (NRC), EPA, and National Cancer Institute (NCI), Luminant concludes that the environmental impacts of radioactive effluents from CPNPP are SMALL. • No additional mitigation is required.
5.7.1.6	Radioactive Wastes			S						S	1. Generation of radioactive waste from operations, decontamination, and decommissioning.	(1) Prepare a detailed contamination and decommissioning plan. (1) Waste will eventually be placed in permanent off-site repositories. • No additional mitigation is required.
5.7.1.7	Occupational Doses									S	1. Impact of radiation exposure to workers.	1. Occupational doses would be maintained to meet the dose limits in 10 CFR Part 20, which is (0.05 Sv/yr) (5 rem/yr). • No additional mitigation is required.
5.7.2	Transportation									S	1. Transportation dose to workers and the public is expected to be 0.101 person-Sv/yr (10.1 person-rem/yr).	• No additional mitigation is required.
5.8	**Socioeconomic Impacts**											
5.8.1	Physical Impacts of Station Operations	S							S	S	1. Limited increased transportation and traffic on two-lane state highways, county highways, local roads, especially Texas State Highway (SH) 144 and Farm To Market (FM) 56 and the highways that feed the plant is expected. FM 56 was improved during the construction of Units 1 and 2 and SH 144 is currently being improve and should be finished by 2010. 2. Potential episodic and limited noise impacts to workers and nearby residents (see 5.8.4). 3. Potential impacts from air emissions associated with operation activities.	(1) Improvements of SH 144 and FM 56 and the potential additional entrance to the site. (2) Zoning and land-use restrictions may be used to help manage development. (2) Train and appropriately protect CPNPP employees to reduce the risk of potential exposure to noise. (3) Monitor release of waste emissions and effluents. (3) Train workers on procedures and regulations involving waste emissions and effluents. • No additional mitigation is required.
5.8.1.5	Noise	S									5.8.1.5 (Noise) is currently being written and once this information is available this subsection is to be revised.	

TABLE 5.10-1 (Sheet 10 of 10)
SUMMARY OF MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATIONS

ER Chapter 5	Section Description	Noise	Erosion	Effluents and wastes	Surface-water impacts	Groundwater impacts	Terrestrial ecosystem impacts	Aquatic ecosystem impacts	Socioeconomic impacts	other site-specific impacts	Impact Description or Activity	Specific Mitigation Measures and Controls
		Potential Environmental Impact Parameters & Significance Level [(a)]										
5.8.2	Social and Economic Impacts								S	S	1. Increase the population in the region by as many as 1100 people. Predicted populating increase is less than 3% each for the two county area. 2. Increased burden on public services accompanying in-migration of new workers and their families. 3. Effects on terrestrial and aquatic ecosystems can affect hunting, fishing, and recreation. 4. 550 new jobs for operational plant employees may result in 682 new indirect jobs in the 50-mi region. 5. Revenue from property taxes paid for Units 3 and 4 and from increased sales in the region is expected to benefit Somervell County. 6. Increased population leads to more housing and building construction. 7. Increased population could spur further development that may affect the ecosystem. 8. Consumption of water for reactor cooling and increased workers may have minor socioeconomic implications. 9. Worker safety and accidents.	(1) Based on vacancy data from the 2000 census, sufficient housing units are available. (1-9) Diversify settlement of new workers into several communities. (2) Increased property and worker-related taxes can help offset some of the problems related to increased population such as community facilities and infrastructure, police, fire protection, and schools. (3,4) Local land zoning and ordinances can help mitigate potential socioeconomic growth problems. (8) Optimization study completed to design the cooling towers to economically limit the amount of water potentially consumed. (9) Provide appropriate job-training to workers. (9) Community Relation Group to manage concerns from adjacent residents or visitors on a case-by-case basis through an employee-concerns resolution program. (9) Provide on-site services for emergency first aid, and conduct regular health and safety monitoring. • No additional mitigation is required.
5.8.3	Environmental Justice	S							S		1. No disproportionately high impacts on minority or low-income populations resulting from operation of the proposed new units. workers and their families.	(1) No mitigation required beyond those listed above.
5.9	**Decommissioning**											
5.9.1	Decommissioning										1. Potential radiation exposure related to decommissioning, including transportation of materials to disposal sites.	(1) The significance of impacts is unknown because the decommissioning methods have not been chosen. No mitigation measures or controls are proposed at this time. • No additional mitigation is required.

a) The assigned significance levels (S) Small, (M) Moderate, or (L) Large are based on the assumption that for impact there are associated proposed mitigation measures and controls.

5.11 CUMULATIVE IMPACTS RELATED TO STATION OPERATIONS

This section of the Environmental Report (ER) provides a summary of potential cumulative environmental impacts associated with operational activities for the proposed project. Cumulative impact on the environment results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Regulatory Guide 4.2, Rev. 2, Preparation of Environmental Reports for Nuclear Power Stations (NRC 1976) states that an application should include an assessment of (1) cumulative and projected long-term effects from the point of view that each generation is trustee of the environment for each succeeding generation, and (2) any cumulative buildup of radionuclides in the environment.

To meet these criteria, this section provides the following information:

- Identification of past, present, and known or anticipated future federal, non-federal, and private actions that could have meaningful cumulative impacts with the proposed action.
- Identification of the geographic area to be considered in evaluating cumulative impacts.
- Information on cumulative impacts of relevant actions within the identified geographic area.

The impact characterization is consistent with the criteria that the NRC established in NRC Regulations 10 CFR Part 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions, Appendix B, Table B-1, Footnote 3: lists impacts as SMALL, MODERATE, and LARGE. The definition of these impacts is presented in Section 5.0.

5.11.1 PAST, PRESENT, AND KNOWN FUTURE FEDERAL, NON-FEDERAL, AND PRIVATE ACTIONS

As discussed in Section 2.8; there is one current federal project within the region (50-mi radius) and one current federal project within the vicinity (6-mi radius) of the proposed project. A review has been performed for future possible federal agency actions in the vicinity of the project site. The two federal projects were identified pursuant to the National Environmental Policy Act (NEPA).

Within the region, an Environmental Assessment was prepared in 2006 to develop Ham Creek Park into a Class A campground at Whitney Lake, Johnson County (USACE 2006). Within the vicinity, Wheeler Branch Reservoir is being built by the Somervell County Water District. A U.S. Army Corps of Engineers (USACE) 404 permit has been issued for this project. The reservoir is expected to provide potable water for Somervell County as well as all four Comanche Peak Nuclear Power Plants (CPNPP) units.

There are no current or known or anticipated future plans at this time for other projects. Possum Kingdom Lake, Lake Granbury, and Whitney Lake were the main projects conducted in the past in the region of the proposed project. The CPNPP site and vicinity are still rural with few major roads or rail lines, and at a sufficient distance from the major metropolitan areas thereby limiting growth such as manufacturing and industrial developments.

Infrastructure in the natural gas industry is developing but in the long-term this industry is expected to reach a maximum activity level in the next few years (prior to the operation of CPNPP Units 3 and 4) and would not be a long-term source of impact on the region surrounding the proposed project. The growth in population in the region is an increasing burden on the groundwater supply, sanitary systems, and surface water usage but the effects of the operations of CPNPP Units 3 and 4 are a small part of that growth and are expected to have an overall SMALL and beneficial impact on the environment, environmental justice, and socioeconomics of the region.

No cumulative adverse impacts from activities associated with the operations of CPNPP Units 3 and 4 are expected in relationship with past, present, or future projects.

5.11.2 GEOGRAPHIC AREA TO BE CONSIDERED

The geographic areas considered vary for each type of impact. Some areas are as small as the plant site, and some are as large as the entire ERCOT region. Geographic areas considered are presented in Table 5.11-1. along with each resource and potential impact. Table 5.11-1 follows the guidance provided by the Council on Environmental Quality (CEQ) guidance document (CEQ 1997).

5.11.3 CUMULATIVE IMPACTS ASSOCIATED WITH OPERATION OF THE PROPOSED PLANT

A summary of potential cumulative impacts related to operational activities for CPNPP Units 3 and 4 is presented in Table 5.11-1. The table is based on Table 2-2 of the CEQ guidance document (CEQ 1997) and compares environmental disturbances versus environmental receptors, or resources. The table lists where these areas of interest are addressed in this report. The significance indicators used in Table 5.11-1 are designated using the following descriptors: SMALL (S), MODERATE (M), or LARGE (L). The significance indicators are defined in Section 5.0. The measures and controls for operations activities described in Sections 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, and 5.9 are presented in Table 5.10-1.

5.11.4 ACTIONS THAT COULD HAVE MEANINGFUL CUMULATIVE IMPACTS WITH THE PROPOSED ACTION

In addition to the eleven sections described in NUREG 1555, two supplemental sections have been added to this report. These sections are Section 5.12 (Impacts to Transportation of Radioactive Materials) and Section 5.13 (Nonradiological Health Impacts During Operations).

As the scheduled activities of this project reach the operational phase, the past, present and known or anticipated future federal projects would be complete. There would be little or no impact on these projects due to the timeline differences. The park and reservoir projects described above would be complete and the operation of this project would have no impact on them.

There are no known private projects proposed in the vicinity of this proposed project that cumulatively impact or would be cumulatively impacted by the operation of CPNPP Units 3 and 4. If such a project is proposed, the project planners would be expected to address environmental interests under the provisions of NEPA with the goal of ensuring the potential cumulative impacts would be SMALL.

Cumulative impacts regarding the proposed project and its relationship with the existing CPNPP Units 1 and 2 have been a design consideration from early in the planning phases. Cooling water systems were chosen to ensure the proposed project would not impact CPNPP Units 1 and 2, so the water source chosen for CPNPP Units 3 and 4 became Lake Granbury. This choice allows minimal cumulative impacts on water resources. Liquid radioactive effluents would combine with CPNPP Units 1 and 2 pathways to produce needed dilution flow for the proposed project and limit the release of radioactive liquid effluents to just one water body, Squaw Creek Reservoir (SCR). Transmission infrastructure is designed to allow separation of units and still provide the inter-connections needed for reliability and back-up power supplies. Several buildings and facilities are being designed for multiple unit compatibility, such as common engineering facilities, parking, warehousing, and security features. The proposed project is using a common potable water source from the Wheeler Branch Reservoir, eliminating any use of groundwater at the site. A new water treatment system would supply water of superior quality water to all four units and is a better and more efficient use of water treatment. These relationships provide a symbiotic tie between the four units and are examples of ways to effectively minimize cumulative impacts and are a valuable method of limiting adverse impacts.

Operations activities of this project (for the life of the project) extends many years into the future. The resulting impacts of operations have been described in the sections of Chapter 5.0. The cumulative impacts that have not been described completely depend on the evolution of technology, the total years of operations, and the methods of decommissioning to be determined at a future time. Future environmental impacts that cannot be determined yet are required to be presented during the decommissioning phase of the project.

Remediation and reclamation of SCR is the only radiological impact outside of the power plant itself that is being cumulatively impacted by each passing year of operational activities. This impact is not just from this proposed project, it is a cumulative impact from the continued operations of CPNPP Units 1 and 2 combined with the operations of the proposed CPNPP Units 3 and 4. Radioactive particulate matter that is permitted and released to SCR in liquid effluents is deposited onto the sediment layer of the reservoir bottom, particularly in the area of the circulating water discharge release point. Unlike the tritium being diluted and removed by rainfall and lake water makeup, the particulates have no removal mechanism other than radioactive decay. The SCR radiological impacts are expected to be SMALL especially when compared to the beneficial impacts of the baseload electrical generation on the entire region over the expected lifetime of the project.

Another cumulative impact that must be addressed in the future is the retirement of the units from service. The entire region is going to use the electricity produced by CPNPP Units 3 and 4. Removal of the power from the grid would impact the entire regional power grid. The ERCOT region must effectively plan to replace the electrical power baseload with new or alternative sources of electrical generation. This project supplies much needed electrical generation, and replacement power must be considered long before retirement of the units from service. Proper planning and good management practices ensure that the eventual retirement of this project would not have an adverse effect on the regional power grid. The retirement of CPNPP Units 1, 2, 3, and 4 from service is expected to result in a SMALL cumulative impact as long as prior planning and sufficient resources are committed well ahead of the retirement date.

5.11.5 REFERENCES

(CEQ 1997) Council on Environmental Quality. Considering Cumulative Effects Under the National Environmental Policy Act. Executive Office of the President. January 1997.

(USACE 2006) US Army Corps of Engineers, Ft. Worth District. Environmental Assessment, Ham Creek Park Development Whitney Lake, Johnson County, Texas. http://www.swf.usace.army.mil/pubdata/notices/HamCreek/Ham_Creek_Final_EA_March_2006_reduced.pdf. Accessed February 2006.

TABLE 5.11-1 (Sheet 1 of 9)
POTENTIAL CUMULATIVE IMPACTS FROM STATION OPERATIONS WITH MEASURES AND CONTROLS TO LIMIT THESE IMPACTS

Resources	Geographic Areas for Analysis	Potential Impact	Cumulative Impact Level	Description and Mitigation (if necessary)	ER Section Impact Addressed
Air Quality	Metropolitan area, airshed, or global atmosphere.	Air pollution.	S	Very small quantities of radioactive gaseous effluents would be released during operations. Monitoring programs are in place to monitor the effluents released. Emissions from operations equipment would be small. Emissions from diesel engines, auxiliary boilers, and trucks and automobile would be small during operations. No long term air pollution issues are foreseen. The air emissions from CPNPP Units 3 and 4 would be of SMALL impact, especially compared to the alternative fossil-fuel sources.	5.4 and 6.4

TABLE 5.11-1 (Sheet 2 of 9)
POTENTIAL CUMULATIVE IMPACTS FROM STATION OPERATIONS WITH MEASURES AND CONTROLS TO LIMIT THESE IMPACTS

Resources	Geographic Areas for Analysis	Potential Impact	Cumulative Impact Level	Description and Mitigation (if necessary)	ER Section Impact Addressed
Water Quality	Stream, watershed, river basin, aquifer, or parts thereof.	Water pollution.	S	Section 5.2 describes site operational water activities, site water supply, hydrological alterations that could result from plant operations activities, and the physical effects of hydrological alterations on other water users and water quality.	5.2
				Impacts to surface water bodies are expected to be SMALL due to the implementation of a operations stormwater pollution protection plan (SWP3), and continued compliance with existing regulatory permits and applicable regulations (TPDES).	
				Impacts to wetland areas and groundwater resources are expected to be negligible while operations activities are taking place. Water bodies adjacent to the plant that could be affected by operations activities include SCR.	
				A *cumulative impact* would be the effects of radioactive discharges to SCR during the years of plant operations. The cumulative impact is expected to be SMALL.	5.11.3
				To a lesser extent, Lake Granbury could be affected by the operations of surface water intake and discharge structures.	
				No long term water pollution issues related to operations activities are foreseen, and any cumulative impact would be SMALL.	

TABLE 5.11-1 (Sheet 3 of 9)
POTENTIAL CUMULATIVE IMPACTS FROM STATION OPERATIONS WITH MEASURES AND CONTROLS TO LIMIT THESE IMPACTS

Resources	Geographic Areas for Analysis	Potential Impact	Cumulative Impact Level	Description and Mitigation (if necessary)	ER Section Impact Addressed
Vegetative Resources	Tower drift zone, watershed, forest, range, or ecosystem.	Salt deposition, land disturbance, erosion, and air and water pollution.	S	Drift from the cooling towers is expected to be of SMALL impact on plants within the very limited drift zone. Based on geographical information system (GIS) and visual inspections the proposed on and off-site operational areas contain no old growth timber, unique or sensitive plants, or unique or sensitive plant communities. To minimize potential impacts during operations activities clearing and maintenance activities (usually around transmission lines) are performed in compliance with federal and state regulations, and permit requirements. Stormwater, before it leaves the site or enters SCR or Lake Granbury, would be incorporated in a site-specific SWP3 using appropriate state or local specifications prior to initiating construction. No long term water pollution issues related to construction activities are foreseen, and any cumulative impact would be SMALL.	5.2 and 5.3

TABLE 5.11-1 (Sheet 4 of 9)
POTENTIAL CUMULATIVE IMPACTS FROM STATION OPERATIONS WITH MEASURES AND CONTROLS TO LIMIT THESE IMPACTS

Resources	Geographic Areas for Analysis	Potential Impact	Cumulative Impact Level	Description and Mitigation (if necessary)	ER Section Impact Addressed
Resident wildlife	Species habitat or ecosystem.	Land disturbance, erosion, air, noise and water pollution.	S	A direct impact on wildlife in the operations area could occur. The direct mortality of wildlife in the limited areas of operation is not expected to be great enough to cause detectible population effects. No commercially valuable, essential, critical, or bio-indicator species that potentially occupy habitats have been identified at or near CPNPP. The only important terrestrial species potentially occupying the site are a small number of rare species and a larger number of recreationally valuable species that are common in northern Texas. No long term air, noise, or water pollution issues related to operations activities are foreseen, and any cumulative impact would be SMALL.	5.1, 5.2, and 5.3
Migratory wildlife	Breeding grounds, migration route, wintering areas, or total range of affected population units.	Land disturbance, air, noise, and water pollution.	S	Visual inspections to date have not identified any valuable, essential, critical, or bio-indicator species that potentially occupy habitats have been identified at or near the proposed project. No long term air, noise, or water pollution issues related to operations activities are foreseen, and any cumulative impact would be SMALL.	5.1, 5.2 and 5.3

TABLE 5.11-1 (Sheet 5 of 9)
POTENTIAL CUMULATIVE IMPACTS FROM STATION OPERATIONS WITH MEASURES AND CONTROLS TO LIMIT THESE IMPACTS

Resources	Geographic Areas for Analysis	Potential Impact	Cumulative Impact Level	Description and Mitigation (if necessary)	ER Section Impact Addressed
Fishery resources	Stream, river basin, estuary, or parts thereof; spawning area and migration route.	Water pollution.	S	Operations and transmission line maintenance near water bodies has the potential to adversely affect aquatic environmental quality. Effects of erosion on areas of disturbed vegetative cover, as well as toxicity caused by unintentional chemical spills may occur. To minimize potential impacts to the surrounding aquatic communities compliance with best management practices (BMPs) provided by site-specific SWP3 and spill prevention guidance that minimize the risk of surface water contamination by operations activities would be required. There are no commercial fisheries on SCR or Lake Granbury. No long term water pollution issues related to operational activities are foreseen and any cumulative impact would be SMALL.	5.2 and 5.3

TABLE 5.11-1 (Sheet 6 of 9)
POTENTIAL CUMULATIVE IMPACTS FROM STATION OPERATIONS WITH MEASURES AND CONTROLS TO LIMIT THESE IMPACTS

Resources	Geographic Areas for Analysis	Potential Impact	Cumulative Impact Level	Description and Mitigation (if necessary)	ER Section Impact Addressed
Historic resources	Neighborhood, rural community, city, state, tribal territory, known or possible historic district.	Land disturbance.	S	Direct effects on existing historic properties from continued operations on the CPNPP site are possible only within the on-site and off-site areas of potential effect (APE) for CPNPP (Subsection 2.5.3 and Figures 2.5-7 and 2.5-8). Indirect (noise-related and aesthetic/ visual) effects from proposed operations are possible on the site and within 10 mi of its boundaries. This 10-mi buffer extends through portions of Somervell and Hood counties. Because of the local vegetation cover and topographic relief, noise-related and aesthetic/visual effects from on-site construction on aboveground historic properties are minimal. Several cultural resource studies were completed prior to construction of CPNPP Units 1 and 2. Studies were also conducted as part of the COLA for the proposed project to assess the potential impact of on-site and off-site water pipeline installation. No historical or archaeological sensitive sites were noted within the proposed construction or operational zones. The cumulative impacts of on-site and off-site operations at CPNPP upon historical, prehistoric and historical archaeological sites within a 10-mi radius of the property are SMALL. No mitigation is warranted.	5.1.3

TABLE 5.11-1 (Sheet 7 of 9)
POTENTIAL CUMULATIVE IMPACTS FROM STATION OPERATIONS WITH MEASURES AND CONTROLS TO LIMIT THESE IMPACTS

Resources	Geographic Areas for Analysis	Potential Impact	Cumulative Impact Level	Description and Mitigation (if necessary)	ER Section Impact Addressed
Sociocultural Resources	Neighborhood, community, distribution of low-income or minority population, or culturally valued landscape.	Land disturbance, erosion, air, noise, visual and water pollution.	S	Locally, there are no minority populations identified adjacent to the site. The nearest minority populations are in the cities of Glen Rose and Granbury. Because the effects of operations occur primarily to the site and adjacent properties, it is anticipated that there are no disproportionate impacts on minority populations. Based on input from sections in Chapter 4 (applicable to operations as well as construction), and the minimal operations outside the CPNPP site boundary, physical impacts are expected to be SMALL. Disproportionate impacts to minority and low-income populations are SMALL. Minority and low-income populations are distributed among the majority population and are not disproportionately impacted due to any benefits.	4.1, 4.2, 4.3 and 5.8
Land use	Community, metropolitan area, county, state, or region.	Land disturbance.	S	Land for operations activities is owned or leased; e.g., pipeline right-of-way, by Luminant. Land disturbances from off-site operations activities are expected to be SMALL.	5.1
Coastal zone	Coastal region or watershed.	None – the CPNPP site is not located in a coastal area.	N/A	N/A	N/A

TABLE 5.11-1 (Sheet 8 of 9)
POTENTIAL CUMULATIVE IMPACTS FROM STATION OPERATIONS WITH MEASURES AND CONTROLS TO LIMIT THESE IMPACTS

Resources	Geographic Areas for Analysis	Potential Impact	Cumulative Impact Level	Description and Mitigation (if necessary)	ER Section Impact Addressed
Recreation	River, lake, geographic area, or land management unit.	Land disturbance, air, noise, and water pollution.	S	The nearest transient attraction, not including the CPNPP Visitor Center is Dinosaur Valley State Park, located 3.3 mi southwest of the center point. The reactor domes for CPNPP Units 1 and 2 are visible from the park; therefore, the operations of the proposed project are anticipated to have a SMALL visual impact. The Texas Amphitheater, on a hill overlooking SCR, is the second closest transient attraction, located 3.7 mi southeast of the center point. The amphitheater hosts outdoor events; therefore, the operations may result in a slight visual (night-time lights) and noise impact. Other identified outdoor attractions in the vicinity are greater than 5 mi away and are unlikely to be impacted by construction at the CPNPP site. Because of the distance of area attractions from the site, cumulative impacts from operations on recreation are SMALL and require no mitigation.	4.1 and 4.4.2.6

TABLE 5.11-1 (Sheet 9 of 9)
POTENTIAL CUMULATIVE IMPACTS FROM STATION OPERATIONS WITH MEASURES AND CONTROLS TO LIMIT THESE IMPACTS

Resources	Geographic Areas for Analysis	Potential Impact	Cumulative Impact Level	Description and Mitigation (if necessary)	ER Section Impact Addressed
Socioeconomics	Community, metropolitan area, county, state, or country.	Land disturbance, air, noise, visual and water pollution.	S, M, L	The discussion of socioeconomic impacts is divided into three subsections. Subsection 5.8.1 describes physical impacts of station operations on the community. Subsection 5.8.2 describes the social and economic impacts of station operations on the surrounding region. Subsection 5.8.3 describes environmental justice impacts as a result of operations activities. There are several SMALL and MODERATE impacts expected during the operations of the proposed project; however, none of these impacts are foreseen to be cumulative in nature. No additional mitigation is warranted. The only LARGE potential cumulative impact that is beneficial is the increase in sales tax revenue from purchases made by the facility and operational employees in the vicinity of the site.	5.8
Radiological	On-site, federal and state licensed disposal facilities	Potential dose to the public and workers, land use permanently changed	S	On-site, SCR received radioactive liquid effluents from Units 1, 2, 3, and 4. As part of the decommissioning plan, SCR remediation must be addressed. The burial facilities that will receive spent fuel and low level radioactive waste will be impacted by the dose contribution from the radioactivity and the land use will be a long term committment to the waste received.	

5.12 IMPACTS OF TRANSPORTATION OF RADIOACTIVE MATERIALS

This is a supplemental Environmental Report (ER) section and, therefore, is not covered by a NUREG-1555, Environmental Standard Review Plan (ESRP). This section is provided to guide the reviewer to other ER sections that address various aspects of the transportation of radioactive materials.

Transport of radioactive materials is an important activity associated with operating Comanche Peak Nuclear Power Plant (CPNPP) Units 3 and 4. The analysis in this section is based on the nuclear power plant characteristics described in Section 3.2 and radioactive waste management systems described in Section 3.5. Information regarding preparation and packaging of the radioactive materials for transport off-site can be found in Section 3.8.

5.12.1 TRANSPORTATION ASSESSMENT

The U.S. Nuclear Regulatory Commission (NRC) regulations in 10 CFR 51.52 state that:

“Every environmental report prepared for the construction permit stage of a lightwater-cooled nuclear power reactor, and submitted after February 4, 1975, shall contain a statement concerning transportation of fuel and radioactive wastes to and from the reactor. That statement shall indicate that the reactor and this transportation either meet all of the conditions in paragraph (a) of this section or all of the conditions in paragraph (b) of this section.”

The NRC evaluated the environmental effects of transportation of fuel and waste for light water reactors (LWRs) in the “Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants,” and in NUREG-75/038, Supplement 1, and found the impacts to be SMALL. These NRC analyses provide the basis for 10 CFR 51.52, Table S-4, which summarizes the environmental impacts of transportation of fuel and radioactive wastes to and from a reference reactor. The table addresses two categories of environmental considerations: (1) normal conditions of transport and (2) accidents in transport.

Section 3.8 analyzes the impacts of transporting United States – Advanced Pressurized Water Reactor (US-APWR) fuel and radioactive waste from CPNPP Units 3 and 4.

Subparagraphs 10 CFR 51.52(a)(1) through (5) delineate specific conditions the reactor licensee must meet to use Table S-4 as part of its environmental report. For reactors not meeting all of the conditions in 10 CFR 51.52(a), 10 CFR 51.52(b) requires a further analysis of the transportation effects.

The conditions in 10 CFR 51.52(a) establishing the applicability of Table S-4 are reactor core thermal power, fuel form, fuel enrichment, fuel encapsulation, average fuel irradiation, time after discharge of irradiated fuel before shipment, mode of transport for unirradiated fuel, mode of transport for irradiated fuel, radioactive waste form and packaging, and mode of transport for radioactive waste other than irradiated fuel. The following subsections describe the characteristics of the US-APWR relative to the conditions in 10 CFR 51.52(a) for use of Table S-4.

5.12.1.1 Reactor Core Thermal Power

Subparagraph 10 CFR 51.52(a)(1) requires that the reactor have a core thermal power level not exceeding 3800 MW. Subsection 3.8.1.1 addresses the reactor core thermal power in detail.

5.12.1.2 Fuel Form

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel be in the form of sintered uranium dioxide (UO2) pellets. Subsection 3.8.1.2 addresses the reactor fuel form.

5.12.1.3 Fuel Enrichment

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel have a U-235 enrichment not exceeding 4 percent by weight. Subsection 3.8.1.3 addresses the fuel enrichment.

5.12.1.4 Fuel Encapsulation

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel pellets be encapsulated in Zircaloy rods. Subsection 3.8.1.4 addresses the fuel encapsulation.

5.12.1.5 Average Fuel Irradiation

Subparagraph 10 CFR 51.52(a)(3) requires that the average burnup not exceed 33,000 MW-days per metric ton uranium (MTU). Subsection 3.8.1.5 addresses the average fuel irradiation.

5.12.1.6 Time after Discharge of Irradiated Fuel Before Shipment

Subsection 3.8.2 addresses the amount of time after discharge of irradiated fuel before shipment in detail.

5.12.1.7 Radioactive Waste Form and Packaging

Subparagraph 10 CFR 51.52(a)(4) requires that, with the exception of spent fuel, radioactive waste shipped from the reactor be packaged and be in a solid form. Subsection 3.8.3 describes the form and packaging of radioactive waste.

5.12.1.8 Transportation of Unirradiated Fuel

Subparagraph 10 CFR 51.52(a)(5) requires that unirradiated fuel be shipped to the reactor site by truck. Subsection 3.8.2.1 describes the transportation of unirradiated fuel.

5.12.1.9 Transportation of Irradiated Fuel

Subparagraph 10 CFR 51.52(a)(5) allows for truck, rail, or barge transport of irradiated fuel. Subsection 3.8.2 describes the transportation of irradiated fuel.

5.12.1.10 Transportation of Radioactive Waste other than Irradiated Fuel

Subparagraph 10 CFR 51.52(a)(5) requires that the mode of transport of radioactive waste other than irradiated fuel be either truck or rail. Subsection 3.8.3 describes the transportation of radioactive waste, other than irradiated fuel.

5.12.1.11 Number of Truck Shipments

Table 3.8-3 compares Table S-4, which limits traffic density to less than one truck shipment per day or three rail cars per month. Subsection 7.4.1 describes the number of truck shipments.

5.12.2 INCIDENT-FREE TRANSPORTATION IMPACTS ANALYSIS

Environmental impacts of incident-free transportation of fuel are discussed in the following subsections. Transportation accidents are discussed in Section 7.4.

5.12.2.1 Transportation of Unirradiated Fuel

10 CFR 51.52, Table S-4 includes conditions related to radiological doses to transport workers and members of the public along transport routes. Subsection 7.4.1 describes the transportation of unirradiated fuel.

5.12.2.2 Transportation of Spent Fuel

Subsection 7.4.2 provides the environmental impacts of transporting spent fuel from the CPNPP site to a spent fuel disposal facility, using Yucca Mountain, Nevada, as a possible location for a geologic repository.

5.12.2.3 Maximally Exposed Individuals Under Normal Transport Conditions

Incident-free radiation doses to maximally exposed individuals (MEIs) for fuel and waste shipments to and from the CPNPP site were also considered. An MEI is a person who may receive the highest radiation dose from a shipment to and from the CPNPP site. The radiological doses to the workers who would load casks, drive trucks, and inspect vehicles in transit would be higher than doses to individuals in the general public. Radiological protection programs would manage and limit doses to workers whose jobs would cause them to receive the greatest exposures. The maximum exposure to the transportation workers is described in Subsection 7.4.2.

5.13 NONRADIOLOGICAL HEALTH IMPACTS DURING OPERATIONS

This is a supplemental Environmental Report (ER) section and, therefore, is not covered by a NUREG-1555, Environmental Standard Review Plan (ESRP). This section is provided to guide the reviewer to other ER sections that address potential nonradiological public and occupational health impacts from work activities associated with the operation of CPNPP Units 3 and 4. Background information is also provided.

5.13.1 PUBLIC HEALTH

Operation of CPNPP Units 3 and 4 could have nonradiological health impacts on the public. Nonradiological air emissions can move off-site to nearby residences or businesses. Noise may be heard off-site. The electrical transmission system can produce induced currents in metal fences and vehicles beneath the transmission lines. Subsection 5.6.3 examines the risk from electric shock from induced currents under transmission lines. The magnitude of the shock is shown to be within the limits established by the National Electrical Code, and the impacts are SMALL. Subsection 5.8.1 describes the risks from noise and air pollution, and concludes that the impacts are SMALL.

5.13.2 OCCUPATIONAL HEALTH

Workers at CPNPP Units 3 and 4 are susceptible to industrial accidents such as falls, electric shock, burns, occupational injury due to noise exposure, exposure to toxic or oxygen replacing gases, and other hazards. Luminant currently has safety and health programs, and personnel to promote safe work practices and respond to occupational injuries and illnesses. Luminant also has a Personal Safety Program that includes procedures that have the objective of providing personnel who work at CPNPP with an effective means of preventing accidents due to unsafe conditions and unsafe acts. The procedures' safe work practices address hearing protection, confined space entry, personal protective equipment, heat stress, electrical safety, ladders, chemical handling, storage, and use, and other industrial hazards. The Senior Safety Committee (SSC) along with CPNPP Safety and Training Departments oversees Luminant safety procedures and ensures that CPNPP personnel receive appropriate training on safety procedures.

Luminant maintains records of a statistic known as total recordable cases (TRC) for existing CPNPP Units 1 and 2. The TRCs include work-related injuries or illnesses that include death, days away from work, restricted work activity, medical treatment beyond first aid, and other criteria. The average TRC incidence rate for the CPNPP workforce for 2003 – 2006 was 1.06 cases per 100 workers or 1.06 percent. This rate compares favorably to the nationwide TRC rate of 3.3 percent for electrical power generation workers (BLS 2006a) and to the Texas rate of 3.1 percent for electrical power generation, transmission, and distribution (BLS 2006b). The number of employees needed to operate CPNPP Units 3 and 4 is estimated at 550 (Subsection 5.8.1.1).

The number of TRCs per year for operating CPNPP Units 3 and 4 can be estimated as the number of workers multiplied by the TRC rate then divided by 100. The estimated TRC incidences would be:

No. of Workers	TRC Incidence at U.S. Rate (%)	TRC Incidence at TX Rate (%)	TRC Incidence at CPNPP Rate (%)
550	13.9	13.3	5.8

The Luminant TRC incidence rate is well below the U.S. and Texas rates for the electrical power generation industry, indicating that Luminant's safety program is effective. This same program would be used to guide operations at CPNPP Units 3 and 4 to ensure that employees work in a safe manner and prevent work-related injuries or illness.

5.13.3 REFERENCES

(BLS 2006a) Bureau of Labor Statistics (BLS). Table 1. Incidence rates of nonfatal occupational injuries and illnesses by industry and case types, 2005. 2006. http://www.bls.gov/iif/oshwc/osh/os/ostb1619.pdf. Accessed February 15, 2008.

(BLS 2006b) BLS. Table 6. Incidence rates of nonfatal occupational injuries and illnesses by industry and case types, 2005, Texas. 2006. http://www.bls.gov/iif/ oshwc/osh/os/pr056tx.pdf. Accessed February 15, 2008.