Omaha Public Power District

10 CFR 50.82(a)(4)

LIC-20-0013
July 16, 2020

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

Fort Calhoun Station (FCS), Unit 1
Renewed Facility License No. DPR-40
NRC Docket No. 50-285

Subject: **Response for Fort Calhoun Station Re: Fort Calhoun Station, Unit No. 1, Revised Post-Shutdown Decommissioning Activities Report**

References:

1. Letter from OPPD (M. J. Fisher) to USNRC (Document Control Desk), "Fort Calhoun Station, Unit No. 1, Revised Post-Shutdown Decommissioning Activities Report," dated December 6, 2019 (LIC-19-0007) (ML19351E355)
2. Letter from USNRC (J. D. Parrott) to OPPD (M.J. Fisher) "Fort Calhoun Station, Unit No. 1 - Request for Additional Information Regarding Revised Post-Shutdown Decommissioning Activities Report," dated May 20, 2020 (ML20111A215)

Pursuant to 10 CFR 50.82(a)(4)(i), Omaha Public Power District (OPPD) is submitting a revised post-shutdown decommissioning activities report (PSDAR) for Fort Calhoun Station (FCS). By letter (Reference 1) dated December 16, 2019, Omaha Public Power District (OPPD) submitted the revised PSDAR for FCS.

On May 20, 2020 (Reference 2), the NRC provided OPPD with a Request for Additional Information (RAI) regarding the revised PSDAR (Reference 1). Regulations have anticipated the eventuality that significant changes to the decommissioning plan may occur as they required they be updated in the PSDAR as new or changed information becomes available. Attachment 1 of this letter provides the OPPD response to the NRC's RAI regarding the revised PSDAR.

For each question, the response includes the NRC question, any pertinent section from the FCS Revised PSDAR (Reference 1), and OPPD's response to the NRC questions. As required by 10 CFR 50.82(a)(7), OPPD will "notify the NRC, in writing and send a copy to the affected State(s), before performing any decommissioning activity inconsistent with, or making any significant schedule change from, those actions and schedules described in the PSDAR, including changes that significantly increase the decommissioning cost." As required, OPPD will verify that the decommissioning activities meet the requirements of 10 CFR 50.82(a)(6)(i) – (iii), or seek appropriate regulatory approval if needed.

This letter contains no regulatory commitments.

If you should have any questions regarding this submittal or require additional information, please contact Mr. Bradley H. Blome, Director - Licensing and Regulatory Assurance, at (402) 533-7270.

Respectfully,

Mary J. Fisher
Vice President, Energy Production & Nuclear Decommissioning

MJF/akb

Attachments:

1. Response to Request For Additional Information Revised Post-Shutdown Decommissioning Activities Report Omaha Public Power District Fort Calhoun Station. Unit No. 1
2. Updated Environmental Supplement
3. Northern Long-Eared Bat Acoustic and Mist Net Surveys on Fort Calhoun Station in Washington County, Nebraska
4. Revised PSDAR, page 28

c: S. A. Morris, NRC Regional Administrator, Region IV
J. D. Parrott, NRC Senior Project Manager
C. D. Steely, NRC Health Physicist, Region IV
Director of Consumer Health Services, Department of Regulation and Licensure, Nebraska Health and Human Services, State of Nebraska

ATTACHMENT 1

**RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
REVISED POST-SHUTDOWN DECOMMISSIONING ACTIVITIES REPORT**

**OMAHA PUBLIC POWER DISTRICT (OPPD)
FORT CALHOUN STATION. UNIT NO. 1
DOCKET NO. 50-285**

By letter dated December 16, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19351E355), the Omaha Public Power District's (OPPD), the licensee submitted Revised Post-Shutdown Decommissioning Activities Report (PSDAR) for Fort Calhoun Station, Unit No. 1 (FCS) to satisfy Title 10 of the Code of Federal Regulations (10 CFR), Section 50.82(a)(4) and generally follow the guidance contained in Regulatory Guide (RG) 1.185, Revision 1, "Standard Format and Content for Post-Shutdown Decommissioning Activities Report," June 2013 (ADAMS Accession No. ML13140A038), governing the PSDAR content and the use of NUREG-0586, Supplement 1, "Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," November 2002 (Decommissioning GEIS) (ADAMS Accession No. ML023470304), as appropriate.

In a PSDAR, a licensee must provide reasons for concluding that the environmental impacts associated with site-specific decommissioning activities will (or will not) be bounded by previously issued environmental impact statements such as the construction final environmental statement (FES), operation FES, license renewal (LR) supplemental environmental impact statement (SEIS), or the Decommissioning GEIS (NUREG-0586).

The regulation 10 CFR 50.82(a)(7) states, in part, that "…the licensee shall notify the NRC, in writing and send a copy to the affected State(s), before performing any decommissioning activity inconsistent with, or making any significant schedule change from, those actions and schedules described in the PSDAR…" In a letter dated December 16, 2019, (ADAMS Accession No. ML19351E355) OPPD stated that they planned to transition from SAFSTOR ("deferred dismantling") to DECON ("immediate dismantling") method of decommissioning, thus requiring the submittal of a revised PSDAR.

Questions 1 & 2: Provide Reference Material

The NRC staff has reviewed OPPD's revised PSDAR submittal for transitioning to the DECON method of decommissioning and determined that additional information is required to enable the NRC staff to make an independent assessment regarding its technical review, requested below:

Provide a copy of Reference 17 of the revised PSDAR for NRC staff review: "Updated Environmental Report Fort Calhoun Station, File No. 127690-003," dated December 2018.

Provide a copy of Reference 20 of the revised PSDAR for NRC staff review: "ESI (Environmental Solution & Innovations, Inc.) – "Northern Long-Eared Bat Acoustic and Mist Net Surveys on Fort Calhoun Station in Washington County, Nebraska," dated September 2018.

Questions 1 & 2: OPPD Response:

The requested documents were sent via e-mail to OPPD's Decommissioning Project Manager previously, and will be formally submitted with this RAI Response letter [Attachments 2 & 3].

Question 3: Further Assessment of Northern Long-Eared Bat Impact Analysis

In its December 14, 2017, RAI response, OPPD stated the northern long-eared bat is not present near the site and would, therefore, not be affected by decommissioning. However, Section 5.1.7, "Threatened and Endangered Species," of the Revised PSDAR states that federally threatened northern long-eared bats (*Myotis septentrionalis*) were detected during the acoustical and mist net surveys conducted at Fort Calhoun in August 2018. The revised PSDAR finds that:

[T]he planned decommissioning of FCS will not result in a direct mortality or otherwise jeopardize the local population of any threatened and endangered species.

"Take" in any form is strictly prohibited under Section 9 of the Endangered Species Act of 1973, as amended. Take is not limited to direct mortality, but also includes any harassment of harm among other forms of impacts. Incidental take is take that results from, but is not the purpose of, carrying out an otherwise lawful activity. The revised PSDAR does not fully analyze all forms of take that may occur during decommissioning.

Please more fully explain how decommissioning activities may affect northern long-eared bats in the area by assessing all possible effects and forms of take that may occur during the decommissioning period. For instance, impacts to bats may result from:
Mortality of injury from collisions with plant structures, equipment, or vehicles;
Habitat loss, degradation, disturbance, or fragmentation, and associated effects; and
Behavioral changes resulting from noise, lighting, and other factors associated with decommissioning activities.
The above list if not comprehensive, and other effects may be relevant for the assessment.

If adverse effects or incidental take of northern long-eared bats is possible, please explain how OPPD would obtain the necessary permits under either Endangered Species Act (ESA) Section 7 or ESA Section 10 to exempt such take during the decommissioning period.

Question 3.a: OPPD Response:

OPPD Revised PSDAR Section

Section 5.1.7: Threatened and Endangered Species

"There were thirteen (13) threatened and endangered species identified in the 2002 Environmental Report (Reference 18). In October 2018, a review for plant and wildlife species protected by the Nebraska Nongame and Endangered Species Act was requested by the Nebraska Game and Parks Commission (NGPC). The United States Department of Interior (UDSI) responded on 13 November 2018 (Reference 19) and identified five (5) state listed protected species (threatened or endangered) within the vicinity (3 miles) of the FCS. The only

new s p e c i e s that was not listed in 2002 and that was identified in 2018 was the federal and state threatened northern long-eared bat (*Myotis septentrionalis)*. The four (4) other species identified were three (3) fish species: the federal and state endangered pallid sturgeon (*Scaphirhyncus albus)*, the state threatened lake sturgeon (*Acipenser fulvescens*), the state endangered sturgeon chub (*Macrhybopsis gelida*), and one (1) plant species: the state threatened American ginseng (*Panax quinquifolium*). A separate review was conducted in November 2018 per the federal Endangered Species Act with the U.S. Fish & Wildlife Service's (USFWS) online Information for Planning and Consultation (IPaC) system. The results of the IPaC identified five (5) protected species. Similar to the NGPC review, it identified the federal threatened northern long-eared bat, the endangered least tern (*Sterna antillarum*), the threatened piping plover (*Charadrius melodus*), the endangered pallid sturgeon, and the threatened western prairie fringed orchid (*Platanthera praeclara*). Bald eagle (*Haliaeetus leucocephalus*) was mentioned in the NGPC response and IPaC, but it is not state or federally listed. However, the bald eagle is still protected by the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. In addition, both the NGPC response and the IPaC review identified eleven (11) bird species that are protected under the Migratory Bird Treaty Act.

It was determined in the SEIS that due to channelization of the Missouri River and the removing of sandbars, both the least tern and piping plover are not likely to be found at FCS. The western prairie fringed orchid potentially occurs in Washington County based on historic observations. However, no populations are known to occur in the County, and the potential for occurrence on or near FCS is low given the lack of appropriate prairie habitat in these areas.

To assess the presence or absence of the northern long-eared bat, acoustical studies and mist net surveys were conducted in August 2018 in accordance with USFWS and NGPC Scientific and Education Permits and a report was generated (Reference 20). Two (2) acoustic sites were recorded within the riparian corridor along the Missouri River and nine (9) mist net nights were completed across nine (9) separate net location on the FCS property. A total of 856 acoustic files were recorded at the two (2) acoustic sites. Nine (9) species were recorded including eight (8) northern long-eared bat call sequences. The statistical analysis of the data supported the presence of six (6) species: big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), northern long-eared bat, evening bat (*Nycticeius humeralis*), and tri-colored bat (*Perimyotis subflavus*). Northern long-eared bat was confirmed at Site 1 by manual vetting. Nine complete net nights resulted in the capture of two eastern red bats: one adult male and one adult female. No federally listed species were captured.

Section 4.3.7 of the GEIS does not make a generic determination on the impact of decommissioning on threatened and endangered species. Rather it concludes that the adverse impacts and associated significance of the impacts must be determined on a site-specific basis.

With respect to the threatened and endangered aquatic species, the environmental impacts during decommissioning are expected to be minimal. Removal of the intake and discharge facilities as well as other shoreline structures will be conducted in accordance with BMPs outlined in permits issued by the NDEE and the U. S. Army Corps of Engineers. As previously discussed in Section 5.1.2, the amount of cooling water withdrawn from the Missouri River will significantly decrease thus reducing the potential impacts of impingement, entrainment, and thermal discharges on aquatic species. One potential adverse impact from the decrease in cooling water withdrawn may be the elimination of the thermal refuge for aquatic species in the discharge area which are preyed upon by the bald eagle in the winter months.

The environmental impacts during decommissioning are expected to be minimal on threatened and endangered terrestrial species. OPPD currently anticipates minimal disturbance of natural habitat beyond the operational areas of the plant for decommissioning and construction activities. Construction activities that disturb one acre or greater of soil necessitate permits by the NDEE and BMPs are required to be implemented to control sediment and the effects of erosion. Additionally, FCS has administrative controls in place which require that significant project activities undergo an environmental review prior to the activity occurring, which ensures that impacts are minimized through implementation of BMPs. Federal and state regulations pertaining to listed species will also remain in effect, which will further ensure that impacts to listed species and their habitats are minimized.

The Iowa Department of Natural Resources was not contacted as part of the updated environmental supplement because the decommissioning and construction activities including ground disturbance are not proposed in the state of Iowa; therefore, it is assumed that the decommissioning of FCS will not result in a significant adverse impact to Iowa protected threatened and endangered species.

Section 4.3.7 of the GEIS also suggests that care be exercised in conducting decommissioning activities after an extended period because there is a greater potential for rare species to colonize the disturbed portion of the site. However as previously discussed, administrative controls and federal and state regulations that will remain in effect would ensure that mitigation measures are implemented as appropriate to protect wildlife.

Based on the above, the planned decommissioning of FCS will not result in a direct mortality or otherwise jeopardize the local population of any threatened or endangered species. Therefore, based on the updated environmental report, OPPD concludes that the impacts of FCS decommissioning on threatened and endangered species are bounded by the GEIS.

The revised PSDAR's conclusion that the decommissioning of FCS would, "not result in a direct mortality or otherwise jeopardize the local population of any threatened and endangered species," is intended to include any jeopardizing or harmful action to the T&ESs that may be found near the project site. OPPD commissioned a study to identify Northern Long-Eared bats at FCS. This study ("Northern Long-Eared Bat Acoustic and Mist Net Surveys on Fort Calhoun Station in Washington County, Nebraska,", Attachment 3) was prepared for OPPD by Haley Aldrich and performed by Environmental Solutions & Innovations, Inc. in accordance with U.S. Fish and Wildlife (USFWS) Federal Fish and Wildlife and Nebraska Game and Parks Commission (NGPC) Scientific and Education Permits. The study as completed is considered valid for 5 years and was provided to the NGPC.

The study (Attachment 3) found low to moderate presence of habitat at the FCS location and identified, through manual vetting, 5 calls out of 856 that matched that of the Northern Long-Eared bat. Although the presence of these bats was limited to calls and no identified habitat, OPPD will continue to be sensitive to the presence of any threatened and endangered species, including the Northern Long-Eared bat. To support OPPD's dedication to environmental stewardship, OPPD environmental personnel conduct periodic (monthly) site environmental inspections to monitor for adverse environmental impacts and general environmental conditions including protected species. OPPD also has a plan in place for protection of the bats, as well as other mammals and birds that may be encountered in their service territory. The OPPD Avian Protection Plan, which also includes Section XII on the northern long-eared bat, has triggers that prompt additional actions to ensure that the federally listed threatened and endangered species and their habitats are protected from any incidental takes. Section XII also references

OPPD employees to the USFWS guidance on how to address incidental takes. The Mountain Prairie Region of the USFWS's conservation measures include not conducting any activities within 0.25 miles of known, occupied hibernacula; not cutting or destroying a known, occupied roost tree from June 1 to July 31; and not clearcutting within 0.25 miles of known, occupied roost trees from June 1 to July 31. The study completed in September 2018 failed to find the presence of identified maternity roosts at the FCS site, and OPPD's Avian Protection Plan (which explicitly includes the Northern Long-Eared bat) defines active nesting season as April 1st through July 31st of each year.

OPPD's Avian Protection Plan has actions in place for any unexpected finding of accidental or unintentional take or harm of the threatened and endangered species that may be in the service territory. Following any incidents to any protected populations, OPPD personnel would utilize the OPPD Avian Protection Plan. OPPD's Forestry Office investigates any incidents to the northern long-eared bat or to birds. This is done in accordance with the state and Federal regulations.

Question 3b: OPPD Response:

OPPD does not currently anticipate disturbing natural habitat beyond the operational areas of the plant for decommissioning and construction activities. With no known, occupied maternity roosts found, OPPD concludes that they would be within the conservation measures specified by the USFWS guidance. Deconstruction activities that may disturb one acre or greater of soil necessitate permits by the NDEE and BMPs are required to be implemented to control sediment and the effects of erosion. FCS has administrative controls in place which require that significant project activities undergo an environmental review prior to the activity occurring, which ensures that impacts are minimized through implementation of BMPs, including consideration for the location and placement of flight path impairments (i.e., cranes) or high noise activities that may disturb species present. Federal and state regulations pertaining to listed species will also remain in effect, which will further ensure that impacts to listed species and their habitats are minimized.

Prior to planned demolition activities, state permits are required which include evaluation of the impacts to the environment which include considerations of threatened and endangered species that may occur from the specific activity. Any necessary mitigation activities, should any be identified due to environmental consequences at the time, would be necessary to receive the appropriate state permitting. This process also includes federal triggers to check for federal threatened and endangered species. No demolition at FCS would be allowed to proceed without the appropriate approval.

Question 4: Cultural, Historical, and Archeological Resources

Section 5.1.14 of the revised PSDAR provides an analysis of potential impacts to cultural, historic, and archeological resources. In reviewing this analysis, staff identified two issues of concern related to the protection of historic and cultural resources at FCS that were not identified during the review of the original PSDAR:

a. **OPPD's review of available information identified the presence of remnants from the former town of DeSoto, a historic site "potentially" eligible for listing the in National Register of Historic Places (NRHP) and located within the lands housing FCS. However, staff have determined that the DeSoto town site's eligibility as a historic property was characterized inconsistently in the 2003 Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-**

1437), Supplement 12 "Regarding Fort Calhoun Station," and this irregularity was carried forward into the original and revised PSDARs. Specifically, the Nebraska State Historic Preservation Office's records, described in an e-mail dated March 15, 2020 (ADAMS Accession No. ML20100L723), identify that the DeSoto town site was formally determined eligible for listing on the NRHP in 1989.

Accordingly, the revised PSDAR should be revised or supplemented to reflect the town site's correct NRHP eligibility status.

Question 4a: OPPD Response:

OPPD Revised PSDAR Section

Section 5.1.14:
"Based on a review of the FCS property through the Nebraska State Historic Preservation Office (NSHPO) files and information provided by the applicant, the NRC concluded in Section 4.4.5 of the SEIS (Reference 8) that the potential impacts from decommissioning of FCS on historic and archaeological resources would be small. The NRC identified the section of the plant site that lies north of the rail spur and is bounded on the west by U.S. Highway 75 as having Moderate to-High Potential. It contains remnants of the former town of Desoto, a historic property that is potentially eligible for listing on the National Register of Historic Places."

The pages of the revised PSDAR (pg. 28) will be revised to correctly reflect the NRHP eligibility status. The marked up page is included as Attachment 4.

Question 4: Cultural, Historical, and Archeological Resources (continued)

b. **The consideration of nuclear power plants for inclusion in the NRHP or Historic American Engineering Record (HAER) increases as the age of the nuclear power plant approaches or exceeds 50 years of age – one of the criterion for inclusion on the register/record. The decision on whether a nuclear power plant can be considered a historic property and eligible for inclusion is determined by each state historic preservation officer (SHPO). OPPD did not indicate in the revised PSDAR whether they have considered the eligibility of the FCS nuclear facility itself for inclusion on the register or record. There is also no indication that OPPD contacted the Nebraska SHPO regarding this matter.**

Section 4.3.14.2 of NUREG-0586, "Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors," (page 4-67) states:

> **In a few situations, the nuclear facility itself could be potentially eligible for inclusion in the National Register of Historic Places, especially if it is older than 50 years and represents a significant historic or engineering achievement. In this case, appropriate mitigation would be developed in consultation with the SHPO [State Historic Preservation Officer]. Even for buildings that are less than 50 years old, the processes and engineering that were employed may be of interest and may be eligible for the Historic American Engineering Record.**

In order to remain in compliance with the National Historic Preservation Act, the NRC is required to take into account the effects of its undertaking on historic properties (see "Protection of Historic Properties" regulations 36 CFR 800). Under these regulations, the NRC staff's review of the PSDAR may be considered an undertaking (see 36 CFR 800.16(y)).

According the Protection of Historic Properties regulations in 36 CFR 800.4(a)(2), Identification of historic properties, in consultation with the SHPO, the NRC Is required to "Review existing information on historic properties within the area of potential effects, including any data concerning possible historic properties not yet identified." In addition, according the 36 CFR 800.4(a)(3), the NRC must "Seek information, as appropriate, from consulting parties, and other individuals and organizations likely to have knowledge of, or concerns with, historic properties in the area, and identify issues relating to the undertaking's potential effects on historic properties…"

Regulations in 36 CFR 800.4(c)(1) state:

> **In consultation with the SHPO…the agency official shall apply the National Register criteria (36 CFR part 63) to properties identified within the area of potential effects that have not been previously evaluated for National Register eligibility.**

If requested by the Nebraska SHPO, an eligibility determination for NRHP listing status would need to be conducted by a professional that meets the Secretary of the Interior's standards in 36 CFR 61. A professional, experienced in conducting Historic American Building Surveys, would also be needed to determine the eligibility of listing FCS in the Historic American Engineering Record.

In light of these considerations, does OPPD plan to determine, in consultation with the Nebraska SHPO, the eligibility of the FCS facility itself for inclusion in the National Register of Historic Places or Historic American Engineering Record, and, if required, identify appropriate mitigation measures (e.g., preservation of historic information and data) potentially resulting from this consultation?

OPPD PSDAR Section

Section 5.1.14 Cultural, Historic, and Archeological Resources

Question 4b: OPPD Response:

OPPD's Environmental and Regulatory Affairs (ERA) department contacted the Nebraska SHPO office in conjunction with our Updated Environmental Supplement. In the Nebraska SHPO office's response dated November 5, 2018, the Deputy State Historic Preservation Officer concluded that, "…there will be no historic properties affected by this [decommissioning] project," (Reference 3). Nebraska SHPO's response was provided in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and implementing regulations 36 CFR Part 800. This letter will be retained by OPPD to show compliance with

Section 106 of the NHPA, as amended. Confirmation of this position was reaffirmed by the ERA department via telephone with the Nebraska SHPO in June 2020. No additional consultation regarding this issue is planned with the Nebraska SHPO office, in light of this letter and confirmation.

References:

1. Letter from OPPD (M. J. Fisher) to USNRC (Document Control Desk), “Fort Calhoun Station, Unit No. 1, Revised Post-Shutdown Decommissioning Activities Report,” dated 16 December 16, 2019 (LIC-19-0007) (ML19351E355)
2. Letter from USNRC (J. D. Parrott) to OPPD (M.J. Fisher) “Fort Calhoun Station, Unit No. 1 - Request for Additional Information Regarding Revised Post-Shutdown Decommissioning Activities Report”, dated May 20, 2020 (ML20111A215)
3. Letter from Nebraska State Historical Preservation Office (SHPO) (J. E. Dolberg) to OPPD (P. Finigan) “Decommissioning of the Fort Calhoun Station, Fort Calhoun, NE (HP#180-138-01),” dated November 5, 2018
4. OPPD Corporate Avian Protection Plan, July 2016, annual review and update dated December 2019

HALEY ALDRICH

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UPDATED ENVIRONMENTAL REPORT
FORT CALHOUN STATION
OMAHA, NEBRASKA

by
Haley & Aldrich, Inc.
Portland, Maine

for
OPPD
Omaha Public Power District
Omaha, Nebraska

File No. 127690-003
March 2019

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List of Abbreviations

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^{63}NI	Nickel-63
^{94}NB	Niobium-63
^{152}EU	Europium-152
^{154}EU	Europium-154
ACS	American Community Survey
AEC	(U.S.) Atomic Energy Commission
AIF	Atomic Industrial Forum
ALARA	As Low As Reasonably Achievable
BMPs	Best Management Practices
CFR	Code of Federal Regulations
D&D	Decontamination and Dismantlement
DCE	Decommissioning Cost Estimate
DCGLs	Derived Concentration Guideline Levels
DOE	Department of Energy
EA	Environmental Assessment
EISs	Environmental Impact Statements
EPA	(U.S.) Environmental Protection Agency
ER	Environmental Report
Exelon	Exelon Nuclear Partners
FCS	Fort Calhoun Station 1
FGEIS	Final Generic Environmental Impact Statement
FSAR	Final Safety Analysis Report
FSS	Final Status Survey
GEIS	Generic Environmental Impact Statement (NUREG-0586)
GPI	Groundwater Protection Initiative
GTCC	Greater than Class C
GW	Groundwater
HSA	Historical Site Assessment
IPaC	Information for Planning and Consultation
ISFSI	Independent Spent Fuel Storage Installation
LLRW	Low-Level Radioactive Waste
LOD	Limits of Disturbance
LTP	License Termination Plan
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MSA	Metropolitan Statistical Area
MW	megawatt
NCLD	National Land Cover Database
NDEQ	Nebraska Department of Environmental Quality
NDNR	Nebraska Department of Natural Resources
NDT	Nuclear Decommissioning Trust
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NESP	National Environmental Studies Project

NGPC	Nebraska Games and Parks Commission
NLEB	Northern Long-Eared Bat
NPDES	National Pollutant Discharge Elimination System
NRC	(U.S.) Nuclear Regulatory Commission
ODCM	Off-site Dose Calculation Manual
NSHPO	Nebraska State Historic Preservation Office
OPPD	Omaha Public Power District
OSHA	Occupational Safety and Health Administration
PA	Protected Area
PAGs	Protective Action Guidelines
PCBs	polychlorinated biphenyls
PSDAR	Post-Shutdown Decommissioning Activities Report
PWR	pressurized water reactor
RAM	Radioactive Material
RP	Radiation Protection
SEIS	Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437), Supplement 12 "Regarding Fort Calhoun Station"
SMEs	Subject Matter Experts
SSCs	Structures, Systems and Components
SWPPP	Stormwater Pollution Prevention Plan
TSCA	Toxic Substance Control Act
USAR	Updated Safety Analysis Report
USFWS	U.S. Fish & Wildlife Service
USGS	United States Geological Survey
VCP	Voluntary Cleanup Program

1. Purpose, Need and Description of Action and Alternatives Considered

1.1 INTRODUCTION

The Omaha Public Power District (OPPD) owns and operates Fort Calhoun Station Unit 1 (FCS), a single unit nuclear power plant on the Missouri River, approximately 19.4 miles north of Omaha, in Blair, Nebraska (Figure 1.1). The U.S. Nuclear Regulatory Commission (NRC) authorized FCS to operate at full power with its issuance of Operating License DPR-40, effective 9 August 1973. In 2002, OPPD prepared and submitted an Environmental Report (ER) in connection with its application to the NRC to renew the FCS operating license, as provided for by the following NRC regulations:

- Title 10, Energy, Code of Federal Regulations, Part 54, Requirements for Renewal of Operating Licenses for Nuclear Power Plants, Section 54.23, Contents of Application-Environmental Information [10 Code of Federal Regulations (CFR) 54.23].

- Title 10, Energy, Code of Federal Regulations, Part 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions, Section 51.53, Post-Construction Environmental Reports, Subsection 51.53(c), Operating License Renewal Stage [10 CFR 51.53(c)].

On 25 August 2016, OPPD notified the NRC that it intended to permanently cease power operations of FCS at the end of October 2016. Pursuant to 10 CFR 50.82(a)(1)(ii), OPPD certified to the NRC that on 13 November, 2016, all fuel was permanently removed from the FCS reactor vessel and placed into the FCS spent fuel pool. In accordance with the requirements of NUREG-0586, OPPD is providing this updated ER in connection with its upcoming License Termination Plan (LTP). This report provides new information and environmental changes associated with site-specific decommissioning and site closure activities.

1.2 BACKGROUND

1.2.1 Fort Calhoun Station Licensee, Ownership, and Operation

Unit 1, a 1,500-megawatt (MW_{th}) pressurized water reactor (PWR), is owned and operated by OPPD. The NRC authorized the FCS to operate at full power with its issuance of Operating License DPR-40, effective 9 August 1973. This license, issued for a 40-year period, was due to expire on 9 August 2013, however; it was extended to 9 August 2033.

In 2006, many upgrades were made to the plant including replacement of the steam generators, pressurizer, reactor vessel head, low pressure turbines, and main transformers. In 2011, the Missouri River surrounded the plant with flood water. The flood and subsequent fire resulted in a three-year cold shutdown of the plant. In August 2012, OPPD hired Exelon Nuclear Partners (Exelon) to manage the plant while they maintained ownership.

On 25 August 2016, OPPD notified the NRC that it intended to permanently cease power operations. On 24 October 2016, the plant was shut down and all the fuel was subsequently permanently removed from the FCS reactor vessel and placed in the FCS spent fuel pool. As such, the 10 CFR Part 50 license for FCS no longer authorizes operation of the reactor or emplacement or retention of fuel in the reactor vessel.

Pursuant to 10 CFR 50.51(b), "Continuation of license," the license for a facility that has permanently ceased operations continues in effect beyond the expiration date to authorize ownership and possession of the utilization facility until the Commission notifies the licensee in writing that the license has been terminated.

During the period that the license remains in effect, 10 CFR 50.51(b) requires that OPPD:

- Take actions necessary to decommission and decontaminate the facility and continue to maintain the facility including storage, control, and maintenance of the spent fuel in a safe condition.

- Conduct activities in accordance with all other restrictions applicable to the facility in accordance with NRC regulations and the 10 CFR 50 facility license.

In accordance with 10 CFR 50.82(a)(9), OPPD will submit an application for termination of the license at least two years prior to the license termination date and the application will be accompanied or preceded by a LTP.

Since power operations have ceased, OPPD ended their contract with Exelon in February 2017 and has started utilizing a SAFSTOR methodology to execute the decontamination and dismantlement (D&D) of the plant.

1.2.2 Site Description

The FCS site is approximately 660 acres in size, located on the west bank of the Missouri River in an area surrounded by farmland and is sparsely populated. Construction of the FCS began in 1966 and the plant officially went online on 1 September 1973. Principal structures at FCS site are shown on Figure 1.2 (Site Plan) and include:

- Containment Building: Constructed of pre-stressed steel reinforced concrete with walls almost four feet thick, with an interior one-quarter inch thick steel liner for leak tightness. The containment building contains the reactor and nuclear steam supply system.

- Auxiliary Building: Houses the reactor auxiliary systems, including waste treatment facilities, certain safety components, the control room, emergency diesel generators, and fuel handling and storage facilities. The Auxiliary Building is a heavily reinforced concrete structure that forms a "U' around the Containment Building.

- Turbine Building: Houses the turbine generator, condensers, condensate and feedwater pumps, feedwater heaters and other turbine heat cycle and electrical generating components. The structural steel superstructure is enclosed with resin wall paneling, it has a reinforced concrete basement.

- Service Building: Office space attached to, and of the similar construction as, the Turbine Building.

- Intake Structure: Houses the equipment that pumps cool river water into the plant for use in condensing the steam leaving the turbine and supporting equipment operation. The building consists of a structural steel frame enclosed by resin wall panels. The intake structure is made of heavily reinforced concrete below the 1,014-foot elevation and extends over the Missouri River.

- Security Access Facility: Serves as the main entrance to the plant.

- Switchyard: Houses electrical transmission equipment that is connected to the main generator at the FCS.

- Administration Building: Currently cool and dim. Formerly housed offices for management and engineering functions and NRC personnel, associated conference rooms and facilities, a fitness for duty laboratory, a radiological health area and a cafeteria.

- Training Center: Includes an auditorium, laboratories and control room simulator.

- Radioactive Waste Processing Building: Used to sort, compact, decontaminate and store (short-term) low-level solid and liquid radioactive waste. In this building, radioactively contaminated equipment and objects can be decontaminated. The building has a ridged steel framework to support a precast concrete exterior panel siding.

- Chemistry and Radiation Protection (RP) Building: Houses chemistry and radiological laboratories, a cafeteria, offices, locker and shower room.

- Warehouse: A 40,000 square-foot building used for receiving deliveries and storage of spare parts and equipment.

- Original Steam Generator Storage Facility (OSGSF): An approximately 4,700 square-foot mausoleum used to store the original steam generators, original pressurizer, and original reactor vessel head. These components will be shipped offsite leaving the building empty.

- FLEX Building: Reinforced building constructed to meet the requirements developed after the incident at Fukushima Daiichi as part of a flexible and diverse (FLEX) strategy to cope with nuclear accidents. Building currently houses minimal emergency equipment including fire protection equipment.

1.3 STATEMENT OF PURPOSE AND NEED

This report supplements the 2002 ER (OPPD 2002a) for license renewal at FCS, describing any new information or significant environmental changes associated with the site-specific decommissioning and license termination activities to be presented in the upcoming LTP. This report includes a description of the remaining decommissioning and site closure activities, the interaction between those activities and the environment, and the likely environmental impact of those activities. This supplement discusses whether the activities and their impacts are bounded by the impacts predicted by the United States Atomic Energy Commission (AEC); August 1972 (AEC Environmental Statement) (AEE 1972); NUREG-0586, Supplement 1, Volume 1 *"Generic Environmental Impact Statement on Decommissioning of*

Nuclear Facilities" (NRC 2002); and the FCS, "*Post Shutdown Decommissioning Activity Report*" (PSDAR) (TGL 2017).

1.4 ENVIRONMENTAL SCOPE AND METHODOLOGY

As part of its obligations under the National Environmental Policy Act (NEPA), the NRC must evaluate the radiological and non-radiological environmental impacts associated with the upcoming LTP and subsequent termination. These evaluations involve an assessment of the impacts of remaining decommissioning and site restoration activities documented in the upcoming LTP and license termination activities (e.g., final site survey).

The NRC previously evaluated the potential environmental impacts of nuclear reactor decommissioning in NUREG–0586, Supplement 1, "Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities" (GEIS) (NRC 2002). The GEIS is used by NRC staff to evaluate environmental impacts that would occur during the decommissioning of nuclear power reactors. The GEIS is considered "generic" in that it evaluates environmental impacts from decommissioning activities common to nuclear power reactor facilities. The GEIS addresses decommissioning of nuclear power reactors licensed by the NRC, including PWRs, boiling-water reactors, and multiple reactor stations. The scope of the GEIS is based on decommissioning from the time that a licensee certifies that it has permanently ceased power operations until the license is terminated. NRC staff concluded in the GEIS that the environmental impacts of decommissioning, including the license termination activities, can be determined generically for all nuclear power plants and will have small impacts[1] in all but six environmental resource areas. The GEIS concluded that two of the six resource areas (i.e., threatened and endangered species and environmental justice) must always be evaluated on a site-specific environmental assessment (EA), such as this EA for FCS.

1.5 SUMMARY OF DECOMMISSIONING ALTERNATIVES

The NRC has evaluated the environmental impacts of three general methods for decommissioning power reactor facilities in NUREG-0586 (NRC 2002). The three general methods evaluated are summarized as follows:

- DECON: The equipment, structures and portions of the facility and site that contain radioactive contaminants are promptly removed or decontaminated to a level that permits termination of the license shortly after cessation of operations.

- SAFSTOR: After the plant is shut down and defueled, the facility is placed in a safe, stable condition and maintained in that state (safe storage). The facility is decontaminated and dismantled at the end of the storage period to levels that permit license termination. During SAFSTOR, a facility is left intact or may be partially dismantled, but the fuel is removed from the reactor vessel and radioactive liquids are drained from systems and components and then processed for final disposition. Radioactive decay occurs during the SAFSTOR period, thereby lowering the level of contamination and radioactivity of materials that must be disposed of during D&D.

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[1] NRC uses a standard of significance in the GEIS, described as either SMALL, MODERATE, or LARGE. "SMALL" impacts are defined as environmental impacts that are not detectable or are so minor, they will neither destabilized nor noticeably alter any important attribute of the resource (NRC 2002).

- ENTOMB: Radioactive structures, systems and components (SSCs) are encased in a structurally long-lived substance, such as concrete. The entombed structure is appropriately maintained, and continued surveillance is carried out until the radioactivity decays to a level that permits termination of the license.

The decommissioning approach selected by OPPD for FCS is the SAFSTOR method. The primary objectives of the FCS decommissioning project are to remove the facility from service, reduce residual radioactivity to levels permitting unrestricted release, restore the site, perform this work safely, and complete the work in a cost-effective manner. The selection of a preferred decommissioning alternative is influenced by a number of factors at the time of and following plant shutdown. These factors include the cost of each decommissioning alternative, minimization of occupational radiation exposure, availability of a high-level waste (spent fuel) repository or a Department of Energy (DOE) interim storage facility, regulatory requirements, and public concerns. In addition, 10 CFR 50.82(a)(3) requires decommissioning to be completed within 60 years of permanent cessation of operations.
During Decommissioning, the facility will undergo D&D to levels that permit license termination. In accordance with 10 CFR 50.82(a)(9), an LTP will be developed and submitted for NRC approval at least two years prior to termination of the license.

2. Description of Planned Decommissioning Activities

OPPD is currently planning to decommission FCS using the SAFSTOR method. Eventual deconstruction of the plant will use the DECON method which is broadly defined as equipment, structures, and portions of the facility and site that contain radioactive contaminants are promptly removed or decontaminated to a level that permits termination of the license shortly after cessation of operations.

Dismantling and decontamination activities will be scheduled to commence to enable the license to be terminated within approximately 11 years after permanent cessation of operations, as compared to SAFSTOR, which would allow the buildings to stand in 'mothball' conditions for up to 60 years. Following completion of the D&D activities and termination of the NRC license, site restoration will be performed, to a to-be-determined condition, such that the site may be re-used for beneficial purposes.

For the purposes of a current decommissioning cost estimate, it is assumed that remaining structures are to be demolished to three-feet below grade and the excavations and deeper basements backfilled with suitable material and erosion controls emplaced.

Decommissioning activities will be performed in accordance with written, reviewed and approved site procedures. There are no identified or anticipated decommissioning activities that are unique to the FCS site outside the bounds considered in the GEIS.

Radiological and environmental programs will be maintained throughout the decommissioning process to ensure occupational, public health and safety, and environmental compliance. Radiological programs will be conducted in accordance with the facility's revised Technical Specifications, Operating License, Defueled Safety Analysis Report (DSAR), Radiological Environmental Monitoring Program, and the Offsite Dose Calculation Manual (ODCM). Non-radiological Environmental Programs will be conducted in accordance with applicable requirements and permits.

Tables 2-1 and 2-2 provide summaries of the schedule / plant status and costs for decommissioning FCS. The major decommissioning activities and the general sequence of activities are discussed in more detail in the sections that follow. Figure 2.1 outlines the specific decommissioning limits of disturbance (LOD) at the FCS site.

Table 2-1. Decommissioning Schedule and Plant Status Summary

Decommissioning Activities/Plant Status	Start	End	Approximate Duration (years)
Pre-Shutdown Planning	2016	October 2016	----------
Transition from Operations			
Plant Shutdown	24 October 2016	----------	----------
Preparations for SAFSTOR Dormancy	24 October 2016	01 July 2018	1.68
Decommissioning Preparations			
Preparations for D&D	2018	2019	1.00
Dismantling & Decontamination			

Decommissioning Activities/Plant Status	Start	End	Approximate Duration (years)
Large Component Removal	2020	2021	1
Plant Systems Removal and Building Decontamination	2021	2025	4.0
License Termination	2025	2026	1.0
Site Restoration			
Site Restoration	2025	2027	1
Total from Shutdown to Completion of License Termination	----------	----------	11

Table 2-2. Decommissioning Cost Summary (thousands of 2017 dollars)

Decommissioning Periods	Cost Estimate
Total NRC License Termination Cost	**$882,212**
Pre-Shutdown Planning	$1,482
License Termination	$25,174
Non-Nuclear Demolition Cost	**$47,979**
Site Reactivation	$50,075
Decommissioning Preparation	$26,644
Large Component Removal	$141,440
Plant Systems Removal and Building Decontamination	$208,777
Site Restoration	$205
Spent Fuel Management Cost	**$365,262**
Total to Decommission with 16.33 Contingency	**$1,295,453**

2.1 DISCUSSION OF DECOMMISSIONING ACTIVITIES

The following narrative describes the basic activities associated with decommissioning the FCS. The site-specific decommissioning cost estimate (DCE) as detailed in Appendix A, is divided into phases or periods based upon major milestones within the project or significant changes in the annual projected expenditures. The following sub-sections correspond to the five major decommissioning periods within the estimate.

2.1.1 Preparations for Decommissioning

Since shutdown, OPPD has initiated the commencement of decommissioning operations. Staff with operational knowledge have been retained and decommissioning Subject Matter Experts (SMEs) employed to support operations and provide oversight and guidance. Preparations include engineering and planning, a site characterization, and the assembly of a decommissioning management

organization. Work plans for preliminary site characterization for both radiological and non-radiological compounds have been developed and implemented, as have the initial building characterization activities.

A DCE has also been developed and planning is underway for fuel transfer and plant dismantlement.

2.1.2 Decommissioning (Dismantling and Decontamination)

Following the preparations for decommissioning, physical decommissioning activities will take place. This includes the removal and disposal of contaminated and/or activated components and structures, leading to the termination of the 10 CFR 50 operating license. During the decommissioning activities, the internal components of the reactor vessel will still exhibit radiation dose rates that will likely require remote sectioning under water due to the presence of long-lived radionuclides such as ^{94}Nb, ^{59}Ni, and ^{63}Ni. Portions of the biological shield wall may also be radioactive due to the presence of activated trace elements with longer half-lives (such as ^{152}Eu and ^{154}Eu). It is assumed that radioactive contamination on structures, systems, and component surfaces will not have decayed to levels that will permit unrestricted release. These surfaces will be surveyed, and items dispositioned in accordance with the existing radioactive release criteria.

Significant decommissioning activities in this phase include:

- Reconfiguration and modification of site structures and facilities, as needed, to support decommissioning operations. Modifications may also be required to the Containment or other buildings to facilitate movement of equipment and materials, support the segmentation of the reactor vessel and reactor vessel internals, and for large component removal.

- Design and fabrication of temporary and longer-term shielding to support removal and transportation activities, construction of contamination control envelopes, and the procurement of specialty tooling.

- Procurement or leasing of shipping cask, cask liners, and industrial packages for the disposition of low-level radioactive waste (LLRW).

- Decontamination of components and piping systems, as required, to control (minimize) worker exposure.

- Removal of piping and components no longer essential to support decommissioning operations.

- Removal of control rod drive housings and the head service structure from reactor vessel head. Segmentation of the vessel closure head.

- Removal and segmentation of the upper internal assemblies. Segmentation will maximize the loading of the shielded transport casks, i.e., by weight and activity. The operations are conducted under water using remotely operated tooling and contamination controls.

- Disassembly and segmentation of the remaining reactor internals, including the core and lower core support assembly. Some material is expected to exceed Class C disposal requirements. As such, the segments will be packaged in modified fuel storage canisters for geologic disposal.

- Segmentation of the reactor vessel, if elected. A shielded platform is installed for segmentation as cutting operations are performed in-air using remotely operated equipment within a contamination control envelope. The water level is maintained just below the cut to minimize the working area dose rates. Segments are transferred in-air to containers that are stored under water, for example, in an isolated area of the refueling canal. A possibility exists to remove the vessel in its entirety as one piece which would be shipped as its own package.

- Removal of the activated portions of the concrete biological shield and accessible contaminated concrete surfaces. If dictated by the steam generator and pressurizer removal scenarios, those portions of the associated cubicles necessary for access and component extraction are removed.

- Removal of the steam generators and pressurizer for material recovery and controlled disposal. The generators will be moved to an on-site processing center, the steam domes removed, and the internal components could be segregated for recycling. The lower shell and tube bundle will be packaged for direct disposal. These components can serve as their own burial containers provided that all penetrations are properly sealed, and the internal contaminants are stabilized, e.g., with grout.

- Underground piping (or similar items) and associated soil will be removed as necessary to meet license termination criteria.

- Remediation of contaminated surface soil or sub-surface media will be performed as necessary to meet the unrestricted use criteria in 10 CFR 20.1402.

- Remediation of contaminated surface soil or sub-surface media for non-radiological constituents will be performed as necessary to meet the Nebraska Department of Environmental Quality (NDEQ) Voluntary Cleanup Program (VCP) criteria.

At least two years prior to the anticipated date of license termination, an LTP will be submitted to the NRC. That plan will include: a site characterization, description of the remaining dismantling *I* removal activities, plans for remediation of remaining radioactive materials (RAM), developed site-specific Derived Concentration Guideline Levels (DCGLs), plans for the final status (radiation) survey (FSS), designation of the end use of the site, an updated DCE, and associated environmental concerns.

The FSS plan will identify the radiological surveys to be performed once the decontamination activities are completed and will be developed using the guidance provided in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). This document incorporates statistical approaches to survey design and data evaluation. It also identifies commercially available instrumentation and procedures for conducting radiological surveys. Use of this guidance ensures that the surveys are conducted in a manner that provides a high degree of confidence that applicable NRC criteria are satisfied. Once the FSS is complete, the results will be submitted to the NRC, along with a request for termination of the NRC license. In addition to the MARSSIM requirements, the site will also comply with both the Nebraska Department of Environmental Quality (NDEQ) for impacts to environmental media, as well as the U.S. Environmental Protection Agency (EPA) should polychlorinated biphenyl (PCBs) be detected at concentrations that are regulated under Toxic Substance Control Act (TSCA).

OPPD may release unaffected portions of the site on a partial site release basis, as they become available, before all site decommissioning work has been completed.

2.1.3 Site Restoration

After the NRC terminates the license, site restoration activities will be performed, at the licensee's discretion. OPPD currently assumes that remaining structures will be removed to a nominal depth of three feet below the surrounding grade level. With erosion and sediment controls established, affected area(s) would then be backfilled with suitable fill materials, graded, top soil added and seeded to stabilize the disturbed areas.

Non-contaminated concrete rubble produced by the demolition activities may be used for backfilling subsurface voids or may be transported to an offsite area for appropriate disposal as construction debris. See Figure 2.2 for the extent of site restoration.

2.2 GENERAL DECOMMISSIONING CONSIDERATIONS

2.2.1 Major Decommissioning Activities

As defined in 10 CFR 50.2, "definitions," a "major decommissioning activity" is "any activity that results in permanent removal of major radioactive components, permanently modifies the structure of the containment, or results in dismantling components for shipment containing greater than Class C waste in accordance with § 61.55." The following discussion provides a summary of the major decommissioning activities currently planned for the FCS. These activities are envisioned to occur in the D&D period. The schedule may be modified as conditions dictate.

Prior to starting a major decommissioning activity, the affected components will be surveyed and decontaminated, as required, to minimize worker exposure, and a plan will be developed for the activity. Shipping casks and other equipment necessary to conduct major decommissioning activities will be procured.

The initial major decommissioning activity inside the containment building will be the removal, packaging, and disposal of systems and components attached to the reactor, to provide access and allow it to be removed.

The reactor vessel internals will be removed from the reactor vessel and segmented, if necessary, for packaging, transport and disposal, or to separate greater than Class C (GTCC) waste. Internals classified as GTCC waste will be segmented and packaged into containers and stored on-site in the Dry Fuel Storage installation similar to spent fuel canisters, for transfer by the DOE to a depository. Removal of the reactor vessel follows the removal of the reactor internals. Industry experience indicates that there may be several options available for the removal and disposal of the reactor vessel (i.e., segmentation or disposal as an intact package). The viability of these options will be analyzed as a part of future planning and preparation activities. If segmented, it is likely that the work would be performed remotely in-air, using a contamination control envelope.

Other major decommissioning activities that will be conducted include the removal and disposal of the steam generators, pressurizer, turbine, condenser, main steam piping, feed water piping, pumps and heaters, spent fuel pool support equipment, and neutron activated / contaminated concrete materials.

2.2.2 Other Decommissioning Activities

In addition to the reactor and large components discussed above, all other plant components will be removed from the Containment, Turbine, Auxiliary, Intake, and associated support buildings, radiologically surveyed and dispositioned appropriately.

2.2.3 Decontamination and Dismantlement Activities

The overall objective of D&D is to ensure that radioactively contaminated or activated materials will be removed from the site to allow the site to be released for unrestricted use. The disposition of radioactive materials will be accomplished by the decontamination and or dismantlement of contaminated structures. This may be accomplished by decontamination in place, off-site processing of the materials, or direct disposal of the materials as radioactive waste. A combination of these methods may be utilized. The final methods chosen will be those deemed most appropriate for the particular circumstances.

LLRW will be managed in accordance with approved procedures and commercial disposal facility requirements. This includes characterizing contaminated materials, packaging, transporting and disposal at a licensed LLRW disposal facility.

2.2.4 Radioactive Waste Management

A major component of the decommissioning work scope for the FCS is the packaging, transportation and disposing of primarily contaminated *I* activated equipment, piping, concrete, and if encountered, soil. A waste management plan will be developed to incorporate the most cost-effective disposal strategy, consistent with regulatory requirements and disposal/processing options for each waste type at the time of the D&D activities. Decommissioning wastes from FCS may be disposed of at the Waste Control Specialists site in Andrews County, Texas and or Energy*Solutions* site in Clive, Utah. If other licensed disposal facilities become available in the future, OPPD may elect to use them. Radioactive wastes from FCS will be transported by licensed transporters. The waste management plan will be based on the evaluation of available methods and strategies for processing, packaging, and transporting radioactive waste in conjunction with the available disposal facility options and associated waste acceptance criteria. Waste will be transported either by rail or truck to the disposal facilities.

2.2.5 Removal of Mixed Wastes

If mixed wastes are generated, they will be managed in accordance with applicable Federal and State regulations.

If generated, mixed wastes will be transported by authorized and licensed transporters and shipped to authorized and licensed facilities. If technology, resources, and approved processes are available, the processes will be evaluated to render the mixed waste non-hazardous.

2.2.6 Site Characterization

During the decommissioning process, site characterization will be performed in which radiological, regulated, and hazardous wastes will be identified, categorized, and quantified. Surveys will be

conducted to establish the contamination and radiation levels throughout the plant. This information will be used in developing procedures to ensure that hazardous, regulated, and radiologically contaminated areas are remediated and to ensure that worker exposure is controlled. As D&D work proceeds, surveys will be conducted to maintain a current site characterization and to ensure that decommissioning activities are adjusted accordingly.

As part of the site characterization process, a neutron activation analysis calculation study of the reactor internals and the reactor vessel was performed. Using the results of this analysis (along with benchmarking surveys), neutron irradiated components were classified (projected for the future D&D time-frame) in accordance with 10 CFR 61, "Licensing requirements for land disposal of radioactive waste." The results of the analysis form the basis of the plans for removal, segmentation, packaging and disposal.

2.2.7 Groundwater Protection and Radiological Decommissioning Records Program

A groundwater (GW) protection program currently exists at FCS in accordance with the Nuclear Energy Institute (NEI) Technical Report 07-07, "Industry Groundwater Protection Initiative - Final Guidance Document". This program is directed by procedures and will continue during decommissioning. FCS currently has 22 groundwater monitoring wells installed on Site, 11 of which are located within the Protected Area (PA) and 11 additional wells located outside the PA, but within the Owner Controlled Areas (See Figure 2.3). In addition to these wells, groundwater samples were collected from two temporary well points during the site characterization effort.

To date, groundwater monitoring results have not detected any long-lived radionuclides in sufficient concentrations to preclude unrestricted release under 10 CFR 20.1402 “Radiological Criteria for Unrestricted Use”. Groundwater data collected out-side the PA, from the fire training area did identify low concentrations non-radiological site-related constituents, but not at concentrations that warrant immediate action or confirmed receptors or exposure pathways.

OPPD will also continue to maintain the existing radiological decommissioning records program required by 10 CFR 50.75(g). The program is directed by procedures.

Neither the monitoring results of the groundwater protection program nor events noted in 10 CFR 50.75(g), and summarized in the Historical Site Assessment (HSA) (TSSD 2016), or the Radiological Limited Characterization Reports (TSSD 2017). These reports also confirm that there is no presence of long-lived radionuclides in soils or structures in sufficient concentrations to preclude unrestricted release under 10 CFR 20.1402, "Radiological criteria for unrestricted use". However, the HSA does document the presence of hazardous levels of lead in soils at the shooting range that will require remediation in accordance with NDNR and Federal regulations prior to license termination.

2.2.8 Changes to Management and Staffing

Throughout the decommissioning process, plant management and staffing levels will be adjusted to reflect the ongoing transition of the site organization. Staffing levels and qualifications of personnel used to monitor and maintain the plant during the various periods after plant shutdown will be subject to appropriate Technical Specification, Quality Assurance Plan, and Emergency Plan requirements. These staffing levels do not include contractor staffing which may be used to carry out the future fuel movements, plant modifications in preparation D&D / license termination / site restoration work.

Contractors may also be used to provide general services, staff augmentation or replace permanent staff. The monitoring and maintenance staff will be comprised of radiation protection, radiological environmental monitoring program, plant engineering, and craft workers as appropriate for the anticipated work activities.

3. Schedule of Planned Decommissioning Activities

OPPD intends to pursue the decommissioning of FCS utilizing the SAFSTOR methodology and will make appropriate filings with the NRC to obtain authority prior to beginning radiological decommissioning. The DECON method involves decontamination and removing equipment, structures, and portions of the facility and site that contain radioactive contaminants to a level that permits termination of the license, as defined in Regulatory Guide 1.184. Work activities associated with the planning and preparation period began before the plant was permanently shut down and will continue through D&D, which is scheduled to begin in 2019. The schedule of major decommissioning activities is provided in Table 2-1. Additional detail is provided in Appendix A, the DCE.

The schedule accounts for spent fuel being stored in the Independent Spent Fuel Storage Installation (ISFSI) until the assumed date of transfer to the DOE.

4. Estimate of Expected Decommissioning and Spent Fuel Management Costs

10 CFR 50.82(a)(4)(i) requires the submission of a PSDAR within two years following permanent cessation of operations that contains a site-specific DCE, including the projected cost of managing irradiated fuel.

A site-specific decommissioning cost analysis has been prepared for FCS, which also provides projected costs of managing spent fuel, as well as non-radiological decommissioning and site restoration costs, accounted for separately. The site-specific DCE is provided in Appendix A and fulfills the requirements of 10 CFR 50.82(a)(4)(i) and 10 CFR 50.82(a)(8)(iii). A summary of the site-specific DCE, including the projected cost of managing spent fuel is provided in Table 2-2.

The methodology used by TLG Services, Inc. to develop the site-specific DCE follows the basic approach originally advanced by the Atomic Industrial Forum (AIF) in its program to develop a standardized model for decommissioning cost estimates. The results of this program were published as AIF/National Environmental Studies Project (NESP)-036, "A Guideline for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," (T.S. LaGuardia 1986). The AIF document presents a unit cost factor method for estimating direct activity costs, simplifying the estimating process. The unit cost factors used in the study reflect the latest available data, at the time of the study, concerning worker productivity during decommissioning.

Under NRC regulations (10 CFR 50.82(a)(8)), a licensee must provide reasonable assurance that funds will be available (or "financial assurance") for decommissioning (i.e., license termination) costs. The regulations also describe the acceptable methods a licensee can use to demonstrate financial assurance. Most licensees do this by funding a nuclear decommissioning trust (NDT). Nebraska State Statues provides the regulatory authority that allows OPPD's Board of Directors to establish the inflation rates and earning rates of OPPD.

OPPD maintains two separate trust accounts for this purpose, one for the License Termination Expenditures (NRC minimum decommissioning amount) and another for the Spent Fuel Management and Site Restoration Expenditures. The trustee for both trust funds is First National Bank of Omaha. As of December 31, 2017, the License Termination Expenditures trust had a balance of $294,500,000 and the Spent Fuel Management and Site Restoration Expenditures trust had a balance of $126,800,000.

The two trust funds are not combined, and the funds accumulated for the additional decommissioning cost are not included as funds for the NRC minimum decommissioning amount. The funds accumulated for the additional decommissioning costs including additional radiological, site restoration and spent fuel management are available for radiological decommissioning without prior approval by a State regulatory authority and are not subject to disapproval for radiological decommissioning by a State regulatory authority.

10 CFR 50.82(a)(6)(iii) states that, "Licensees shall not perform any decommissioning activities," as defined in 10 CFR 50.2 that, "Result in there no longer being reasonable assurance that adequate funds will be available for decommissioning." OPPD does not intend to perform any decommissioning activities that would jeopardize the availability of adequate funds for the completion of decommissioning.

10 CFR 50.82(a)(8)(iv) states that, "For decommissioning activities that delay completion of decommissioning by including a period of storage or surveillance, the licensee shall provide a means of adjusting cost estimates and associated funding levels over the storage or surveillance period."

4.1 MEANS OF ADJUSTING COST ESTIMATES

Costs are inflated using a blending of the IHS Global Insight's forecasts for Consumer Price Index, All-Urban and Employment Cost Index, and Total Private Compensation. The indices are blended based on the ratio of labor and all other costs to the total DCE. For the years beyond the available forecast, the final forecast rate available is held constant for the duration of the analysis.

Consistent with Regulatory Guide 1.159 (NRC 2013), OPPD will update the FCS DCE as required. In calculating projected earnings, OPPD uses the IHS Global Insight's forecast for the yield on 5-year Treasury Notes which is within a two percent (2%) annual real rate of return.

4.2 MEANS OF ADJUSTING ASSOCIATED FUNDING LEVELS

In the event that additional financial assurance beyond the amounts contained in the remaining trust fund for FCS is required pursuant to NRC regulations to complete radiological decommissioning and spent fuel management at FCS, OPPD will augment the NDTs with annual contributions to the NDTs.

As conditions may change, OPPD will adjust the funding, as appropriate, using alternative funding mechanisms acceptable to the NRC.

5. Environmental Impacts

The total area of the FCS facility that will be decommissioned is approximately 119 acres. All the decommissioning will take place on previously developed/built portion of the FCS facility. The environmental impacts associated with the planned FCS decommissioning activities are less than and bounded by the previously issued environmental impact statements (EISs). The following discussion provides additional information on the potential impacts resulting from decommissioning FCS and updates the Applicant's previous ER issued in 2002 for license renewal.

OPPD is also referencing the following previously issued EISs for decommissioning of nuclear facilities:

- NUREG-0586, Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors (NRC 2002(Referred to as the GEIS).

- NUREG-1496, Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities (NRC 1997).

In evaluating whether the impacts in these previously issued EISs are bounding, information from NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 12, Regarding Fort Calhoun Station, Unit 1 (OPPD 2003b) was also considered (herein referred to as the SEIS).

5.1 ENVIRONMENTAL IMPACT OF FCS DECOMMISSIONING

The following sections summarize the potential impacts and proposed mitigation resulting from the decommissioning of FCS. OPPD has modeled the impacts analysis on the GEIS.

5.1.1 Onsite/Offsite Land Use

Currently, there are six (6) types of land use/vegetative cover-types within the total approximately 660 acres FCS property. The land-use/vegetative cover-type categories and associated acreage for each are:

- Cultivated Crops: approximately 336 acres within the FCS property;
- Deciduous Forest: approximately 61 acres within the FCS property;
- Developed: approximately 105 acres within the FCS property;
- Grassland/Herbaceous: approximately 54 acres within the FCS property;
- Open Water: approximately 6 acres within the FCS property; and
- Forested Wetland: approximately 97 acres within the FCS property.

These land use/vegetative cover types are depicted on Figure 5.1 and are derived from the National Land Cover Database (NCLD) and aerial interpretation. OPPD does have approximately 582 acres of land included in the license as an easement in the event of an emergency, 475 of which are being reviewed for release under 10 CFR 50.83.

OPPD is proposing to conduct decommissioning of FCS within the developed portion of the facility only and does not propose new ground disturbance to other land types. There is sufficient area onsite that

has been previously disturbed (due to construction or operations activities) for use during decommissioning. It is assumed that construction activities will disturb one acre or greater of soil and will require a National Pollution Discharge Elimination System (NPDES) Construction Stormwater General Permit from the NDEQ prior to proceeding with the activity. OPPD will prepare a Stormwater Pollution Prevention Plan (SWPPP) and a Notice of Intent (NOI) and submit both prior to initiating decommissioning /construction activities at the FCS site. The SWPPP will contain best management practices (BMPs) to avoid and/or minimize sediment and erosion discharges to water courses and wetlands. All BMPs will be in place prior to initiating decommissioning/construction activities.

Once decommissioning is complete, decommissioned areas at FCS will be either be left as a gravel/paved area with appropriate permanent stormwater controls left in place or restored back to grassland (see Figure 2.2), therefore, there will be a net gain in undisturbed area at FCS and no significant adverse impacts to land use as a result of decommissioning.

5.1.2 Water Use

As stated in the 2002 ER, maximum water withdrawal for FCS during normal operation amounted to approximately 371,000 gallons per minute (827 cubic feet per second or 534 million gallons per day). Water was supplied by a combination of raw water from the Missouri River, treated municipal water supply and a limited amount of groundwater. Since FCS was shut down in 2016, the operational demand for cooling water and makeup water has dramatically decreased. This reduced demand in cooling water will continue to decrease as the heat load of spent fuel in the spent fuel pool declines due to radioactive decay and as spent fuel is relocated from the spent fuel pool to the ISFSI. During decommissioning, the use of potable water will decrease commensurate with the expected decrease in plant staffing levels.

Additionally, as the plant is shut down and defueled, the amount of water used by the service water system is much less than during normal operation of the plant. The need for cooling water will cease after decommissioning of the site and only minimal amount of potable water will continue to be provided by the Town of Blair to serve the guard house after decommissioning is complete at FCS.

During decommissioning of FCS, the 80-feet long water intake structure inlet along the Missouri River will be removed and all maintenance dredging activities within the river in front of the intake unit will cease. However, the intake and discharge tunnels will be sealed off at both ends and left in place.

Based on the significant decrease of water supply use at FCS, it can be concluded that the decommissioning of FCS will have a positive effect upon the available water supply.

5.1.3 Water Quality

OPPD has chosen to decommission FCS using the DECON method which includes the prompt removal of all equipment, structures, and portions of the facility and site that contain radioactive contaminants and completion of D&D activities. Regulatory mandated programs and processes designed to minimize, detect, and contain spills will be maintained throughout the decommissioning process. OPPD will maintain all federal, state and local permits pertaining to water quality throughout decommissioning activities and will obtain additional construction NPDES permits to avoid and/or minimize impacts to water quality. FCS will also continue to receive potable water from the City of Blair throughout

decommissioning and for the several buildings left on site. Once decommissioning is complete, the following NPDES permits currently in place for Industrial Activity discharge will be terminated:

- General NPDES Permit Number NER910000 for Stormwater Discharges from Industrial Activity to Waters of the State of Nebraska.

- General NPDES Permit Number NEG671000, A General NPDES Permit Authorizing Dewatering Discharges.

- NPDES Permit Number NE0000418, An NPDES Industrial Discharge Permit.

Once FCS has completed decommissioning, industrial water discharge will cease and approximately 96 acres of developed land will be restored back to native grassland. Therefore, the decommissioning of FCS will have a positive impact on water quality once complete.

5.1.4 Air Quality

Air Quality Construction Permit (CP07-0063) was issued to OPPD by the NDEQ and regulates air emission sources at FCS. This permit will remain in place during decommissioning. If new sources of air emissions are added or changed at the facility to support the decommissioning process, the certificate will be modified as required. As new regulations are issued that impact these sources, these requirements will be addressed at FCS.

There are five non-radiological types of decommissioning activities listed in Section 4.3.4 of the GEIS that have the potential to affect air quality:

- Worker Transportation to and from the site;
- Dismantling of systems and removal of equipment;
- Movement of open storage of materials onsite;
- Demolition of buildings and structures; and
- Shipment of material and debris to offsite locations.

5.1.4.1 Worker Transportation

The work force at FCS has decreased significantly from the time the plant ceased operation in 2016 to a work force of approximately 300 people. The work force will temporarily increase during decommissioning to approximately 150 people. There will also be occasional increases during specific D&D activities until completion. The work force during decommissioning will be smaller than the work force needed during plant construction and routine refueling/maintenance operations. Therefore, there will be no significant adverse changes in air quality associated with changes in worker transportation since these changes in worker transportation will generally not be detectable or destabilizing.

5.1.4.2 Dismantling Systems and Removal of Equipment

There are potential sources of particulate matter that could impact air quality during the dismantlement of systems and the associated release of gases from systems during removal. There are several mitigation efforts that can be used to minimize fugitive dust such as wet suppression and chemical stabilization agents. In addition, airborne contamination can be minimized by isolating certain

contaminated areas and implementing the use of air filtration systems when activities are located in areas that are not ventilated to the plant stack and are likely to generate airborne radioactivity or other hazardous pollutants. Other sources of air pollutants such as refrigerants will be disposed of according to applicable local, state and federal regulations. With the installation of these BMPs during decommissioning, it is highly unlikely that particulate matter generated during decommissioning and released to the environment will be detectable offsite.

5.1.4.3 Movement and Open Storage of Materials Onsite

Movement of equipment and open storage of materials such as construction debris and soil stockpiling during decommissioning may result in fugitive dust. However, BMPs such as temporarily stabilizing stockpiled soil with seed and mulch and spraying of the debris containing particulates and dust will minimize fugitive dust during stockpiling. Similar BMPs will be established to mitigate effects while moving material within the site. Therefore, no significant adverse impacts to air quality from the particulate matter generated as a result of movement or storage of material onsite are anticipated.

5.1.4.4 Demolition of Buildings or Structures

It is anticipated that the demolition of buildings and structures will temporarily increase fugitive dust at FCS during decommissioning. Demolition activities will be conducted in an organized and methodical manner to avoid and minimize significant amounts of particulate and fugitive dust generation at one time during decommissioning. As demolition and loading of material occurs, the area exposed will be sprayed to minimize airborne dust and particulates. It is therefore anticipated that the demolition of buildings and structures will potentially create temporary impacts to air quality, but none that would be considered significant or adverse.

5.1.4.5 Shipments of Material to an Offsite Location

It is anticipated that a maximum of 43,983 truck trips to and from the local landfill located at Pheasant Point, Douglas County containing construction materials, debris, and equipment will be removed and brought onto the FCS site during decommissioning. The decommissioning will take place over an estimated 11 years and there will be periods of heavier activity than others. Again, fugitive dust and small particulates generated from truck traffic will be the primary contributor of potential air quality impacts during this phase of decommissioning. All appropriate BMP’s will be implemented and maintained throughout decommissioning to ensure that there is a minimal amount of impacts to air quality.

In addition to the current air monitoring program at FCS, all air emissions will be monitored during decommissioning activities (fugitive dust, equipment exhaust, etc.) and will continue to be monitored in accordance with ODCM which sets limits on doses caused by effluents, based upon the ALARA (as low as reasonably achievable) objectives of 10 CFR 50.34a, 10 CFR 50.36a, and Section IV.B.1 of Appendix I to 10 CFR 50. Effluents are reported annually to the NRC.

5.1.5 Aquatic Ecology

Aquatic ecology includes the interaction of aquatic organisms with each other and their environment. The primary aquatic habitat on site and within the vicinity of FCS for both plants and wildlife is the Missouri River and its associated riparian floodplain and forest (See Figure 5.2). The 2002 ER provides a

comprehensive analysis of the extent and types of aquatic organisms present on site and within the vicinity of FCS. In addition, and as previously discussed in Section 5.1.2, the amount of cooling water withdrawn from the Missouri River will significantly decrease thus reducing the potential impacts from impingement and entrainment of aquatic species.

Direct impacts can result from activities such as the removal of shoreline structures or the active dredging of canals/ponds. It is understood that decommissioning of shoreline and in-water structures has the potential to impact aquatic habitat. Removal of the intake and discharge facilities as well as other shoreline structures will be conducted in accordance with BMPs outlined in permits issued by the NDEQ and if necessary, the U.S. Army Corps of Engineers. Intake structure dredging has been greatly reduced/eliminated due to the cessation of operations and diminished residual heat removal requirements, and the eventual relocation of the spent fuel to the ISFSI.

The potential for significant adverse impacts resulting from the generation of surface water runoff due to ground disturbances and erosion during decommissioning will be minimized by implementing proper BMPs as is required by regulatory agencies. OPPD does not anticipate disturbance of lands beyond the current operational areas of the plant, therefore, it is not anticipated that additional new impacts to aquatic ecology from runoff associated with land disturbance activities will occur.

OPPD will consult with regulatory and resource agencies to obtain permits and plan activities to minimize the duration and extent of these impacts. Regardless, impacts to aquatic ecology would be limited to those areas previously disturbed during construction and operation, and these areas would be expected to re-colonize as they did following the initial construction. Thus, even considering the removal of shoreline and in-water structures, the impacts of decommissioning on aquatic ecology are anticipated to be minimal.

5.1.6 Terrestrial Ecology

Terrestrial ecology considers the plants and animals in the vicinity of FCS as well as the interaction of those organisms with each other and the environment. Evaluations of impacts to terrestrial ecology are usually directed at important habitats and species, including plant and animals that are important to industry, recreational activities, the area ecosystems, and those protected by endangered species regulations and legislation. Section 4.3.6 of the GEIS evaluates the potential impacts from both direct and indirect disturbance of terrestrial ecology.

OPPD does not anticipate disturbing any upland terrestrial habitat (e.g. clearing vegetation, the permanent fill of a stream or wetland, etc.) beyond the removal of the operational areas of the plant which are all previously disturbed or developed. All D&D and waste staging activities will be conducted within the previously disturbed area of the site. All areas within the decommissioning LOD will be restored back to native grassland or left as impervious surface in a stabilized condition.

Potential indirect impacts that may result from decommissioning activities include surface water runoff and erosion, fugitive dust and noise. Any construction activities that would disturb one acre or greater of soil would require a Construction Stormwater General Permit from the NDEQ prior to proceeding with the activity. The storm water permit would contain BMPs to control sediment and the effects of erosion associated with the construction activity. Fugitive dust emissions will be controlled during decommissioning with routine water spraying of the site and public roads as needed.

Section 4.3.6 of the GEIS concludes that if BMPs are used to control indirect disturbances and habitat disturbance is limited to operational areas, the potential impacts to terrestrial ecology are small. As discussed above, there are no unique disturbances to the terrestrial ecology anticipated during the decommissioning of FCS.

5.1.7 Threatened and Endangered Species

There were thirteen (13) threatened and endangered species identified in the 2002 ER (OPPD 2002a). In October 2018, a review for plant and wildlife species protected by the *Nebraska* Nongame and Endangered Species Act was requested by the Nebraska Game and Parks Commission (NGPC). The NGPC responded on 13 November 2018 (See Appendix B, USDI 2018) and identified five (5) state listed protected species (threatened or endangered) within the vicinity (3 miles) of the FCS (see Table 5-1-1 below and Figure 5.3). The only new species that was not listed in 2002 and that was identified in 2018 was the federal and state threatened northern long-eared bat (*Myotis septentrionalis)*. The four (4) other species identified were three (3) fish species; the federal and state endangered pallid sturgeon (*Scaphirhyncus albus)*, the state threatened lake sturgeon (*Acipenser fulvescens*), the state endangered sturgeon chub (*Macrhybopsis gelida*), and one (1) plant species the state threatened American ginseng (*Panax quinquifolium*). A separate review was conducted in November 2018 per the federal Endangered Species Act with the U.S. Fish & Wildlife Service's (USFWS) online Information for Planning and Consultation (IPaC) system (USFWS 2018). The results of the IPaC identified five (5) protected species. Similar to the NGPC review, it identified the federal threatened northern long-eared bat, the endangered least tern (*Sterna antillarum*), the threatened piping plover (*Charadrius melodus*), the endangered pallid sturgeon, and the threatened western prairie fringed orchid (*Platanthera praeclara*). Bald eagle (*Haliaeetus leucocephalus*) was mentioned in the NGPC response and IPaC, but it is not state or federally listed. However, the bald eagle is still protected by the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. In addition, both the NGPC response and the IPaC review identified eleven (11) bird species that are protected under the Migratory Bird Treaty Act.

It was determined in the SEIS that due to channelization of the Missouri River and the removing of sandbars, both the least tern and piping plover are not likely to be found at FCS. The western prairie fringed orchid potentially occurs in Washington County based on historic observations. However, no populations are known to occur in the County, and the potential for occurrence on or near FCS is low given the lack of appropriate prairie habitat in these areas.

To assess the presence or absence of the northern long-eared bat, acoustical studies and mist net surveys were conducted in August 2018 in accordance with USFWS and NGPC Scientific and Education Permits and a report was generated (Appendix C, ESI 2018) Two (2) acoustic sites were recorded within the riparian corridor along the Missouri River and nine (9) mist net nights were completed across nine (9) separate net location on the FCS property. A total of 856 acoustic files were recorded at the two (2) acoustic sites. Nine (9) species were recorded including eight (8) northern long-eared bat call sequences. The statistical analysis of the data supported the presence of six (6) species: big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), northern long-eared bat, evening bat (*Nycticeius humeralis*), and tri-colored bat (*Perimyotis subflavus*). Northern long-eared bat was confirmed at Site 1 by manual vetting. Nine complete net nights resulted in the capture of two eastern red bats: one adult male and one adult female. No federally listed species were captured.

Section 4.3.7 of the GEIS does not make a generic determination on the impact of decommissioning on threatened and endangered species. Rather it concludes that the adverse impacts and associated significance of the impacts must be determined on a site-specific basis.

With respect to the threatened and endangered aquatic species, the environmental impacts during decommissioning are expected to be minimal. Removal of the intake and discharge facilities as well as other shoreline structures will be conducted in accordance with BMPs outlined in permits issued by the NDEQ and the U.S. Army Corps of Engineers. As previously discussed in Section 5.1.2, the amount of cooling water withdrawn from the Missouri River will significantly decrease thus reducing the potential impacts of impingement, entrainment, and thermal discharges on aquatic species. One potential adverse impact from the decrease in cooling water withdrawn may be the elimination of the thermal refuge for aquatic species in the discharge area which are preyed upon by the bald eagle in the winter months.

The environmental impacts during decommissioning are expected to be minimal on threatened and endangered terrestrial species. OPPD does not anticipate disturbing natural habitat or tree clearing beyond the already developed portions of the operational areas of the plant for decommissioning and construction activities. Construction activities that disturb one acre or greater of soil necessitate permits by the NDEQ and BMPs are required to be implemented to control sediment and the effects of erosion. Additionally, FCS has administrative controls in place which require that significant project activities undergo an environmental review prior to the activity occurring, which ensures that impacts are minimized through implementation of BMPs. Federal and state regulations pertaining to listed species will also remain in effect, which will further ensure that impacts to listed species and their habitats are minimized.

In addition, a request to the Iowa Department of Natural Resources was not made for the preparation of this updated ER since decommissioning and construction activities including ground disturbance are not proposed in the state of Iowa, therefore, it is assumed that the decommissioning of the FCS will not result in a significant adverse impact to Iowa protected threatened and endangered species.

Section 4.3.7 of the GEIS also suggests that care be exercised in conducting decommissioning activities after an extended period because there is a greater potential for rare species to colonize the disturbed portion of the site. However as previously discussed, administrative controls and federal and state regulations that will remain in effect would ensure that mitigation measures are implemented as appropriate to protect wildlife.

It is not anticipated that the planned decommissioning of FCS will result in any significant adverse impacts to any of the protected species' habitat or the direct mortality of any threatened or endangered species.

Table 5-1-1. Threatened and Endangered Species Documented/Potential for Occurrence within the Vicinity of Fort Calhoun Station[1]

Common Name	Scientific Name	Status[2]	
		Nebraska	U.S.
Fish			
Pallid Sturgeon	*Scaphirhyncus albus*	E	E
Lake Sturgeon	*Acipenser fulvescens*	T	
Sturgeon Chub	*Macrhybopsis gelida*	E	

Common Name	Scientific Name	Status[2]	
		Nebraska	U.S.
Birds			
Least Tern	*Sterna antillarum*		E
Piping Plover	*Charadrius melodus*		T
Bald Eagle[3]	*Haliaeetus leucocephalus*		
Plants			
American Ginseng	*Panax quinquifolium*	T	
Western Prairie Fringed Orchid	*Platanthera praeclara*		T
Mammals			
Northern Long-Eared Bat	*Myotis septentrionalis*	T	T

Notes:

[1] Based on occurrence documented/potential within vicinity of FCS and within 3 miles reported by the Nebraska Game and Parks Commission for Washington County, Nebraska dated October 31, 2018 (NGPC 2018) and by the U.S. Fish and Wildlife Service's IPaC review dated November 2018 (USFWS 2018).

[2] T = Threatened; E = Endangered.

[3] Although delisted in 2007, the bald eagle is still protected by the Bald and Golden Eagle Protection Act (1940) and the Migratory Bird Treaty Act (1918).

5.1.8 Radiological

The OPPD conducts an annual radiological environmental monitoring program (REMP) around Fort Calhoun Station. This program was initiated prior to plant operation in 1973. The primary function of the REMP is to ensure the overall safety of the general public by monitoring plant liquid and gaseous discharges to the environment. The accumulated data is used to assess the overall impact of plant operation on the environment and to determine whether adjustments to plant operations or the REMP are needed.

Program objectives are accomplished by monitoring the potential radiation-exposure pathways to the public, including adsorption, inhalation, ingestion, and direct exposure. Both grab samples and composite samples are collected and analyzed to represent these exposure pathways, including air, water, milk, vegetation, fish, sediment, and food crops. Direct exposure is monitored by using thermoluminescent dosimeters (TLDs) that are installed in the field at several locations, including air-monitoring stations. Samples are collected at both control (background) and indicator locations, which are selected based on radiological, meteorological, and geographical factors that are obtained from the *Annual Radiological Effluent Release Report*) and the Environmental Land Use Survey. Most monitoring is conducted within an 8-km-radius (5-mi-radius) circle centered on Fort Calhoun Station, Unit 1. However, some samples, typically control samples, are collected outside the 8-km (5-mi) radius.

Radiological releases are summarized in two annual reports: The *Fort Calhoun Station Radiological Environmental Operating Report* and the *Annual Radiological Effluent Release Report*. The limits for all radiological releases are specified in the Fort Calhoun Station ODCM, and these limits are designed to meet Federal standards and requirements.

A review of the historical data on releases and the resultant dose calculations revealed that the doses to maximally exposed individuals in the vicinity of Fort Calhoun Station were a small fraction of the design objectives of 10 CFR Part 50, Appendix I, and the limits specified in the U.S. Environmental Protection Agency's environmental radiation standards in 40 CFR Part 190, as required by 10 CFR 20.1301(d). A breakdown of the maximum dose to an individual located at the Fort Calhoun Station boundary from liquid and gaseous effluents released during 2017 is summarized as follows:

- The total body dose from liquid effluents at the site discharge was 2.80×10^{-3} mSv (2.80×10^{-1} mrem), which is about 9.33% of the 0.03 mSv (3 mrem) dose limit. The critical organ dose due to the liquid effluents at the site discharge was 4.39×10^{-3} mSv (4.39×10^{-1} mrem). This dose was about 4.39% of the respective 0.10-mSv (10 mrem) dose limit.

- The air dose due to noble gases in gaseous effluents was 1.13×10^{-11} mSv (1.13×10^{-9} mrad) gamma (0.00% of the 0.10 mGy [10 mrad] gamma dose limit) and $1.28 \times 10^{-}9$ mGy (1.28×10^{-7} mrad) beta (5.95% of the 0.20 mGy [20 mrad] beta dose limit).

- The critical organ dose from gaseous effluents due to iodine-131, tritium, and particulates with half-lives greater than eight days was 0.00 mSv (0.00 mrem), which is 0.00 % of the 0.15 mSv (15 mrem) dose limit.

Fort Calhoun Station anticipates only a reduction to the radioactive effluent releases or exposures from Fort Calhoun Station decommissioning operations during the D&D period, and, therefore, the impacts to the environment are not expected to change.

5.1.8.1 Activities Resulting in Occupational Doses to Workers

The environmental impacts associated with radiological activities resulting in occupational doses to worker have been determined by the NRC to be generically applicable with a small impact, because of the existence of guidance regulating doses to workers (10 CFR 20) which remain applicable to the FCS. The NRC's analysis of the environmental impacts of radiological activities resulting in occupational doses to workers is documented in Section 4.3.8 of Supplement 1 to NUREG-0586.

5.1.8.2 Activities Resulting in Doses to the Public

The environmental impacts associated with radiological activities resulting in doses to the public have been determined by the NRC to be generically applicable with a small impact, because of the existence of guidance regulating and documenting doses to members of the public (10 CFR 20). The NRC's analysis of the environmental impacts of radiological activities resulting in doses to the public is documented in Section 4.3.8 of Supplement 1 to NUREG-0586. OPPD has not identified any new information or significant environmental change associated with the site-specific termination activities related to the end use of the site.

Potential doses to the public following license termination are not covered by the Supplement to the FGEIS but were evaluated during promulgation of rulemaking for the radiological criteria for license termination (10 CFR 20.1402). The basis for public health and safety considerations associated with the license termination rule is discussed in NUREG-1496.

5.1.9 Radiological Accidents

The environmental impacts associated with radiological accidents have been determined by the NRC to be generically applicable with a small impact. The NRC's analysis of the environmental impacts of radiological accidents is documented in Section 4.3.9 of Supplement 1 to NUREG-0586. OPPD has not identified any new information or significant environmental change associated with the site-specific termination activities related to the end use of the site.

The NRC concluded that radiological impacts, due to accidents, are considered to be undetectable and non-destabilizing, with regards to the National Environmental Policy Act (NEPA), if the doses remain within regulatory limits. The FCS Defueled Safety Analysis Report (DSAR) provides a summary of the evaluation of plant transients that have a potential impact on both occupational and public safety and health. The risk of accidents resulting in a significant radiological release during decommissioning activities is considerably less than during plant operations.

The analysis of decommissioning events includes all phases of decommissioning activities: decontamination, dismantlement, packaging, storage, radioactive materials handling, and license termination activities (including final status surveys). The following radiological events were identified as having the potential to affect public health and safety:

- Decommissioning activity events.
- Loss of support system events, including loss of offsite power.
- Fire and explosion events.
- External events.
- Spent fuel storage events (including ISFSI).

The dose consequences resulting from radiological events, identified as having the potential to affect public health and safety, are below the EPA PAGs and the criteria of 10 CFR 100, the associated impacts on the environment are minimal.

5.1.10 Occupational Issues

The environmental impacts of occupational issues have been determined by the NRC to be generically applicable with a small impact. The NRC's analysis of the environmental impacts of occupational issues is documented in Section 4.3.10 of Supplement 1 to NUREG-0586. OPPD has not identified any new information or significant environmental change associated with the site-specific termination activities related to the end use of the site.

As Supplement 1 to the FGEIS indicates, the Occupational Safety and Health Act of 1970 was enacted to protect the health of workers, and applicable regulations are administered by the Occupational Safety and Health Administration (OSHA). YNPS is subject to 29 CFR 1910 and 1926 for worker health and safety protection under OSHA regulations. These requirements are implemented under existing plant programs and procedures.

5.1.11 Socioeconomics

5.1.11.1 General Demography

FCS is in largely rural and agricultural Washington County, Nebraska. According to 2010 Census data, approximately 981,137 people live within 50 miles of the station in both Nebraska and Iowa. Of these, 442,242 live within 20 miles of the station. (USCB 2012a).

Omaha lies approximately 19 miles south of FCS. It is the 45th largest city in the United States with a population of approximately 408,958 according to 2010 Census data (USCB 2012b). The Omaha-Council Bluffs Metropolitan Area is the 59th largest metropolitan statistical area (MSA) in the United States, with an estimated decennial population of 865,350 (USCB 2012c). The Omaha-Council Bluffs MSA includes Washington, Douglas, and Sarpy Counties, as well as Pottawattamie and Harrison Counties in Iowa.

Blair, the nearest municipality to FCS (3 miles to the northwest) and the largest in Washington County, has a population of 7,990 according to year 2010 U.S. Census Bureau estimates. Fort Calhoun lies approximately 5 miles to the southeast of FCS and has an estimated year 2010 population of 908. Missouri Valley City, approximately 11 miles east of FCS, is the largest municipality in Harrison County, Iowa. It has an estimated year 2010 population of 2,838 (USCB 2012b).

Approximately one-half of the Winnebago and Omaha reservations in Thurston County fall within the 50-mile radius of FCS. According to U.S. Census Bureau year 2010 estimates, approximately 6,940 people reside on these tribal lands. Offutt Air Force Base is south of Omaha, approximately 30 miles southeast of FCS, and has a year 2010 population of 4,644.

Although OPPD may have some effect on the region as a whole, the vast majority of FCS employees have resided in Washington, Douglas, and Sarpy Counties. Any effect on the local economy will be due to the approximately 400 jobs lost due to plant closure, because as a public utility the closure of FCS does not affect the local tax base.

FCS employees may be expected to impact the economy the most in terms of real estate and consumer goods within the Counties where they live. Therefore, any effects of FCS's closure can be expected to be focused within these Counties. Although effects outside of the Counties are possible, if the effects within these Counties are negligible it can be expected that effects in the surrounding area are also negligible.

Table 5-1-2 below depicts the population data within Douglas, Sarpy, and Washington Counties for 2000 and 2010 Census data, and 2012-2016 American Community Survey (ACS) 5-year estimates.

Table 5-1-2. 2000 and 2010 Census Population Data Comparison[1]

Year	Douglas	Sarpy	Washington	Nebraska
2000	463,585	122,595	18,780	1,711,265
2010	517,110	158,840	20,234	1,826,341
2015	550,064	175,692	20,248	1,896,190
2017	561,620	181,439	20,721	1,920,076

1. Data is from the U.S. Census Bureau's *Nebraska: 2010 Population and Housing Unit Counts* (USCB 2012b) and Unweighted Sample Count of the Population. 2017 American Community Survey 1-Year Supplemental Estimates with a Population Threshold of 20,000 or more (USCB 2018).

The data generally demonstrate increasing population on par with the Nebraska average as a whole. Washington County demonstrates a reduced growth rate from 2010 to 2017, however, this was due to stagnant growth from 2010 to 2015 and cannot be attributed to the closure of FCS.

5.1.11.1.1. Minority Populations

Tables 5-1-3 and 5-1-4 below depict the population data within Nebraska as a whole as well as Douglas, Sarpy, and Washington Counties from the annual survey updates.

Table 5-1-3. 2014 Projected Population Data Comparison with Minority Populations[1]

Minority Population	Nebraska	Douglas County	Sarpy County	Washington County
Black or African American Alone	4.7%	11.1%	4.1%	0.6%
American Indian and Alaska Native	1.0%	0.9%	0.3%	0.1%
Asian Alone	2.1%	3.2%	2.3%	0.1%
Other Race	1.6%	1.8%	0.8%	0.2%
Hispanic	10.1%	11.8%	8.3%	0.6%
Two or More Races	2.3%	2.9%	3.4%	1.4%

1. Data is from the U.S. Census Bureau's Race Data from 2014 (USCB 2014) and Race Data from 2017 (USCB 2017a) American Community Survey 1-Year Supplemental Estimates with a Population Threshold of 20,000 or More.

Table 5-1-4. 2017 Projected Population Data Comparison with Minority Populations[1]

Minority Population	Nebraska	Douglas County	Sarpy County	Washington County
Black or African American Alone	4.6%	10.9%	3.3%	0.8%
American Indian and Alaska Native	0.8%	0.4%	0.4%	0.4%
Asian Alone	2.5%	3.9%	2.9%	0.4%
Other Race	2.0%	1.7%	2.6%	Data Not Available
Hispanic	10.9%	12.7%	9.4%	3.1%
Two or More Races	2.7%	3.3%	3.3%	1.2%

1. Data is from the U.S. Census Bureau's Race Data from 2014 (USCB 2014) and Race Data from 2017 (USCB 2017a) American Community Survey 1-Year Supplemental Estimates with a Population Threshold of 20,000 or More.

In general, the minority population numbers can be said to be relatively stable between 2014 and 2017. The changes that have occurred have been increases in minority population within the counties closest to FCS. These data demonstrate that the closing of FCS has not reduced minority populations. Due to the small size of the job losses and the lack of any effect on the tax base there is no reason that minority populations should be affected.

5.1.11.1.2 Low-Income Populations

NRC guidance defines "low-income" using U.S. Census Bureau statistical poverty thresholds. U.S. Census Bureau data was used to analyze trends in the percentage of families whose income in the past 12 months was below the poverty level. Data were analyzed across the 2000 Census, the 2010 Census, and

the 2012-2016 ACS 5- year estimates for Washington, Douglas, and Sarpy counties. The 2012-2016 ACS 5-year estimates are based on data collected between January 1, 2012 and December 31, 2016. The results are presented in Table 5-1-5 below.

Table 5-1-5. 2014 Projected Minority Population Data Comparison Across Counties[1]

Year	Douglas	Sarpy	Washington	Nebraska	Midwest
2000	9.8%	4.2%	6.0%	9.7%	10.2%
2010	13.1%	5.7%	4.4%	11.8%	13.1%
2012-2016	14.2%	6.2%	9.2%	12.4%	14.2%

1. Data is from the U.S. Census Bureau *Profile of Selected Economic Characteristics: 2000* (USCB 2002); *Selected Economic Characteristics 2012-2016* American Community Survey 5-Year Estimates (USCB 2017b); and *ACS Demographics and Housing Estimates*. 2006-2010 American Community Survey 5-Year Estimates (USCB 2012d).

As the data shows, the poverty rates in Douglas, Sarpy, and Washington Counties parallel a general trend of rising poverty in Nebraska as a whole. The rise in poverty has slowed somewhat due to the generally improved economy since 2010.

According to the 2012-2016 ACS 5-Year Estimates, there are a total of approximately 296,000 employed workers in Douglas County, 90,000 in Sarpy County, and 11,000 in Washington County. For the three Counties together, losing 400 jobs would cause a loss of jobs of 0.1%. Therefore, the FCS closure should not have a significant adverse impact on the local economy in the years following closure. The similarity between the trajectory of the local and regional numbers demonstrates that, according to the most recent available data, no difference in rates of poverty can be attributed to the closure of FCS.

5.1.12 Environmental Justice

Executive Order 12898 dated February 16, 1994, directs Federal executive agencies to consider environmental justice under NEPA. It is designed to ensure that low-income and minority populations do not experience disproportionately high and adverse human health or environmental effects because of Federal actions.

Based on 2010 census data, the minority population within a 20-mile radius comprises of 21.2% of the total population, and within a 50-mile radius is 16.6% of the total population. Douglas County is composed of greater than 10% black and 10% Hispanic populations. Thurston County is composed of the Omaha and Winnebago reservations. Native Americans comprised 55% according to 2010 data.

Section 4.13.3 of the GEIS reviewed environmental justice decommissioning impacts related to land use, environmental and human health, and socioeconomics. OPPD does not anticipate any offsite land disturbances during decommissioning, thus the land use impacts are not applicable for FCS. In addition, as previously discussed in Section 5.1.12, it was determined that socioeconomic impacts from decommissioning are bounded by the GEIS. Potential impacts to minority and low-income populations would mostly consist of radiological effects. Based on the radiological environmental monitoring program data from FCS, the SEIS determined that the radiation and radioactivity in the environmental media monitored around the plant have been well within applicable regulatory limits. As a result, the SEIS found that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations (i.e., minority and or low-income populations) in the region as a result of subsistence consumption of water, local food, fish, and wildlife.

Therefore, OPPD concludes that there are no significant adverse impacts on environmental justice resulting from FCS decommissioning.

5.1.13 Cultural, Historic and Archaeological Resources

Based on a review of the FCS property through the Nebraska State Historic Preservation Office (NSHPO) files and information provided by the applicant, the NRC concluded in Section 4.4.5 of the SEIS (OPPD 2003b) that the potential impacts from decommissioning of FCS on historic and archaeological resources would be small. The NRC identified the section of the FCS site that lies north of the rail spur and bounded on the west by U.S. Highway 75 as having Moderate to High Potential for archaeological resources. It contains remnants of the former Town of Desoto, a historic property that is potentially eligible for listing on the National Register of Historic Places. It is anticipated that the decommissioning of the FCS site will have no potential for impacts to cultural resources either pre-historic or historic under Section 106 of the National Historic Preservation Act since all proposed ground disturbance is proposed on previously disturbed areas of the FCS site, the FCS site is situated on floodplain alluvium soil, because FCS was constructed after 1850, and since all decommissioning activities will occur south of the current Union Pacific rail spur. Environmental review procedures have been put in place at FCS regarding ground disturbance activities in undisturbed surface and subsurface areas. These environmental protection procedures include contacting the NESHPO to establish the actions necessary to protect known or as of yet undiscovered cultural resources before an action is allowed to occur. The cultural, historic, and archeological impact evaluation conducted in the GEIS (NRC 2002) focused on similar attributes as the SEIS (OPPD 2003b). The GEIS evaluated direct effects such as land clearing and indirect effects such as erosion and siltation.

The conclusion for the license renewal evaluation is also applicable to the decommissioning period because:

1. Decommissioning activities will be primarily contained to disturbed areas located away from areas of existing or high potential for archaeological sites;
2. Construction activities that disturb one acre or greater of soil are permitted by NDEQ approval and BMPs are required to control sediment and the effects of erosion; and
3. Environmental protection procedures pertaining to archaeological and cultural resources will remain in effect during decommissioning.

Figure 5.4 depicts the locations of the nearest cultural resources based on a recent (October 2018) search of publicly available data. In addition, OPPD submitted a letter of inquiry to the NESHPO in October 2018 requesting a review of the proposed decommissioning activities at the FCS site and any potential for impacts to any know cultural resources in the vicinity (See Appendix D). A response from NESHPO has not been received since the date of this ER update. Updated correspondence with the NESHPO will be forwarded to the NRC as they are received.

5.1.14 Aesthetic Resources

During decommissioning, the impact of activities on aesthetic resources will be temporary and remain consistent with the aesthetics of an industrial plant. In most cases, Section 4.3.15 of the GEIS concludes that impacts such as dust, construction disarray, and noise would not easily be detectable offsite.

After the decommissioning process is complete, site restoration activities may result in structures being removed from the site and the site being backfilled, graded and landscaped as needed. The GEIS concludes that the removal of structures is generally considered beneficial to the aesthetic impacts of the region. Therefore, OPPD concludes that the impacts of FCS decommissioning on aesthetic issues are consistent with the conclusions made in the GEIS.

5.1.15 Noise

General noise levels during the decommissioning process are not expected to be any more severe than typical construction activities and are not expected to present an audible intrusion on the surrounding community. Some decommissioning activities may result in higher than normal onsite noise levels (i.e., some types of demolition activities). However, these noise levels would be temporary and are not expected to produce an audible intrusion onto the surrounding community.

Section 4.3.16 of the GEIS indicates that noise impacts are not detectable or destabilizing and makes a generic conclusion that potential noise impacts are small. Based on the standard decommissioning approach proposed for FCS, OPPD concludes that the impacts of FCS decommissioning on noise are consistent with the findings in the GEIS.

5.1.16 Transportation

The transportation impacts of decommissioning are dependent on the number of shipments to and from the plant, the types of shipments, the distance the material is shipped, and the radiological waste quantities and disposal plans. The shipments from the plant would be primarily radioactive wastes and nonradioactive wastes associated with dismantlement and disposal of SSCs.

The estimated volume of radioactive waste associated with FCS decommissioning either destined for land disposal (Class A, B and C) or a geologic repository (for GTCC waste) is summarized as follows:

- Class A: 198,630 cubic feet
- Class B: 725 cubic feet
- Class C: 963 cubic feet
- GTCC: 1,179 cubic feet

Decommissioning wastes from FCS may be disposed of at the Waste Control Specialists site in Andrews County, Texas and or Energy*Solutions* site in Clive, Utah. See Figure 5.5 for potential waste facility locations. In addition to the above, there will also be 26,406 tons of scrap metal waste that will be processed/conditioned at an offsite recycling center. Clean construction and debris material will likely be transported to Pheasant Point land fill in Douglas County.

Table 4-7 of the GEIS estimated that the volume of land needed for LLRW disposal from the referenced PWR was 591,600 cubic feet. OPPD estimates the LLRW volume (Class A, B, and C) for FCS that is destined for land disposal will be approximately 163,921 cubic feet. This volume of radioactive waste is well within the range analyzed in the GEIS.

OPPD must comply with applicable regulations when shipping radioactive waste from decommissioning. The NRC has concluded in Section 4.3.17 of the GEIS that these regulations are adequate to protect the public against unreasonable risk from the transportation of radioactive materials.

The number of GTCC waste shipments expected to occur during decommissioning is expected to be ≤ 2, which is below the number referenced in Table 4-6 of the GEIS. These shipments will occur over 11 years and will not result in significant changes to local traffic density or patterns, the need for construction of new methods of transportation, or significant radioactive exposure/dose to workers or the public.

In addition, shipments of non-radioactive wastes from the FCS site are not expected to result in measurable deterioration of affected roads or a destabilizing increase in traffic density. OPPD is also contemplating the use of freight rail for the transportation of waste from the FCS site. A detailed transportation plan has not yet been developed, but it is anticipated that any potential impacts resulting from the transport of waste material to and/or from the FCS site whether by rail or road will not have significant or adverse impacts to the local community. It is anticipated that any impacts to public roads or the local rail system will be properly mitigated for after decommissioning has been completed.

5.1.17 Irreversible and Irretrievable Commitment of Resources

Irreversible commitments are commitments of resources that cannot be recovered, and irretrievable commitments of resources are those that are lost for only a period of time.

Uranium is a natural resource that is irretrievably consumed during power operation. After the plant is shutdown, uranium is no longer consumed. The use of the environment (air, water, land) is not considered to represent a significant irreversible or irretrievable resource commitment, but rather a relatively short-term investment. Since the FCS site will be decommissioned to meet the unrestricted release criteria found in 10 CFR 20.1402, the land is not considered an irreversible resource. The only irretrievable resources that would occur during decommissioning would be materials used to decontaminate the facility (e.g., rags, solvents, gases, and tools), and the fuel used for decommissioning activities and transportation of materials to and from the site. However, the use of these resources is minor.

Therefore, OPPD concludes that the impacts of FCS decommissioning on irreversible and irretrievable commitment of resources are not significant or adverse.

5.2 ENVIRONMENTAL IMPACTS OF LICENSE TERMINATION – NUREG-1496

According to the schedule provided in Section 2 of this report, an LTP for FCS will not be developed until approximately two years prior to the final site decontamination (approximately the year 2025). At that time, a supplemental ER will be submitted as required by 10 CFR 50.82(a) (9). Detailed planning for license termination activities has commenced including the evaluation of groundwater quality, unusual demographics, or impediments to achieving unrestricted release. Current understanding suggests that impacts resulting from license termination will be similar to those evaluated in the GEIS (NUREG-1496).

5.3 DISCUSSION OF DECOMMISSIONING IN THE SEIS

Postulated impacts associated with decommissioning are discussed in Section 7.0 of the SEIS (OPPD 2003b), which identified six issues related to decommissioning as follows:

- Radiation Doses

- Waste Management
- Air Quality
- Water Quality
- Ecological Resources
- Socioeconomic Impacts

The NRC staff did not identify any new and significant information during their independent review of the FCS license renewal ER at that time (OPPD 2002a), the site audit, or the scoping process for license renewal. Therefore, the NRC concluded that there are no impacts related to these issues beyond those discussed in the GEIS for license renewal (NRS 1996; 1999) or the GEIS for decommissioning (NRC 2002). For the issues above, the license renewal and decommissioning GEISs both concluded the impacts are small. The NRC found no site-specific issues related to decommissioning and there are no decommissioning activities contemplated that would alter that conclusion.

5.4 ADDITIONAL CONSIDERATIONS

While not quantitative, the following considerations are relevant to concluding that decommissioning activities will not result in significant environmental impacts not previously reviewed:

- The release of effluents will continue to be controlled by plant license requirements and plant procedures.

- FCS will continue to comply with the ODCM, Radiological Environmental Monitoring Program, and the Groundwater Protection Initiative (GPI) Program during decommissioning.

- Releases of non-radiological effluents will continue to be controlled per the requirements of the NPDES permit and applicable State of Nebraska permits.

- Systems used to treat or control effluents during power operation will either be maintained or replaced by temporary or mobile systems for the decommissioning activities.

- Radiation protection principles used during plant operations will remain in effect during decommissioning.

- Sufficient decontamination and source term reduction prior to dismantlement will be performed to ensure that occupational dose and public exposure will be maintained below applicable limits.

- Transport of hazardous and or radioactive waste will be completed in accordance with plant procedures, applicable Federal regulations, and the requirements of the receiving facility.

- Site access control during decommissioning will minimize or eliminate radiation release pathways to the public.

Additionally, NUREG-2157 found that the generic environmental impacts of ongoing spent fuel storage are small (NRC 2013).

5.5 CONCLUSIONS

Based on the above discussions, OPPD concludes that the environmental impacts associated with planned FCS site-specific decommissioning activities will be bounded by appropriate, previously issued EISs. Specifically, the environmental impacts are bounded by the GEIS (NRC 2002) and SEIS (OPPD 2003b).

- The postulated impacts associated with the decommissioning method chosen, DECON, have already been considered in the SEIS and GEIS.

- There are no unique aspects of FCS or of the decommissioning techniques to be utilized that would invalidate the conclusions reached in the SEIS and GEIS.

- The methods assumed to be employed to dismantle and decontaminate FCS are standard construction-based techniques fully considered in the SEIS and GEIS.

Therefore, it can be concluded that the environmental impacts associated with the site-specific decommissioning activities for FCS will be bounded by appropriate previously issued EISs.

10 CFR 50.82(a) (6) (ii) states that licensees shall not perform any decommissioning activities, as defined in 10 CFR 50.2 that result in significant environmental impacts not previously reviewed. No such impacts have been identified.

References

1. AEC (U.S. Atomic Energy Commission). 1972. *Final Environmental Statement Related to the Operation of Fort Calhoun Station, Unit 1; Omaha Public Power District.* Docket No. 50-285. August 1972.

2. ESI (Environmental Solutions & Innovations, Inc.). 2018. *Northern Long-Eared Bat Acoustic and Mist Net Surveys on Fort Calhoun Station in Washington County, Nebraska*. September 2018.

3. NGPC (Nebraska Game and Parks Commission). 2018. *Conservation Planning Report*, OPPD Fort Calhoun Property Record Request. October 2018.

4. NRC (United States Nuclear Regulatory Commission). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants.*NUREG-1437, Volumes 1 and 2. May 1996.

5. NRC. 1997. *Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criterial for License Termination of NRC-Licensed Nuclear Facilities*. NUREG-1496, July 1997.

6. NRC. 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants. Section 6.3-Transportation, Table 9.1, Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants*. Final Report. NUREG-1437. Volume 1. Addendum 1. August 1999.

7. NRC. 2002. *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities.* Final Report. NUREG-0586, Supplement 1, Vol. 1. November 2002.

8. NRC. 2013. *Standard Format and Content for Post-Shutdown Decommissioning Activities Report.* Regulatory Guide 1.185, Revision 1. June 2013.

9. OPPD (Omaha Public Power District). 1999. *Fort Calhoun Station Unit No. 1 Offsite Dose Calculation Manual*. July 1999.

10. OPPD. 2001a. *Fort Calhoun Station Radiological Environmental Operating Report 2000.* 2001.

11. OPPD 2001b. *Fort Calhoun Station Unit No. 1 Updated Safety Analysis Report*. Revised June 2001.

12. OPPD. 2002a. *Applicant's Environmental Report Operating License Renewal Stage, Fort Calhoun Station Unit 1*, Appendix E. January 2002.

13. OPPD. 2002b. *Fort Calhoun Station Radiological Environmental Operating Report 2001*. 2002.

14. OPPD. 2002c. *Fort Calhoun Station Unit No. 1 Annual Report for Technical Specification Section 5.9.4.A, January 1, 2001 to December 31, 2001 (Annual Radiological Effluent Release Report)*. March 2002.

15. OPPD. 2003a. *Supplement to the Omaha Public Power Districts Fort Calhoun Station 2001 Annual Radiological Release Report for Technical Specification*, Section 5.9.4.A. April 2003.

16. OPPD. 2003b. *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants, Supplement 12, Regarding Fort Calhoun Nuclear Power Station*. NUREG-1437. August 2003.

17. OPPD. 2016. *Limited Radiological Characterization Survey Plan for Decommissioning of the Fort Calhoun Nuclear Power Station.* October 2016.

18. TLG (TLG Services, Inc.). 2017. *Post-Shutdown Decommissioning Activities Report for the Fort Calhoun Station*. March 2017.

19. T.S. LaGuardia (T.S. LaGuardia et al.). 1986. *Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates*. AIF/NESP-036. May 1986.

20. TSSD (TSSD Services, Inc.). 2016. *Fort Calhoun Nuclear Station Historical Site Assessment Report*. October 2016.

21. TSSD. 2017. *Fort Calhoun Station Limited Site Radiological Characterization Survey Report*. January 2017.

22. USCB (United States Census Bureau). 2002. *Profile of Selected Economic Characteristics: 2000. Census 2000 Summary File 3*. Retrieved from: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_00_SF3_DP3&prodType=table. 2002.

23. USCB. 2012a*. Race Demographics in the 2010 Census*. GIS Data. 2012.

24. USCB. 2012b*. Nebraska: 2010 Population and Housing Unit Counts*. Retrieved from https://www.census.gov/prod/cen2010/cph-2-29.pdf. 2012.

25. USCB. 2012c. *Patterns of Metropolitan and Micropolitan Population Change: 2000 to 2010*. Table 1. Retrieved from https://www.census.gov/library/publications/2012/dec/c2010sr-01.html. 2012.

26. USCB. 2012d. *ACS Demographics and Housing Estimates. 2006-2010 American Community Survey 5-Year Estimates.* Retrieved from: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_10_5YR_DP05&prodType=table.

27. USCB. 2014. Race Data from 2014 American Community Survey 1-Year Supplemental Estimates with A population Threshold of 20,000 or more. Retrieved from: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_SPL_K200201&prodType=table. 2014.

28. USCB. 2017a. Race Data from 2017 American Community Survey 1-Year Supplemental Estimates with A population Threshold of 20,000 or more. Retrieved from: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_SPL_K200201&prodType=table. 2017.

29. USCB. 2017b. *Selected Economic Characteristics. 2012-2016 American Community Survey 5-Year Estimates.* Retrieved from:

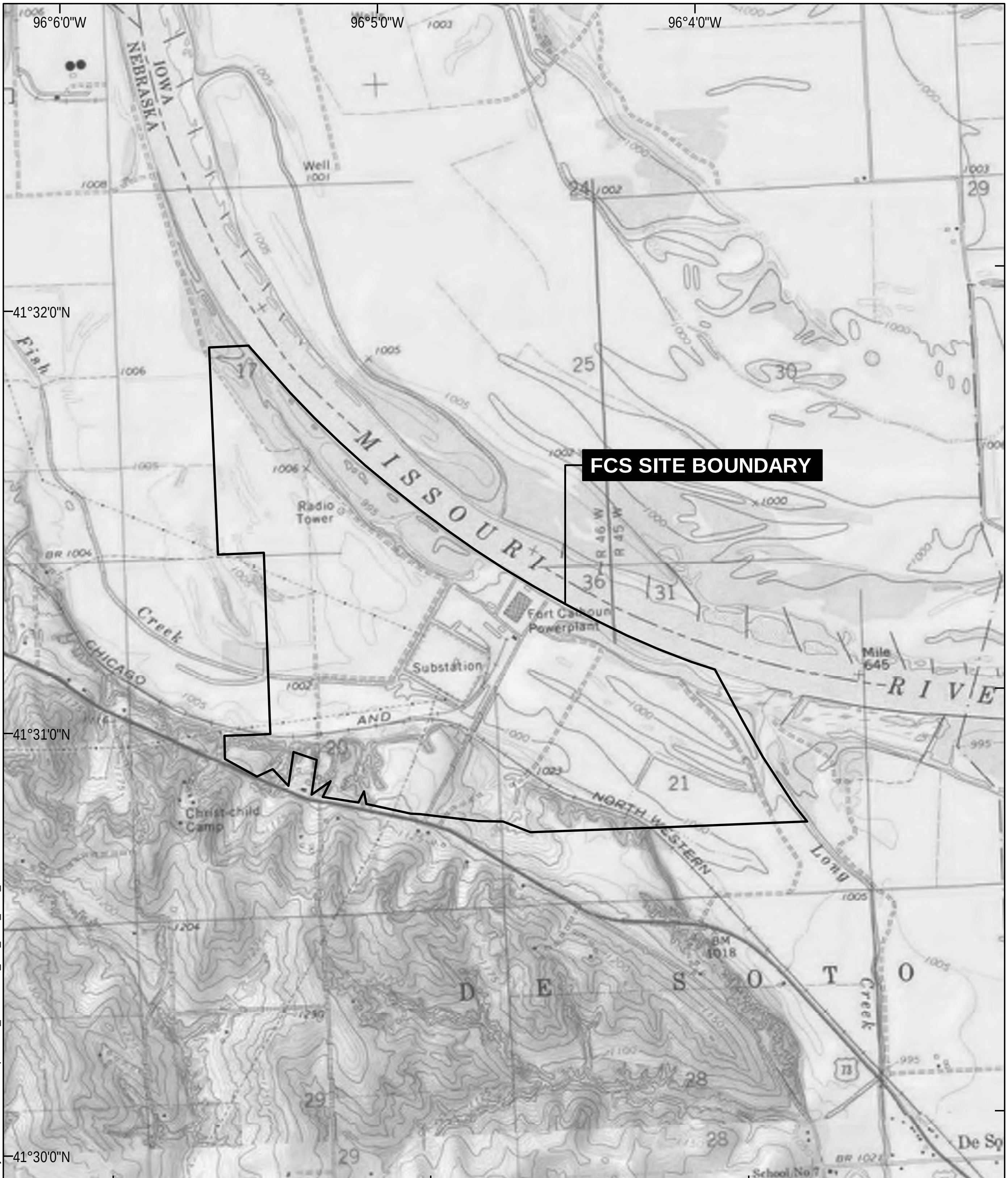
https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_16_5YR_DP03&prodType=table.

30. USCB. 2018. *Unweighted Sample Count of the Population. 2017 American Community Survey 1-Year Supplemental Estimates With A Population Threshold of 20,000 or More.* Retrieved from: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_SPL_K200001&prodType=table. 2018.

31. USDI (United States Department of the Interior). 2018. *List of Threatened and Endangered Species That May Occur in your Proposed Project Location, and/or may be Affected by your Proposed Project.* Fish and Wildlife Service, Nebraska Ecological Services Field Office. November 2018.

USFWS (United States Fish & Wildlife Service). 2018. IPac Information for Planning and Consultation. Retrieved from https://ecos.fws.gov/ipac. Accessed November 2018.

FIGURES



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MAP SOURCE: USGS
SITE COORDINATES: 41°31'12"N, 96°04'45"W

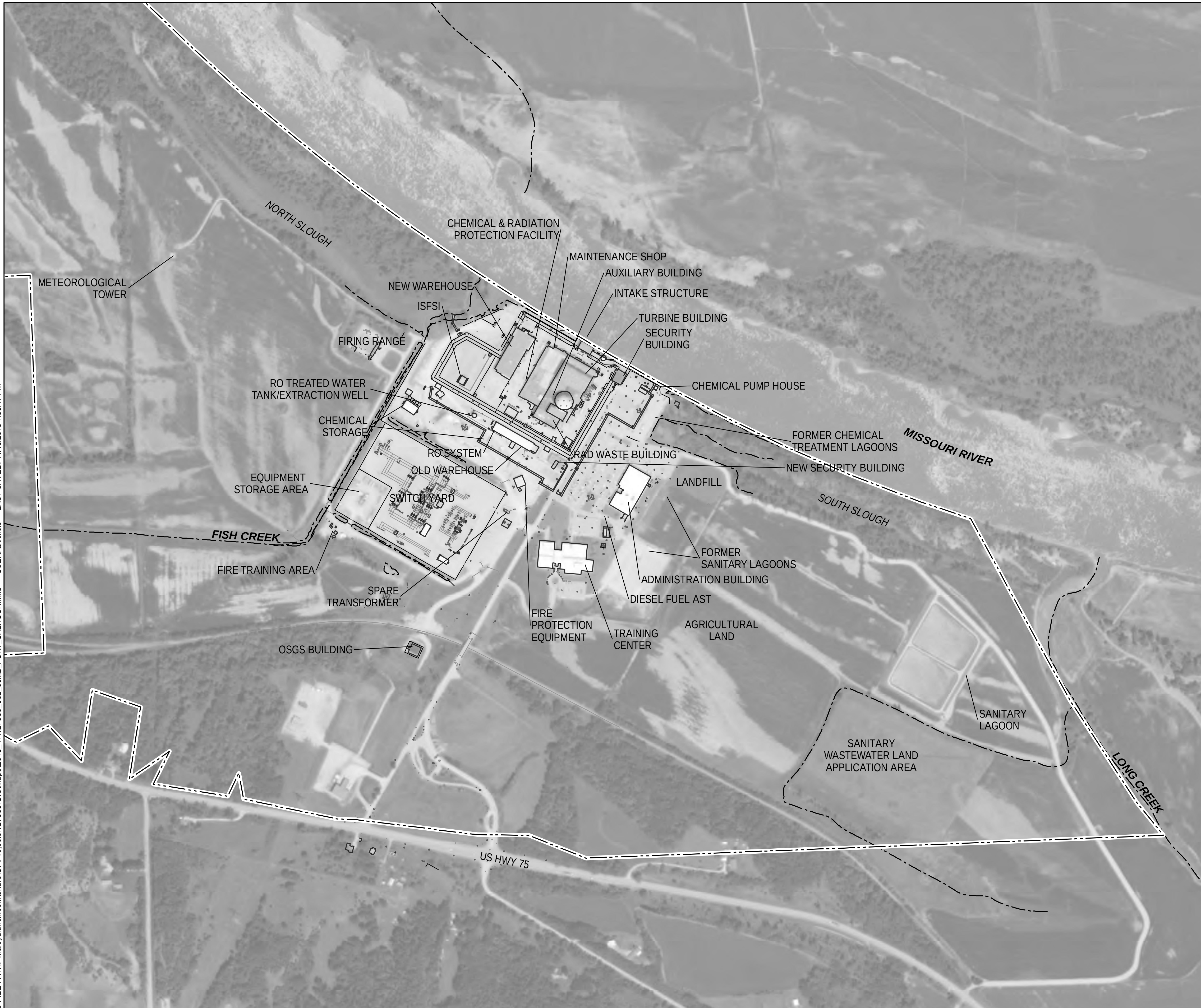
HALEY ALDRICH

FORT CALHOUN STATION
POWER LANE
BLAIR, NEBRASKA

SITE LOCUS

APPROXIMATE SCALE: 1 IN = 2000 FT
NOVEMBER 2018

FIGURE 1.1



LEGEND

- EXISTING BUILDING
- UTILITY
- STREAM
- PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: ESRI

N

0 700 1,400
SCALE IN FEET

HALEY ALDRICH

FORT CALHOUN STATION
POWER LANE
BLAIR, NEBRASKA

SITE PLAN

NOVEMBER 2018

FIGURE 1.2

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LEGEND

- BUILDING PROPOSED FOR DECOMMISSIONING
- BUILDING TO REMAIN
- LIMITS OF DISTURBANCE
- STREAM
- PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: ESRI

N

0 600 1,200
SCALE IN FEET

HALEY ALDRICH

FORT CALHOUN STATION
POWER LANE
BLAIR, NEBRASKA

DECOMMISSIONING
LIMITS OF DISTURBANCE

NOVEMBER 2018

FIGURE 2.1

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LEGEND

- PAVEMENT/GRAVEL SURFACE TO REMAIN
- AREA TO BE RESTORED WITH TOPSOIL AND SEEDED
- LIMITS OF DISTURBANCE
- STREAM
- PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: ESRI

N

0 600 1,200
SCALE IN FEET

HALEY ALDRICH

FORT CALHOUN STATION
POWER LANE
BLAIR, NEBRASKA

SITE RESTORATION

NOVEMBER 2018

FIGURE 2.2

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LEGEND

- MONITORING WELL
- PROPERTY BOUNDARY
- STREAM

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: ESRI

N

0 300 600

SCALE IN FEET

HALEY ALDRICH

FORT CALHOUN STATION
POWER LANE
BLAIR, NEBRASKA

GROUNDWATER MONITORING WELLS

NOVEMBER 2018

FIGURE 2.3

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LEGEND

LAND COVER

- DEVELOPED
- CULTIVATED CROPS
- DECIDUOUS FOREST
- GRASSLAND/HERBACEOUS
- OPEN WATER
- WOODY WETLAND
- STREAM
- PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. LAND USE DATA SOURCE: MODIFIED FROM NATIONAL LAND COVER DATABASE, 2011
3. AERIAL IMAGERY SOURCE: ESRI

N

0 600 1,200
SCALE IN FEET

HALEY ALDRICH

FORT CALHOUN STATION
POWER LANE
BLAIR, NEBRASKA

LAND USE/VEGETATIVE COVER TYPE

NOVEMBER 2018

FIGURE 5.1

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LEGEND

WETLAND TYPE

- FRESHWATER EMERGENT WETLAND
- FRESHWATER FORESTED/SHRUB WETLAND
- FRESHWATER POND
- RIVERINE
- STREAM
- PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. STREAM DATA SOURCE: NATIONAL HYDROGRAPHY DATASET
3. WETLANDS DATA SOURCE: U.S. FISH AND WILDLIFE SERVICE (USFWS) NATIONAL WETLANDS INVENTORY (NWI)
4. AERIAL IMAGERY SOURCE: ESRI

0 600 1,200

SCALE IN FEET

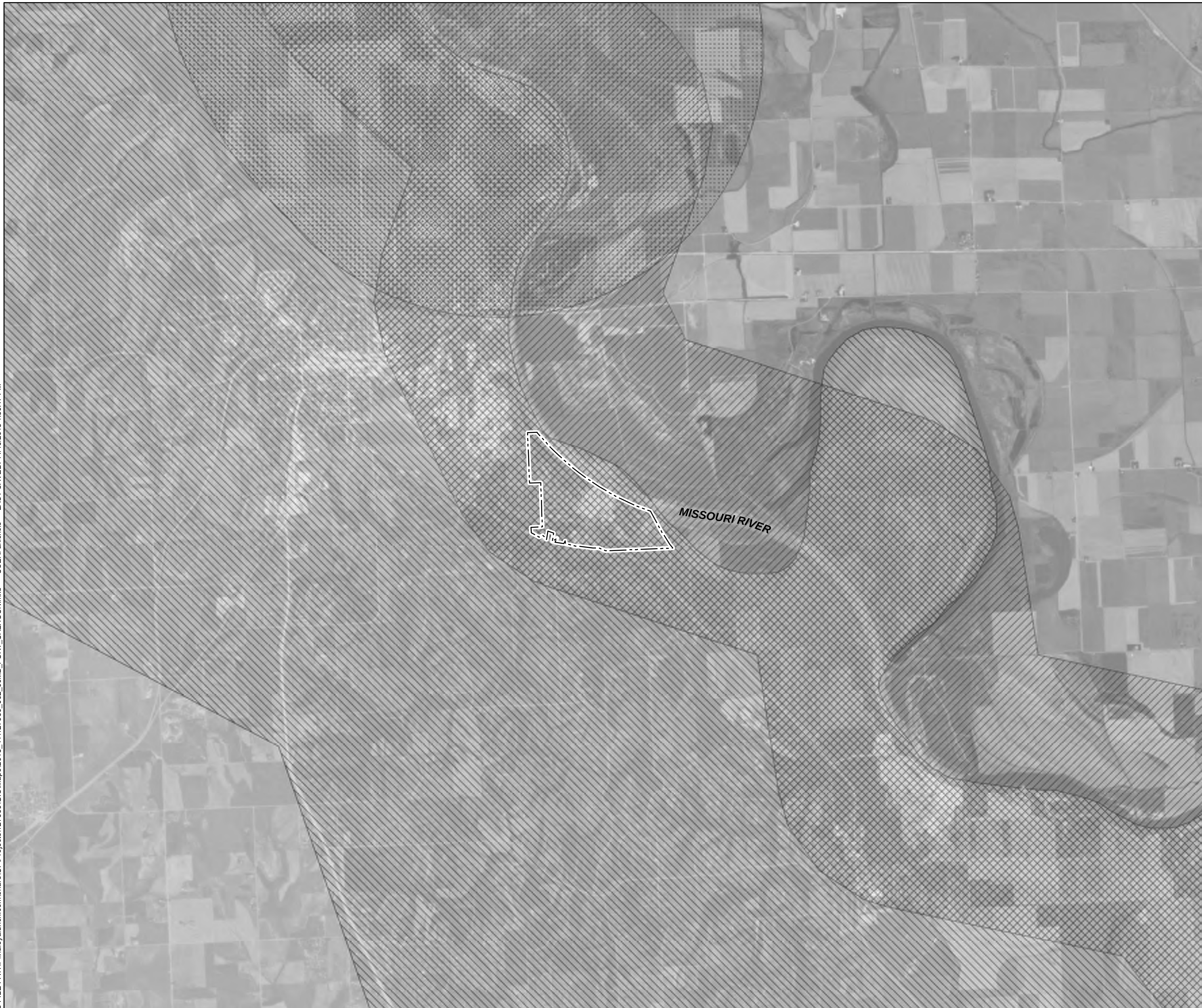
HALEY ALDRICH

FORT CALHOUN STATION
POWER LANE
BLAIR, NEBRASKA

AQUATIC RESOURCES

NOVEMBER 2018

FIGURE 5.2



LEGEND

THREATEND OR ENDANGERED SPECIES

- AMERICAN GINSENG
- LAKE STURGEON, PALLID STURGEON, AND STURGEON
- RIVER OTTER
- NORTHERN LONG-EARED BAT
- PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

2. RANGE MAP OF NEBRASKA THREATENED ENDANGERED SPECIES SOURCE: NEBRASKA NATURAL HERITAGE PROGRAM

3. AERIAL IMAGERY SOURCE: ESRI

N

0 5,900 11,800

SCALE IN FEET

HALEY ALDRICH

FORT CALHOUN STATION
POWER LANE
BLAIR, NEBRASKA

THREATENED AND ENDANGERED SPECIES

NOVEMBER 2018

FIGURE 5.3

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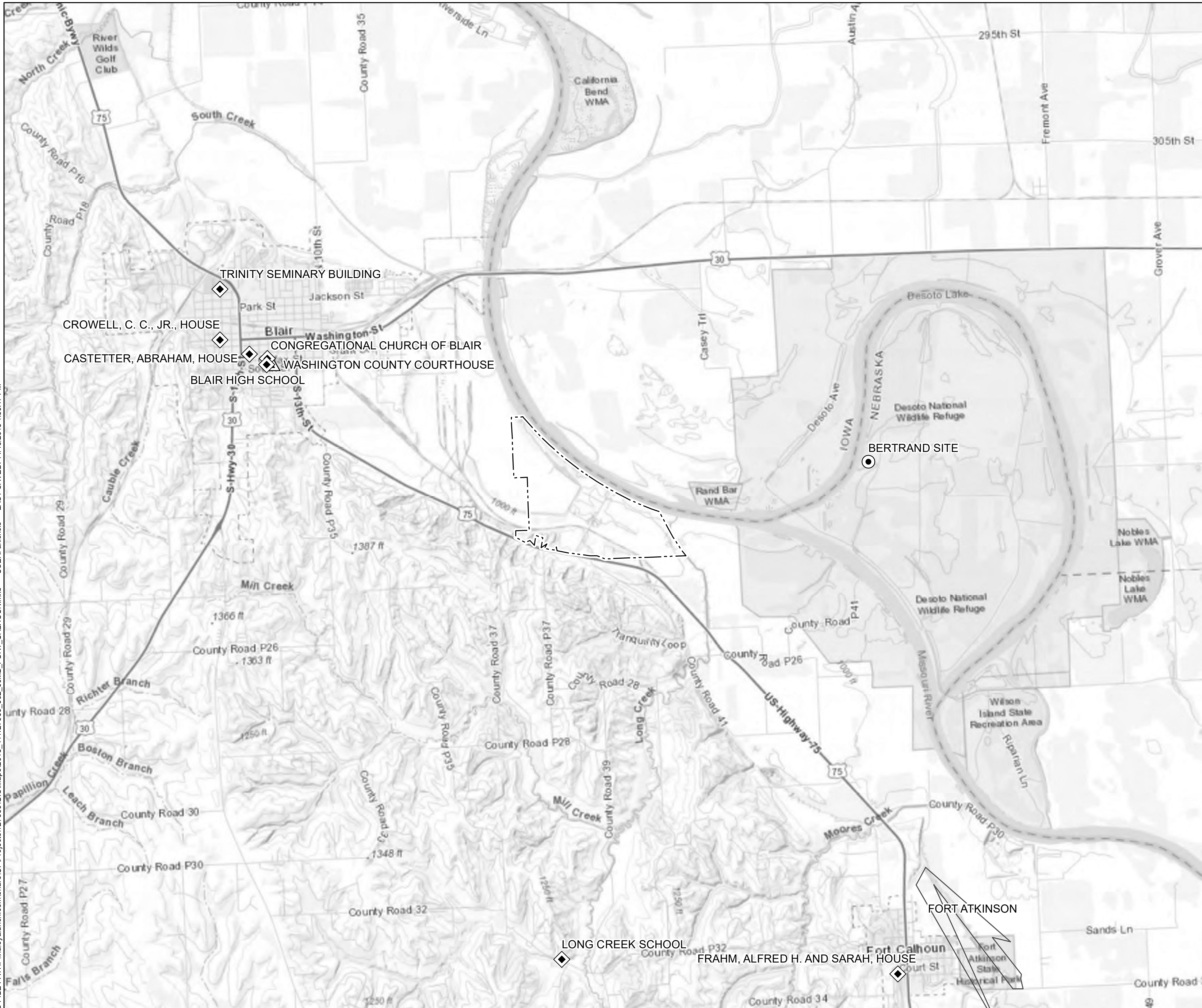

LEGEND

NATIONAL REGISTER OF HISTORICAL PLACES

- BUILDING
- DISTRICT
- SITE
- SITE
- PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. CULTURAL AND HISTORICAL RESOURCE DATA SOURCE: NATIONAL REGISTER OF HISTORICAL PLACES
3. AERIAL IMAGERY SOURCE: ESRI

0 5,000 10,000
SCALE IN FEET

HALEY ALDRICH

FORT CALHOUN STATION
POWER LANE
BLAIR, NEBRASKA

CULTURAL AND HISTORICAL RESOURCES

NOVEMBER 2018

FIGURE 5.4

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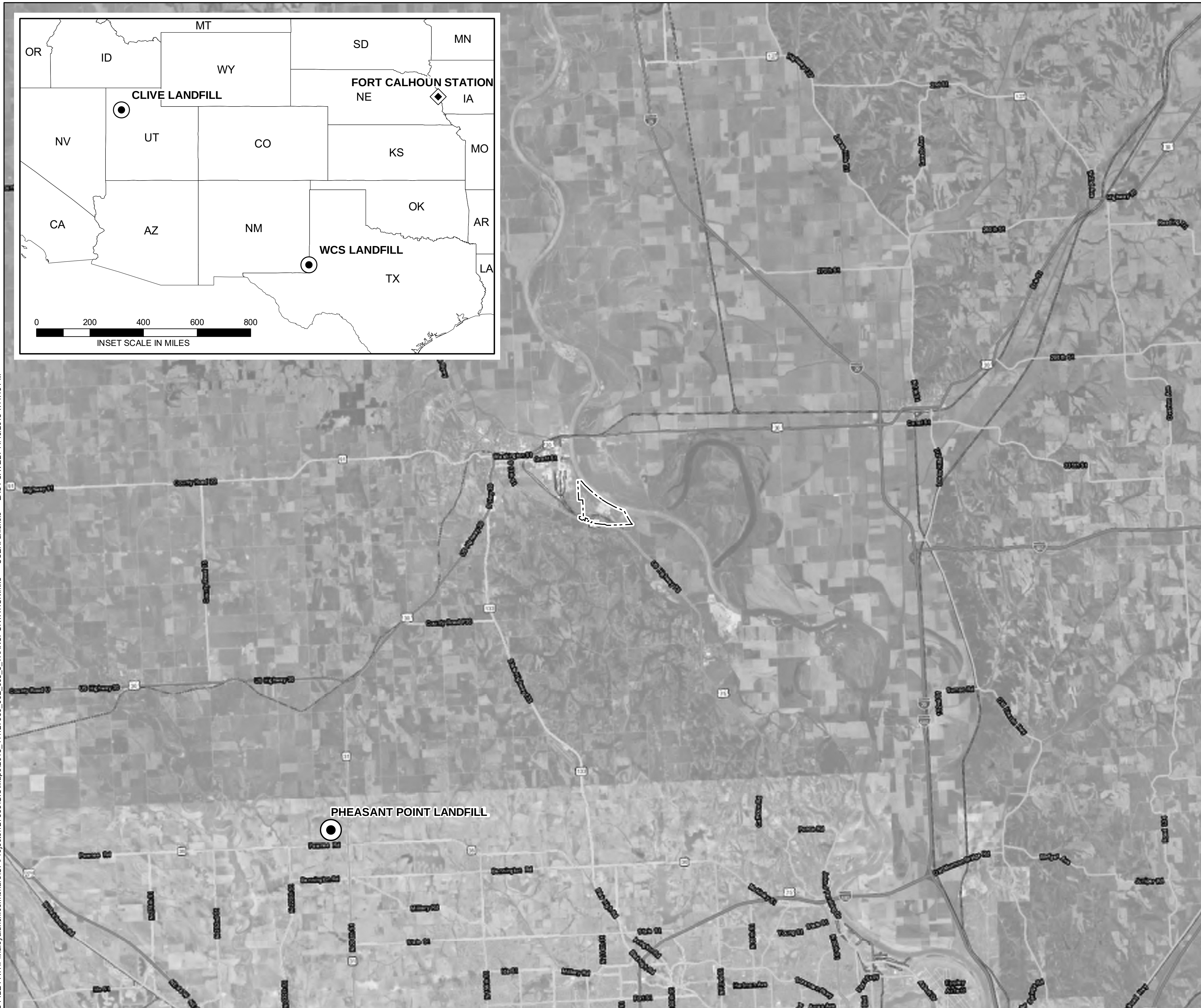

LEGEND

LANDFILL

PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: ESRI

0 14,000 28,000

MAIN MAP SCALE IN FEET

HALEY ALDRICH

FORT CALHOUN STATION
POWER LANE
BLAIR, NEBRASKA

TRANSPORTATION

NOVEMBER 2018

FIGURE 5.5

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APPENDIX A

Decommissioning Cost Estimate (DCE)

Document O02-1737-003, Rev. A

SITE-SPECIFIC DECOMMISSIONING COST ESTIMATE

for the

FORT CALHOUN STATION

prepared for

OMAHA PUBLIC POWER DISTRICT

prepared by

TLG Services, Inc.
Bridgewater, Connecticut

February 2018

APPROVALS

Project Manager	______________________ **William A. Cloutier**	__________ **Date**
Project Engineer	______________________ **John A. Carlson**	__________ **Date**
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DRAFT

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REVISION LOG

No.	Date	Item Revised	Reason for Revision
A	02-28-2018		Draft Issue

EXECUTIVE SUMMARY

This report presents an updated estimate of the cost to decommission the Fort Calhoun Station (Fort Calhoun) for the Nuclear Regulatory Commission's (NRC) approved SAFSTOR decommissioning alternative. The nuclear unit ceased operations on October 24, 2016 and completed the defueling of the reactor on November 13, 2016.[1] A site-specific estimate was prepared in 2016 for the Omaha Public Power District (OPPD) to comply with the requirements of 10 CFR 50.82(a)(8)(iii).[2]

The analysis relies upon the detailed planning that has been performed with the permanent cessation of operations and the site-specific, technical information from an earlier evaluation prepared in 2016,[3] updated to reflect current assumptions pertaining to the disposition of the nuclear unit and relevant industry experience in undertaking such projects.

The current estimate is designed to provide OPPD with sufficient information to assess its financial obligations, as they pertain to the decommissioning of the nuclear unit. It is not a detailed budget and engineering document, but a financial analysis prepared in advance of the detailed budgeting and engineering work that will be required to carry out the decommissioning.

The estimate does include the detailed planning (and budgeting) for placing the unit in safe-storage and moving the spent fuel from the pool located within the fuel handling area of the auxiliary building to the on-site independent spent fuel storage installation (ISFSI). It may not reflect the actual plan to decommission Fort Calhoun following a period of safe storage; the plan may differ from the assumptions made in this analysis based on facts that exist at the time the plant is dismantled.

The projected total cost to decommission the nuclear unit, after an extended period of safe storage, is estimated at $1.295 billion, as reported in 2017 dollars. The cost includes monies anticipated to be spent for operating license termination (radiological remediation), interim spent fuel storage and site restoration activities. The cost is based on several key assumptions in areas of regulation, component characterization, high-level radioactive waste management, low-level radioactive waste disposal,

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1 Letter from OPPD to the NRC, LIC-16-0074, "Certification of Permanent Removal of Fuel from the Reactor Vessel," dated November 13, 2016, NRC Accession No. ML16319A254

2 Within 2 years following permanent cessation of operations, if not already submitted, the licensee shall submit a site-specific decommissioning cost estimate.

3 "Site-Specific Decommissioning Cost Estimate for the Fort Calhoun Station," TLG Document No. O02-1737-001, Rev. 0, February 2017

performance uncertainties (contingency) and site remediation and restoration requirements.

A discussion of the assumptions relied upon in this analysis is provided in Section 3, along with schedules of annual expenditures. A sequence of significant project activities is provided in Section 4 along with a timeline for the scenario. A detailed cost report, used to generate the summary tables presented within this document, is provided in Appendix C.

The estimate includes the continued operation of the fuel handling area of the auxiliary building as an interim wet fuel storage facility for approximately three years (until the end of 2020). During this time period, the spent fuel residing in the storage pool will be transferred to an independent spent fuel storage installation (ISFSI) at the site. The ISFSI will remain operational until the Department of Energy (DOE) is able to complete the transfer of the fuel to a federal facility (e.g., a monitored retrievable storage facility).[4]

DOE has breached its obligations to remove fuel from reactor sites on the contracted schedule, and has also failed to provide plant owners with information about how it will ultimately perform and fulfill its obligation. DOE officials have stated that DOE does not have an obligation to accept already-canistered fuel without an amendment to DOE's contracts with plant licensees to remove the fuel (the "Standard Contract"), but DOE has not explained what costs any such amendment would involve. Consequently, the plant owner has no information or expectations on how DOE will remove fuel from the site in the future. In the absence of information about how DOE will specifically deal with already-canistered fuel, and for purposes of this analysis only, this cost estimate assumes that there will be no additional costs associated with DOE's acceptance of such fuel. If this assumption is incorrect, it is assumed that DOE will have liability for costs incurred to transfer the fuel to DOE-supplied containers, and to dispose of existing containers.

<u>Alternatives and Regulations</u>

The NRC provided general decommissioning guidance in a rule adopted on June 27, 1988.[5] In this rule, the NRC set forth technical and financial criteria for

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4 Projected expenditures for spent fuel management identified in the cost analyses do not consider the outcome of the litigation (including compensation for damages) with the DOE with regard to the delays incurred by the OPPD in the timely removal of spent fuel from the site. As such, this analysis takes no credit for collection of damages, even though utilities are now routinely being awarded such damages in the courts. Collection of spent fuel damages from the DOE is expected to provide the majority of funds needed for spent fuel management.

5 U.S. Code of Federal Regulations, Title 10, Parts 30, 40, 50, 51, 70 and 72 "General Requirements for Decommissioning Nuclear Facilities," Nuclear Regulatory Commission, Federal Register Volume

decommissioning licensed nuclear facilities. The regulations addressed planning needs, timing, funding methods, and environmental review requirements for decommissioning. The rule also defined three decommissioning alternatives as being acceptable to the NRC: DECON, SAFSTOR, and ENTOMB.

> DECON is defined as "the alternative in which the equipment, structures, and portions of a facility and site containing radioactive contaminants are removed or decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of operations."[6]
>
> SAFSTOR is defined as "the alternative in which the nuclear facility is placed and maintained in a condition that allows the nuclear facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use."[7] Decommissioning is required to be completed within 60 years, although longer time periods will be considered when necessary to protect public health and safety.
>
> ENTOMB is defined as "the alternative in which radioactive contaminants are encased in a structurally long-lived material, such as concrete; the entombed structure is appropriately maintained and continued surveillance is carried out until the radioactive material decays to a level permitting unrestricted release of the property."[8] As with the SAFSTOR alternative, decommissioning is currently required to be completed within 60 years, although longer time periods will also be considered when necessary to protect public health and safety.
>
> The 60-year restriction has limited the practicality for the ENTOMB alternative at commercial reactors that generate significant amounts of long-lived radioactive material. In 1997, the Commission directed its staff to re-evaluate this alternative and identify the technical requirements and regulatory actions that would be necessary for entombment to become a viable option. The resulting evaluation provided several recommendations, however, rulemaking has been deferred pending the completion of additional research studies (e.g., on engineered barriers).

53, Number 123 (p 24018 et seq.), June 27, 1988

6 Ibid. Page FR24022, Column 3

7 Ibid.

8 Ibid. Page FR24023, Column 2

In 1996, the NRC published revisions to its general requirements for decommissioning nuclear power plants to clarify ambiguities and codify procedures and terminology as a means of enhancing efficiency and uniformity in the decommissioning process.[9] The amendments allow for greater public participation and better define the transition process from operations to decommissioning. Regulatory Guide 1.184 Revision 1, issued in October 2013, further described the methods and procedures that are acceptable to the NRC staff for implementing the requirements of the 1996 revised rule that relate to the initial activities and the major phases of the decommissioning process. The costs and schedules presented in this analysis follow the general guidance and sequence in the amended regulations. The format and content of the estimate is also consistent with the recommendations of Regulatory Guide 1.202, issued February 2005.[10]

In 2011, the NRC published amended regulations to improve decommissioning planning and thereby reduce the likelihood that any current operating facility will become a legacy site.[11] The amended regulations require licensees to report additional details in their decommissioning cost estimate including a decommissioning estimate for the ISFSI. This estimate is provided in Appendix D.

Basis of the Cost Estimate

For planning purposes, the SAFSTOR decommissioning alternative has been selected by OPPD for Fort Calhoun. In SAFSTOR, the facility is placed in a safe and stable condition and maintained in that state, allowing levels of radioactivity to decrease through radioactive decay. After the safe storage period, the facility is decontaminated and dismantled, removing residual radioactivity so as to permit termination of the operating license and unrestricted use of the site.

The spent fuel will remain in storage at the site until it can be transferred to a DOE facility. The existing ISFSI pad is able to accommodate the entire inventory of spent fuel that has been generated over the reactor's operating life. Based upon the performance assumptions discussed herein, the OPPD anticipates that the removal of spent fuel from the site could be completed by the end of 2058.

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9 U.S. Code of Federal Regulations, Title 10, Parts 2, 50, and 51, "Decommissioning of Nuclear Power Reactors," Nuclear Regulatory Commission, Federal Register Volume 61, (p 39278 et seq.), July 29, 1996

10 "Standard Format and Content of Decommissioning Cost Estimates for Nuclear Power Reactors," Regulatory Guide 1.202, Nuclear Regulatory Commission, February 2005

11 U.S. Code of Federal Regulations, Title 10, Parts 20, 30, 40, 50, 70, and 72, "Decommissioning Planning," Nuclear Regulatory Commission, Federal Register Volume 76, (p 35512 et seq.), June 17, 2011

For purposes of this analysis, the plant is assumed to remain in safe-storage until the spent fuel has been removed from the site (e.g., through 2058), at which time decommissioning will commence. The start date allows sufficient time to accomplish the activities described in this document and to terminate the operating license within the required 60-year time period.

Methodology

The OPPD decommissioning project organization, plant staff, and numerous other subject matter experts have been engaged in the detailed planning and engineering needed to transition the nuclear unit and its operating organization from power generation to safe-storage. This information has been used to create working budgets and a forecast for the next three years, or until the spent fuel is relocated to the ISFSI (years 2018 through 2020), and the plant secured for long-term storage.

The methodology used to develop the estimate for the deferred decontamination and dismantling activities described within this document (years 2059 through 2066) follows the basic approach originally presented in the cost estimating guidelines[12] developed by the Atomic Industrial Forum (now Nuclear Energy Institute). This reference describes a unit factor method for determining decommissioning activity costs. The unit factors used in this analysis incorporate site-specific costs and the latest available information on worker productivity in decommissioning.

An activity duration critical path is used to determine the total decommissioning program schedule. The schedule is relied upon in calculating the carrying costs, which include program management, administration, field engineering, equipment rental, and support services such as quality control and security. This systematic approach for assembling decommissioning estimates ensures a high degree of confidence in the reliability of the resulting cost estimate.

Contingency

Consistent with standard cost estimating practices, contingencies are applied to the decontamination and dismantling costs developed as a "specific provision for unforeseeable elements of cost within the defined project scope, particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events which will increase costs are likely to occur."[13] The cost elements in the estimate are based on ideal conditions; therefore, the types of unforeseeable

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12 T.S. LaGuardia et al., "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," AIF/NESP-036, May 1986

13 Project and Cost Engineers' Handbook, Second Edition, American Association of Cost Engineers, Marcel Dekker, Inc., New York, New York, p. 239.

events that are almost certain to occur in decommissioning, based on industry experience, are addressed through a percentage contingency applied on a line-item basis. This contingency factor is a nearly universal element in all large-scale construction and demolition projects. It should be noted that contingency, as used in this analysis, does not account for price escalation and inflation in the cost of decommissioning over the period of performance (these factors are typically addressed in a funding analysis).

The use and role of contingency within decommissioning estimates is not a safety factor issue. Safety factors provide additional security and address situations that may never occur. Contingency funds, by contrast, are expected to be fully expended throughout the program. Inclusion of contingency is necessary to provide assurance that sufficient funding is available to accomplish the intended tasks.

Low-Level Radioactive Waste Management

The contaminated and activated material generated in the decontamination and dismantling of a commercial nuclear reactor is generally classified as low-level radioactive waste, although not all of the material is suitable for shallow-land disposal. With the passage of the "Low-Level Radioactive Waste Disposal Act" in 1980 and its Amendments of 1985,[14] the states became ultimately responsible for the disposition of low-level radioactive waste generated within their own borders.

With the exception of Texas, no new compact facilities have been successfully sited, licensed, and constructed. The Texas Compact disposal facility, operated by Waste Control Specialists (WCS), is now operational. The facility is able to accept limited quantities of non-Compact waste; however, at this time the cost for non-Compact generators is being negotiated on an individual basis.

Disposition of the various waste streams produced by the decommissioning process considered all options and services currently available to the OPPD. The majority of the low-level radioactive waste designated for direct disposal (Class A[15]) can be sent to Energy*Solutions'* facility in Clive, Utah. Therefore, disposal costs for Class A waste were based upon OPPD's *USA Agreement* with Energy*Solutions*. This facility is not licensed to receive the higher activity portion (Classes B and C) of the decommissioning waste stream.

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14 "Low-Level Radioactive Waste Policy Amendments Act of 1985," Public Law 99-240, January 15, 1986

15 Low-level radioactive waste is classified in accordance with U.S. Code of Federal Regulations, Title 10, Part 61.55

The Texas facility is able to receive the higher activity waste forms (Classes B and C). As such, for this analysis, disposal costs for the Class B and C waste were based upon indicative information on the cost for such from the Texas Commission on Environmental Quality.

The dismantling of the components residing closest to the reactor core generates radioactive waste that may be considered unsuitable for shallow-land disposal (i.e., low-level radioactive waste with concentrations of radionuclides that exceed the limits established by the NRC for Class C radioactive waste (GTCC)). The Low-Level Radioactive Waste Policy Amendments Act of 1985 assigned the federal government the responsibility for the disposal of this material. The Act also stated that the beneficiaries of the activities resulting in the generation of such radioactive waste bear all reasonable costs of disposing of such waste. However, to date, the federal government has not identified a cost for disposing of GTCC or a schedule for acceptance.

For purposes of this analysis only, the GTCC radioactive waste is assumed to be packaged and disposed of in a similar manner as high-level waste and at a cost equivalent to that envisioned for the spent fuel. The GTCC is shipped directly to a DOE facility as it is generated (assuming that the spent fuel has been removed from the site prior to the start of decommissioning).

A significant portion of the waste material generated during decommissioning may only be potentially contaminated by radioactive materials. This waste can be analyzed on site or shipped off site to licensed facilities for further analysis, for processing and/or for conditioning/recovery. Reduction in the volume of low-level radioactive waste requiring disposal in a licensed low-level radioactive waste disposal facility can be accomplished through a variety of methods, including analyses and surveys or decontamination to eliminate the portion of waste that does not require disposal as radioactive waste, compaction, incineration or metal melt. The estimate reflects the savings from waste recovery/volume reduction.

<u>High-Level Radioactive Waste Management</u>

Congress passed the "Nuclear Waste Policy Act" (NWPA) in 1982, assigning the federal government's long-standing responsibility for disposal of the spent nuclear fuel created by the commercial nuclear generating plants to the DOE. The DOE was to begin accepting spent fuel by January 31, 1998; however, to date no progress in the removal of spent fuel from commercial generating sites has been made.

Completion of the decommissioning process is dependent upon the DOE's ability to remove spent fuel from the site in a timely manner. DOE's repository program assumes that spent fuel allocations will be accepted for disposal from the nation's commercial

nuclear plants, with limited exceptions, in the order (the "queue") in which it was discharged from the reactor.[16] The plan for the management of all irradiated fuel at the reactor was based in general upon: 1) a 2034 start date for DOE initiating transfer of commercial spent fuel to a federal facility (not necessarily a final repository), and 2) expectations for spent fuel receipt by the DOE for the Fort Calhoun fuel. The DOE's generator allocation/receipt schedules are based upon the oldest fuel receiving the highest priority. Assuming a maximum rate of transfer of 3,000 metric tons of uranium (MTU)/year, [17] the removal of spent fuel from the site is assumed to be completed in 2058. Different DOE acceptance schedules may result in different completion dates.

Today, the country is at an impasse on high-level waste disposal, despite DOE's submittal of its License Application for a geologic repository to the NRC in 2008. The Obama administration eliminated the budget for the repository program while promising to "conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle … and make recommendations for a new plan."[18] Towards this goal, the administration appointed a Blue Ribbon Commission on America's Nuclear Future (Blue Ribbon Commission) to make recommendations for a new plan for nuclear waste disposal. The Blue Ribbon Commission's charter includes a requirement that it consider "[o]ptions for safe storage of used nuclear fuel while final disposition pathways are selected and deployed."[19]

On January 26, 2012, the Blue Ribbon Commission issued its "Report to the Secretary of Energy" containing a number of recommendations on nuclear waste disposal. Two of the recommendations that may impact decommissioning planning are:

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16 In 2008, the DOE issued a report to Congress in which it concluded that it did not have authority, under present law, to accept spent nuclear fuel for interim storage from decommissioned commercial nuclear power reactor sites. However, the Blue Ribbon Commission, in its final report, noted that: "[A]ccepting spent fuel according to the OFF [Oldest Fuel First] priority ranking instead of giving priority to shutdown reactor sites could greatly reduce the cost savings that could be achieved through consolidated storage if priority could be given to accepting spent fuel from shutdown reactor sites before accepting fuel from still-operating plants. …. The magnitude of the cost savings that could be achieved by giving priority to shutdown sites appears to be large enough (i.e., in the billions of dollars) to warrant DOE exercising its right under the Standard Contract to move this fuel first." For planning purposes only, this estimate does not assume that Fort Calhoun, as a permanently shutdown unit, will receive priority; the fuel removal schedule assumed in this estimate is based upon DOE acceptance of fuel according to the "Oldest Fuel First" priority ranking. The plant owner will seek the most expeditious means of removing fuel from the site when DOE commences performance.

17 "Acceptance Priority Ranking & Annual Capacity Report," DOE/RW-0567, July 2004

18 "Advisory Committee Charter, Blue Ribbon Commission on America's Nuclear Future, Report to the Secretary of Energy," https://energy.gov/sites/prod/files/2013/04/f0/brc_finalreport_jan2012.pdf, Appendix A, January 2012

19 Ibid.

- "[T]he United States [should] establish a program that leads to the timely development of one or more consolidated storage facilities"[20]
- "[T]he United States should undertake an integrated nuclear waste management program that leads to the timely development of one or more permanent deep geological facilities for the safe disposal of spent fuel and high-level nuclear waste."[21]

In January 2013, the DOE issued the "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste," in response to the recommendations made by the Blue Ribbon Commission and as "a framework for moving toward a sustainable program to deploy an integrated system capable of transporting, storing, and disposing of used nuclear fuel..."[22] This document states:

"With the appropriate authorizations from Congress, the Administration currently plans to implement a program over the next 10 years that:

- Sites, designs and licenses, constructs and begins operations of a pilot interim storage facility by 2021 with an initial focus on accepting used nuclear fuel from shut-down reactor sites;
- Advances toward the siting and licensing of a larger interim storage facility to be available by 2025 that will have sufficient capacity to provide flexibility in the waste management system and allows for acceptance of enough used nuclear fuel to reduce expected government liabilities; and
- Makes demonstrable progress on the siting and characterization of repository sites to facilitate the availability of a geologic repository by 2048."[23]

The NRC's review of DOE's license application to construct a geologic repository at Yucca Mountain was suspended in 2011 when the Administration significantly reduced the budget for completing that work. However, the US Court of Appeals for the District of Columbia Circuit issued a writ of mandamus (in August 2013)[24]

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20 "Blue Ribbon Commission on America's Nuclear Future, Report to the Secretary of Energy," https://energy.gov/sites/prod/files/2013/04/f0/brc_finalreport_jan2012.pdf, p. 32, January 2012

21 Ibid., p.27

22 "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste," U.S. DOE, January 11, 2013

23 Ibid., p.2

24 U.S. Court of Appeals for the District Of Columbia Circuit, In Re: Aiken County, et al, Aug. 2013,http://www.cadc.uscourts.gov/internet/opinions.nsf/BAE0CF34F762EBD985257BC6004DEB18/$file/11-1271-1451347.pdf

ordering NRC to comply with federal law and resume its review of DOE's Yucca Mountain repository license application to the extent allowed by previously appropriated funding for the review. That review is now complete with the publication of the five-volume safety evaluation report. A supplement to DOE's environmental impact statement and an adjudicatory hearing on the contentions filed by interested parties must be completed before a licensing decision can be made.

The NRC requires that licensees establish a program to manage and provide funding for the caretaking of all irradiated fuel at the reactor site until title of the fuel is transferred to the DOE.[25] Interim storage of the fuel, until the DOE has completed the transfer, will be in the auxiliary building's spent fuel storage pool, as well as at an on-site ISFSI.

An ISFSI, operated under a Part 50 General License (in accordance with 10 CFR 72, Subpart K[26]), was constructed to support continued plant operations. The facility is able to accommodate all the spent fuel generated during operations. Once the spent fuel storage pool is emptied, the auxiliary building will be prepared for long term storage.

OPPD's position is that the DOE has a contractual obligation to accept the spent fuel earlier than the projections set out in this cost study, consistent with its contract commitments. No assumption made in this study should be interpreted to be inconsistent with this position. However, at this time, including the cost of long-term spent fuel storage at Fort Calhoun in this study and assuming DOE acceptance of fuel on an Oldest Fuel First basis is the most reasonable approach because it insures the availability of sufficient decommissioning funds given that, contrary to its contractual obligation, the DOE has not performed to date.

<u>Site Restoration</u>

The efficient removal of the contaminated materials at the site may result in damage to many of the site structures. Blasting, coring, drilling, and the other decontamination activities can substantially damage power block structures, potentially weakening the footings and structural supports. It is unreasonable to anticipate that these structures would be repaired and preserved after the radiological contamination is removed. The cost to dismantle site structures with a work force already mobilized is more efficient and less costly than if the process is deferred.

[25] U.S. Code of Federal Regulations, Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities," Subpart 54 (bb), "Conditions of Licenses"

[26] U.S. Code of Federal Regulations, Title 10, Part 72, Subpart K, "General License for Storage of Spent Fuel at Power Reactor Sites"

This study consequently assumes that the site structures addressed by this analysis are removed and further assumes that such removal will be to a nominal depth of three feet below the local grade level wherever possible. The site can then be graded and stabilized.

Summary

The estimate to decommission Fort Calhoun assumes the removal of all contaminated and activated plant components and structural materials such that the owner may then have unrestricted use of the site with no further requirements for an operating license. Low-level radioactive waste, other than GTCC waste, is sent to a commercial processor for treatment/conditioning or to a controlled disposal facility.

Decommissioning is accomplished within the 60-year period required by current NRC regulations. In the interim, the spent fuel remains in storage at the site until such time that the transfer to a DOE facility is complete.

The SAFSTOR alternative evaluated in this analysis is described in Section 2. The assumptions are presented in Section 3, along with schedules of annual expenditures. The major cost contributors are identified in Section 6, with detailed activity costs, waste volumes, and associated manpower requirements delineated in Appendix C. The major cost components are also identified in the cost summary provided at the end of this section.

The cost elements are assigned to one of three subcategories: NRC License Termination (radiological remediation), Spent Fuel Management, and Site Restoration. The subcategory “NRC License Termination” is used to accumulate costs that are consistent with “decommissioning” as defined by the NRC in its financial assurance regulations (i.e., 10 CFR §50.75). In situations where the long-term management of spent fuel is not an issue, the cost reported for this subcategory is generally sufficient to terminate a reactor’s operating license.

The “Spent Fuel Management” subcategory contains costs associated with the containerization and transfer of spent fuel to the ISFSI, and the operation of the ISFSI until such time that the transfer of all fuel from this facility to an off-site location is complete. It does not include any costs related to the final disposal of the spent fuel.

“Site Restoration” is used to capture costs associated with the dismantling and demolition of buildings and facilities demonstrated to be free from contamination. This includes structures never exposed to radioactive materials, as well as those facilities that have been decontaminated to appropriate levels. Structures are

assumed to be removed to a nominal depth of three feet and backfilled to conform to local grade.

It should be noted that the costs assigned to these subcategories are allocations. Delegation of cost elements is for the purposes of comparison (e.g., with NRC financial guidelines) or to permit specific financial treatment (e.g., Asset Retirement Obligations determinations). In reality, there can be considerable interaction between the activities in the three subcategories. For example, an owner may decide to remove non-contaminated structures early in the project to improve access to highly contaminated facilities or plant components. In these instances, the non-contaminated removal costs could be reassigned from Site Restoration to an NRC License Termination support activity. However, in general, the allocations represent a reasonable accounting of those costs that can be expected to be incurred for the specific subcomponents of the total estimated program cost, if executed as described.

As noted within this document, the estimate was developed and costs are presented in 2017 dollars. The estimate does not reflect the escalation of costs (due to inflationary and market forces) over the safe-storage and decommissioning period.

The decommissioning subperiods and milestone dates for the analyzed SAFSTOR decommissioning alternative are identified in Table 1. The cost projected for license termination (in accordance with 10 CFR 50.75) is shown in Table 2, along with the costs for spent fuel management and site restoration. The schedule of expenditures for license termination activities is provided in Table 3.

TABLE 1
DECOMMISSIONING SCHEDULE AND PLANT STATUS SUMMARY

Decommissioning Activities / Plant Status	Start	End	Approximate Duration (years)
Transition from Operations			
Plant Shutdown	24 Oct 2016	--------	--------
Preparations for SAFSTOR Dormancy	24 Oct 2016	07 Apr 2018	1.45
SAFSTOR Dormancy			
Dormancy w/Wet Fuel Storage	2018	2020	2.74
Dormancy w/Dry Fuel Storage	2021	2058	38.00
Decommissioning Preparations			
Preparations for D&D	2059	2060	1.49
Dismantling & Decontamination			
Large Component Removal	2060	2061	1.10
Plant Systems Removal and Building Decontamination	2061	2064	3.11
License Termination	2064	2065	0.75
Site Restoration			
Site Restoration	2065	2066	1.50
Total from Shutdown to Completion of Site Restoration	---------	--------	50.18

TABLE 2
DECOMMISSIONING COST SUMMARY
(thousands of 2017 dollars)

Decommissioning Periods	License Termination	Spent Fuel Management	Site Restoration
Planning and Preparations (2018)	21,726	1,105	-
Dormancy w/Wet Fuel Storage	161,105	119,185	-
Dormancy w/Dry Fuel Storage	212,385	244,972	-
Site Reactivation	53,114	-	743
Decommissioning Preparation	29,125	-	976
Large Component Removal	153,714	-	844
Plant Sys. Removal and Bldg. Remediation	223,620	-	7,535
License Termination	27,180	-	-
Site Restoration	243	-	37,881
Total [1]	882,212	365,262	47,979

[1] Columns may not add due to rounding

TABLE 3
LICENSE TERMINATION EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equip. & Materials	Energy	Waste Disposal	Other	Total
2018	46,684	759	638	676	16,306	65,064
2019	40,477	567	638	618	16,503	58,803
2020	40,588	568	640	620	16,548	58,964
2021	4,316	3	0	12	1,683	6,014
2022	4,316	3	0	12	1,683	6,014
2023	4,316	3	0	12	1,683	6,014
2024	4,326	3	0	13	1,688	6,029
2025	4,316	3	0	12	1,683	6,014
2026	4,316	3	0	12	1,683	6,014
2027	4,316	3	0	12	1,683	6,014
2028	4,326	3	0	13	1,688	6,029
2029	4,316	3	0	12	1,683	6,014
2030	4,316	3	0	12	1,683	6,014
2031	4,316	3	0	12	1,683	6,014
2032	4,326	3	0	13	1,688	6,029
2033	4,316	3	0	12	1,683	6,014
2034	4,316	3	0	12	1,683	6,014
2035	4,316	3	0	12	1,683	6,014
2036	4,326	3	0	13	1,688	6,029
2037	3,576	3	0	12	1,683	5,274
2038	3,576	3	0	12	1,683	5,274
2039	3,576	3	0	12	1,683	5,274
2040	3,586	3	0	13	1,688	5,289
2041	3,576	3	0	12	1,683	5,274
2042	3,576	3	0	12	1,683	5,274
2043	3,576	3	0	12	1,683	5,274
2044	3,586	3	0	13	1,688	5,289
2045	3,576	3	0	12	1,683	5,274
2046	3,576	3	0	12	1,683	5,274
2047	3,576	3	0	12	1,683	5,274
2048	3,586	3	0	13	1,688	5,289
2049	3,576	3	0	12	1,683	5,274
2050	3,576	3	0	12	1,683	5,274

TABLE 3 (continued)
LICENSE TERMINATION EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equip. & Materials	Energy	Waste Disposal	Other	Total
2051	3,576	3	0	12	1,683	5,274
2052	3,586	3	0	13	1,688	5,289
2053	3,576	3	0	12	1,683	5,274
2054	3,576	3	0	12	1,683	5,274
2055	3,576	3	0	12	1,683	5,274
2056	3,586	3	0	13	1,688	5,289
2057	3,576	3	0	12	1,683	5,274
2058	3,576	3	0	12	1,683	5,274
2059	44,688	5,019	0	47	3,360	53,114
2060	52,313	21,018	0	16,494	10,421	100,246
2061	51,798	23,335	0	23,074	13,716	111,923
2062	47,087	6,406	0	9,677	8,680	71,850
2063	47,087	6,406	0	9,677	8,680	71,850
2064	42,764	4,999	0	6,826	6,773	61,363
2065	14,723	745	0	20	1,008	16,495
2066	155	0	0	0	0	155
Total	576,174	69,925	1,916	68,205	165,991	882,212

1. INTRODUCTION

This report presents an updated estimate of the cost to decommission the Fort Calhoun Station (Fort Calhoun) for the Nuclear Regulatory Agency's (NRC) approved SAFSTOR decommissioning alternative. The nuclear unit ceased operations on October 24, 2016 and completed the defueling of the reactor on November 13, 2016.[1] This estimate updates an analysis prepared for the Omaha Public Power District (OPPD) in 2016 to comply with the requirements of 10 CFR 50.82(a)(8)(iii).[2]

The analysis relies upon the detailed planning that has been performed with the permanent cessation of operations and the site-specific, technical information from an earlier evaluation prepared in 2016,[3] updated to reflect current assumptions pertaining to the disposition of the nuclear unit and relevant industry experience in undertaking such projects.

The current estimate is designed to provide OPPD with sufficient information to assess its financial obligations, as they pertain to the decommissioning of the nuclear unit. It is not a detailed budget and engineering document, but a financial analysis prepared in advance of the detailed budgeting and engineering work that will be required to carry out the decommissioning.

The estimate does include the detailed planning (and budgeting) for placing the unit in safe-storage and moving the spent fuel from the pool located within the fuel handling area of the auxiliary building to the on-site dry storage facility. It may not reflect the actual plan to decommission Fort Calhoun; the plan may differ from the assumptions made in this analysis based on facts that exist at the plant.

1.1 OBJECTIVE

The plant entered commercial operation in 1973. In January 2002, OPPD submitted an application to the NRC for renewal of the facility's operating license (DPR-40) for an additional 20 years. In November 2003, the NRC approved the request to extend the facility operating license from midnight August 9, 2013, until midnight August 9, 2033.

On June 16, 2016, the OPPD Board of Directors voted to cease nuclear operations and begin decommissioning the Fort Calhoun nuclear power plant. The plant permanently ceased operations on October 24, 2016.

The objective of this analysis is to prepare a comprehensive estimate of the cost, detailed schedule of the associated activities, and projections of the low-level radioactive waste generated in decommissioning Fort Calhoun for the SAFSTOR

alternative. The estimate is based upon the assumptions delineated within this document, including the Department of Energy's (DOE) performance as it relates to the removal of spent fuel from the site.

1.2 SITE DESCRIPTION

Fort Calhoun is located on the west bank of the Missouri River between the towns of Fort Calhoun and Blair, approximately 19 miles north of Omaha, Nebraska. The Nuclear Steam Supply System (NSSS) consists of a pressurized water reactor supplied by Combustion Engineering Corporation and two heat transfer loops, each containing a vertical shell and U-tube steam generator, and two vertical centrifugal reactor coolant pumps. In addition, the system includes an electrically heated pressurizer, a pressurizer relief tank, and interconnecting piping and valves. The reactor operated at a rated power level of 1,500 megawatts thermal. The corresponding net electrical output was approximately 480 megawatts electric.

The NSSS system is housed within the reactor building, a seismic Category I structure. The reactor building has cylindrical walls, a flat foundation mat, and a shallow dome roof. The foundation slab is reinforced with conventional mild-steel reinforcing. The cylindrical wall is prestressed with a post tensioning system in a helical pattern. The dome roof is prestressed, utilizing a three-way post-tensioning system. The inside surface of the reactor building is lined with a carbon steel liner to ensure a high degree of leak tightness during operating and accident conditions.

A turbine-generator system converted the thermal energy of the steam produced in the steam generators into mechanical shaft power and then into electrical energy. The turbine consists of a high-pressure cylinder and two double-flow low-pressure cylinders all aligned in tandem. The generator is a direct driven 1800-rpm conductor-cooled, synchronous generator. The turbine operated in a closed feedwater cycle that condensed the steam; the heated feedwater was returned to the steam generators. Heat rejected in the main condensers was removed by the circulating water system.

The circulating water system provided the heat sink required for removal of waste heat in the power plant's thermal cycle. This system had the principal function of removing heat by absorbing this energy in the main condenser. The Missouri River served as the normal and ultimate heat sink, with the condenser circulating water taken from and returned to the Missouri River through the intake and discharge canals, respectively.

1.3 REGULATORY GUIDANCE

The NRC (or Commission) provided initial decommissioning requirements in its rule "General Requirements for Decommissioning Nuclear Facilities," issued in June 1988.[4] This rule set forth financial criteria for decommissioning licensed nuclear power facilities. The regulation addressed decommissioning planning needs, timing, funding methods, and environmental review requirements. The intent of the rule was to ensure that decommissioning would be accomplished in a safe and timely manner and that adequate funds would be available for this purpose. Subsequent to the rule, the NRC issued Regulatory Guide 1.159, "Assuring the Availability of Funds for Decommissioning Nuclear Reactors,"[5] which provided additional guidance to the licensees of nuclear facilities on the financial methods acceptable to the NRC staff for complying with the requirements of the rule. The regulatory guide addressed the funding requirements and provided guidance on the content and form of the financial assurance mechanisms indicated in the rule.

The rule defined three decommissioning alternatives as being acceptable to the NRC: DECON, SAFSTOR, and ENTOMB. The DECON alternative assumes that any contaminated or activated portion of the plant's systems, structures and facilities are removed or decontaminated to levels that permit the site to be released for unrestricted use shortly after the cessation of plant operations, while the SAFSTOR and ENTOMB alternatives defer the process.

The rule also placed limits on the time allowed to complete the decommissioning process. For all alternatives, the process is restricted in overall duration to 60 years, unless it can be shown that a longer duration is necessary to protect public health and safety. At the conclusion of a 60-year dormancy period (or longer if the NRC approves such a case), the site would still require significant remediation to meet the unrestricted release limits for license termination.

The ENTOMB alternative has not been viewed as a viable option for power reactors due to the significant time required to isolate the long-lived radionuclides for decay to permissible levels. However, with rulemaking permitting the controlled release of a site,[6] the NRC did re-evaluate the alternative. The resulting feasibility study, based upon an assessment by Pacific Northwest National Laboratory, concluded that the method did have conditional merit for some, if not most reactors. The staff also found that additional rulemaking would be needed before this option could be treated as a generic alternative.

The NRC had considered rulemaking to alter the 60-year time for completing decommissioning and to clarify the use of engineered barriers for reactor

entombments.[7] However, the NRC's staff has subsequently recommended that rulemaking be deferred, based upon several factors (e.g., no licensee has committed to pursuing the entombment option, the unresolved issues associated with the disposition of greater-than-Class C material (GTCC), and the NRC's current priorities), at least until after the additional research studies are complete. The Commission concurred with the staff's recommendation.

In 1996, the NRC published revisions to the general requirements for decommissioning nuclear power plants.[8] When the decommissioning regulations were adopted in 1988, it was assumed that the majority of licensees would decommission at the end of the facility's operating licensed life. Since that time, several licensees permanently and prematurely ceased operations. Exemptions from certain operating requirements were required once the reactor was defueled to facilitate the decommissioning. Each case was handled individually, without clearly defined generic requirements. The NRC amended the decommissioning regulations in 1996 to clarify ambiguities and codify procedures and terminology as a means of enhancing efficiency and uniformity in the decommissioning process. The amendments allow for greater public participation and better define the transition process from operations to decommissioning.

Under the revised regulations, licensees will submit written certification to the NRC within 30 days after the decision to cease operations. Certification will also be required once the fuel is permanently removed from the reactor vessel. Submittal of these notices, along with related changes to Technical Specifications, entitle the licensee to a fee reduction and eliminate the obligation to follow certain requirements needed only during operation of the reactor. Within two years of submitting notice of permanent cessation of operations, the licensee is required to submit a Post-Shutdown Decommissioning Activities Report (PSDAR) to the NRC. The PSDAR describes the planned decommissioning activities, the associated sequence and schedule, and an estimate of expected costs. Prior to completing decommissioning, the licensee is required to submit an application to the NRC to terminate the license, which includes a license termination plan (LTP).

In 2011, the NRC published amended regulations to improve decommissioning planning and thereby reduce the likelihood that any current operating facility will become a legacy site.[9] The amended regulations require licensees to conduct their operations to minimize the introduction of residual radioactivity into the site, which includes the site's subsurface soil and groundwater. Licensees also may be required to perform site surveys to determine whether residual radioactivity is present in subsurface areas and to keep records of these surveys with records important for decommissioning. The amended regulations

require licensees to report additional details in their decommissioning cost estimate as well as requiring additional financial reporting and assurances. These additional details, including an ISFSI decommissioning estimate, are included in this analysis.

1.3.1 High-Level Radioactive Waste Management

Congress passed the "Nuclear Waste Policy Act" (NWPA) in 1982,[10] assigning the federal government's long-standing responsibility for disposal of the spent nuclear fuel created by the commercial nuclear generating plants to the DOE. The NWPA Amendments Act of 1987[11] designated Yucca Mountain as the sole site to be considered for a permanent geologic repository. The DOE was to begin accepting spent fuel by January 31, 1998; however, to date no progress in the removal of spent fuel from commercial generating sites has been made.

Completion of the decommissioning process is dependent upon the DOE's ability to remove spent fuel from the site in a timely manner. DOE's repository program assumes that spent fuel allocations will be accepted for disposal from the nation's commercial nuclear plants, with limited exceptions, in the order (the "queue") in which it was discharged from the reactor. The plan for the management of all irradiated fuel at the reactor was based in general upon: 1) a 2034 start date for DOE initiating transfer of commercial spent fuel to a federal facility (not necessarily a final repository), and 2) expectations for spent fuel receipt by the DOE for the Fort Calhoun fuel. The DOE's generator allocation/receipt schedules are based upon the oldest fuel receiving the highest priority. Assuming a maximum rate of transfer of 3,000 metric tons of uranium (MTU)/year, as reflected in DOE's latest Acceptance Priority Ranking and Annual Capacity Report dated June 2004 (DOE/RW-0567),[12] the removal of spent fuel from the site is assumed to be completed in 2058. Different DOE acceptance schedules may result in different completion dates.

Today, the country is at an impasse on high-level waste disposal, despite DOE's submittal of its License Application for a geologic repository to the NRC in 2008. The Obama administration eliminated the budget for the repository program while promising to "conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle … and make recommendations for a new plan." Towards this goal, the administration appointed a Blue Ribbon Commission on America's Nuclear Future (Blue Ribbon Commission) to make recommendations for a new plan for nuclear waste disposal. The Blue Ribbon Commission's charter includes a

requirement that it consider "[o]ptions for safe storage of used nuclear fuel while final disposition pathways are selected and deployed."[13]

On January 26, 2012, the Blue Ribbon Commission issued its "Report to the Secretary of Energy" containing a number of recommendations on nuclear waste disposal. Two of the recommendations that may impact decommissioning planning are:

- "[T]he United States [should] establish a program that leads to the timely development of one or more consolidated storage facilities"
- "[T]he United States should undertake an integrated nuclear waste management program that leads to the timely development of one or more permanent deep geological facilities for the safe disposal of spent fuel and high-level nuclear waste."[14]

In January 2013, the DOE issued the "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste," in response to the recommendations made by the Blue Ribbon Commission and as "a framework for moving toward a sustainable program to deploy an integrated system capable of transporting, storing, and disposing of used nuclear fuel..."[15] This document states:

"With the appropriate authorizations from Congress, the Administration currently plans to implement a program over the next 10 years that:

- Sites, designs and licenses, constructs and begins operations of a pilot interim storage facility by 2021 with an initial focus on accepting used nuclear fuel from shut-down reactor sites;
- Advances toward the siting and licensing of a larger interim storage facility to be available by 2025 that will have sufficient capacity to provide flexibility in the waste management system and allows for acceptance of enough used nuclear fuel to reduce expected government liabilities; and
- Makes demonstrable progress on the siting and characterization of repository sites to facilitate the availability of a geologic repository by 2048."

The NRC's review of DOE's license application to construct a geologic repository at Yucca Mountain was suspended in 2011 when the Administration significantly reduced the budget for completing that work. However, the US Court of Appeals for the District of Columbia Circuit

issued a writ of mandamus (in August 2013) [16] ordering NRC to comply with federal law and resume its review of DOE's Yucca Mountain repository license application to the extent allowed by previously appropriated funding for the review. That review is now complete with the publication of the five-volume safety evaluation report. A supplement to DOE's environmental impact statement and an adjudicatory hearing on the contentions filed by interested parties must be completed before a licensing decision can be made.

The NRC requires that licensees establish a program to manage and provide funding for the caretaking of all irradiated fuel at the reactor site until title of the fuel is transferred to the DOE.[17] Interim storage of the fuel, until the DOE has completed the transfer, will be in the reactor building's spent fuel storage pool, as well as at an on-site ISFSI. DOE has breached its obligations to remove fuel from reactor sites, and has also failed to provide the plant owner with information about how it will ultimately perform. DOE officials have stated that DOE does not have an obligation to accept already-canistered fuel without an amendment to DOE's contracts with plant licensees to remove the fuel (the "Standard Contract"), but DOE has not explained what costs any such amendment would involve. Consequently, the plant owner has no information or expectations on how DOE will remove fuel from the site in the future. In the absence of information about how DOE will specifically deal with already-canistered fuel, and for purposes of this analysis only, this cost estimate assumes that there will be no additional costs associated with DOE's acceptance of such fuel. If this assumption is incorrect, it is assumed that DOE will have liability for costs incurred to transfer the fuel to DOE-supplied containers, and to dispose of existing containers.

An ISFSI, operated under a Part 50 General License (in accordance with 10 CFR 72, Subpart K),[18] has been constructed to support continued plant operations. The facility will be expanded to accommodate all spent fuel generated over the plant life. Once the spent fuel storage pool is emptied the auxiliary building will be prepared for long term storage.

OPPD's position is that the DOE has a contractual obligation to accept Fort Calhoun's fuel earlier than the projections set out in this cost study, consistent with its contract commitments. No assumption made in this study should be interpreted to be inconsistent with this position. However, at this time, including the cost of long-term spent fuel storage at Fort Calhoun in this study and assuming DOE acceptance of fuel on an Oldest Fuel First basis is the most reasonable approach because it insures

the availability of sufficient decommissioning funds given that, contrary to its contractual obligation, the DOE has not performed to date.

1.3.2 Low-Level Radioactive Waste Management

The contaminated and activated material generated in the decontamination and dismantling of a commercial nuclear reactor is classified as low-level (radioactive) waste, although not all of the material is suitable for "shallow-land" disposal. With the passage of the "Low-Level Radioactive Waste Policy Act" in 1980,[19] and its Amendments of 1985,[20] the states became ultimately responsible for the disposition of low-level radioactive waste generated within their own borders.

In 2011, a new low-level waste disposal facility was successfully completed and opened in Andrews County, Texas pursuant to the Texas Low-Level Radioactive Waste Disposal Compact. The facility has been declared operational by the operator, Waste Control Specialists (WCS). The facility will be able to accept limited quantities of non-Compact waste; however, at this time the cost for non-Compact generators is being negotiated on an individual basis.

Disposition of the various waste streams produced by the decommissioning process considered all options and services currently available to OPPD. The majority of the low-level radioactive waste designated for direct disposal (Class A [21]) can be sent to Energy*Solutions'* facility in Clive, Utah. Therefore, disposal costs for Class A waste were based upon OPPD's *Utilities Service Alliance* (*USA) Agreement* with Energy*Solutions*. This facility is not licensed to receive the higher activity portion (Classes B and C) of the waste stream.

The Texas facility is able to receive the higher activity waste forms (Classes B and C). As such, for this analysis, disposal costs for the Class B and C waste are based upon the preliminary and indicative information on the cost from the Texas Commission on Environmental Quality.

The dismantling of the components residing closest to the reactor core generates radioactive waste that may be considered unsuitable for shallow-land disposal (i.e., low-level radioactive waste with concentrations of radionuclides that exceed the limits established by the NRC for Class C radioactive waste (GTCC)). The Low-Level Radioactive Waste Policy Amendments Act of 1985 assigned the federal government the responsibility for the disposal of this material. The Act also stated that the beneficiaries of the activities resulting in the generation of such

radioactive waste bear all reasonable costs of disposing of such waste. However, to date, the federal government has not identified a cost for disposing of GTCC or a schedule for acceptance.

For purposes of this analysis, the GTCC radioactive waste is assumed to be packaged and disposed of in a similar manner as high-level waste and at a cost equivalent to that envisioned for the spent fuel. The GTCC is shipped directly to a DOE facility as it is generated (assuming that the spent fuel has been removed from the site prior to the start of delayed decommissioning).

A significant portion of the waste material generated during decommissioning may only be potentially contaminated by radioactive materials. This waste can be analyzed on site or shipped off site to licensed facilities for further analysis, for processing and/or for conditioning/recovery. Reduction in the volume of low-level radioactive waste requiring disposal in a licensed low-level radioactive waste disposal facility can be accomplished through a variety of methods, including analyses and surveys or decontamination to eliminate the portion of waste that does not require disposal as radioactive waste, compaction, incineration or metal melt. The estimate reflects the savings from waste recovery/volume reduction.

1.3.3 Radiological Criteria for License Termination

In 1997, the NRC published Subpart E, "Radiological Criteria for License Termination,"[22] amending 10 CFR Part 20. This subpart provides radiological criteria for releasing a facility for unrestricted use. The regulation states that the site can be released for unrestricted use if radioactivity levels are such that the average member of a critical group would not receive a Total Effective Dose Equivalent (TEDE) in excess of 25 millirem per year, and provided that residual radioactivity has been reduced to levels that are As Low As Reasonably Achievable (ALARA). The decommissioning estimate assumes that the Fort Calhoun site will be remediated to a residual level consistent with the NRC-prescribed level.

It should be noted that the NRC and the Environmental Protection Agency (EPA) differ on the amount of residual radioactivity considered acceptable in site remediation. The EPA has two limits that apply to radioactive materials. An EPA limit of 15 millirem per year is derived from criteria established by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund).[23] An

additional and separate limit of 4 millirem per year, as defined in 40 CFR §141.16, is applied to drinking water.[24]

On October 9, 2002, the NRC signed an agreement with the EPA on the radiological decommissioning and decontamination of NRC-licensed sites. The Memorandum of Understanding (MOU)[25] provides that EPA will defer exercise of authority under CERCLA for the majority of facilities decommissioned under NRC authority. The MOU also includes provisions for NRC and EPA consultation for certain sites when, at the time of license termination, (1) groundwater contamination exceeds EPA-permitted levels; (2) NRC contemplates restricted release of the site; and/or (3) residual radioactive soil concentrations exceed levels defined in the MOU.

The MOU does not impose any new requirements on NRC licensees and should reduce the involvement of the EPA with NRC licensees who are decommissioning. Most sites are expected to meet the NRC criteria for unrestricted use, and the NRC believes that only a few sites will have groundwater or soil contamination in excess of the levels specified in the MOU that trigger consultation with the EPA. However, if there are other hazardous materials on the site, the EPA may be involved in the cleanup. As such, the possibility of dual regulation remains for certain licensees. The present study does not include any costs for this possibility.

2. SAFSTOR DECOMMISSIONING ALTERNATIVE

Costs were determined for decommissioning Fort Calhoun based upon the NRC-approved SAFSTOR decommissioning alternative. The following sections describe the basic activities associated with the SAFSTOR alternative. Although detailed procedures for each activity identified are not provided, and the actual sequence of work may vary, the activity descriptions provide a basis not only for estimating but also for the expected scope of work (i.e., engineering and planning).

The conceptual approach that the NRC has described in its regulations divides decommissioning into three phases. The initial phase commences with the effective date of permanent cessation of operations and involves the transition of both plant and licensee from reactor operations (i.e., power production) to facility de-activation and closure. During the first phase, notification was provided to the NRC certifying the permanent cessation of operations and the removal of fuel from the reactor vessel.

The second phase encompasses activities during the storage period. The third phase pertains to the activities involved in license termination. The decommissioning estimate developed for Fort Calhoun is also divided into phases or periods; however, demarcation of the phases is based upon major milestones within the project or significant changes in the projected expenditures.

2.1 PERIOD 1 - PREPARATIONS

The NRC defines SAFSTOR as "the alternative in which the nuclear facility is placed and maintained in a condition that allows the nuclear facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use." The facility is left intact (during the dormancy period), with structures maintained in a sound condition. Systems that are not required to support the spent fuel pool or site surveillance and security are drained, de-energized, and secured. Minimal cleaning/removal of loose contamination and/or fixation and sealing of remaining contamination are performed. Access to contaminated areas is secured to provide controlled access for inspection and maintenance.

2.1.1 Engineering and Planning

Detailed preparations have been undertaken to provide a smooth transition from plant operations to site decommissioning. Through implementation of a staffing transition plan, the organization required to manage the intended decommissioning activities is assembled from available plant staff and outside resources. Preparations include the

planning for permanent defueling of the reactor, revision of technical specifications applicable to the operating conditions and requirements, addition of security barriers, a limited characterization of the facility and major components, and the development of the PSDAR.

2.1.2 Site Preparations

The process of placing the plant in safe-storage will include, but is not limited to, the following activities:

- Creation of an organizational structure to support the decommissioning plan and evolving emergency planning and site security requirements.
- Revision of technical specifications, plans and operating procedures appropriate to the operating conditions and requirements.
- Characterization of the facility and major components as may be necessary to plan and prepare for the dormancy phase.
- Management of the spent fuel pool and reconfiguring fuel pool support systems so that draining and de-energizing may commence in other areas of the plant.
- Deactivation (de-energizing and /or draining) of systems that are no longer required during the dormancy period.
- Processing and disposal of water and water filter and treatment media not required to support dormancy operation.
- Disposition of incidental waste that is present prior to the start of the dormancy period, such as excess tools and equipment and waste produced while deactivating systems and preparing the facility for dormancy.
- Reconfiguration of power, lighting, heating, ventilation, fire protection, and any other services needed to support long-term storage and periodic plant surveillance and maintenance.
- Stabilization by fixing or removing loose incidental surface contamination to facilitate future building access and plant maintenance. Decontamination of high-dose areas is not anticipated.
- Performance of interim radiation surveys of the plant, posting caution signs and establishing access requirements, where appropriate.

- Maintenance of appropriate barriers for contaminated and radiation areas.
- Reconfiguration of security boundaries and surveillance systems, as required.

2.2 PERIOD 2 - DORMANCY

The second phase identified by the NRC in its rule addresses licensed activities during a storage period and is applicable to the dormancy phases of a deferred decommissioning alternative. Activities required during the early dormancy period while spent fuel is stored in the fuel pool will be substantially different than those activities required during dry fuel storage.

Early activities include operating and maintaining the spent fuel pool and its associated systems, expanding the ISFSI, and transferring spent fuel from the pool to the ISFSI. Spent fuel transfer is expected to be complete by end of 2020. After the fuel transfer is completed, the pool and systems will be drained and de-energized for long-term storage.

Dormancy activities will include a 24-hour security force, preventive and corrective maintenance on security systems, area lighting, general building maintenance, freeze protection heating, ventilation of buildings for periodic habitability, routine radiological inspections of contaminated structures, maintenance of structural integrity, and a site environmental and radiation monitoring program.

Security during the dormancy period will be conducted primarily to safeguard the spent fuel on site and prevent unauthorized entry. A security barrier, sensors, alarms, and other surveillance equipment will be maintained as required to provide security.

An environmental surveillance program will be carried out during the dormancy period to monitor for radioactive material in the environment. Appropriate procedures will be established and initiated for potential releases that exceed prescribed limits. The environmental surveillance program will consist of a version of the program in effect during normal plant operations that will be modified to reflect the plant's conditions and risks at the time.

Late in the dormancy period, additional activities will include transferring the spent fuel from the ISFSI to the DOE. For planning purposes, OPPD's current spent fuel management plan for the Fort Calhoun spent fuel is based, in general, upon the following projections: 1) a 2034 start date for the DOE initiating transfer of commercial spent fuel to a federal facility, 2) a corresponding 2036

start date for removal of spent fuel from the Fort Calhoun ISFSI, and 3) a 2058 completion date for removal of all Fort Calhoun spent fuel from the site. This assumption is made for purposes of this estimate, although it is acknowledged that the plant owner will seek the most expeditious means of removing fuel from the site when DOE commences performance. The ISFSI pad and associated facilities are assumed to be decommissioned along with the power block structures during the deferred decontamination and dismantling phases.

After a period of safe-storage, it is required that the licensee submit an application to terminate the license, thereby initiating the third phase.

2.3 PERIOD 3 – PREPARATIONS FOR DECOMMISSIONING

Prior to the commencement of decommissioning operations, preparations will be undertaken to reactivate site services and prepare for decommissioning. Preparations include engineering and planning, a site characterization, and the assembly of a decommissioning management organization. This would likely include the development of work plans, specifications and procedures.

2.4 PERIOD 4 – DECOMMISSIONING OPERATIONS (DECONTAMINATION AND DISMANTLING)

Following the preparations for decommissioning, physical decommissioning activities will take place. This includes the removal and disposal of contaminated and activated components and structures, leading to the termination of the 10 CFR 50 operating license. Although much of the radioactivity will decrease during the dormancy period due to decay of ^{60}Co and other short-lived radionuclides, the internal components of the reactor vessel will still exhibit radiation dose rates that will likely require remote sectioning under water due to the presence of long-lived radionuclides such as ^{94}Nb, ^{59}Ni, and ^{63}Ni. Portions of the biological shield wall may also be radioactive due to the presence of activated trace elements with longer half-lives (such as ^{152}Eu and ^{154}Eu). It is assumed that radioactive contamination on structures, systems, and component surfaces will not have decayed to levels that will permit unrestricted release. These surfaces will be surveyed and items dispositioned in accordance with the existing radioactive release criteria.

Significant decommissioning activities in this phase include:

- Reconfiguration and modification of site structures and facilities, as needed, to support decommissioning operations. Modifications may also be required to the reactor or other buildings to facilitate movement of

equipment and materials, support the segmentation of the reactor vessel and reactor vessel internals, and for large component removal.

- Design and fabrication of temporary and longer-term shielding to support removal and transportation activities, construction of contamination control envelopes, and the procurement of specialty tooling.
- Procurement or leasing of shipping cask, cask liners, and industrial packages for the disposition of low-level radioactive waste.
- Decontamination of components and piping systems, as required, to control (minimize) worker exposure.
- Removal of piping and components no longer essential to support decommissioning operations.
- Removal of control rod drive housings and the head service structure from reactor vessel head. Segmentation of the vessel closure head.
- Removal and segmentation of the upper internals assemblies. Segmentation will maximize the loading of the shielded transport casks, i.e., by weight and activity. The operations are conducted under water using remotely operated tooling and contamination controls.
- Disassembly and segmentation of the remaining reactor internals, including the core former and lower core support assembly. Some material is expected to exceed Class C disposal requirements. As such, the segments will be packaged in modified fuel storage canisters for geologic disposal.
- Segmentation of the reactor vessel. A shielded platform is installed for segmentation as cutting operations are performed in-air using remotely operated equipment within a contamination control envelope. The water level is maintained just below the cut to minimize the working area dose rates. Segments are transferred in-air to containers that are stored under water, for example, in an isolated area of the refueling canal.
- Removal of the activated portions of the concrete biological shield and accessible contaminated concrete surfaces. If dictated by the steam generator and pressurizer removal scenarios, those portions of the associated cubicles necessary for access and component extraction are removed.
- Removal of the steam generators and pressurizer for material recovery and controlled disposal. The generators will be moved to an on-site processing center, the steam domes removed and the internal components segregated for recycling. The lower shell and tube bundle will be packaged for direct disposal. These components can serve as their

own burial containers provided that all penetrations are properly sealed and the internal contaminants are stabilized, e.g., with grout.

- Remediation of contaminated surface soil or sub-surface media will be performed as necessary to meet the unrestricted use criteria in 10 CFR 20.1402.
- Underground piping (or similar items) and associated soil will be removed as necessary to meet license termination criteria.

At least two years prior to the anticipated date of license termination, a License Termination Plan (LTP) will be submitted to the NRC. That plan will include: a site characterization, description of the remaining dismantling / removal activities, plans for remediation of remaining radioactive materials, developed site-specific Derived Concentration Guideline Levels, plans for the final status (radiation) survey, designation of the end use of the site, an updated cost estimate to complete the decommissioning, and associated environmental concerns.

The final status survey plan will identify the radiological surveys to be performed once the decontamination activities are completed and will be developed using the guidance provided in the "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)."[26] This document incorporates statistical approaches to survey design and data evaluation. It also identifies commercially available instrumentation and procedures for conducting radiological surveys. Use of this guidance ensures that the surveys are conducted in a manner that provides a high degree of confidence that applicable NRC criteria are satisfied. Once the final status survey is complete, the results will be submitted to the NRC, along with a request for termination of the NRC license.

2.5 PERIOD 5 – SITE RESTORATION

After the NRC terminates the license, site restoration activities will be performed, at the licensee's discretion. Efficient removal of the contaminated materials and verification that residual radionuclide concentrations are below the NRC limits will result in substantial damage to many of the structures. Although performed in a controlled, safe manner, blasting, coring, drilling, scarification (surface removal), and the other decontamination activities may substantially degrade power block structures including the containment, auxiliary, turbine, service, technical support center, maintenance shop, chemistry and radiation protection facility, and the radioactive waste processing buildings.

Under certain circumstances, verifying that subsurface radionuclide concentrations meet NRC site release requirements will require removal of grade slabs and lower floors, potentially weakening footings and structural supports. This removal activity will be necessary for those facilities and plant areas where historical records, when available, indicate the potential for radionuclides having been present in the soil, where system failures have been recorded, or where it is required to confirm that subsurface process and drain lines were not breached over the operating life of the station.

It is not currently anticipated that these structures would be repaired and preserved after the radiological contamination is removed. The cost to dismantle site structures with a work force already mobilized on site is more efficient than if the process is deferred.

This cost study presumes that non-essential structures and site facilities are dismantled as a continuation of the decommissioning activity. Foundations and exterior walls are removed to a nominal depth of three feet below grade. The three-foot depth allows for the placement of gravel for drainage, as well as topsoil, so that vegetation can be established for erosion control. Site areas affected by the dismantling activities are restored and the plant area graded as required to prevent ponding and inhibit the refloating of subsurface materials.

Non-contaminated concrete rubble produced by demolition activities is processed to remove reinforcing steel and miscellaneous embedments. The processed material is then used on site to backfill foundation voids. Excess non-contaminated materials are trucked to an off-site area for disposal as construction debris.

3. COST ESTIMATE

The estimate prepared for decommissioning Fort Calhoun considers the unique features of the site, including the nuclear steam supply system, electric power generating systems, structures, and supporting facilities. The basis of the estimate, including the sources of information relied upon, the estimating methodology employed, site-specific considerations, and other pertinent assumptions, is described in this section.

3.1 BASIS OF ESTIMATE

The estimate relies upon the detailed planning and engineering that has been performed with the permanent cessation of operations and the site-specific, technical information from an earlier evaluation prepared in 2016. The 2016 information was reviewed for the current analysis and updated to reflect any significant changes in the plant configuration over the past year. The site-specific considerations and assumptions used in the previous evaluation were also revisited. Modifications were incorporated where new information was available or experience from previously completed decommissioning projects provided viable alternatives or improved processes.

3.2 METHODOLOGY

OPPD's decommissioning organization, plant staff, and numerous other subject matter experts have been engaged in the detailed planning and engineering needed to transition the nuclear unit and its operating organization from power generation to safe-storage. This information will be used to assist in creating working budgets until the spent fuel is relocated to the ISFSI (years 2018 through 2020) and the plant secured for long-term storage.

The methodology used to develop the estimate follows the basic approach originally presented in the AIF/NESP-036 study report, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates,"[27] and the DOE "Decommissioning Handbook."[28] These documents present a unit factor method for estimating decommissioning activity costs, which simplifies the estimating calculations. Unit factors for concrete removal ($/cubic yard), steel removal ($/ton), and cutting costs ($/inch) are developed using local labor rates. The activity-dependent costs are estimated with the item quantities (cubic yards and tons), developed from plant drawings and inventory documents. Removal rates and material costs for the conventional disposition of components and structures rely upon information available in the industry publication, "Building Construction Cost Data," published by R.S. Means.[29]

The unit factor method provides a demonstrable basis for establishing reliable cost estimates. The detail provided in the unit factors, including activity duration, labor costs (by craft), and equipment and consumable costs, ensures that essential elements have not been omitted. Appendix A presents the detailed development of a typical unit factor. Appendix B provides the values contained within one set of factors developed for this analysis.

This analysis reflects lessons learned from TLG's involvement in the Shippingport Station Decommissioning Project, completed in 1989, as well as the decommissioning of the Cintichem reactor, hot cells, and associated facilities, completed in 1997. In addition, the planning and engineering for the Pathfinder, Shoreham, Rancho Seco, Trojan, Yankee Rowe, Big Rock Point, Maine Yankee, Humboldt Bay-3, Oyster Creek, Connecticut Yankee, San Onofre-1, Crystal River and Vermont Yankee nuclear units have provided additional insight into the process, the regulatory aspects, and the technical challenges of decommissioning commercial nuclear units.

Work Difficulty Factors

TLG has historically applied work difficulty adjustment factors (WDFs) to account for the inefficiencies in working in a power plant environment. WDFs are assigned to each unique set of unit factors, commensurate with the inefficiencies associated with working in confined, hazardous environments. The ranges used for the WDFs for the SAFSTOR estimate are as follows:

- Access Factor 0% to 20%
- Respiratory Protection Factor 0% to 50%
- Radiation/ALARA Factor 0% to 15%
- Protective Clothing Factor 0% to 30%
- Work Break Factor 8.33%

The factors and their associated range of values were developed in conjunction with the AIF/NESP-036 study. The application of the factors is discussed in more detail in that publication.

Scheduling Program Durations

An activity duration critical path is used to determine the total decommissioning program schedule. The schedule is relied upon in calculating the carrying costs, which include program management, administration, field engineering, equipment rental, and support services such as quality control and security. This systematic approach for assembling decommissioning estimates ensures a high degree of confidence in the reliability of the resulting costs.

The unit factors, adjusted by the WDFs as described above, are applied against the inventory of materials to be removed in the radiological controlled areas. The resulting labor-hours, or crew-hours, are used in the development of the decommissioning program schedule, using resource loading and event sequencing considerations. The scheduling of conventional removal and dismantling activities is based upon productivity information available from the "Building Construction Cost Data" publication.

3.3 FINANCIAL COMPONENTS OF THE COST MODEL

TLG's proprietary decommissioning cost model, DECCER, produces a number of distinct cost elements. These direct expenditures, however, do not comprise the total cost to accomplish the project goal, i.e., license termination, spent fuel management and site restoration.

3.3.1 Contingency

Inherent in any cost estimate that does not rely on historical data is the inability to specify the precise source of costs imposed by factors such as tool breakage, accidents, illnesses, weather delays, and labor stoppages. In the DECCER cost model, contingency fulfills this role. Contingency is added to each line item to account for costs that are difficult or impossible to develop analytically. Such costs are historically inevitable over the duration of a job of this magnitude; therefore, this cost analysis includes funds to cover these types of expenses.

The activity- and period-dependent costs are combined to develop the total decommissioning cost. A contingency is then applied on a line-item basis, using one or more of the contingency types listed in the AIF/NESP-036 study. "Contingencies" are defined in the American Association of Cost Engineers "Project and Cost Engineers' Handbook"[30] as "specific provision for unforeseeable elements of cost within the defined project scope; particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events which will increase costs are likely to occur." The cost elements in this analysis are based upon ideal conditions and maximum efficiency; therefore, consistent with industry practice, contingency is included. In the AIF/NESP-036 study, the types of unforeseeable events that are likely to occur in decommissioning are discussed and guidelines are provided for a contingency percentage in each category. It should be noted that contingency, as used in this analysis, does not account for price escalation and inflation over the period of performance (these factors are typically addressed in the funding analysis).

Contingency funds are an integral part of the total cost to complete the decommissioning process. Exclusion of this component puts at risk a successful completion of the intended tasks and, potentially, subsequent related activities. For this study, TLG examined the major activity-related problems (decontamination, segmentation, equipment handling, packaging, transport, and waste disposal) that necessitate a contingency. Individual activity contingencies ranged from 10% to 75%, depending on the degree of difficulty judged to be appropriate from TLG's actual decommissioning experience. The contingency values used in this study are as follows:

• Decontamination	50%
• Contaminated Component Removal	25%
• Contaminated Component Packaging	10%
• Contaminated Component Transport	15%
• Low-Level Radioactive Waste Disposal	25%
• Reactor Segmentation	75%
• NSSS Component Removal	25%
• Reactor Waste Packaging	25%
• Reactor Waste Transport	25%
• Reactor Vessel Component Disposal	50%
• GTCC Disposal	15%
• Non-Radioactive Component Removal	15%
• Heavy Equipment and Tooling	15%
• Supplies	25%
• Engineering	15%
• Insurance, Taxes and Fees	10%
• Staffing	15%
• Characterization and Termination Surveys	30%
• Operations and Maintenance Expenses	15%
• ISFSI Decommissioning	25%

The contingency values are applied to the appropriate components of the estimate on a line item basis. A composite value is then reported at the end of the detailed estimate (provided in Appendix C). The composite contingency value reported for the SAFSTOR alternative in Appendix C is approximately 16.33%. Appendix D, the ISFSI decommissioning calculation, uses a flat 25% contingency added at the end of the calculation.

It should be noted that where OPPD provided cost information for near-term projects or site activities, the contingency component value(s) may be less, commensurate with the increased cost certainty. In some instances, OPPD specified a contingency component for specific projects and/or site activities. This can be seen for several line item costs in three years prior to ISFSI operations (Periods 1b through 2a in Appendix C).

3.3.2 Financial Risk

In addition to the routine uncertainties addressed by contingency, another cost element that is sometimes necessary to consider when bounding decommissioning costs relates to uncertainty, or risk. Examples can include changes in work scope, pricing, job performance, and other variations that could conceivably, but not necessarily, occur. Consideration is sometimes necessary to generate a level of confidence in the estimate, within a range of probabilities. TLG considers these types of costs under the broad term "financial risk." Included within the category of financial risk are:

- Delays in approval of the decommissioning plan due to intervention, legal challenges, and national and local hearings.
- Changes in the project work scope from the baseline estimate, involving the discovery of unexpected levels of contaminants, contamination in places not previously expected, contaminated soil previously undiscovered (either radioactive or hazardous material contamination), variations in plant inventory or configuration not indicated by the as-built drawings.
- Regulatory changes (e.g., affecting worker health and safety, site release criteria, waste transportation, and disposal).
- Policy decisions altering national commitments (e.g., in the ability to accommodate certain waste forms for disposition, or in the timetable for such, or the start and rate of acceptance of spent fuel by the DOE).
- Pricing changes for basic inputs, such as labor, energy, materials, and waste disposal.

This cost study does not add any additional costs to the estimate for financial risk. Uncertainties as discussed above that would impact the estimate are revisited periodically and addressed through repeated revisions or updates of the base estimate (e.g., in accordance with Regulatory Guide 1.159).

3.4 SITE-SPECIFIC CONSIDERATIONS

There are a number of site-specific considerations that affect the method for dismantling and removal of equipment from the site and the degree of restoration required. The cost impact of the considerations identified below is included in this cost study.

3.4.1 Spent Fuel Management

The cost to dispose the spent fuel generated from plant operations is not reflected within the estimate to decommission Fort Calhoun. Ultimate disposition of the spent fuel is within the province of the DOE's Waste Management System, as defined by the Nuclear Waste Policy Act. As such, the disposal cost is financed by a 1 mill/kW-hr surcharge paid into the DOE's waste fund during operations. On November 19, 2013, the U.S. Court of Appeals for the D.C. Circuit ordered the Secretary of the Department of Energy to suspend collecting annual fees for nuclear waste disposal from nuclear power plant operators until the DOE has conducted a legally adequate fee assessment.

The NRC does, however, require licensees to establish a program to manage and provide funding for the management of all irradiated fuel at the reactor site until title of the fuel is transferred to the Secretary of Energy. This requirement is prepared for through inclusion of certain high-level waste cost elements within the estimate, as described below.

Completion of the decommissioning process is highly dependent upon the DOE's ability to remove spent fuel from the site. DOE's repository program assumes that spent fuel is accepted for disposal from the nation's commercial nuclear plants in the order (the "queue") in which it was removed from service ("oldest fuel first"). The contracts that U.S. generators have with the DOE provide mechanisms for altering the oldest fuel first allocation scheme, including emergency deliveries, exchanges of allocations amongst generators and the option of providing priority acceptance from permanently shutdown nuclear reactors. Given DOE's failure to accept fuel under its contracts, it is unclear how these mechanisms may operate once DOE begins accepting spent fuel from commercial reactors. Accordingly, this study assumes that DOE will accept spent fuel in an oldest fuel first order. The timing for removal of spent fuel from the site is based upon the DOE's most recently published annual acceptance rates of 400 MTU/year for year 1, 3,800 MTU total for years 2 through 4 and 3,000 MTU/year for year 5 and beyond.[31]

Irradiated Fuel Storage System

The design and capacity of the current ISFSI is based upon the Transnuclear, Inc., NUHOMS®-32PT dry cask storage system. The system consists of a dry fuel storage canister (DSC) with a nominal capacity of 32 pressurized water reactor fuel assemblies and a concrete horizontal storage module (HSM). DOE has not identified any cask systems it may use.

The estimate includes the costs to purchase, load, and transfer the DSCs from the pool to the HSMs on the ISFSI pad and from the ISFSI to the DOE.

ISFSI Pad

An ISFSI pad had been constructed within the protected area to support plant operations. Ten HSMs were loaded in two campaigns between 2006 and 2009. It is expected that another 30 modules (each containing a DSC able to accommodate 32 pressurized water reactor spent fuel assemblies) will be required to off-load the spent fuel pool, for a total of 40 HSMs. With a current capacity of 40 HSMs, the existing pad is capable of supporting long term storage operations without modification.

The ISFSI will be expected to operate until such time that the transfer of spent fuel to the DOE can be completed. Assuming that DOE begins accepting commercial spent fuel in 2034, Fort Calhoun fuel is projected to be removed from the site beginning in 2036. The process is expected to be completed by the year 2058 based upon the previously stated assumptions.

Operations and Maintenance

The estimate includes the cost of operating and maintaining the spent fuel pool and the ISFSI, respectively. Pool operations are expected to continue approximately four years (from the permanent cessation of operations). It is assumed that this time provides the necessary cooling period for the final core to meet the dry cask storage vendor's system. ISFSI operating costs are based upon the previously stated assumptions on fuel transfer expectations.

ISFSI Decommissioning

In accordance with 10 CFR §72.30, licensees must have a proposed decommissioning plan for the ISFSI site and facilities that includes a cost estimate for the plan. The plan should contain sufficient information on the proposed practices and procedures for the decontamination of the ISFSI and for the disposal of residual radioactive materials after all spent fuel, high-level radioactive waste, and reactor-related GTCC waste have been removed.

A multi-purpose (storage and transport) DSC with a HSM is used as a basis for the cost analyses. The HSMs are assumed to have some level of neutron-induced activation as a result of the long-term storage of the fuel, i.e., to levels exceeding free-release limits. As an allowance, a total of 5 NUHOMS modules are assumed to be affected, i.e., contain residual radioactivity. The allowance is based upon the number of modules required for the final core off-load (i.e., 133 offloaded assemblies, 32 assemblies per cask) which results in 5 DSCs. It is assumed that these are the final modules offloaded; consequently they have the least time for radioactive decay of the neutron activation products.

No contamination or activation of the ISFSI pad is assumed. It would be expected that this assumption would be confirmed as a result of good radiological practice of surveying potentially impacted areas after each spent fuel transfer campaign. As such, only verification surveys are included for the pad in the decommissioning estimate. The estimate is limited to costs necessary to terminate the ISFSI's NRC license and meet the §20.1402 criteria for unrestricted use.

The cost estimate for decommissioning the ISFSI reflects: 1) the cost of an independent contractor performing the decommissioning activities; 2) an adequate contingency factor; and 3) the cost of meeting the criteria for unrestricted use. The cost of the disposition of this material, as well as the demolition of the ISFSI facility, is included in the estimate. The cost summary for decommissioning the ISFSI is presented in Appendix D.

GTCC

The dismantling of the reactor internals generates radioactive waste considered unsuitable for shallow land disposal (i.e., low-level radioactive waste with concentrations of radionuclides that exceed the limits established by the NRC for Class C radioactive waste (GTCC)). The Low-Level Radioactive Waste Policy Amendments Act of 1985 assigned the

Federal Government the responsibility for the disposal of this material. The Act also stated that the beneficiaries of the activities resulting in the generation of such radioactive waste bear all reasonable costs of disposing of such waste. Although the DOE is responsible for disposing of GTCC waste, any costs for that service have not been determined. For purposes of this estimate, the GTCC radioactive waste has been assumed to be packaged in the spent fuel DSCs (the DOE has not identified a disposal package), at a cost equivalent to that envisioned for the spent fuel. The number of canisters required and the packaged volume for GTCC was based upon the activation analysis prepared by WMG, Inc.

The GTCC material is assumed to be shipped directly to a DOE facility as it is generated (since the fuel is assumed to have been removed from the site prior to the start of decommissioning and the ISFSI deactivated).

3.4.2 Reactor Vessel and Internal Components

The reactor pressure vessel and internal components are segmented for disposal in shielded, reusable transportation casks. Segmentation is performed in the refueling canal, where a turntable and remote cutter are installed. The vessel is segmented in place, using a mast-mounted cutter supported off the lower head and directed from a shielded work platform installed overhead in the reactor cavity. Transportation cask specifications and transportation regulations dictate the segmentation and packaging methodology.

Intact disposal of reactor vessel shells has been successfully demonstrated at several of the sites that have been decommissioned. Access to navigable waterways has allowed these large packages to be transported to the Barnwell disposal site with minimal overland travel. Intact disposal of the reactor vessel and internal components can provide savings in cost and worker exposure by eliminating the complex segmentation requirements, isolation of the GTCC material, and transport/storage of the resulting waste packages. Portland General Electric (PGE) was able to dispose of the Trojan reactor as an intact package (including the internals). However, its location on the Columbia River simplified the transportation analysis since:

- the reactor package could be secured to the transport vehicle for the entire journey, i.e., the package was not lifted during transport,

- there were no man-made or natural terrain features between the plant site and the disposal location that could produce a large drop, and
- transport speeds were very low, limited by the overland transport vehicle and the river barge.

As a member of the Northwest Compact, PGE had a site available for disposal of the package - the US Ecology facility in Washington State. The characteristics of this arid site proved favorable in demonstrating compliance with land disposal regulations.

It is not known whether this option will be available when Fort Calhoun decides to dismantle the unit. Future viability of this option will depend upon the ultimate location of the disposal site, as well as the disposal site licensee's ability to accept highly radioactive packages and effectively isolate them from the environment. Consequently, the study assumes that the reactor vessel will require segmentation, as a bounding condition.

3.4.3 Primary System Components

Since this estimate is based on a SAFSTOR scenario, a chemical decontamination of the reactor coolant system is not included. With a nominal dormancy period of 40 years, radionuclide decay is expected to provide the same benefit.

The following discussion deals with the removal and disposition of the steam generators, but the techniques involved are also applicable to other large components, such as heat exchangers, component coolers, and the pressurizer. The steam generators' size and weight, as well as their location within the reactor building, will ultimately determine the removal strategy.

A trolley crane is set up for the removal of the generators. It can also be used to move portions of the steam generator cubicle walls and floor slabs from the reactor building to a location where they can be decontaminated and transported to the material handling area. Interferences within the work area, such as grating, piping, and other components are removed to create sufficient laydown space for processing these large components.

The generators are rigged for removal, disconnected from the surrounding piping and supports, and maneuvered into the open area where they are lowered onto a dolly. Each generator is rotated into the horizontal position

for extraction from the containment and placed onto a multi-wheeled vehicle for transport to an on-site processing and storage area.

The generators are disassembled on-site with the outer shell and lightly contaminated subassemblies designated for off-site recycling. The more highly contaminated tube sheet and tube bundle are packaged for direct disposal.

Disposal costs are based upon the displaced volume and weight of the units. Each component is then loaded onto a rail car for transport to the disposal facility.

Reactor coolant piping is cut from the reactor vessel once the water level in the vessel (used for personnel shielding during dismantling and cutting operations in and around the vessel) is dropped below the nozzle zone. The piping is boxed and transported by shielded van. The reactor coolant pumps and motors are lifted out intact, packaged, and transported for processing and/or disposal.

3.4.4 Main Turbine and Condenser

The main turbine is dismantled using conventional maintenance procedures. The turbine rotors and shafts are removed to a laydown area. The lower turbine casings are removed from their anchors by controlled demolition. The main condensers are also disassembled and moved to a laydown area. Material is then prepared for transportation to an off-site recycling facility where it is surveyed and designated for either decontamination or volume reduction, conventional disposal, or controlled disposal. Components are packaged and readied for transport in accordance with the intended disposition.

3.4.5 Retired Components

The estimate included the disposition of previously retired components, including:

- Steam Generators (2)
- Pressurizer
- Reactor Pressure Vessel Closure Head

3.4.6 Transportation Methods

Contaminated piping, components, and structural material other than the highly activated reactor vessel and internal components will qualify as LSA-I, II or III or Surface Contaminated Object, SCO-I or II, as described in Title 49.[32] The contaminated material will be packaged in Industrial Packages (IP-1, IP-2, or IP-3, as defined in subpart 173.411) for transport unless demonstrated to qualify as their own shipping containers. The reactor vessel and internal components are expected to be transported in accordance with 10 CFR Part 71, in Type B containers. It is conceivable that the reactor, due to its limited specific activity, could qualify as LSA II or III. However, the high radiation levels on the outer surface would require that additional shielding be incorporated within the packaging so as to attenuate the dose to levels acceptable for transport.

Any fuel cladding failure that occurred during the lifetime of the plant is assumed to have released fission products at sufficiently low levels that the buildup of quantities of long-lived isotopes (e.g., ^{137}Cs, ^{90}Sr, or transuranics) has been prevented from reaching levels exceeding those that permit the major reactor components to be shipped under current transportation regulations and disposal requirements.

Transport of the highly activated metal, produced in the segmentation of the reactor vessel and internal components, will be by shielded truck cask. Cask shipments may exceed 95,000 pounds, including vessel segment(s), supplementary shielding, cask tie-downs, and tractor-trailer. The maximum level of activity per shipment assumed permissible was based upon the license limits of the available shielded transport casks. The segmentation scheme for the vessel and internal segments is designed to meet these limits.

The transport of large intact components (e.g., large heat exchangers and other oversized components) will be by a combination of truck, rail, and/or multi-wheeled transporter.

Transportation costs for Class A radioactive material requiring controlled disposal are based upon the mileage to the Energy*Solutions* facility in Clive, Utah. Transportation costs for the higher activity Class B and C radioactive material are based upon the mileage to the WCS facility in Andrews County, Texas. The transportation cost for the GTCC material is assumed to be contained within the disposal cost. Transportation costs for off-site waste processing are based upon the mileage to Oak Ridge,

Tennessee. Truck transport costs were developed from published tariffs from Tri-State Motor Transit.[33]

3.4.7 Low-Level Radioactive Waste Disposal

To the greatest extent practical, metallic material generated in the decontamination and dismantling processes is processed to reduce the total cost of controlled disposal. Material meeting the regulatory and/or site release criterion, is released as scrap, requiring no further cost consideration. Conditioning (preparing the material to meet the waste acceptance criteria of the disposal site) and recovery of the waste stream is performed off site at a licensed processing center. Any material leaving the site is subject to a survey and release charge, at a minimum.

The mass of radioactive waste generated during the various decommissioning activities at the site is shown on a line-item basis in the Appendix C, and summarized in Section 5. The quantified waste summaries shown in these tables are consistent with 10 CFR Part 61 classifications. Commercially available steel containers are presumed to be used for the disposal of piping, small components, and concrete. Larger components can serve as their own containers, with proper closure of all openings, access ways, and penetrations. The volumes are calculated based on the exterior package dimensions for containerized material or a specific calculation for components serving as their own waste containers.

The more highly activated reactor components will be shipped in reusable, shielded truck casks with disposable liners. In calculating disposal costs, the burial fees are applied against the liner volume, as well as the special handling requirements of the payload. Packaging efficiencies are lower for the highly activated materials (greater than Class A waste), where high concentrations of gamma-emitting radionuclides limit the capacity of the shipping canisters.

Disposal fees are based upon estimated charges, with surcharges added for the highly activated components, for example, generated in the segmentation of the reactor vessel. The cost to dispose of the lowest level waste and the majority of the material generated from the decontamination and dismantling activities is based upon the current cost for disposal at Energy*Solutions* facility in Clive, Utah. Disposal costs for the higher activity waste (Class B and C) were based upon information available from Texas Commission on Environmental Quality for the Andrews County facility.

3.4.8 Site Remediation

A limited Historical Site Assessment (HSA)[34] was conducted at Fort Calhoun between August and October 2016. The HSA effort focused on environmental (open land) areas at the FCS site; assessment of potential radiological impact to FCS site buildings, structures, or systems was not included. As a follow-up to the HSA, a Limited Radiological Characterization Plan (LRCP)[35] was developed with the objective of closing the gaps in historical radiological data identified by the HSA. The LRCP was implemented at the FCS site between October 19th and 28th, 2016 and included the collection of 52 soil samples (36 surface soil samples and 16 subsurface soil samples) from potentially radiologically impacted environmental areas. Additionally, several gamma scans were performed within each target environmental area.

Laboratory results identified low concentrations of ^{137}Cs (i.e., approximately 0.1 pCi/g to 0.4 pCi/g) in 5 of the 36 surface soil samples. However, the ^{137}Cs concentrations were small percentages (i.e., <4%) of the NRC screening value for ^{137}Cs (11 pCi/g) published in NUREG 1757,[36] and are well below concentrations that would require remediation or special consideration during decommissioning. Results for all other plant-related radionuclides were below the a posteriori minimum detectable concentration (MDC) values.

The gamma scans did not identify any elevated radiation levels within the targeted environmental areas.

The limited scope of this project did not include the collection of sub-surface soil from under building foundations (e.g., containment, auxiliary, turbine, service, technical support center, maintenance shop, radioactive waste processing, and the chemistry and radiation protection facility) or soil adjacent to underground systems, structures, and components containing radioactive materials (e.g., radioactive waste lines and sumps).

At this time, and for purposes of this SAFSTOR estimate (recognizing that they could be up to 40 years of additional decay), no cost for radiologically contaminated soil remediation is included.

A limited site non-radiological characterization investigation was also conducted.[37] The investigation was designed to identify significant environmental impacts to soils, sediments, and groundwater to the extent that subsequent characterization and remediation could impact the DCE and/or decommissioning schedule.

Only two areas of interest were identified where chemical or non-radiological constituents impacted environmental media; the Fire Training Area and Firing Range.

Perfluoroalkyl surfactants (PFAs) were found in the Fire Training Area in excess of the EPA Health Advisory standard of 0.07 micrograms per liter. PFAs do not have a Nebraska Department of Environmental Quality criteria, but have been identified recently by EPA as an emerging compound, with a Health Advisory number for drinking water already in effect. Although the site will require a more thorough characterization, an allowance for remediation of the Fire Training Area (soil removal) has been included in the estimate.

Elevated concentrations of lead, above the EPA hazardous threshold of 5 mg/L, are present in samples of the berm at the Firing Range. Groundwater grab samples, collected on the downgradient site of the Firing Range also reported lead. Although the site will require a more thorough characterization, an allowance for lead remediation and closure of the Firing Range has been included in the estimate.

3.4.9 Disposition of Underground Piping and Site Services

A significant amount of the below grade piping is located around the perimeter of the power block. The estimate includes a cost to excavate this area to an average depth of six feet so as to expose the piping, duct bank, conduit, and any near-surface grounding grid. The overburden is surveyed and stockpiled on site for future use in backfilling the below grade voids.

3.4.10 Site Conditions Following Decommissioning

The NRC will terminate the site license if it determines that site remediation has been performed in accordance with the license termination plan, and that the terminal radiation survey and associated documentation demonstrate that the facility is suitable for release. The NRC's involvement in the decommissioning process will end at this point. Building codes and environmental regulations will dictate the next step in the decommissioning process, as well as owner's own future plans for the site.

Only existing site structures are considered in the dismantling cost. The electrical switchyard remains after Fort Calhoun is decommissioned in support of the regional transmission and distribution system. Structures

are removed to a nominal depth of three feet below grade. The voids are backfilled with clean debris and capped with soil. The site is then re-graded to conform to the adjacent landscape. Vegetation is established to inhibit erosion. These "non-radiological costs" are included in the total cost of decommissioning.

Concrete rubble generated from demolition activities (after the NRC license is terminated) is processed (crushed and rebar removed) and made available as clean fill for below grade voids, such as the power block foundations. If necessary, excess construction debris is trucked off site. The excavations will be regraded such that the power block area will have a final contour consistent with adjacent surroundings.

3.5 ASSUMPTIONS

The following are the major assumptions made in the development of the estimate for decommissioning the site.

3.5.1 Estimating Basis

Decommissioning costs are reported in the year of projected expenditure; however, the values are provided in 2017 dollars. Costs are not inflated, escalated, or discounted over the periods of performance.

The estimate relies upon the physical plant inventory that was the basis for the 2016 analysis. There were no material changes to the site since 2016.

The study follows the principles of ALARA through the use of work duration adjustment factors. These factors address the impact of activities such as radiological protection instruction, mock-up training, and the use of respiratory protection and protective clothing. The factors lengthen a task's duration, increasing costs and lengthening the overall schedule. ALARA planning is considered in the costs for engineering and planning, and in the development of activity specifications and detailed procedures. Changes to worker exposure limits may impact the decommissioning cost and project schedule.

3.5.2 Labor Costs

For purposes of this estimate, it is assumed that OPPD (or a comparable organization) will manage the decontamination and dismantling of the nuclear unit in addition to maintaining site security, radiological health

and safety, quality assurance and overall site administration during the decommissioning. A Decommissioning Operations Contractor (DOC) will provide the supervisory staff needed to oversee the labor subcontractors, consultants, and specialty contractors engaged to perform the field work associated with the decontamination and dismantling efforts.

Personnel costs are based upon a single average salary provided by OPPD for all site personnel. Overhead costs are included for site and corporate support; such overhead costs are reduced commensurate with the staffing levels envisioned throughout the project. Personnel staffing levels through the SAFSTOR dormancy period were provided by OPPD.

Reduction in the operating organization is assumed to be handled through normal staffing processes (e.g., reassignment and outplacement).

The craft labor required to decontaminate and dismantle the nuclear unit is acquired through standard site contracting practices. The cost of contracted labor is used as an estimating basis and is escalated as appropriate to 2017 dollars.

Security, while reduced from operating levels, is maintained throughout the decommissioning for access control, material control, and to safeguard the spent fuel (in accordance with the requirements of 10 CFR Part 37, Part 72, and Part 73). Once the fuel has been transferred to the DOE in 2058, the security organization will be reduced to Part 37 requirements.

3.5.3 Non-Labor Recurring Costs

Site O&M non-labor overhead costs were provided by OPPD for five years beginning in 2018. The O&M costs estimated for the balance of the decommissioning schedule were escalated from the 2016 estimate. Costs identified by the OPPD as near-term or one-time expenditures were removed from the budget as the schedule dictated.

3.5.4 Design Conditions

Activation levels in the vessel and internal components are based upon an activation analysis prepared by WMG, Inc.[38] The activation source terms were adjusted for decay for the safe-storage period (approximately 40 years).

It is anticipated that there will be five-fingered control element assemblies (CEAs) in the spent fuel pool at the cessation of operations

(including the CEAs from the final core). This analysis assumes that the CEAs can be disposed of along with the spent fuel at no additional cost (in accordance with Appendix E of the Standard Contract). This analysis further assumes that the CEAs would be loaded into the DSCs at the time spent fuel is transferred from the spent fuel pool to the ISFSI.

Neutron activation of the containment building structure is assumed to be confined to the biological shield.

The estimate includes an allowance for the disposition of Tri Nuc filters, filters stored in the radwaste building and spent fuel pool, filter baskets, equipment, tools and other miscellaneous material currently stored in the spent fuel pool.

3.5.5 General

Transition Activities

The estimate includes costs for the processing of water in various tanks, sumps, the spent fuel pool and spent fuel transfer canal as well as water collected on site.

Existing warehouses are cleared of non-essential material and remain for use by the OPPD and its subcontractors. The plant's operating staff performs the following activities at no additional cost or credit to the project during the transition period:

- Drain and collect fuel oils, lubricating oils, and transformer oils for recycle and/or sale.
- Drain and collect acids, caustics, and other chemical stores for recycle and/or sale.

Scrap and Salvage

The existing plant equipment is considered obsolete and suitable for scrap as deadweight quantities only. OPPD will make economically reasonable efforts to salvage equipment following final plant shutdown. However, dismantling techniques assumed by TLG for equipment in this analysis are not consistent with removal techniques required for salvage (resale) of equipment. Experience has indicated that some buyers wanted equipment stripped down to very specific requirements before they would consider purchase. This required expensive rework after the equipment

had been removed from its installed location. Since placing a salvage value on this machinery and equipment would be speculative, and the value would be small in comparison to the overall decommissioning expenses, this analysis does not attempt to quantify the value that an owner may realize based upon those efforts.

It is assumed, for purposes of this analysis, that any value received from the sale of scrap generated in the dismantling process would be more than offset by the on-site processing costs. The dismantling techniques assumed in the decommissioning estimate do not include the additional cost for size reduction and preparation to meet “furnace ready” conditions. For example, the recovery of copper from electrical cabling may require the removal and disposition of any contaminated insulation, an added expense. With a volatile market, the potential profit margin in scrap recovery is highly speculative, regardless of the ability to free release this material. This assumption is an implicit recognition of scrap value in the disposal of clean metallic waste at no additional cost to the project.

Furniture, tools, mobile equipment such as forklifts, trucks, bulldozers, and other property is removed at no cost or credit to the decommissioning project. Disposition may include relocation to other facilities. Spare parts are also made available for alternative use.

Mobile vehicle barriers are assumed to be potentially useful at other facilities. As such, the cost for disposing of the barriers is not included in the estimate.

Energy

For estimating purposes, the plant is assumed to be de-energized, with the exception of those facilities associated with spent fuel storage. Electricity is provided to the site by OPPD at no cost to the project. The estimate does include a cost for heating oil through the year 2020, at which time the site will be converted to electric.

Emergency Planning

FEMA, state and local fees associated with emergency planning are assumed to continue through mid-April, 2018. At this time, the FEMA fees are discontinued. The timing is based upon the anticipated condition of the spent fuel (i.e., the hottest spent fuel assemblies are assumed to be cool enough that no substantial Zircaloy oxidation and off-site event would occur with the loss of spent fuel pool water).

A nominal value for miscellaneous emergency plan expenses is included until the spent fuel is removed from the site.

NRC Fees

The estimate includes several cost elements associated with the NRC and its oversight of the decommissioning process, including:

- An annual fee assessed to a power reactor holding a 10 CFR Part 50 license that is in decommissioning (until the license is terminated),
- OPPD provided the NRC cost for five years, starting in 2018,
- NRC review of OPPD submittals (license amendment requests, exemptions, etc.), based upon the published cost of a professional staff-hour

Insurance

Costs for continuing coverage (nuclear liability and property insurance) following cessation of plant operations and during decommissioning are included and based upon current operating premiums. Reductions in premiums, throughout the decommissioning process, are based upon the guidance and the limits for coverage defined in the NRC's proposed rulemaking "Financial Protection Requirements for Permanently Shutdown Nuclear Power Reactors."[39] The NRC's financial protection requirements are based on various reactor (and spent fuel) configurations.

Taxes

Property taxes are not included within the estimate with the exception of a nominal allowance associated with state of Iowa.

Site Modifications

The perimeter fence and in-plant security barriers will be moved, as appropriate, to conform to the Site Security Plan in force during the various stages of the project.

3.6 COST ESTIMATE SUMMARY

Schedules of expenditures are provided in Table 3.2. The schedules are based upon the costs reported in Appendix C.

The cost elements in Appendix C are assigned to one of three subcategories: "License Termination," "Spent Fuel Management," and "Site Restoration." The subcategory "License Termination" is used to accumulate costs that are consistent with "decommissioning" as defined by the NRC in its financial assurance regulations (i.e., 10 CFR §50.75). The cost reported for this subcategory is generally sufficient to terminate the plant's operating license, recognizing that there may be some additional cost impact from spent fuel management. The License Termination cost subcategory also includes costs to decommission the ISFSI (as required by 10 CFR §72.30). The basis for the ISFSI decommissioning cost is provided in Appendix D.

The "Spent Fuel Management" subcategory contains costs associated with the containerization and transfer of spent fuel from the pool to the ISFSI, and the transfer of the multipurpose canisters from the ISFSI to the DOE. Costs are also included for the operations of the pool and management of the ISFSI until such time that the transfer of all fuel from this facility to an off-site location (e.g., interim storage facility) is complete.

"Site Restoration" is used to capture costs associated with the dismantling and demolition of buildings and facilities demonstrated to be free from contamination. This includes structures never exposed to radioactive materials, as well as those facilities that have been decontaminated to appropriate levels. Structures are assumed to be removed to a nominal depth of three feet and backfilled to conform to local grade.

The disposal of the GTCC is assumed to be concurrent with the disposal of the other reactor internals. While designated for disposal at the geologic repository along with the spent fuel, GTCC waste is still classified as low-level radioactive waste and, as such, included as a "License Termination" expense.

Decommissioning costs are reported in 2017 dollars. Costs are not inflated, escalated, or discounted over the period of expenditure. The schedules are based upon the detailed activity costs reported in Appendix C, along with the timeline presented in Section 4.

TABLE 3.1
SPENT FUEL MANAGEMENT SCHEDULE
(Fuel Assembly Totals by Location)

Year	Pool Inventory	ISFSI Inventory	DOE Acceptance[1]
2016	944	320	
2017	944	320	
2018	688	576	
2019	336	928	
2020	0	1,264	
2021		1,264	
2022		1,264	
2023		1,264	
2024		1,264	
2025		1,264	
2026		1,264	
2027		1,264	
2028		1,264	
2029		1,264	
2030		1,264	
2031		1,264	
2032		1,264	
2033		1,264	
2034		1,264	
2035		1,264	
2036		1,200	64
2037		1,104	96
2038		1,072	32
2039		1,008	64
2040		912	96
2041		880	32
2042		848	32
2043		816	32
2044		784	32
2045		752	32
2046		720	32
2047		656	64

TABLE 3.1 (continued)
SPENT FUEL MANAGEMENT SCHEDULE
(Fuel Assembly Totals by Location)

Year	Pool Inventory	ISFSI Inventory	DOE Acceptance[1]
2048		592	64
2049		560	32
2050		464	96
2051		432	32
2052		432	0
2053		368	64
2054		304	64
2055		240	64
2056		176	64
2057		80	96
2058		0	80
Total			1,264

[1] DOE acceptance schedule assuming industry acceptance begins in year 2034 and Fort Calhoun acceptance begins in year 2036. The schedule is provided for illustrative purposes only. It is expected that OPPD will seek to accelerate acceptance based on shutdown reactor priority, exchanges of acceptance allocations and other contractual provisions.

TABLE 3.2
TOTAL ANNUAL EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2018	60,586	759	638	676	35,570	98,230
2019	59,340	567	638	618	41,143	102,306
2020	59,503	568	640	620	41,255	102,586
2021	10,873	3	0	12	1,891	12,779
2022	10,873	3	0	12	1,891	12,779
2023	10,873	3	0	12	1,891	12,779
2024	10,898	3	0	13	1,897	12,810
2025	10,873	3	0	12	1,891	12,779
2026	10,873	3	0	12	1,891	12,779
2027	10,873	3	0	12	1,891	12,779
2028	10,898	3	0	13	1,897	12,810
2029	10,873	3	0	12	1,891	12,779
2030	10,873	3	0	12	1,891	12,779
2031	10,873	3	0	12	1,891	12,779
2032	10,898	3	0	13	1,897	12,810
2033	10,873	3	0	12	1,891	12,779
2034	10,873	3	0	12	1,891	12,779
2035	10,873	3	0	12	1,891	12,779
2036	11,041	434	0	13	1,897	13,385
2037	9,269	650	0	12	1,891	11,822
2038	9,125	218	0	12	1,891	11,247
2039	9,197	434	0	12	1,891	11,535
2040	9,293	650	0	13	1,897	11,852
2041	9,125	218	0	12	1,891	11,247
2042	9,125	218	0	12	1,891	11,247
2043	9,125	218	0	12	1,891	11,247
2044	9,150	218	0	13	1,897	11,277
2045	9,125	218	0	12	1,891	11,247
2046	9,125	218	0	12	1,891	11,247
2047	9,197	434	0	12	1,891	11,535
2048	9,222	434	0	13	1,897	11,565
2049	9,125	218	0	12	1,891	11,247
2050	9,269	650	0	12	1,891	11,822

TABLE 3.2 (continued)
TOTAL ANNUAL EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2051	9,125	218	0	12	1,891	11,247
2052	9,078	3	0	13	1,897	10,990
2053	9,197	434	0	12	1,891	11,535
2054	9,197	434	0	12	1,891	11,535
2055	9,197	434	0	12	1,891	11,535
2056	9,222	434	0	13	1,897	11,565
2057	9,269	650	0	12	1,891	11,822
2058	9,269	650	0	12	1,891	11,822
2059	45,431	5,019	0	47	3,360	53,857
2060	53,662	21,035	0	16,494	10,421	101,612
2061	52,932	23,506	0	23,074	13,853	113,365
2062	48,803	6,776	0	9,677	9,014	74,271
2063	48,803	6,776	0	9,677	9,014	74,271
2064	43,973	5,260	0	6,826	7,009	63,068
2065	23,361	4,893	0	20	1,978	30,251
2066	15,303	7,275	0	0	1,702	24,280
Total	887,927	91,164	1,916	68,205	246,241	1,295,453

TABLE 3.2a
LICENSE TERMINATION EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2018	46,684	759	638	676	16,306	65,064
2019	40,477	567	638	618	16,503	58,803
2020	40,588	568	640	620	16,548	58,964
2021	4,316	3	0	12	1,683	6,014
2022	4,316	3	0	12	1,683	6,014
2023	4,316	3	0	12	1,683	6,014
2024	4,326	3	0	13	1,688	6,029
2025	4,316	3	0	12	1,683	6,014
2026	4,316	3	0	12	1,683	6,014
2027	4,316	3	0	12	1,683	6,014
2028	4,326	3	0	13	1,688	6,029
2029	4,316	3	0	12	1,683	6,014
2030	4,316	3	0	12	1,683	6,014
2031	4,316	3	0	12	1,683	6,014
2032	4,326	3	0	13	1,688	6,029
2033	4,316	3	0	12	1,683	6,014
2034	4,316	3	0	12	1,683	6,014
2035	4,316	3	0	12	1,683	6,014
2036	4,326	3	0	13	1,688	6,029
2037	3,576	3	0	12	1,683	5,274
2038	3,576	3	0	12	1,683	5,274
2039	3,576	3	0	12	1,683	5,274
2040	3,586	3	0	13	1,688	5,289
2041	3,576	3	0	12	1,683	5,274
2042	3,576	3	0	12	1,683	5,274
2043	3,576	3	0	12	1,683	5,274
2044	3,586	3	0	13	1,688	5,289
2045	3,576	3	0	12	1,683	5,274
2046	3,576	3	0	12	1,683	5,274
2047	3,576	3	0	12	1,683	5,274
2048	3,586	3	0	13	1,688	5,289
2049	3,576	3	0	12	1,683	5,274
2050	3,576	3	0	12	1,683	5,274

TABLE 3.2a (continued)
LICENSE TERMINATION EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2051	3,576	3	0	12	1,683	5,274
2052	3,586	3	0	13	1,688	5,289
2053	3,576	3	0	12	1,683	5,274
2054	3,576	3	0	12	1,683	5,274
2055	3,576	3	0	12	1,683	5,274
2056	3,586	3	0	13	1,688	5,289
2057	3,576	3	0	12	1,683	5,274
2058	3,576	3	0	12	1,683	5,274
2059	44,688	5,019	0	47	3,360	53,114
2060	52,313	21,018	0	16,494	10,421	100,246
2061	51,798	23,335	0	23,074	13,716	111,923
2062	47,087	6,406	0	9,677	8,680	71,850
2063	47,087	6,406	0	9,677	8,680	71,850
2064	42,764	4,999	0	6,826	6,773	61,363
2065	14,723	745	0	20	1,008	16,495
2066	155	0	0	0	0	155
Total	576,174	69,925	1,916	68,205	165,991	882,212

TABLE 3.2b
SPENT FUEL MANAGEMENT EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2018	13,902	0	0	0	19,264	33,166
2019	18,863	0	0	0	24,640	43,503
2020	18,915	0	0	0	24,707	43,622
2021	6,557	0	0	0	208	6,765
2022	6,557	0	0	0	208	6,765
2023	6,557	0	0	0	208	6,765
2024	6,572	0	0	0	209	6,781
2025	6,557	0	0	0	208	6,765
2026	6,557	0	0	0	208	6,765
2027	6,557	0	0	0	208	6,765
2028	6,572	0	0	0	209	6,781
2029	6,557	0	0	0	208	6,765
2030	6,557	0	0	0	208	6,765
2031	6,557	0	0	0	208	6,765
2032	6,572	0	0	0	209	6,781
2033	6,557	0	0	0	208	6,765
2034	6,557	0	0	0	208	6,765
2035	6,557	0	0	0	208	6,765
2036	6,716	431	0	0	209	7,356
2037	5,693	647	0	0	208	6,548
2038	5,549	216	0	0	208	5,973
2039	5,621	431	0	0	208	6,261
2040	5,708	647	0	0	209	6,564
2041	5,549	216	0	0	208	5,973
2042	5,549	216	0	0	208	5,973
2043	5,549	216	0	0	208	5,973
2044	5,564	216	0	0	209	5,989
2045	5,549	216	0	0	208	5,973
2046	5,549	216	0	0	208	5,973
2047	5,621	431	0	0	208	6,261
2048	5,636	431	0	0	209	6,276
2049	5,549	216	0	0	208	5,973
2050	5,693	647	0	0	208	6,548

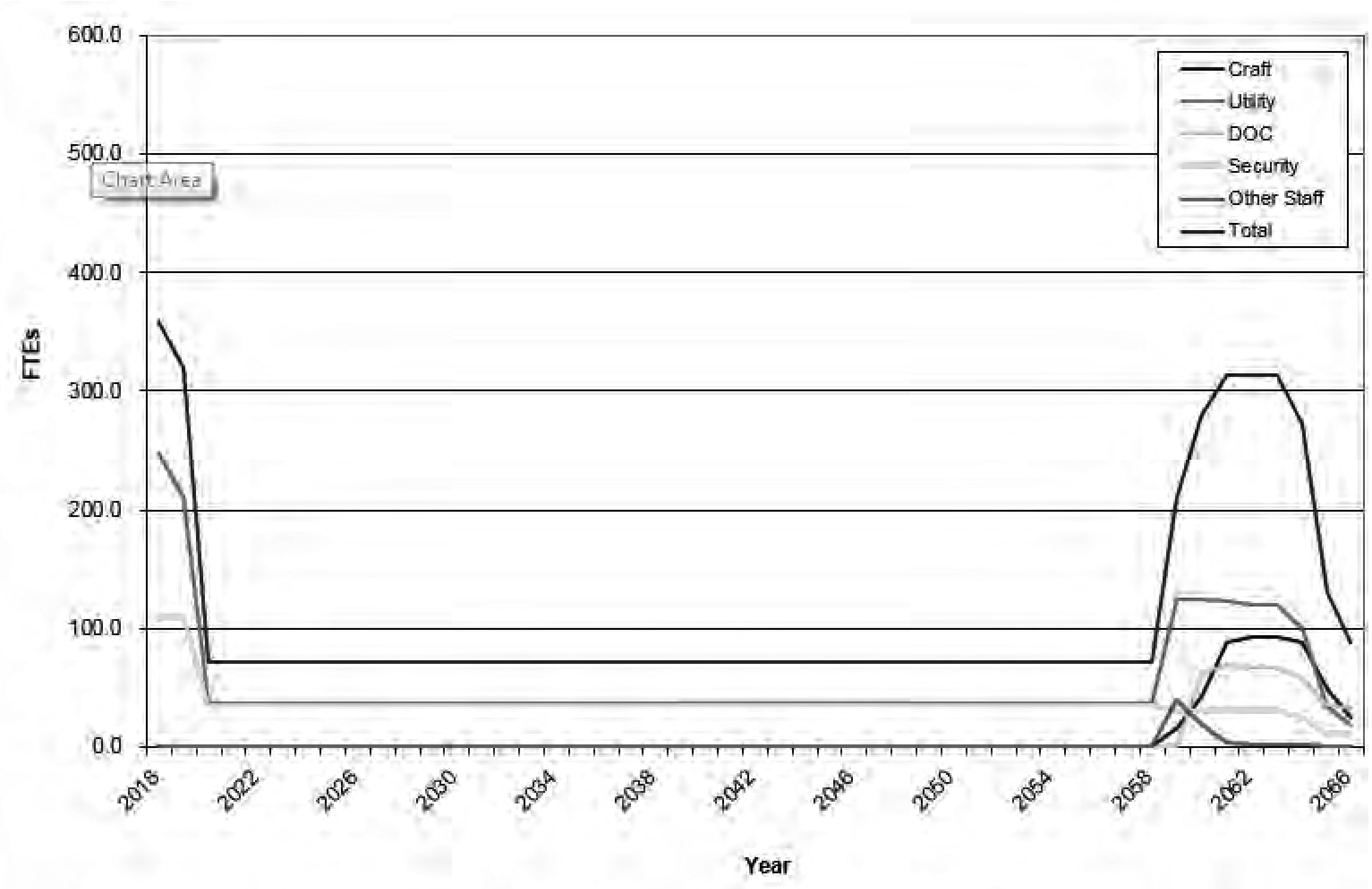
TABLE 3.2b (continued)
SPENT FUEL MANAGEMENT EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2051	5,549	216	0	0	208	5,973
2052	5,492	0	0	0	209	5,701
2053	5,621	431	0	0	208	6,261
2054	5,621	431	0	0	208	6,261
2055	5,621	431	0	0	208	6,261
2056	5,636	431	0	0	209	6,276
2057	5,693	647	0	0	208	6,548
2058	5,693	647	0	0	208	6,548
Total	280,099	8,625	0	0	76,538	365,262

TABLE 3.2c
SITE RESTORATION EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2059	743	0	0	0	0	743
2060	1,349	17	0	0	0	1,366
2061	1,134	171	0	0	136	1,442
2062	1,716	371	0	0	334	2,421
2063	1,716	371	0	0	334	2,421
2064	1,209	261	0	0	235	1,705
2065	8,637	4,148	0	0	970	13,756
2066	15,148	7,275	0	0	1,702	24,125
Total	31,654	12,614	0	0	3,711	47,979

FIGURE 3.1
SITE STAFFING LEVELS
(Full Time Equivalent Positions)



4. SCHEDULE ESTIMATE

The schedule for the SAFSTOR decommissioning scenario follows the sequence presented in the AIF/NESP-036 study, with minor changes to reflect recent experience and site-specific constraints. In addition, the scheduling has been revised to reflect the spent fuel management described in Section 3.4.1.

A schedule or sequence of activities for the SAFSTOR alternative is presented in Figure 4.1. The scheduling sequence is based on the fuel being removed from the spent fuel pool within six years after shutdown. The key activities listed in the schedule do not reflect a one-to-one correspondence with those activities in the cost tables, but reflect dividing some activities for clarity and combining others for convenience. The schedule was prepared using the "Microsoft Project Professional" computer software.[40]

4.1 SCHEDULE ESTIMATE ASSUMPTIONS

The schedule reflects the results of a precedence network developed for the site decommissioning activities, i.e., a PERT (Program Evaluation and Review Technique) Software Package. The work activity durations used in the precedence network reflect the actual man-hour estimate from the cost table, adjusted by stretching certain activities over their slack range and shifting the start and end dates of others. The following assumptions were made in the development of the decommissioning schedule:

- The fuel handling area of the auxiliary building is isolated until such time that all spent fuel has been discharged from the spent fuel pool to the ISFSI. Layup of the storage pool is initiated once the transfer of spent fuel is complete.
- All work (except vessel and internals removal) is performed during an 8-hour workday, 5 days per week, with no overtime.
- Reactor and internals removal activities are performed by using separate crews for different activities working on different shifts, with a corresponding backshift charge for the second shift.
- Multiple crews work parallel activities to the maximum extent possible, consistent with optimum efficiency, adequate access for cutting, removal and laydown space, and with the stringent safety measures necessary during demolition of heavy components and structures.
- For plant systems removal, the systems with the longest removal durations in areas on the critical path are considered to determine the duration of the activity.

4.2 PROJECT SCHEDULE

The period-dependent costs presented in the detailed cost table are based upon the durations developed in the schedules for decommissioning. Durations are established between several milestones in each project period; these durations are used to establish a critical path for the entire project. In turn, the critical path duration for each period is used as the basis for determining the period-dependent costs.

A project timelines is provided in Figure 4.2, with milestone dates based on an October 24, 2016 shutdown date. The fuel pool is emptied approximately four years after shutdown, while ISFSI operations continue until the DOE can complete the transfer of assemblies. For purposes of this analysis, the plant is assumed to remain in safe-storage until the spent fuel has been removed from the site (through 2058). Deferred decommissioning is assumed to commence such that the operating license is terminated within the required 60-year time period (from the cessation of plant operations).

FIGURE 4.1a
SAFSTOR ACTIVITY SCHEDULE
(Years 2018 through 2020)

ID	Task Name
1	Fort Calhoun SAFSTOR Activity Schedule
2	Period 1b Limited DECON activities
3	Spent fuel pool management
4	Spent fuel Security modifications
5	Engineering, training, procedures and fuel loading plans
6	Process decommissioning water waste
7	Period 2a SAFSTOR Dormancy / Wet Fuel
8	Spent fuel pool management
9	HSM procurement
10	Engineering, planning, procedures and loading plans
11	Licensing, engineering and SF characterization
12	Spent fuel pool security modifications
13	Pool to Pad Services
14	Hazardous/ mixed waste removal
15	Site reconfiguration
16	Fukushima modifications
17	Class 1 structures
18	2018 filter campaign
19	Spent fuel pool non-fuel inventory removal
20	Soil Remediation
21	Spent fuel pool cleanup
22	Remove spent fuel racks
23	Asbestos abatement

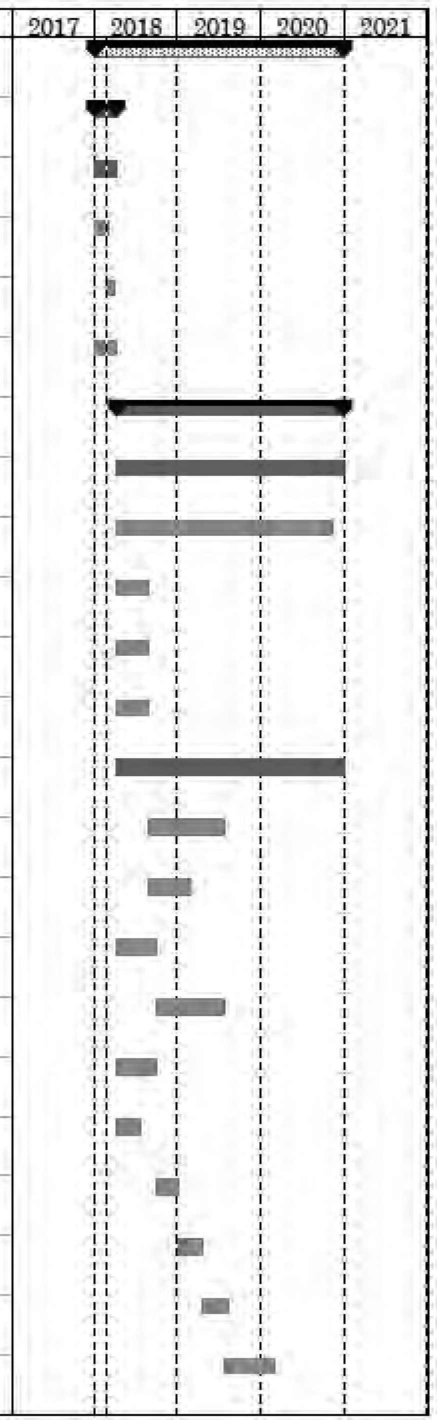


FIGURE 4.1b
SAFSTOR ACTIVITY SCHEDULE
(Years 2059 through 2066)

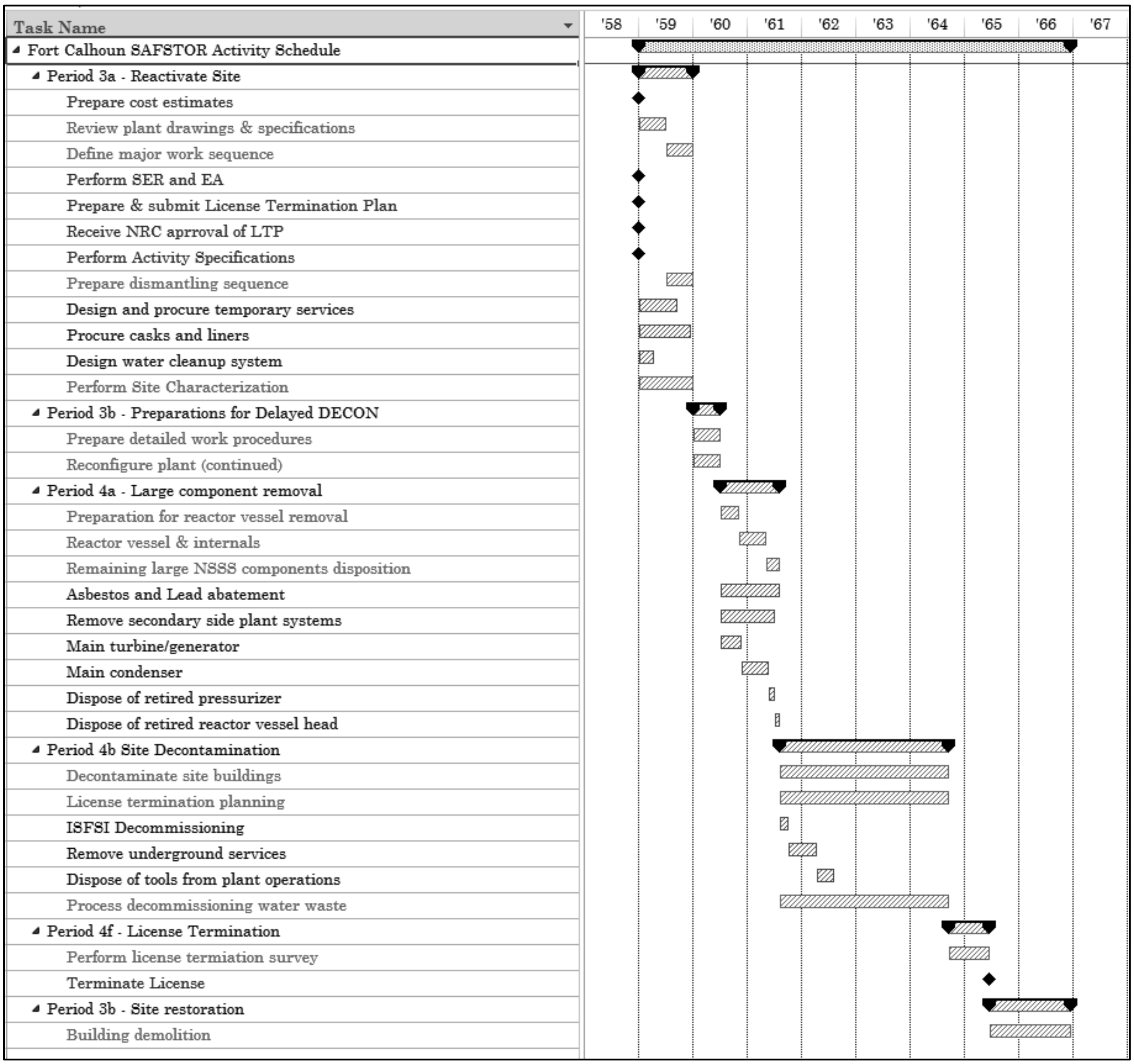
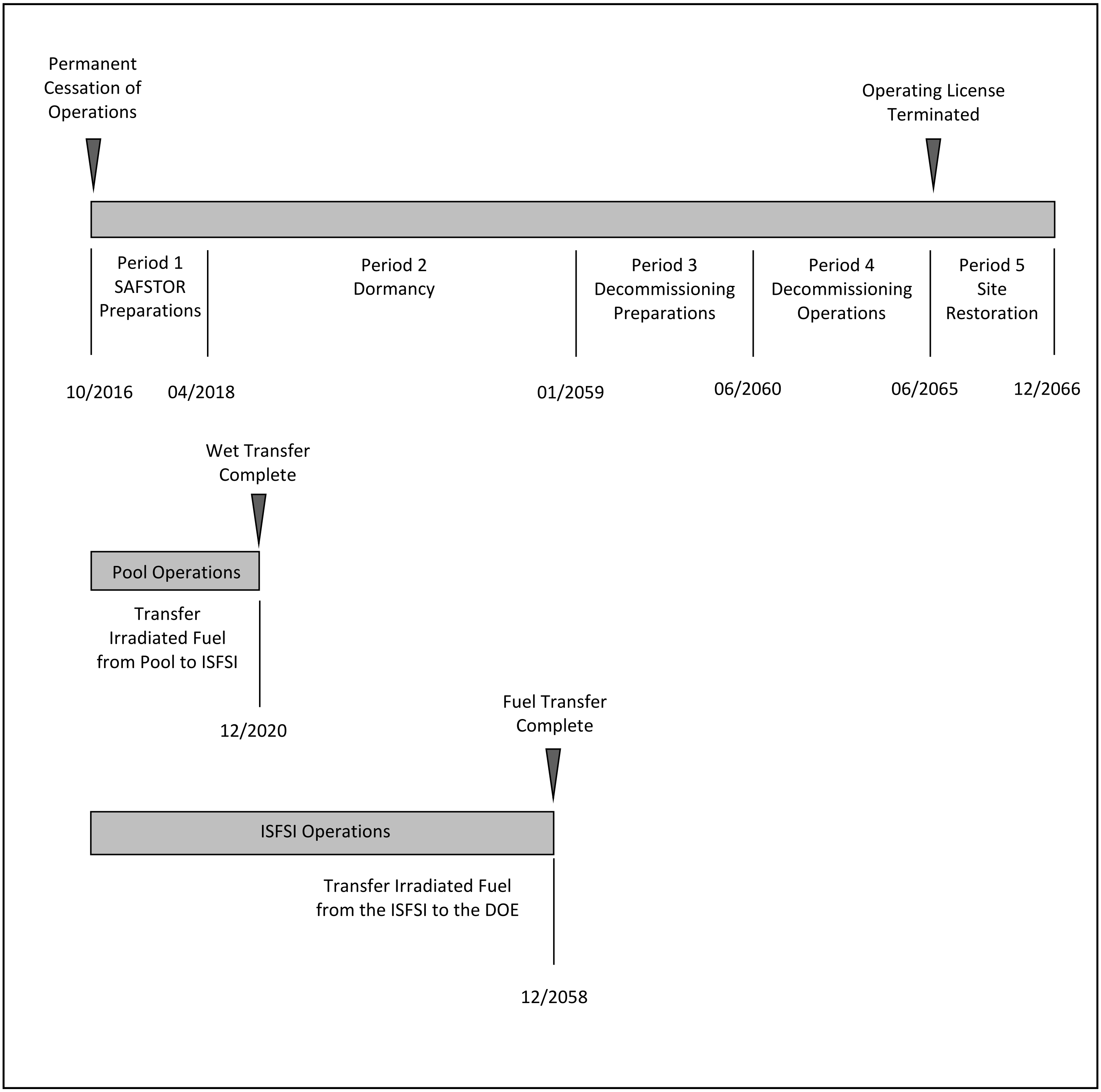


TABLE 4.1
DECOMMISSIONING SCHEDULE AND PLANT STATUS SUMMARY

Decommissioning Activities / Plant Status	Start	End	Approximate Duration (years)
Transition from Operations			
Plant Shutdown	24 Oct 2016	--------	--------
Preparations for SAFSTOR Dormancy	24 Oct 2016	07 Apr 2018	1.45
SAFSTOR Dormancy			
Dormancy w/Wet Fuel Storage	2018	2020	2.74
Dormancy w/Dry Fuel Storage	2021	2058	38.00
Decommissioning Preparations			
Preparations for D&D	2059	2060	1.49
Dismantling & Decontamination			
Large Component Removal	2060	2061	1.10
Plant Systems Removal and Building Decontamination	2061	2064	3.11
License Termination	2064	2065	0.75
Site Restoration			
Site Restoration	2065	2066	1.50
Total from Shutdown to Completion of Site Restoration	---------	--------	50.18

FIGURE 4.2
DECOMMISSIONING TIMELINE
(not to scale)



5. RADIOACTIVE WASTES

The objectives of the decommissioning process are the removal of all radioactive material from the site that would restrict its future use and the termination of the NRC license. This currently requires the remediation of all radioactive material at the site in excess of applicable legal limits. Under the Atomic Energy Act,[41] the NRC is responsible for protecting the public from sources of ionizing radiation. Title 10 of the Code of Federal Regulations delineates the production, utilization, and disposal of radioactive materials and processes. In particular, Part 71 defines radioactive material as it pertains to transportation and Part 61 specifies its disposition.

Most of the materials being transported for controlled burial are categorized as Low Specific Activity (LSA) or Surface Contaminated Object (SCO) materials containing Type A quantities, as defined in 49 CFR Parts 173-178. Shipping containers are required to be Industrial Packages (IP-1, IP-2 or IP-3, as defined in 10 CFR §173.411). For this study, commercially available steel containers are presumed to be used for the disposal of piping, small components, and concrete. Larger components can serve as their own containers, with proper closure of all openings, access ways, and penetrations.

The destinations for the various waste streams from decommissioning are identified in Figure 5.1. The volumes are shown on a line-item basis in Appendix C and summarized in Table 5.1. The volumes are calculated based on the exterior dimensions for containerized material and on the displaced volume of components serving as their own waste containers.

The reactor vessel and internals are categorized as large quantity shipments and, accordingly, will be shipped in reusable, shielded truck casks with disposable liners. In calculating disposal costs, the burial fees are applied against the liner volume, as well as the special handling requirements of the payload. Packaging efficiencies are lower for the highly activated materials (greater than Type A quantity waste), where high concentrations of gamma-emitting radionuclides limit the capacity of the shipping canisters.

No process system containing/handling radioactive substances at shutdown is presumed to meet material release criteria by decay alone (i.e., systems radioactive at shutdown will still be radioactive over the time period during which the decommissioning is accomplished, due to the presence of long-lived radionuclides). While the dose rates decrease with time, radionuclides such as ^{137}Cs will still control the disposition requirements.

The waste material produced in the decontamination and dismantling of the nuclear plant is primarily generated during Period 4 of SAFSTOR. Material that is considered potentially contaminated when removed from the radiological controlled area is sent to processing facilities in Tennessee for conditioning and disposal. Heavily contaminated components and activated materials are routed for controlled disposal. The disposal volumes reported in the tables reflect the savings resulting from reprocessing and recycling.

For purposes of constructing the estimate, the current cost for disposal at Energy*Solutions* facility in Clive, Utah was used for a majority of the radioactive waste produced from the decommissioning activities. Separate rates were used for containerized waste and large components. Demolition debris including miscellaneous steel, scaffolding, and concrete was disposed of at a bulk rate. The decommissioning waste stream also included resins and dry active waste.

Since Energy*Solutions* is not currently able to receive the more highly radioactive components generated in the decontamination and dismantling of the reactor, disposal costs for the Class B and C material were based upon preliminary information from the Texas Commission on Environmental Quality on the cost at the Andrews County, Texas facility.

The estimate includes the disposition of retired components currently stored on site, as well as contaminated tools necessary to support current operations and maintenance activities.

FIGURE 5.1
RADIOACTIVE WASTE DISPOSITION

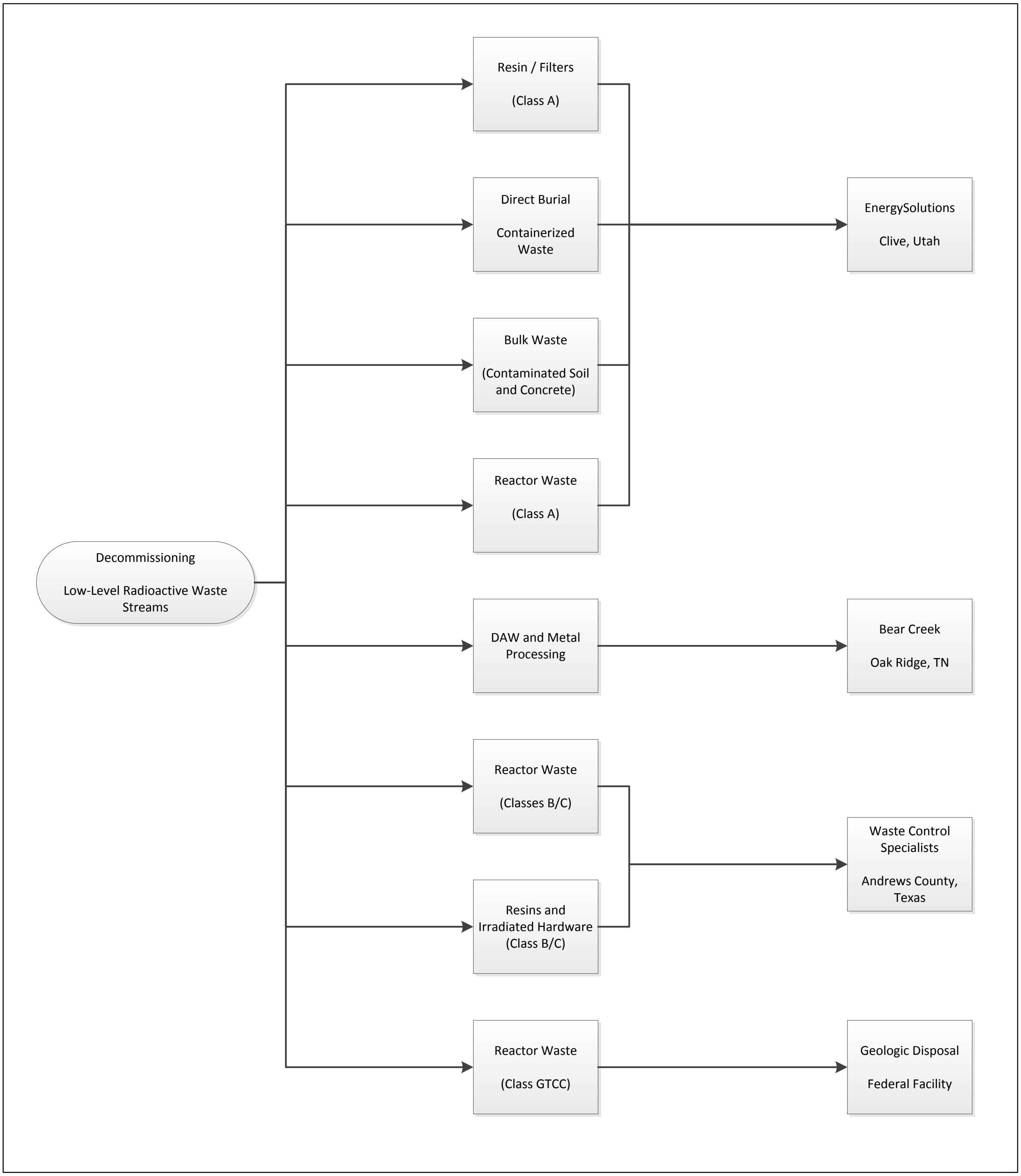


FIGURE 5.2
DECOMMISSIONING WASTE DESTINATIONS
RADIOLOGICAL

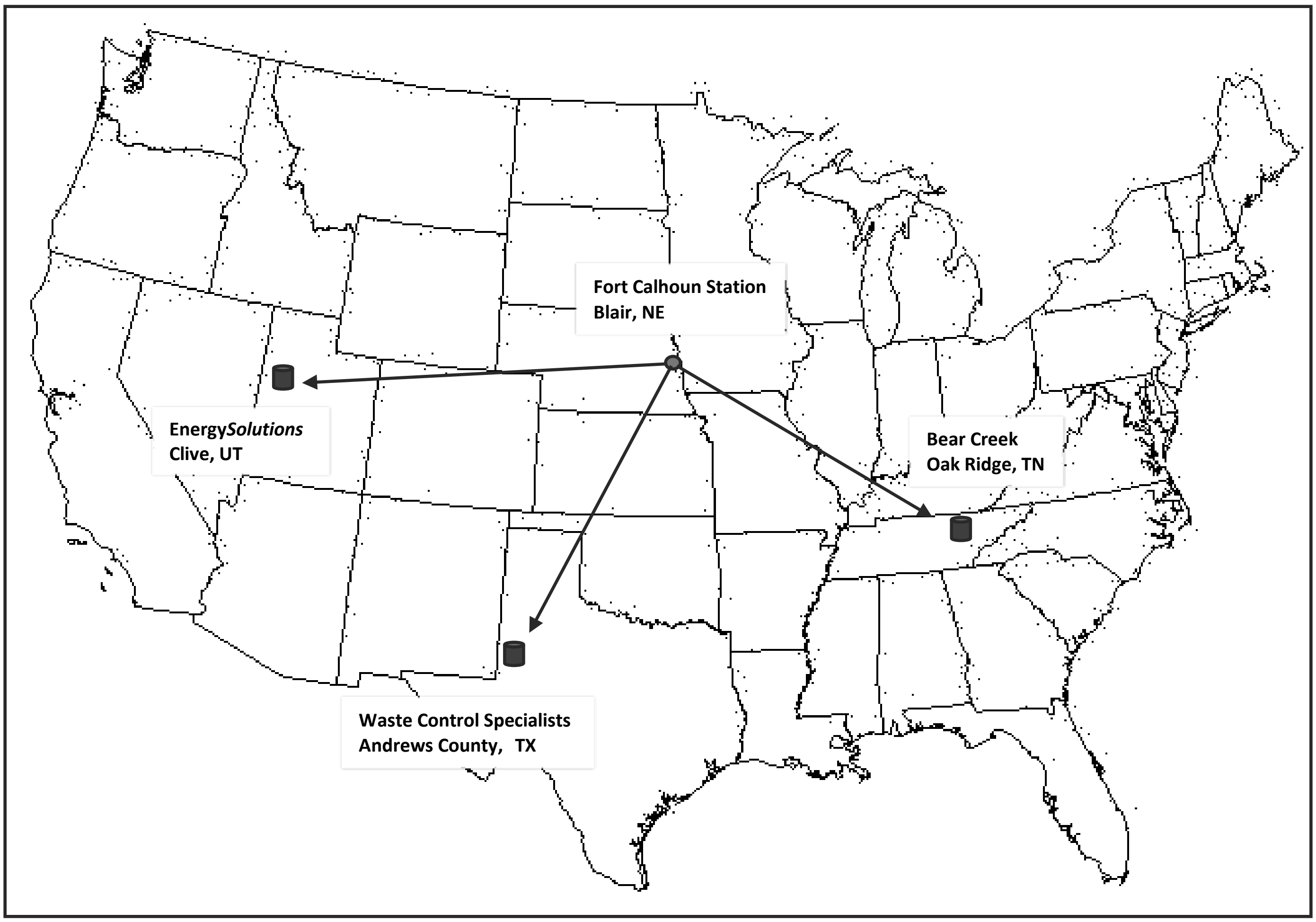


TABLE 5.1
SAFSTOR ALTERNATIVE
DECOMMISSIONING WASTE SUMMARY

Waste	Cost Basis	Class [1]	Waste Volume (cubic feet)	Weight (pounds)
Low-Level Radioactive Waste (near-surface disposal)	Energy*Solutions*	A	162,484	7,654,628
	WCS	B	475	47,238
	WCS	C	963	111,732
Greater than Class C (geologic repository)	Spent Fuel Equivalent	GTCC	1,179	201,521
Processed/Conditioned (off-site recycling center)	Recycling Vendors	A	305,976	11,961,890
Total [2]			471,077	19,977,009

[1] Waste is classified according to the requirements as delineated in Title 10 CFR, Part 61.55

[2] Columns may not add due to rounding

6. RESULTS

The analysis to estimate the costs to decommission Fort Calhoun relied upon the planning by OPPD's decommissioning organization as well as the site-specific, technical information developed for a previous analysis prepared in 2016. While not an engineering study, the estimate provides the owner with sufficient information to assess its financial obligations, as they pertain to the eventual decommissioning of the nuclear station.

The estimate described in this report is based on numerous fundamental assumptions, including regulatory requirements, project contingencies, low-level radioactive waste disposal practices, high-level radioactive waste management options, and site restoration requirements. The decommissioning scenarios assume continued operation of the station's spent fuel pool for another three years through 2020.

The cost projected for deferred decommissioning (SAFSTOR) is estimated to be $1.295 billion. The majority of this cost (approximately 68.1%) is associated with placing the plant in storage, ongoing caretaking of the plant during dormancy, and the eventual physical decontamination and dismantling of the nuclear plant so that the operating license can be terminated. Another 28.2% is associated with the management, interim storage, and eventual transfer of the spent fuel. The remaining 3.7% is for the demolition of the designated structures and limited restoration of the site.

The primary cost contributors, identified in Table 6.1, are either labor-related or associated with the management and disposition of the radioactive waste. Program management is the largest single contributor to the overall cost. The magnitude of the expense is a function of both the size of the organization required to manage the decommissioning, as well as the duration of the program. It is assumed, for purposes of this analysis, that OPPD will oversee the decommissioning program, using a DOC to manage the decommissioning labor force and the associated subcontractors. The size and composition of the management organization varies with the decommissioning phase and associated site activities.

The cost for waste disposal includes only those costs associated with the controlled disposition of the low-level radioactive waste generated from decontamination and dismantling activities, including plant equipment and components, structural material, filters, resins and dry-active waste. As described in Section 5, disposition of the majority of the low-level radioactive material requiring controlled disposal is at the Energy*Solutions*' facility in Utah or Waste Control Specialists' facility in Texas. Highly activated components, requiring additional isolation from the environment

(GTCC), are packaged for geologic disposal. The cost of geologic disposal is based upon a cost equivalent for spent fuel.

A significant portion of the metallic waste is designated for additional processing and treatment at an off-site facility. Processing reduces the volume of material requiring controlled disposal through such techniques and processes as survey and sorting, decontamination, and volume reduction. The material that cannot be unconditionally released is packaged for controlled disposal at one of the currently operating facilities. The cost identified in the summary tables for processing is all-inclusive, incorporating the ultimate disposition of the material.

Removal costs reflect the labor-intensive nature of the decommissioning process, as well as the management controls required to ensure a safe and successful program. Decontamination and packaging costs also have a large labor component that is based upon prevailing wages. Non-radiological demolition is a natural extension of the decommissioning process. The methods employed in decontamination and dismantling are generally destructive and indiscriminate in inflicting collateral damage. With a work force mobilized to support decommissioning operations, non-radiological demolition can be an integrated activity and a logical expansion of the work being performed in the process of terminating the operating license.

The reported cost for transport includes the tariffs and surcharges associated with moving large components and/or overweight shielded casks overland, as well as the general expense, e.g., labor and fuel, of transporting material to the destinations identified in this report. For purposes of this analysis, material is primarily moved overland by truck, although large components, such as the steam generators are transported via railway.

Decontamination is used to reduce the plant's radiation fields and minimize worker exposure. Slightly contaminated material or material located within a contaminated area is sent to an off-site processing center, i.e., this analysis does not assume that contaminated plant components and equipment can be decontaminated for uncontrolled release in-situ. Centralized processing centers have proven to be a more economical means of handling the large volumes of material produced in the dismantling of a nuclear plant.

License termination survey costs are associated with the labor intensive and complex activity of verifying that contamination has been removed from the site to the levels specified by the regulating agency. This process involves a systematic survey of all remaining plant surface areas and surrounding environs, sampling, isotopic analysis, and documentation of the findings. The status of any plant components and materials not removed in the decommissioning process will also require confirmation and will add to the expense of surveying the facilities alone.

The remaining costs include allocations for heavy equipment and temporary services, as well as for other expenses such as regulatory fees and the premiums for nuclear insurance. While site operating costs are greatly reduced following the final cessation of plant operations, certain administrative functions do need to be maintained either at a basic functional or regulatory level.

TABLE 6.1
DECOMMISSIONING COST SUMMARY
(thousands of 2017 dollars)

Decommissioning Periods	License Termination	Spent Fuel Management	Site Restoration
Planning and Preparations (2018)	21,726	1,105	-
Dormancy w/Wet Fuel Storage	161,105	119,185	-
Dormancy w/Dry Fuel Storage	212,385	244,972	-
Site Reactivation	53,114	-	743
Decommissioning Preparation	29,125	-	976
Large Component Removal	153,714	-	844
Plant Sys. Removal and Bldg. Remediation	223,620	-	7,535
License Termination	27,180	-	-
Site Restoration	243	-	37,881
Total [1]	882,212	365,262	47,979

[1] Columns may not add due to rounding

TABLE 6.2
DECOMMISSIONING COST ELEMENTS
(thousands of $2017)

Cost Elements	$000
Decontamination	6,245
Removal	105,271
Waste Packaging	16,431
Transportation	8,748
Low-Level Radioactive Waste Disposal	40,983
Off-site Waste Processing	29,808
Program Management	588,338
Site Non-Labor Overhead	31,914
Corporate A&G	35,448
Security	225,642
Property Taxes	1,077
Insurance	23,120
NRC Fees	16,368
Energy	1,916
Characterization and Surveys	90,423
Support Services	27,790
Projects	17,103
Spent Fuel Management	19,792
Other	9,035
TOTAL [1]	1,295,453

Cost Categories	$000
License Termination	882,212
Spent Fuel Management [2]	365,262
Site Restoration	47,979
TOTAL [1]	1,295,453

[1] Columns may not add due to rounding

[2] Includes period dependent costs, as appropriate, during fuel storage periods

7. REFERENCES

1. Letter from OPPD to the NRC, LIC-16-0074, "Certification of Permanent Removal of Fuel from the Reactor Vessel," dated November 13, 2016, NRC Accession No. ML16319A254

2. U.S. Code of Federal Regulations, Title 10, Subpart 50.82(a)(8)(iii); "Termination of License"

3. Site-Specific Decommissioning Cost Estimate for the Fort Calhoun Station," TLG Document No. O02-1737-001, Rev. 0, February 2017

4. U.S. Code of Federal Regulations, Title 10, Parts 30, 40, 50, 51, 70 and 72, "General Requirements for Decommissioning Nuclear Facilities," Nuclear Regulatory Commission, 53 Fed. Reg. 24018, June 27, 1988

5. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.159, "Assuring the Availability of Funds for Decommissioning Nuclear Reactors," Rev. 2, October 2011

6. U.S. Code of Federal Regulations, Title 10, Part 20, Subpart E, "Radiological Criteria for License Termination"

7. U.S. Code of Federal Regulations, Title 10, Parts 20 and 50, "Entombment Options for Power Reactors," Advanced Notice of Proposed Rulemaking, 66 Fed. Reg. 52551, October 16, 2001

8. U.S. Code of Federal Regulations, Title 10, Parts 2, 50 and 51, "Decommissioning of Nuclear Power Reactors," Nuclear Regulatory Commission, 61 Fed. Reg. 39278, July 29, 1996

9. U.S. Code of Federal Regulations, Title 10, Parts 20, 30, 40, 50, 70, and 72, "Decommissioning Planning," Nuclear Regulatory Commission, Federal Register Volume 76, (p 35512 et seq.), June 17, 2011

10. "Nuclear Waste Policy Act of 1982," 42 U.S. Code 10101, et seq. http://pbadupws.nrc.gov/docs/ML1327/ML13274A489.pdf#page=419

11. "Nuclear Waste Policy Amendments of 1987," 42 U.S. Code 10172

7. REFERENCES
(continued)

12. "Acceptance Priority Ranking & Annual Capacity Report," DOE/RW-0567, July 2004

13. Charter of the Blue Ribbon Commission on America's Nuclear Future, "Objectives and Scope of Activities," http://cybercemetery.unt.edu/archive/brc/20120620215336/http://brc.gov/index.php?q=page/charter

13. "Blue Ribbon Commission on America's Nuclear Future, Report to the Secretary of Energy," http://www.brc.gov/sites/default/files/documents /brc_finalreport_jan2012.pdf, p. 32, January 2012

15. "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste," U.S. DOE, January 11, 2013

16. United States Court of Appeals for the District of Columbia Circuit, In Re: Aiken County, Et Al., August 2013, http://www.cadc.uscourts.gov/internet/opinions.nsf/BAE0CF34F762EBD985257BC6004DEB18/$file/11-1271-1451347.pdf

17. U.S. Code of Federal Regulations, Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities," Subpart 54 (bb), "Conditions of Licenses"

18. U.S. Code of Federal Regulations, Title 10, Part 72, Subpart K, "General License for Storage of Spent Fuel at Power Reactor Sites"

19. "Low Level Radioactive Waste Policy Act," Public Law 96-573, 1980

20. "Low-Level Radioactive Waste Policy Amendments Act of 1985," Public Law 99-240, 1986

21. U.S. Code of Federal Regulations, Title 10, Part 61.55 "Waste Classification"

22. U.S. Code of Federal Regulations, Title 10, Part 20, Subpart E, "Final Rule, Radiological Criteria for License Termination," 62 Fed. Reg. 39058, July 21, 1997

23. "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination," EPA Memorandum OSWER No. 9200.4-18, August 22, 1997

7. REFERENCES
(continued)

24. U.S. Code of Federal Regulations, Title 40, Part 141.16, “Maximum contaminant levels for beta particle and photon radioactivity from man-made radionuclides in community water systems”

25. “Memorandum of Understanding Between the Environmental Protection Agency and the Nuclear Regulatory Commission: Consultation and Finality on Decommissioning and Decontamination of Contaminated Sites,” OSWER 9295.8-06a, October 9, 2002

26. “Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),” NUREG/CR-1575, Rev. 1, EPA 402-R-97-016, Rev. 1, August 2000

27. T.S. LaGuardia et al., "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," AIF/NESP-036, May 1986

28. W.J. Manion and T.S. LaGuardia, "Decommissioning Handbook," U.S. Department of Energy, DOE/EV/10128-1, November 1980

29. "Building Construction Cost Data 2017," Robert Snow Means Company, Inc., Kingston, Massachusetts

30. Project and Cost Engineers’ Handbook, Second Edition, p. 239, American Association of Cost Engineers, Marcel Dekker, Inc., New York, New York, 1984

31. Civilian Radioactive Waste Management System Waste Acceptance System Requirements Document, Revision 5” (DOE/RW-0351) issued May 31, 2007

32. U.S. Department of Transportation, Title 49 of the Code of Federal Regulations, "Transportation," Parts 173 through 178

33. Tri-State Motor Transit Company, published tariffs Interstate Commerce Commission (ICC), Docket No. MC-427719 Rules Tariff, May 2014, Radioactive Materials Tariff, August 2014

34. “For Calhoun Nuclear Station Historical Site Assessment Report,” performed by BHI Energy and Haley Aldrich and presented by TSSD Services, Incorporated, October 2016

7. REFERENCES
(continued)

35. "Fort Calhoun Nuclear Station Limited Site Radiological Characterization Survey Report," prepared by BHI Energy and presented by TSSD Services, Incorporated, January 2017

36. "Consolidated Decommissioning Guidance: Characterization, Survey, and Determination of Radiological Criteria," NUREG-1757, Volume 2, Revision 1, September 2006

37. "Fort Calhoun Nuclear Station Limited Site Non-Radiological Characterization Survey Report," prepared by Haley Aldrich and presented by TSSD Services, Incorporated, December 2016

38. "Fort Calhoun Activation Analysis and Component Characterization," Report 16-3179-RE-213, WMG Inc., December 2016

39. "Financial Protection Requirements for Permanently Shutdown Nuclear Power Reactors," 10 CFR Parts 50 and 140, Proposed Rule, 62 Fed. Reg. 58690, October 30, 1997

40. "Microsoft Project Professional," Microsoft Corporation, Redmond, WA

41. "Atomic Energy Act of 1954," (68 Stat. 919)

APPENDIX A

UNIT COST FACTOR DEVELOPMENT

APPENDIX A
UNIT COST FACTOR DEVELOPMENT

Example: Unit Factor for Removal of Contaminated Heat Exchanger < 3,000 lbs.

1. SCOPE

Heat exchangers weighing < 3,000 lbs. will be removed in one piece using a crane or small hoist. They will be disconnected from the inlet and outlet piping. The heat exchanger will be sent to the waste processing area.

2. CALCULATIONS

Act ID	Activity Description	Activity Duration (minutes)	Critical Duration (minutes)*
a	Remove insulation	60	(b)
b	Mount pipe cutters	60	60
c	Install contamination controls	20	(b)
d	Disconnect inlet and outlet lines	60	60
e	Cap openings	20	(d)
f	Rig for removal	30	30
g	Unbolt from mounts	30	30
h	Remove contamination controls	15	15
i	Remove, wrap, send to waste processing area	60	60
	Totals (Activity/Critical)	355	255

Duration adjustment(s):	
+ Respiratory protection adjustment (50% of critical duration)	128
+ Radiation/ALARA adjustment (15 % of critical duration)	38
Adjusted work duration	421
+ Protective clothing adjustment (30% of adjusted duration)	126
Productive work duration	547
+ Work break adjustment (8.33 % of productive duration)	46
Total work duration (minutes)	593

***** Total duration = 9.883 hr *****

* alpha designators indicate activities that can be performed in parallel

APPENDIX A
(continued)

3. LABOR REQUIRED

Crew	Number	Duration (hours)	Rate ($/hr)	Cost
Laborers	3.00	9.883	$37.03	$1,097.90
Craftsmen	2.00	9.883	$55.37	$1,094.44
Foreman	1.00	9.883	$58.70	$580.13
General Foreman	0.25	9.883	$61.09	$150.94
Fire Watch	0.05	9.883	$37.03	$18.30
Health Physics Technician	1.00	9.883	$66.05	$652.77
Total Labor Cost				$3,594.48

4. EQUIPMENT & CONSUMABLES COSTS

Equipment Costs	none
Consumables/Materials Costs	
-Universal Sorbent 50 @ $0.58 sq. ft. {1}	$29.00
-Tarpaulins (oil resistant/fire retardant) 50 @ $0.43/sq. ft. {2}	$21.50
-Gas torch consumables 1 @ $19.17/hr. x 1 hr. {3}	$19.17
Subtotal cost of equipment and materials	$69.67
Overhead & profit on equipment and materials @ 15.5 %	$10.80
Total costs, equipment & material	$80.47

TOTAL COST:

Removal of contaminated heat exchanger <3000 pounds:	**$3,674.95**
Total labor cost:	$3,594.48
Total equipment/material costs:	$80.47
Total craft labor man-hours required per unit:	72.146

5. NOTES AND REFERENCES

- Work difficulty factors were developed in conjunction with the Atomic Industrial Forum's (now NEI) program to standardize nuclear decommissioning cost estimates and are delineated in Volume 1, Chapter 5 of the "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," AIF/NESP-036, May 1986.

- References for equipment & consumables costs:

  1. www.mcmaster.com online catalog, McMaster Carr Spill Control (7193T88)
  2. R.S. Means (2017) Division 01 56, Section 13.60-0600, page 23
  3. R.S. Means (2017) Division 01 54 33, Section 40-6360, page 718

- Material and consumable costs were adjusted using the regional indices for Omaha, Nebraska.

APPENDIX B

UNIT COST FACTOR LISTING
(SAFSTOR: Power Block Structures Only)

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of clean instrument and sampling tubing, $/linear foot	0.43
Removal of clean pipe 0.25 to 2 inches diameter, $/linear foot	4.48
Removal of clean pipe >2 to 4 inches diameter, $/linear foot	6.51
Removal of clean pipe >4 to 8 inches diameter, $/linear foot	13.05
Removal of clean pipe >8 to 14 inches diameter, $/linear foot	24.82
Removal of clean pipe >14 to 20 inches diameter, $/linear foot	32.37
Removal of clean pipe >20 to 36 inches diameter, $/linear foot	47.61
Removal of clean pipe >36 inches diameter, $/linear foot	56.52
Removal of clean valve >2 to 4 inches	86.09
Removal of clean valve >4 to 8 inches	130.54
Removal of clean valve >8 to 14 inches	248.19
Removal of clean valve >14 to 20 inches	323.74
Removal of clean valve >20 to 36 inches	476.07
Removal of clean valve >36 inches	565.16
Removal of clean pipe hanger for small bore piping	30.36
Removal of clean pipe hanger for large bore piping	103.88
Removal of clean pump, <300 pound	222.43
Removal of clean pump, 300-1000 pound	622.39
Removal of clean pump, 1000-10,000 pound	2,433.85
Removal of clean pump, >10,000 pound	4,714.69
Removal of clean pump motor, 300-1000 pound	258.82
Removal of clean pump motor, 1000-10,000 pound	1,009.33
Removal of clean pump motor, >10,000 pound	2,270.97
Removal of clean heat exchanger <3000 pound	1,311.88
Removal of clean heat exchanger >3000 pound	3,313.07
Removal of clean feedwater heater/deaerator	9,304.40
Removal of clean moisture separator/reheater	19,081.41
Removal of clean tank, <300 gallons	285.86
Removal of clean tank, 300-3000 gallon	897.13
Removal of clean tank, >3000 gallons, $/square foot surface area	7.67

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of clean electrical equipment, <300 pound	119.32
Removal of clean electrical equipment, 300-1000 pound	421.40
Removal of clean electrical equipment, 1000-10,000 pound	842.79
Removal of clean electrical equipment, >10,000 pound	2,018.43
Removal of clean electrical transformer < 30 tons	1,401.77
Removal of clean electrical transformer > 30 tons	4,036.85
Removal of clean standby diesel generator, <100 kW	1,431.78
Removal of clean standby diesel generator, 100 kW to 1 MW	3,195.85
Removal of clean standby diesel generator, >1 MW	6,616.03
Removal of clean electrical cable tray, $/linear foot	11.31
Removal of clean electrical conduit, $/linear foot	4.95
Removal of clean mechanical equipment, <300 pound	119.32
Removal of clean mechanical equipment, 300-1000 pound	421.40
Removal of clean mechanical equipment, 1000-10,000 pound	842.79
Removal of clean mechanical equipment, >10,000 pound	2,018.43
Removal of clean HVAC equipment, <300 pound	144.29
Removal of clean HVAC equipment, 300-1000 pound	506.34
Removal of clean HVAC equipment, 1000-10,000 pound	1,009.12
Removal of clean HVAC equipment, >10,000 pound	2,018.43
Removal of clean HVAC ductwork, $/pound	0.45
Removal of contaminated instrument and sampling tubing, $/linear foot	1.36
Removal of contaminated pipe 0.25 to 2 inches diameter, $/linear foot	19.71
Removal of contaminated pipe >2 to 4 inches diameter, $/linear foot	32.21
Removal of contaminated pipe >4 to 8 inches diameter, $/linear foot	52.91
Removal of contaminated pipe >8 to 14 inches diameter, $/linear foot	100.50
Removal of contaminated pipe >14 to 20 inches diameter, $/linear foot	120.30
Removal of contaminated pipe >20 to 36 inches diameter, $/linear foot	165.71
Removal of contaminated pipe >36 inches diameter, $/linear foot	195.10
Removal of contaminated valve >2 to 4 inches	401.03
Removal of contaminated valve >4 to 8 inches	471.86

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated valve >8 to 14 inches	946.66
Removal of contaminated valve >14 to 20 inches	1,203.52
Removal of contaminated valve >20 to 36 inches	1,598.81
Removal of contaminated valve >36 inches	1,892.68
Removal of contaminated pipe hanger for small bore piping	132.54
Removal of contaminated pipe hanger for large bore piping	419.72
Removal of contaminated pump, <300 pound	836.83
Removal of contaminated pump, 300-1000 pound	1,927.49
Removal of contaminated pump, 1000-10,000 pound	6,083.21
Removal of contaminated pump, >10,000 pound	14,787.40
Removal of contaminated pump motor, 300-1000 pound	841.14
Removal of contaminated pump motor, 1000-10,000 pound	2,486.50
Removal of contaminated pump motor, >10,000 pound	5,592.21
Removal of contaminated heat exchanger <3000 pound	3,674.95
Removal of contaminated heat exchanger >3000 pound	10,731.36
Removal of contaminated tank, <300 gallons	1,397.03
Removal of contaminated tank, >300 gallons, $/square foot	27.21
Removal of contaminated electrical equipment, <300 pound	647.75
Removal of contaminated electrical equipment, 300-1000 pound	1,555.92
Removal of contaminated electrical equipment, 1000-10,000 pound	3,001.59
Removal of contaminated electrical equipment, >10,000 pound	5,959.69
Removal of contaminated electrical cable tray, $/linear foot	31.41
Removal of contaminated electrical conduit, $/linear foot	15.95
Removal of contaminated mechanical equipment, <300 pound	721.44
Removal of contaminated mechanical equipment, 300-1000 pound	1,738.41
Removal of contaminated mechanical equipment, 1000-10,000 pound	3,346.99
Removal of contaminated mechanical equipment, >10,000 pound	5,959.69
Removal of contaminated HVAC equipment, <300 pound	721.44
Removal of contaminated HVAC equipment, 300-1000 pound	1,738.41
Removal of contaminated HVAC equipment, 1000-10,000 pound	3,346.99

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated HVAC equipment, >10,000 pound	5,959.69
Removal of contaminated HVAC ductwork, $/pound	1.95
Removal/plasma arc cut of contaminated thin metal components, $/linear in.	3.39
Additional decontamination of surface by washing, $/square foot	6.96
Additional decontamination of surfaces by hydrolasing, $/square foot	31.58
Decontamination rig hook up and flush, $/ 250 foot length	6,055.74
Chemical flush of components/systems, $/gallon	19.10
Removal of clean standard reinforced concrete, $/cubic yard	66.84
Removal of grade slab concrete, $/cubic yard	76.01
Removal of clean concrete floors, $/cubic yard	356.20
Removal of sections of clean concrete floors, $/cubic yard	1,057.84
Removal of clean heavily rein concrete w/#9 rebar, $/cubic yard	96.45
Removal of contaminated heavily rein concrete w/#9 rebar, $/cubic yard	1,859.90
Removal of clean heavily rein concrete w/#18 rebar, $/cubic yard	130.72
Removal of contaminated heavily rein concrete w/#18 rebar, $/cubic yard	2,456.94
Removal heavily rein concrete w/#18 rebar & steel embedments, $/cubic yard	428.92
Removal of below-grade suspended floors, $/cubic yard	183.28
Removal of clean monolithic concrete structures, $/cubic yard	858.36
Removal of contaminated monolithic concrete structures, $/cubic yard	1,845.56
Removal of clean foundation concrete, $/cubic yard	676.11
Removal of contaminated foundation concrete, $/cubic yard	1,718.18
Explosive demolition of bulk concrete, $/cubic yard	47.13
Removal of clean hollow masonry block wall, $/cubic yard	23.67
Removal of contaminated hollow masonry block wall, $/cubic yard	55.90
Removal of clean solid masonry block wall, $/cubic yard	23.67
Removal of contaminated solid masonry block wall, $/cubic yard	55.90
Backfill of below-grade voids, $/cubic yard	29.33
Removal of subterranean tunnels/voids, $/linear foot	104.96
Placement of concrete for below-grade voids, $/cubic yard	136.07
Excavation of clean material, $/cubic yard	2.94

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Excavation of contaminated material, $/cubic yard	36.83
Removal of clean concrete rubble (tipping fee included), $/cubic yard	24.34
Removal of contaminated concrete rubble, $/cubic yard	22.14
Removal of building by volume, $/cubic foot	0.29
Removal of clean building metal siding, $/square foot	1.22
Removal of contaminated building metal siding, $/square foot	4.04
Removal of standard asphalt roofing, $/square foot	2.00
Removal of transite panels, $/square foot	1.96
Scarifying contaminated concrete surfaces (drill & spall), $/square foot	11.10
Scabbling contaminated concrete floors, $/square foot	6.54
Scabbling contaminated concrete walls, $/square foot	17.44
Scabbling contaminated ceilings, $/square foot	59.76
Scabbling structural steel, $/square foot	5.56
Removal of clean overhead crane/monorail < 10 ton capacity	600.46
Removal of contaminated overhead crane/monorail < 10 ton capacity	1,634.50
Removal of clean overhead crane/monorail >10-50 ton capacity	1,441.09
Removal of contaminated overhead crane/monorail >10-50 ton capacity	3,920.86
Removal of polar crane > 50 ton capacity	6,053.57
Removal of gantry crane > 50 ton capacity	25,230.32
Removal of structural steel, $/pound	0.19
Removal of clean steel floor grating, $/square foot	4.56
Removal of contaminated steel floor grating, $/square foot	12.25
Removal of clean free standing steel liner, $/square foot	11.50
Removal of contaminated free standing steel liner, $/square foot	31.56
Removal of clean concrete-anchored steel liner, $/square foot	5.75
Removal of contaminated concrete-anchored steel liner, $/square foot	36.67
Placement of scaffolding in clean areas, $/square foot	14.73
Placement of scaffolding in contaminated areas, $/square foot	23.42
Landscaping with topsoil, $/acre	22,314.95
Cost of CPC B-88 LSA box & preparation for use	1,897.80

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Cost of CPC B-25 LSA box & preparation for use	1,787.07
Cost of CPC B-12V 12 gauge LSA box & preparation for use	1,418.47
Cost of CPC B-144 LSA box & preparation for use	9,657.12
Cost of LSA drum & preparation for use	198.30
Cost of cask liner for CNSI 8 120A cask (resins)	11,220.77
Cost of cask liner for CNSI 8 120A cask (filters)	8,059.34
Decontamination of surfaces with vacuuming, $/square foot	0.74

APPENDIX C

DETAILED COST ANALYSIS

Table C
Fort Calhoun Station
SAFSTOR Decommissioning Cost Estimate
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
PERIOD 1b - SAFSTOR Limited DECON Activities																					
Period 1b Additional Costs																					
1b.2.1	Engineering, Training, Procedures, Loading Plans	-	-	-	-	-	-	361	18	379	-	379	-	-	-	-	-	-	-	-	-
1b.2.2	Spent Fuel Security Modifications	-	-	-	-	-	-	229	34	263	-	263	-	-	-	-	-	-	-	-	-
1b.2	Subtotal Period 1b Additional Costs	-	-	-	-	-	-	590	52	642	-	642	-	-	-	-	-	-	-	-	-
Period 1b Collateral Costs																					
1b.3.2	Process decommissioning water waste	79	-	47	109	-	163	-	101	500	500	-	-	-	501	-	-	-	30,070	98	-
1b.3.4	Site O&M (Non Labor Overhead)	-	-	-	-	-	-	150	22	172	172	-	-	-	-	-	-	-	-	-	-
1b.3	Subtotal Period 1b Collateral Costs	79	-	47	109	-	163	150	124	672	672	-	-	-	501	-	-	-	30,070	98	-
Period 1b Period-Dependent Costs																					
1b.4.2	Insurance	-	-	-	-	-	-	299	30	329	329	-	-	-	-	-	-	-	-	-	-
1b.4.3	Property taxes	-	-	-	-	-	-	5	1	6	6	-	-	-	-	-	-	-	-	-	-
1b.4.5	Heavy equipment rental	-	149	-	-	-	-	-	22	172	172	-	-	-	-	-	-	-	-	-	-
1b.4.6	Disposal of DAW generated	-	-	4	1	-	14	-	4	22	22	-	-	-	184	-	-	-	3,688	6	-
1b.4.7	Plant energy budget	-	-	-	-	-	-	146	22	168	168	-	-	-	-	-	-	-	-	-	-
1b.4.8	NRC Fees	-	-	-	-	-	-	636	64	699	699	-	-	-	-	-	-	-	-	-	-
1b.4.9	Emergency Planning Fees	-	-	-	-	-	-	179	18	197	-	197	-	-	-	-	-	-	-	-	-
1b.4.10	Corporate A&G	-	-	-	-	-	-	1,070	161	1,231	1,231	-	-	-	-	-	-	-	-	-	-
1b.4.11	Spent Fuel Pool O&M	-	-	-	-	-	-	205	31	236	-	236	-	-	-	-	-	-	-	-	-
1b.4.12	ISFSI Operating Costs	-	-	-	-	-	-	27	4	31	-	31	-	-	-	-	-	-	-	-	-
1b.4.13	Support Services	-	-	-	-	-	-	1,304	196	1,499	1,499	-	-	-	-	-	-	-	-	-	-
1b.4.14	Post-Operations Water Processing	-	-	-	-	-	-	69	10	80	80	-	-	-	-	-	-	-	-	-	-
1b.4.15	Security Staff Cost	-	-	-	-	-	-	3,365	505	3,870	3,870	-	-	-	-	-	-	-	-	-	66,195
1b.4.16	Utility Staff Cost	-	-	-	-	-	-	11,286	1,693	12,979	12,979	-	-	-	-	-	-	-	-	-	152,632
1b.4	Subtotal Period 1b Period-Dependent Costs	-	149	4	1	-	14	18,591	2,759	21,518	21,054	463	-	-	184	-	-	-	3,688	6	218,827
1b.0	TOTAL PERIOD 1b COST	79	149	51	111	-	176	19,331	2,935	22,832	21,726	1,105	-	-	686	-	-	-	33,757	104	218,827
PERIOD 1 TOTALS		79	149	51	111	-	176	19,331	2,935	22,832	21,726	1,105	-	-	686	-	-	-	33,757	104	218,827
PERIOD 2a - SAFSTOR Dormancy with Wet Spent Fuel Storage																					
Period 2a Additional Costs																					
2a.2.1	HSM and Fuel Canister Fabrication	-	-	-	-	-	-	31,745	3,175	34,920	-	34,920	-	-	-	-	-	-	-	-	-
2a.2.2	Engineering, Training, Procedures, Loading Plans	-	-	-	-	-	-	1,542	154	1,696	-	1,696	-	-	-	-	-	-	-	-	-
2a.2.3	Licensing, Engineering, SF Characterization	-	-	-	-	-	-	1,470	147	1,617	-	1,617	-	-	-	-	-	-	-	-	-
2a.2.4	Pool to Pad Services	-	-	-	-	-	-	18,315	1,832	20,147	-	20,147	-	-	-	-	-	-	-	-	-
2a.2.5	ISFSI Modifications	-	-	-	-	-	-	1,463	146	1,609	-	1,609	-	-	-	-	-	-	-	-	-
2a.2.6	Security Modifications	-	-	-	-	-	-	536	80	616	-	616	-	-	-	-	-	-	-	-	-
2a.2.7	Spent Fuel Security Modifications	-	-	-	-	-	-	3,250	487	3,737	-	3,737	-	-	-	-	-	-	-	-	-
2a.2.8	2018 Filter Campaign	-	-	-	-	-	-	3,000	-	3,000	3,000	-	-	-	-	-	-	-	-	-	-
2a.2.9	Hazardous/Mixed Waste	-	-	-	-	-	-	864	130	994	994	-	-	-	-	-	-	-	-	-	-
2a.2.10	Site Reconfiguration	-	-	-	-	-	-	146	22	168	168	-	-	-	-	-	-	-	-	-	-
2a.2.11	Fukushima	-	-	-	-	-	-	59	9	68	68	-	-	-	-	-	-	-	-	-	-
2a.2.12	Class 1 Structures	-	-	-	-	-	-	714	107	821	821	-	-	-	-	-	-	-	-	-	-
2a.2.13	Spent Fuel Pool Non-Fuel Inventory	-	-	2,233	57	-	453	-	306	3,049	3,049	-	-	-	-	-	56	355	59,531	-	-
2a.2.14	Soil Remediation	-	-	-	-	-	-	100	15	115	115	-	-	-	-	-	-	-	-	-	-
2a.2.15	Spent Fuel Pool Cleanup	-	-	-	-	-	-	4,000	600	4,600	4,600	-	-	-	-	-	-	-	-	-	-
2a.2.16	Remove Spent Fuel Racks	317	35	117	32	-	924	-	415	1,840	1,840	-	-	-	2,865	-	-	-	181,987	-	-
2a.2.17	Asbestos Abatement	-	-	-	-	-	-	500	-	500	500	-	-	-	13,500	-	-	-	175,500	-	-
2a.2	Subtotal Period 2a Additional Costs	317	35	2,350	88	-	1,378	67,703	7,624	79,496	15,154	64,341	-	-	16,365	-	56	355	417,017	-	-
Period 2a Collateral Costs																					
2a.3.1	Process decommissioning water waste	21	-	13	30	-	45	-	28	138	138	-	-	-	139	-	-	-	8,366	27	-
2a.3.3	Small tool allowance	-	19	-	-	-	-	-	3	21	21	-	-	-	-	-	-	-	-	-	-
2a.3.4	Site O&M (Non Labor Overhead)	-	-	-	-	-	-	1,560	234	1,794	1,794	-	-	-	-	-	-	-	-	-	-
2a.3	Subtotal Period 2a Collateral Costs	21	19	13	30	-	45	1,560	265	1,954	1,954	-	-	-	139	-	-	-	8,366	27	-

Table C
Fort Calhoun Station
SAFSTOR Decommissioning Cost Estimate
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 2a Period-Dependent Costs																					
2a.4.1	Insurance	-	-	-	-	-	-	1,204	120	1,324	1,324	-	-	-	-	-	-	-	-	-	-
2a.4.2	Property taxes	-	-	-	-	-	-	55	5	60	60	-	-	-	-	-	-	-	-	-	-
2a.4.4	Disposal of DAW generated	-	-	24	8	-	90	-	26	149	149	-	-	-	1,228	-	-	-	24,550	40	-
2a.4.5	Plant energy budget	-	-	-	-	-	-	1,520	228	1,748	1,748	-	-	-	-	-	-	-	-	-	-
2a.4.6	NRC Fees	-	-	-	-	-	-	2,023	202	2,225	2,225	-	-	-	-	-	-	-	-	-	-
2a.4.7	Emergency Planning Fees	-	-	-	-	-	-	351	35	387	-	387	-	-	-	-	-	-	-	-	-
2a.4.8	Corporate A&G	-	-	-	-	-	-	11,136	1,670	12,806	12,806	-	-	-	-	-	-	-	-	-	-
2a.4.9	Spent Fuel Pool O&M	-	-	-	-	-	-	2,136	320	2,456	-	2,456	-	-	-	-	-	-	-	-	-
2a.4.10	ISFSI Operating Costs	-	-	-	-	-	-	279	42	321	-	321	-	-	-	-	-	-	-	-	-
2a.4.11	Support Services	-	-	-	-	-	-	13,568	2,035	15,604	15,604	-	-	-	-	-	-	-	-	-	-
2a.4.12	Post-Operations Water Processing	-	-	-	-	-	-	723	108	831	831	-	-	-	-	-	-	-	-	-	-
2a.4.13	Security Staff Cost	-	-	-	-	-	-	34,457	5,169	39,626	6,142	33,484	-	-	-	-	-	-	-	-	626,849
2a.4.14	Utility Staff Cost	-	-	-	-	-	-	105,481	15,822	121,304	103,108	18,196	-	-	-	-	-	-	-	-	1,256,289
2a.4	Subtotal Period 2a Period-Dependent Costs	-	-	24	8	-	90	172,934	25,785	198,841	143,997	54,844	-	-	1,228	-	-	-	24,550	40	1,883,138
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2a.0	TOTAL PERIOD 2a COST	338	53	2,388	127	-	1,514	242,197	33,673	280,290	161,105	119,185	-	-	17,732	-	56	355	449,933	67	1,883,138
PERIOD 2b - SAFSTOR Dormancy with Dry Spent Fuel Storage																					
Period 2b Collateral Costs																					
2b.3.1	Spent Fuel Capital and Transfer	-	-	-	-	-	-	10,000	1,500	11,500	-	11,500	-	-	-	-	-	-	-	-	-
2b.3.2	Site O&M (Non Labor Overhead)	-	-	-	-	-	-	17,099	2,565	19,664	19,664	-	-	-	-	-	-	-	-	-	-
2b.3	Subtotal Period 2b Collateral Costs	-	-	-	-	-	-	27,099	4,065	31,164	19,664	11,500	-	-	-	-	-	-	-	-	-
Period 2b Period-Dependent Costs																					
2b.4.1	Insurance	-	-	-	-	-	-	16,707	1,671	18,378	18,378	-	-	-	-	-	-	-	-	-	-
2b.4.2	Property taxes	-	-	-	-	-	-	760	76	836	836	-	-	-	-	-	-	-	-	-	-
2b.4.4	Disposal of DAW generated	-	-	102	33	-	380	-	110	626	626	-	-	-	5,164	-	-	-	103,288	168	-
2b.4.6	NRC Fees	-	-	-	-	-	-	9,013	901	9,914	9,914	-	-	-	-	-	-	-	-	-	-
2b.4.7	Emergency Planning Fees	-	-	-	-	-	-	3,152	315	3,467	-	3,467	-	-	-	-	-	-	-	-	-
2b.4.8	Corporate A&G	-	-	-	-	-	-	13,188	1,978	15,166	15,166	-	-	-	-	-	-	-	-	-	-
2b.4.9	ISFSI Operating Costs	-	-	-	-	-	-	3,878	582	4,460	-	4,460	-	-	-	-	-	-	-	-	-
2b.4.10	Security Staff Cost	-	-	-	-	-	-	136,978	20,547	157,524	77,659	79,865	-	-	-	-	-	-	-	-	2,768,195
2b.4.11	Utility Staff Cost	-	-	-	-	-	-	187,671	28,151	215,822	70,142	145,680	-	-	-	-	-	-	-	-	2,926,378
2b.4	Subtotal Period 2b Period-Dependent Costs	-	-	102	33	-	380	371,347	54,331	426,193	192,721	233,472	-	-	5,164	-	-	-	103,288	168	5,694,573
2b.0	TOTAL PERIOD 2b COST	-	-	102	33	-	380	398,446	58,395	457,357	212,385	244,972	-	-	5,164	-	-	-	103,288	168	5,694,573
PERIOD 2 TOTALS		338	53	2,490	160	-	1,894	640,643	92,069	737,647	373,490	364,157	-	-	22,896	-	56	355	553,221	236	7,577,711
PERIOD 3a - Reactivate Site Following SAFSTOR Dormancy																					
Period 3a Direct Decommissioning Activities																					
3a.1.1	Prepare preliminary decommissioning cost	-	-	-	-	-	-	176	26	203	203	-	-	-	-	-	-	-	-	-	1,300
3a.1.2	Review plant dwgs & specs.	-	-	-	-	-	-	624	94	718	718	-	-	-	-	-	-	-	-	-	4,600
3a.1.3	Perform detailed rad survey	-	-	-	-	-	-	-	-	a	-	-	-	-	-	-	-	-	-	-	-
3a.1.4	End product description	-	-	-	-	-	-	136	20	156	156	-	-	-	-	-	-	-	-	-	1,000
3a.1.5	Detailed by-product inventory	-	-	-	-	-	-	176	26	203	203	-	-	-	-	-	-	-	-	-	1,300
3a.1.6	Define major work sequence	-	-	-	-	-	-	1,018	153	1,170	1,170	-	-	-	-	-	-	-	-	-	7,500
3a.1.7	Perform SER and EA	-	-	-	-	-	-	421	63	484	484	-	-	-	-	-	-	-	-	-	3,100
3a.1.8	Perform Site-Specific Cost Study	-	-	-	-	-	-	678	102	780	780	-	-	-	-	-	-	-	-	-	5,000
Activity Specifications																					
3a.1.9.1	Re-activate plant & temporary facilities	-	-	-	-	-	-	1,000	150	1,150	1,035	-	115	-	-	-	-	-	-	-	7,370
3a.1.9.2	Plant systems	-	-	-	-	-	-	565	85	650	585	-	65	-	-	-	-	-	-	-	4,167
3a.1.9.3	Reactor internals	-	-	-	-	-	-	963	145	1,108	1,108	-	-	-	-	-	-	-	-	-	7,100
3a.1.9.4	Reactor vessel	-	-	-	-	-	-	882	132	1,014	1,014	-	-	-	-	-	-	-	-	-	6,500
3a.1.9.5	Biological shield	-	-	-	-	-	-	68	10	78	78	-	-	-	-	-	-	-	-	-	500
3a.1.9.6	Steam generators	-	-	-	-	-	-	423	64	487	487	-	-	-	-	-	-	-	-	-	3,120
3a.1.9.7	Reinforced concrete	-	-	-	-	-	-	217	33	250	125	-	125	-	-	-	-	-	-	-	1,600
3a.1.9.8	Main Turbine	-	-	-	-	-	-	54	8	62	-	-	62	-	-	-	-	-	-	-	400

Table C
Fort Calhoun Station
SAFSTOR Decommissioning Cost Estimate
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Activity Specifications (continued)																					
3a.1.9.9	Main Condensers	-	-	-	-	-	-	54	8	62	-	-	62	-	-	-	-	-	-	-	400
3a.1.9.10	Plant structures & buildings	-	-	-	-	-	-	423	64	487	243	-	243	-	-	-	-	-	-	-	3,120
3a.1.9.11	Waste management	-	-	-	-	-	-	624	94	718	718	-	-	-	-	-	-	-	-	-	4,600
3a.1.9.12	Facility & site closeout	-	-	-	-	-	-	122	18	140	70	-	70	-	-	-	-	-	-	-	900
3a.1.9	Total	-	-	-	-	-	-	5,397	810	6,207	5,464	-	743	-	-	-	-	-	-	-	39,777
Planning & Site Preparations																					
3a.1.10	Prepare dismantling sequence	-	-	-	-	-	-	326	49	375	375	-	-	-	-	-	-	-	-	-	2,400
3a.1.11	Plant prep. & temp. svces	-	-	-	-	-	-	3,300	495	3,795	3,795	-	-	-	-	-	-	-	-	-	-
3a.1.12	Design water clean-up system	-	-	-	-	-	-	190	28	218	218	-	-	-	-	-	-	-	-	-	1,400
3a.1.13	Rigging/Cont. Cntrl Envlps/tooling/etc.	-	-	-	-	-	-	2,300	345	2,645	2,645	-	-	-	-	-	-	-	-	-	-
3a.1.14	Procure casks/liners & containers	-	-	-	-	-	-	167	25	192	192	-	-	-	-	-	-	-	-	-	1,230
3a.1	Subtotal Period 3a Activity Costs	-	-	-	-	-	-	14,909	2,236	17,146	16,402	-	743	-	-	-	-	-	-	-	68,607
Period 3a Additional Costs																					
3a.2.1	Site Characterization	-	-	-	-	-	-	6,130	1,839	7,970	7,970	-	-	-	-	-	-	-	-	30,500	10,852
3a.2	Subtotal Period 3a Additional Costs	-	-	-	-	-	-	6,130	1,839	7,970	7,970	-	-	-	-	-	-	-	-	30,500	10,852
Period 3a Collateral Costs																					
3a.3.1	Site O&M (Non Labor Overhead)	-	-	-	-	-	-	1,485	223	1,707	1,707	-	-	-	-	-	-	-	-	-	-
3a.3	Subtotal Period 3a Collateral Costs	-	-	-	-	-	-	1,485	223	1,707	1,707	-	-	-	-	-	-	-	-	-	-
Period 3a Period-Dependent Costs																					
3a.4.1	Insurance	-	-	-	-	-	-	433	43	476	476	-	-	-	-	-	-	-	-	-	-
3a.4.2	Property taxes	-	-	-	-	-	-	20	2	22	22	-	-	-	-	-	-	-	-	-	-
3a.4.3	Health physics supplies	-	450	-	-	-	-	-	113	563	563	-	-	-	-	-	-	-	-	-	-
3a.4.4	Heavy equipment rental	-	567	-	-	-	-	-	85	652	652	-	-	-	-	-	-	-	-	-	-
3a.4.5	Disposal of DAW generated	-	-	10	3	-	38	-	11	62	62	-	-	-	514	-	-	-	10,287	17	-
3a.4.7	NRC Fees	-	-	-	-	-	-	333	33	367	367	-	-	-	-	-	-	-	-	-	-
3a.4.8	Corporate A&G	-	-	-	-	-	-	682	102	784	784	-	-	-	-	-	-	-	-	-	-
3a.4.9	Security Staff Cost	-	-	-	-	-	-	3,261	489	3,751	3,751	-	-	-	-	-	-	-	-	-	65,000
3a.4.10	Utility Staff Cost	-	-	-	-	-	-	17,702	2,655	20,358	20,358	-	-	-	-	-	-	-	-	-	257,920
3a.4	Subtotal Period 3a Period-Dependent Costs	-	1,018	10	3	-	38	22,432	3,534	27,035	27,035	-	-	-	514	-	-	-	10,287	17	322,920
3a.0	TOTAL PERIOD 3a COST	-	1,018	10	3	-	38	44,956	7,832	53,857	53,114	-	743	-	514	-	-	-	10,287	30,517	402,379
PERIOD 3b - Decommissioning Preparations																					
Detailed Work Procedures																					
3b.1.1.1	Plant systems	-	-	-	-	-	-	642	96	739	665	-	74	-	-	-	-	-	-	-	4,733
3b.1.1.2	Reactor internals	-	-	-	-	-	-	339	51	390	390	-	-	-	-	-	-	-	-	-	2,500
3b.1.1.3	Remaining buildings	-	-	-	-	-	-	183	27	211	53	-	158	-	-	-	-	-	-	-	1,350
3b.1.1.4	CRD cooling assembly	-	-	-	-	-	-	136	20	156	156	-	-	-	-	-	-	-	-	-	1,000
3b.1.1.5	CRD housings & ICI tubes	-	-	-	-	-	-	136	20	156	156	-	-	-	-	-	-	-	-	-	1,000
3b.1.1.6	Incore instrumentation	-	-	-	-	-	-	136	20	156	156	-	-	-	-	-	-	-	-	-	1,000
3b.1.1.7	Reactor vessel	-	-	-	-	-	-	493	74	566	566	-	-	-	-	-	-	-	-	-	3,630
3b.1.1.8	Facility closeout	-	-	-	-	-	-	163	24	187	94	-	94	-	-	-	-	-	-	-	1,200
3b.1.1.9	Missile shields	-	-	-	-	-	-	61	9	70	70	-	-	-	-	-	-	-	-	-	450
3b.1.1.10	Biological shield	-	-	-	-	-	-	163	24	187	187	-	-	-	-	-	-	-	-	-	1,200
3b.1.1.11	Steam generators	-	-	-	-	-	-	624	94	718	718	-	-	-	-	-	-	-	-	-	4,600
3b.1.1.12	Reinforced concrete	-	-	-	-	-	-	136	20	156	78	-	78	-	-	-	-	-	-	-	1,000
3b.1.1.13	Main Turbine	-	-	-	-	-	-	212	32	243	-	-	243	-	-	-	-	-	-	-	1,560
3b.1.1.14	Main Condensers	-	-	-	-	-	-	212	32	243	-	-	243	-	-	-	-	-	-	-	1,560
3b.1.1.15	Auxiliary building	-	-	-	-	-	-	370	56	426	383	-	43	-	-	-	-	-	-	-	2,730
3b.1.1.16	Reactor building	-	-	-	-	-	-	370	56	426	383	-	43	-	-	-	-	-	-	-	2,730
3b.1.1	Total							4375	656	5031	4056		976								32243
3b.1	Subtotal Period 3b Activity Costs							4375	656	5031	4056		976								32243
Period 3b Collateral Costs																					
3b.3.1	Decon equipment	974	-	-	-	-	-	-	146	1,120	1,120	-	-	-	-	-	-	-	-	-	-
3b.3.2	DOC staff relocation expenses	-	-	-	-	-	-	1,431	215	1,646	1,646	-	-	-	-	-	-	-	-	-	-

Table C
Fort Calhoun Station
SAFSTOR Decommissioning Cost Estimate
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 3b Collateral Costs (continued)																					
3b.3.3	Pipe cutting equipment	-	1,200	-	-	-	-	-	180	1,380	1,380	-	-	-	-	-	-	-	-	-	-
3b.3.4	Site O&M (Non Labor Overhead)	-	-	-	-	-	-	732	110	842	842	-	-	-	-	-	-	-	-	-	-
3b.3	Subtotal Period 3b Collateral Costs	974	1,200	-	-	-	-	2,163	651	4,988	4,988	-	-	-	-	-	-	-	-	-	-
Period 3b Period-Dependent Costs																					
3b.4.1	Decon supplies	34	-	-	-	-	-	-	8	42	42	-	-	-	-	-	-	-	-	-	-
3b.4.2	Insurance	-	-	-	-	-	-	217	22	238	238	-	-	-	-	-	-	-	-	-	-
3b.4.3	Property taxes	-	-	-	-	-	-	10	1	11	11	-	-	-	-	-	-	-	-	-	-
3b.4.4	Health physics supplies	-	245	-	-	-	-	-	61	306	306	-	-	-	-	-	-	-	-	-	-
3b.4.5	Heavy equipment rental	-	280	-	-	-	-	-	42	322	322	-	-	-	-	-	-	-	-	-	-
3b.4.6	Disposal of DAW generated	-	-	6	2	-	21	-	6	35	35	-	-	-	287	-	-	-	5,738	9	-
3b.4.8	NRC Fees	-	-	-	-	-	-	164	16	181	181	-	-	-	-	-	-	-	-	-	-
3b.4.9	Corporate A&G	-	-	-	-	-	-	336	50	387	387	-	-	-	-	-	-	-	-	-	-
3b.4.10	Security Staff Cost	-	-	-	-	-	-	1,608	241	1,850	1,850	-	-	-	-	-	-	-	-	-	32,055
3b.4.11	DOC Staff Cost	-	-	-	-	-	-	5,800	870	6,670	6,670	-	-	-	-	-	-	-	-	-	57,442
3b.4.12	Utility Staff Cost	-	-	-	-	-	-	8,730	1,309	10,039	10,039	-	-	-	-	-	-	-	-	-	127,193
3b.4	Subtotal Period 3b Period-Dependent Costs	34	524	6	2	-	21	16,866	2,628	20,081	20,081	-	-	-	287	-	-	-	5,738	9	216,690
3b.0	TOTAL PERIOD 3b COST	1,008	1,724	6	2	-	21	23,404	3,935	30,100	29,125	-	976	-	287	-	-	-	5,738	9	248,933
PERIOD 3 TOTALS		1,008	2,742	16	5	-	59	68,360	11,767	83,958	82,239	-	1,719	-	801	-	-	-	16,026	30,526	651,312
PERIOD 4a - Large Component Removal																					
Nuclear Steam Supply System Removal																					
4a.1.1.1	Reactor Coolant Piping	22	100	20	15	15	345	-	129	646	646	-	-	102	972	-	-	-	74,632	2,292	-
4a.1.1.2	Pressurizer Quench Tank	3	13	6	4	4	99	-	31	161	161	-	-	29	278	-	-	-	21,376	322	-
4a.1.1.3	Reactor Coolant Pumps & Motors	21	85	53	114	-	1,920	-	534	2,728	2,728	-	-	-	5,658	-	-	-	444,400	2,489	80
4a.1.1.4	Pressurizer	6	55	439	140	-	630	-	239	1,510	1,510	-	-	-	1,856	-	-	-	145,522	1,463	1,500
4a.1.1.5	Steam Generators	31	6,480	1,463	1,390	1,107	2,397	-	2,756	15,625	15,625	-	-	16,338	7,063	-	-	-	1,349,262	10,851	2,250
4a.1.1.6	Retired Steam Generator Units	-	-	1,463	1,390	1,107	2,397	-	1,120	7,478	7,478	-	-	16,338	7,063	-	-	-	1,349,262	5,400	2,250
4a.1.1.7	CRDMs/ICIs/Service Structure Removal	23	175	168	25	16	533	-	211	1,151	1,151	-	-	203	2,117	-	-	-	112,422	3,699	-
4a.1.1.8	Reactor Vessel Internals	57	5,601	4,759	730	-	7,010	234	9,142	27,534	27,534	-	-	-	1,144	475	907	-	220,027	18,423	895
4a.1.1.9	Vessel & Internals GTCC Disposal	-	-	-	-	-	2,111	-	317	2,428	2,428	-	-	-	-	-	-	825	147,014	-	-
4a.1.1.10	Reactor Vessel	-	6,974	1,327	279	-	3,526	234	7,430	19,770	19,770	-	-	-	10,389	-	-	-	649,209	18,423	895
4a.1.1	Totals	164	19,483	9,699	4,090	2,249	20,968	468	21,910	79,031	79,031	-	-	33,010	36,541	475	907	825	4,513,126	63,363	7,871
Removal of Major Equipment																					
4a.1.2	Main Turbine/Generator	-	207	71	23	346	-	-	114	762	762	-	-	3,565	-	-	-	-	160,412	3,989	-
4a.1.3	Main Condensers	-	804	53	17	258	-	-	247	1,379	1,379	-	-	2,654	-	-	-	-	119,434	15,762	-
Cascading Costs from Clean Building Demolition																					
4a.1.4.1	Containment	-	212	-	-	-	-	-	32	244	244	-	-	-	-	-	-	-	-	1,619	-
4a.1.4.2	Auxiliary	-	150	-	-	-	-	-	22	172	172	-	-	-	-	-	-	-	-	1,117	-
4a.1.4.3	Radwaste	-	23	-	-	-	-	-	3	27	27	-	-	-	-	-	-	-	-	183	-
4a.1.4	Totals	-	385	-	-	-	-	-	58	443	443	-	-	-	-	-	-	-	-	2,920	-
Disposal of Plant Systems																					
4a.1.5.1	Auxiliary Steam & Condensate Return-RCA	-	33	0	2	28	-	-	13	76	76	-	-	316	-	-	-	-	12,831	549	-
4a.1.5.2	Chemical Feed	-	6	-	-	-	-	-	1	7	-	-	7	-	-	-	-	-	-	134	-
4a.1.5.3	Chemical Feed-RCA	-	6	0	0	4	-	-	2	12	12	-	-	43	-	-	-	-	1,739	85	-
4a.1.5.4	Circulating Water	-	285	-	-	-	-	-	43	327	-	-	327	-	-	-	-	-	-	6,317	-
4a.1.5.5	Condensate	-	176	-	-	-	-	-	26	202	-	-	202	-	-	-	-	-	-	3,866	-
4a.1.5.6	Condenser Evacuation & H2-CO2 Piping	-	40	-	-	-	-	-	6	46	-	-	46	-	-	-	-	-	-	857	-
4a.1.5.7	Gas Control	-	0	-	-	-	-	-	0	0	-	-	0	-	-	-	-	-	-	5	-
4a.1.5.8	Heater Drains & Vents	-	42	-	-	-	-	-	6	48	-	-	48	-	-	-	-	-	-	935	-
4a.1.5.9	Heater Drains & Vents-RCA	-	93	2	7	109	-	-	41	252	252	-	-	1,240	-	-	-	-	50,358	1,491	-
4a.1.5.10	Jacket Water For Diesel Gen # 1-RCA	-	5	0	0	4	-	-	2	12	12	-	-	46	-	-	-	-	1,875	90	-
4a.1.5.11	Jacket Water For Diesel Gen # 2-RCA	-	5	0	0	4	-	-	2	11	11	-	-	43	-	-	-	-	1,748	80	-
4a.1.5.12	Main Steam	-	63	-	-	-	-	-	10	73	-	-	73	-	-	-	-	-	-	1,378	-
4a.1.5.13	Main Steam-RCA	-	132	5	20	297	-	-	81	536	536	-	-	3,387	-	-	-	-	137,564	2,329	-

Table C
Fort Calhoun Station
SAFSTOR Decommissioning Cost Estimate
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Disposal of Plant Systems (continued)																					
4a.1.5.14	Secondary Plant Sampling	-	19	-	-	-	-	-	3	21	-	-	21	-	-	-	-	-	-	437	-
4a.1.5.15	Shaft Sealing Steam	-	12	-	-	-	-	-	2	14	-	-	14	-	-	-	-	-	-	273	-
4a.1.5.16	Starting Air - RCA	-	53	1	3	51	-	-	22	130	130	-	-	579	-	-	-	-	23,511	959	-
4a.1.5.17	Stator Winding Cooling Water	-	21	-	-	-	-	-	3	24	-	-	24	-	-	-	-	-	-	440	-
4a.1.5.18	Steam Generator Blowdown Processing-RCA	-	192	3	11	164	-	-	75	445	445	-	-	1,869	-	-	-	-	75,911	3,146	-
4a.1.5.19	Steam Generator Feedwater & Blowdown-RCA	-	1,035	57	211	3,178	-	-	773	5,254	5,254	-	-	36,228	-	-	-	-	1,471,243	18,725	-
4a.1.5.20	Turbine Plant Cooling Water	-	56	-	-	-	-	-	8	64	-	-	64	-	-	-	-	-	-	1,239	-
4a.1.5.21	Turbine Plant Cooling Water-RCA	-	44	1	3	49	-	-	19	116	116	-	-	556	-	-	-	-	22,582	763	-
4a.1.5	Totals	-	2,319	70	258	3,887	-	-	1,136	7,669	6,842	-	828	44,308	-	-	-	-	1,799,361	44,099	-
4a.1.6	Scaffolding in support of decommissioning	-	683	13	5	60	17	-	186	964	964	-	-	614	54	-	-	-	31,075	15,113	-
4a.1	Subtotal Period 4a Activity Costs	164	23,881	9,906	4,392	6,800	20,985	468	23,652	90,247	89,420	-	828	84,151	36,595	475	907	825	6,623,408	145,245	7,871
Period 4a Additional Costs																					
4a.2.1	Retired Pressurizer	-	-	439	140	-	630	-	222	1,432	1,432	-	-	-	1,856	-	-	-	145,522	-	-
4a.2.2	Retired RX Closure Head	-	119	266	707	-	373	-	256	1,721	1,721	-	-	-	2,029	-	-	-	164,824	3,157	2,000
4a.2.3	Remedial Action Surveys	-	-	-	-	-	-	1,513	454	1,967	1,967	-	-	-	-	-	-	-	-	22,908	-
4a.2.4	Lead Abatement Crew	-	667	-	-	-	-	-	167	834	834	-	-	-	-	-	-	-	-	13,745	-
4a.2.5	Asbestos Abatement	-	-	-	-	-	-	4,000	-	4,000	4,000	-	-	-	27,000	-	-	-	351,000	-	-
4a.2	Subtotal Period 4a Additional Costs	-	786	705	848	-	1,002	5,513	1,099	9,953	9,953	-	-	-	30,885	-	-	-	661,346	39,811	2,000
Period 4a Collateral Costs																					
4a.3.1	Process decommissioning water waste	4	-	5	11	-	17	-	8	44	44	-	-	-	51	-	-	-	3,069	10	-
4a.3.3	Small tool allowance	-	145	-	-	-	-	-	22	167	150	-	17	-	-	-	-	-	-	-	-
4a.3.4	Site O&M (Non Labor Overhead)	-	-	-	-	-	-	1,550	232	1,782	1,782	-	-	-	-	-	-	-	-	-	-
4a.3	Subtotal Period 4a Collateral Costs	4	145	5	11	-	17	1,550	262	1,993	1,977	-	17	-	51	-	-	-	3,069	10	-
Period 4a Period-Dependent Costs																					
4a.4.1	Decon supplies	76	-	-	-	-	-	-	19	95	95	-	-	-	-	-	-	-	-	-	-
4a.4.2	Insurance	-	-	-	-	-	-	484	48	532	532	-	-	-	-	-	-	-	-	-	-
4a.4.3	Property taxes	-	-	-	-	-	-	22	2	24	24	-	-	-	-	-	-	-	-	-	-
4a.4.4	Health physics supplies	-	1,334	-	-	-	-	-	333	1,667	1,667	-	-	-	-	-	-	-	-	-	-
4a.4.5	Heavy equipment rental	-	2,416	-	-	-	-	-	362	2,778	2,778	-	-	-	-	-	-	-	-	-	-
4a.4.6	Disposal of DAW generated	-	-	59	19	-	218	-	63	358	358	-	-	-	2,958	-	-	-	59,159	96	-
4a.4.8	NRC Fees	-	-	-	-	-	-	601	60	661	661	-	-	-	-	-	-	-	-	-	-
4a.4.9	Corporate A&G	-	-	-	-	-	-	751	113	864	864	-	-	-	-	-	-	-	-	-	-
4a.4.10	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	446	67	513	513	-	-	-	-	-	-	-	-	-	-
4a.4.11	Security Staff Cost	-	-	-	-	-	-	3,566	535	4,101	4,101	-	-	-	-	-	-	-	-	-	71,589
4a.4.12	DOC Staff Cost	-	-	-	-	-	-	15,799	2,370	18,169	18,169	-	-	-	-	-	-	-	-	-	158,069
4a.4.13	Utility Staff Cost	-	-	-	-	-	-	19,654	2,948	22,602	22,602	-	-	-	-	-	-	-	-	-	286,356
4a.4	Subtotal Period 4a Period-Dependent Costs	76	3,750	59	19	-	218	41,324	6,921	52,365	52,365	-	-	-	2,958	-	-	-	59,159	96	516,014
4a.0	TOTAL PERIOD 4a COST	243	28,561	10,675	5,270	6,800	22,222	48,854	31,934	154,559	153,714	-	844	84,151	70,489	475	907	825	7,346,982	185,162	525,885
PERIOD 4b - Site Decontamination																					
Disposal of Plant Systems																					
4b.1.2.1	Chemical & Volume Control	-	404	32	26	187	393	-	234	1,275	1,275	-	-	2,127	1,198	-	-	-	163,669	7,052	-
4b.1.2.2	Component Cooling - RCA	-	370	22	80	1,211	-	-	288	1,971	1,971	-	-	13,805	-	-	-	-	560,640	6,558	-
4b.1.2.3	Compressed Air	-	54	-	-	-	-	-	8	62	-	-	62	-	-	-	-	-	-	1,188	-
4b.1.2.4	Compressed Air-RCA	-	23	0	1	12	-	-	8	44	44	-	-	141	-	-	-	-	5,716	377	-
4b.1.2.5	Demineralized Water	-	178	-	-	-	-	-	27	204	-	-	204	-	-	-	-	-	-	3,769	-
4b.1.2.6	Demineralized Water-RCA	-	80	1	5	72	-	-	32	190	190	-	-	818	-	-	-	-	33,204	1,311	-
4b.1.2.7	Electrical - Clean	-	3,688	-	-	-	-	-	553	4,242	-	-	4,242	-	-	-	-	-	-	77,827	-
4b.1.2.8	Electrical - Clean-RCA	-	6,819	132	483	7,290	-	-	2,884	17,608	17,608	-	-	83,110	-	-	-	-	3,375,151	125,395	-
4b.1.2.9	Electrical - Contaminated	-	990	14	54	808	-	-	378	2,244	2,244	-	-	9,216	-	-	-	-	374,272	18,552	-
4b.1.2.10	Fire Protection	-	101	-	-	-	-	-	15	116	-	-	116	-	-	-	-	-	-	2,211	-
4b.1.2.11	Fire Protection-RCA	-	186	4	16	241	-	-	85	532	532	-	-	2,747	-	-	-	-	111,573	3,164	-
4b.1.2.12	Fuel Oil	-	35	-	-	-	-	-	5	40	-	-	40	-	-	-	-	-	-	720	-
4b.1.2.13	Fuel Oil-RCA	-	3	0	0	2	-	-	1	7	7	-	-	24	-	-	-	-	971	48	-

Table C
Fort Calhoun Station
SAFSTOR Decommissioning Cost Estimate
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Disposal of Plant Systems (continued)																					
4b.1.2.14	HVAC - Auxiliary	-	359	11	41	622	-	-	190	1,223	1,223	-	-	7,090	-	-	-	-	287,911	6,005	-
4b.1.2.15	HVAC - Chem & Radiation Prot. Fac.	-	26	-	-	-	-	-	4	30	-	-	30	-	-	-	-	-	-	572	-
4b.1.2.16	HVAC - Chem & Radiation Prot. Fac.-RCA	-	50	1	4	54	-	-	21	130	130	-	-	619	-	-	-	-	25,145	752	-
4b.1.2.17	HVAC - Containment	-	336	11	42	631	-	-	186	1,206	1,206	-	-	7,196	-	-	-	-	292,239	5,904	-
4b.1.2.18	HVAC - Intake Structure	-	22	-	-	-	-	-	3	25	-	-	25	-	-	-	-	-	-	532	-
4b.1.2.19	HVAC - Office/Cafeteria Addition	-	15	-	-	-	-	-	2	18	-	-	18	-	-	-	-	-	-	361	-
4b.1.2.20	HVAC - Rad Processing	-	109	3	10	150	-	-	52	324	324	-	-	1,714	-	-	-	-	69,606	1,816	-
4b.1.2.21	HVAC - Tech Support Center	-	15	-	-	-	-	-	2	17	-	-	17	-	-	-	-	-	-	359	-
4b.1.2.22	HVAC - Turbine Bldg	-	148	-	-	-	-	-	22	170	-	-	170	-	-	-	-	-	-	3,590	-
4b.1.2.23	Instrument Air	-	8	-	-	-	-	-	1	9	-	-	9	-	-	-	-	-	-	188	-
4b.1.2.24	Instrument Air-RCA	-	37	0	1	15	-	-	12	65	65	-	-	175	-	-	-	-	7,091	653	-
4b.1.2.25	Nitro/Hydro/Methane/Propane & Oxygen	-	1	-	-	-	-	-	0	1	-	-	1	-	-	-	-	-	-	26	-
4b.1.2.26	Nitro\Hydro\Methane\Propane & Oxygen-RCA	-	7	0	1	14	-	-	4	25	25	-	-	155	-	-	-	-	6,282	118	-
4b.1.2.27	PH Neutralization	-	80	2	6	98	-	-	36	222	222	-	-	1,114	-	-	-	-	45,238	1,444	-
4b.1.2.28	Post Accident Sampling	-	75	1	2	30	-	-	24	132	132	-	-	346	-	-	-	-	14,065	1,434	-
4b.1.2.29	Potable Water	-	21	-	-	-	-	-	3	24	-	-	24	-	-	-	-	-	-	476	-
4b.1.2.30	Potable Water-RCA	-	33	0	1	21	-	-	12	67	67	-	-	237	-	-	-	-	9,606	510	-
4b.1.2.31	Primary Plant Sampling	-	95	1	3	43	-	-	31	172	172	-	-	490	-	-	-	-	19,905	1,779	-
4b.1.2.32	Raw Water	-	76	-	-	-	-	-	11	88	-	-	88	-	-	-	-	-	-	1,705	-
4b.1.2.33	Raw Water-RCA	-	27	1	4	53	-	-	15	101	101	-	-	608	-	-	-	-	24,689	495	-
4b.1.2.34	Reactor Coolant Misc	-	44	3	3	21	38	-	24	133	133	-	-	239	114	-	-	-	17,091	851	-
4b.1.2.35	Safety Injection & Containment Spray	-	2,679	88	340	5,121	-	-	1,498	9,726	9,726	-	-	58,385	-	-	-	-	2,371,037	50,618	-
4b.1.2.36	Service Water	-	6	-	-	-	-	-	1	7	-	-	7	-	-	-	-	-	-	142	-
4b.1.2.37	Service Water-RCA	-	19	0	1	12	-	-	7	40	40	-	-	142	-	-	-	-	5,775	286	-
4b.1.2.38	Spent Fuel Pool Cooling	-	190	14	13	98	198	-	115	629	629	-	-	1,122	609	-	-	-	84,508	3,441	-
4b.1.2.39	Waste Disposal	-	1,138	86	75	646	931	-	634	3,510	3,510	-	-	7,368	2,816	-	-	-	482,477	19,628	-
4b.1.2	Totals	-	18,548	427	1,210	17,455	1,559	-	7,430	46,629	41,576	-	5,054	198,987	4,738	-	-	-	8,387,861	351,857	-
4b.1.3	Scaffolding in support of decommissioning	-	1,025	20	7	90	26	-	279	1,446	1,446	-	-	921	81	-	-	-	46,613	22,669	-
Decontamination of Site Buildings																					
4b.1.5	Prepare/submit License Termination Plan	-	-	-	-	-	-	556	83	639	639	-	-	-	-	-	-	-	-	-	4,096
4b.1.6	Receive NRC approval of termination plan	-	-	-	-	-	-	-	-	a	-	-	-	-	-	-	-	-	-	-	-
4b.1	Subtotal Period 4b Activity Costs	-	19,573	447	1,217	17,544	1,585	556	7,792	48,715	43,661	-	5,054	199,908	4,819	-	-	-	8,434,473	374,526	4,096
Period 4b Additional Costs																					
4b.2.1	License Termination Survey Planning	-	-	-	-	-	-	1,370	411	1,780	1,780	-	-	-	-	-	-	-	-	-	12,480
4b.2.2	Remedial Action Surveys	-	-	-	-	-	-	4,276	1,283	5,559	5,559	-	-	-	-	-	-	-	-	64,736	-
4b.2.3	Underground Services Excavation	-	1,442	-	-	-	-	904	136	2,481	-	-	2,481	-	-	-	-	-	-	13,986	-
4b.2.4	Operational Tools & Equipment	-	-	6	57	632	-	-	104	800	800	-	-	11,710	-	-	-	-	292,750	44	-
4b.2.5	Decommissioning ISFSI	-	34	96	362	-	2,721	2,252	1,366	6,831	6,831	-	-	-	13,829	-	-	-	1,626,384	5,539	10,495
4b.2.6	Lead Abatement Crew	-	1,885	-	-	-	-	-	471	2,357	2,357	-	-	-	-	-	-	-	-	38,842	-
4b.2.7	Asbestos Abatement	-	-	-	-	-	-	4,000	-	4,000	4,000	-	-	-	27,000	-	-	-	351,000	-	-
4b.2.8	Containment	1,194	617	30	116	145	1,051	-	1,056	4,210	4,210	-	-	1,691	10,300	-	-	-	556,345	33,336	-
4b.2.9	Auxiliary	624	185	12	42	32	380	-	466	1,740	1,740	-	-	374	3,745	-	-	-	192,346	15,020	-
4b.2.10	Radwaste	80	19	1	5	6	47	-	58	217	217	-	-	70	465	-	-	-	24,743	1,850	-
4b.2.11	Fuel Handling Area (Decon)	623	663	7	17	178	80	-	527	2,094	2,094	-	-	2,072	609	-	-	-	114,409	23,613	-
4b.2	Subtotal Period 4b Additional Costs	2,522	4,845	152	599	993	4,279	12,801	5,878	32,068	29,587	-	2,481	15,918	55,948	-	-	-	3,157,978	196,967	22,975
Period 4b Collateral Costs																					
4b.3.1	Process decommissioning water waste	8	-	11	25	-	38	-	18	100	100	-	-	-	116	-	-	-	6,968	23	-
4b.3.3	Small tool allowance	-	385	-	-	-	-	-	58	443	443	-	-	-	-	-	-	-	-	-	-
4b.3.4	Decommissioning Equipment Disposition	-	-	130	51	583	171	-	151	1,086	1,086	-	-	6,000	529	-	-	-	303,608	147	-
4b.3.5	Site O&M (Non Labor Overhead)	-	-	-	-	-	-	4,397	660	5,057	5,057	-	-	-	-	-	-	-	-	-	-
4b.3	Subtotal Period 4b Collateral Costs	8	385	141	76	583	208	4,397	886	6,685	6,685	-	-	6,000	645	-	-	-	310,575	170	-
Period 4b Period-Dependent Costs																					
4b.4.1	Decon supplies	253	-	-	-	-	-	-	63	317	317	-	-	-	-	-	-	-	-	-	-
4b.4.2	Insurance	-	-	-	-	-	-	1,367	137	1,504	1,504	-	-	-	-	-	-	-	-	-	-

Table C
Fort Calhoun Station
SAFSTOR Decommissioning Cost Estimate
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 4b Period-Dependent Costs (continued)																					
4b.4.3	Property taxes	-	-	-	-	-	-	62	6	68	68	-	-	-	-	-	-	-	-	-	-
4b.4.4	Health physics supplies	-	4,260	-	-	-	-	-	1,065	5,325	5,325	-	-	-	-	-	-	-	-	-	-
4b.4.5	Heavy equipment rental	-	7,019	-	-	-	-	-	1,053	8,072	8,072	-	-	-	-	-	-	-	-	-	-
4b.4.6	Disposal of DAW generated	-	-	116	37	-	430	-	125	708	708	-	-	-	5,848	-	-	-	116,969	191	-
4b.4.8	NRC Fees	-	-	-	-	-	-	1,699	170	1,869	1,869	-	-	-	-	-	-	-	-	-	-
4b.4.9	Corporate A&G	-	-	-	-	-	-	2,123	318	2,441	2,441	-	-	-	-	-	-	-	-	-	-
4b.4.10	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	1,260	189	1,448	1,448	-	-	-	-	-	-	-	-	-	-
4b.4.11	Security Staff Cost	-	-	-	-	-	-	10,151	1,523	11,673	11,673	-	-	-	-	-	-	-	-	-	202,301
4b.4.12	DOC Staff Cost	-	-	-	-	-	-	43,449	6,517	49,966	49,966	-	-	-	-	-	-	-	-	-	433,734
4b.4.13	Utility Staff Cost	-	-	-	-	-	-	52,430	7,864	60,294	60,294	-	-	-	-	-	-	-	-	-	763,890
4b.4	Subtotal Period 4b Period-Dependent Costs	253	11,280	116	37	-	430	112,540	19,031	143,687	143,687	-	-	-	5,848	-	-	-	116,969	191	1,399,926
4b.0	TOTAL PERIOD 4b COST	2,783	36,082	856	1,929	19,120	6,503	130,294	33,587	231,155	223,620	-	7,535	221,826	67,261	-	-	-	12,020,000	571,853	1,426,996
PERIOD 4f - License Termination																					
Period 4f Direct Decommissioning Activities																					
4f.1.1	ORISE confirmatory survey	-	-	-	-	-	-	169	51	219	219	-	-	-	-	-	-	-	-	-	-
4f.1.2	Terminate license	-	-	-	-	-	-	-	-	a	-	-	-	-	-	-	-	-	-	-	-
4f.1	Subtotal Period 4f Activity Costs	-	-	-	-	-	-	169	51	219	219	-	-	-	-	-	-	-	-	-	-
Period 4f Additional Costs																					
4f.2.1	License Termination Survey	-	-	-	-	-	-	7,120	2,136	9,256	9,256	-	-	-	-	-	-	-	-	116,433	6,240
4f.2	Subtotal Period 4f Additional Costs	-	-	-	-	-	-	7,120	2,136	9,256	9,256	-	-	-	-	-	-	-	-	116,433	6,240
Period 4f Collateral Costs																					
4f.3.1	DOC staff relocation expenses	-	-	-	-	-	-	1,431	215	1,646	1,646	-	-	-	-	-	-	-	-	-	-
4f.3.2	Site O&M (Non Labor Overhead)	-	-	-	-	-	-	429	64	493	493	-	-	-	-	-	-	-	-	-	-
4f.3	Subtotal Period 4f Collateral Costs	-	-	-	-	-	-	1,860	279	2,139	2,139	-	-	-	-	-	-	-	-	-	-
Period 4f Period-Dependent Costs																					
4f.4.1	Insurance	-	-	-	-	-	-	103	10	113	113	-	-	-	-	-	-	-	-	-	-
4f.4.2	Property taxes	-	-	-	-	-	-	15	2	17	17	-	-	-	-	-	-	-	-	-	-
4f.4.3	Health physics supplies	-	654	-	-	-	-	-	163	817	817	-	-	-	-	-	-	-	-	-	-
4f.4.4	Disposal of DAW generated	-	-	7	2	-	26	-	7	43	43	-	-	-	351	-	-	-	7,025	11	-
4f.4.5	Plant energy budget	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4f.4.6	NRC Fees	-	-	-	-	-	-	412	41	453	453	-	-	-	-	-	-	-	-	-	-
4f.4.7	Corporate A&G	-	-	-	-	-	-	514	77	591	591	-	-	-	-	-	-	-	-	-	-
4f.4.8	Security Staff Cost	-	-	-	-	-	-	944	142	1,085	1,085	-	-	-	-	-	-	-	-	-	18,805
4f.4.9	DOC Staff Cost	-	-	-	-	-	-	5,714	857	6,572	6,572	-	-	-	-	-	-	-	-	-	57,200
4f.4.10	Utility Staff Cost	-	-	-	-	-	-	5,109	766	5,875	5,875	-	-	-	-	-	-	-	-	-	74,438
4f.4	Subtotal Period 4f Period-Dependent Costs	-	654	7	2	-	26	12,811	2,066	15,566	15,566	-	-	-	351	-	-	-	7,025	11	150,444
4f.0	TOTAL PERIOD 4f COST	-	654	7	2	-	26	21,959	4,532	27,180	27,180	-	-	-	351	-	-	-	7,025	116,445	156,684
PERIOD 4 TOTALS		3,026	65,297	11,537	7,201	25,920	28,751	201,107	70,053	412,893	404,514	-	8,379	305,976	138,101	475	907	825	19,374,000	873,460	2,109,565
Period 5b Direct Decommissioning Activities																					
Demolition of Remaining Site Buildings																					
5b.1.1.1	Containment	-	1,207	-	-	-	-	-	181	1,388	-	-	1,388	-	-	-	-	-	-	9,293	-
5b.1.1.2	Administration	-	60	-	-	-	-	-	9	69	-	-	69	-	-	-	-	-	-	842	-
5b.1.1.3	Auxiliary	-	1,346	-	-	-	-	-	202	1,548	-	-	1,548	-	-	-	-	-	-	10,052	-
5b.1.1.4	Chemistry & Radiation Protection Fac.	-	126	-	-	-	-	-	19	145	-	-	145	-	-	-	-	-	-	1,504	-
5b.1.1.5	Intake	-	103	-	-	-	-	-	15	118	-	-	118	-	-	-	-	-	-	1,271	-
5b.1.1.6	Maintenance Shop	-	156	-	-	-	-	-	23	179	-	-	179	-	-	-	-	-	-	2,201	-
5b.1.1.7	Miscellaneous Structures	-	609	-	-	-	-	-	91	700	-	-	700	-	-	-	-	-	-	7,381	-
5b.1.1.8	New Security Access Facility	-	59	-	-	-	-	-	9	68	-	-	68	-	-	-	-	-	-	610	-
5b.1.1.9	Original Steam Generator Storage	-	126	-	-	-	-	-	19	145	-	-	145	-	-	-	-	-	-	763	-
5b.1.1.10	Radwaste	-	238	-	-	-	-	-	36	274	-	-	274	-	-	-	-	-	-	2,322	-
5b.1.1.11	Security	-	47	-	-	-	-	-	7	55	-	-	55	-	-	-	-	-	-	684	-

Table C
Fort Calhoun Station
SAFSTOR Decommissioning Cost Estimate
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Demolition of Remaining Site Buildings (continued)																					
5b.1.1.12	Security Modifications	-	244	-	-	-	-	-	37	281	-	-	281	-	-	-	-	-	-	1,138	-
5b.1.1.13	Service	-	174	-	-	-	-	-	26	200	-	-	200	-	-	-	-	-	-	1,919	-
5b.1.1.14	Technical Support Center	-	59	-	-	-	-	-	9	68	-	-	68	-	-	-	-	-	-	468	-
5b.1.1.15	Turbine	-	844	-	-	-	-	-	127	971	-	-	971	-	-	-	-	-	-	13,015	-
5b.1.1.16	Turbine Pedestal	-	307	-	-	-	-	-	46	353	-	-	353	-	-	-	-	-	-	2,245	-
5b.1.1.17	Warehouse	-	235	-	-	-	-	-	35	270	-	-	270	-	-	-	-	-	-	2,467	-
5b.1.1	Totals	-	5,943	-	-	-	-	-	891	6,834	-	-	6,834	-	-	-	-	-	-	58,174	-
Site Closeout Activities																					
5b.1.2	Remove Rubble	-	570	-	-	-	-	-	86	656	-	-	656	-	-	-	-	-	-	3,209	-
5b.1.3	Grade & landscape site	-	552	-	-	-	-	-	83	634	-	-	634	-	-	-	-	-	-	1,326	-
5b.1.4	Final report to NRC	-	-	-	-	-	-	212	32	243	243	-	-	-	-	-	-	-	-	-	1,560
5b.1	Subtotal Period 5b Activity Costs	-	7,064	-	-	-	-	212	1,091	8,367	243	-	8,124	-	-	-	-	-	-	62,709	1,560
Period 5b Additional Costs																					
5b.2.1	Lagoon Closure	-	177	-	-	-	-	213	58	448	-	-	448	-	-	-	-	-	-	1,264	-
5b.2.2	Concrete Processing	-	374	-	-	-	-	11	58	442	-	-	442	-	-	-	-	-	-	1,952	-
5b.2.3	Demolition and site restoration - ISFSI	-	602	-	-	-	-	162	115	879	-	-	879	-	-	-	-	-	-	2,893	160
5b.2.4	Disposal of construction debris from demolition	-	-	-	-	-	-	284	43	327	-	-	327	-	-	-	-	-	-	-	-
5b.2.5	Firing Range Closure	-	4	-	-	-	-	55	8	67	-	-	67	-	-	-	-	-	-	25	-
5b.2.6	Intake Cofferdam	-	939	-	-	-	-	-	141	1,080	-	-	1,080	-	-	-	-	-	-	8,721	-
5b.2.7	Demolition Credit from Site Reconfiguration	-	(230)	-	-	-	-	-	-	(230)	-	-	(230)	-	-	-	-	-	-	-	-
5b.2	Subtotal Period 5b Additional Costs	-	1,865	-	-	-	-	724	422	3,012	-	-	3,012	-	-	-	-	-	-	14,854	160
Period 5b Collateral Costs																					
5b.3.1	Small tool allowance	-	66	-	-	-	-	-	10	76	-	-	76	-	-	-	-	-	-	-	-
5b.3.2	Site O&M (Non Labor Overhead)	-	-	-	-	-	-	351	53	403	-	-	403	-	-	-	-	-	-	-	-
5b.3	Subtotal Period 5b Collateral Costs	-	66	-	-	-	-	351	62	479	-	-	479	-	-	-	-	-	-	-	-
Period 5b Period-Dependent Costs																					
5b.4.1	Insurance	-	-	-	-	-	-	205	20	225	-	-	225	-	-	-	-	-	-	-	-
5b.4.2	Property taxes	-	-	-	-	-	-	30	3	33	-	-	33	-	-	-	-	-	-	-	-
5b.4.3	Heavy equipment rental	-	4,722	-	-	-	-	-	708	5,430	-	-	5,430	-	-	-	-	-	-	-	-
5b.4.5	Corporate A&G	-	-	-	-	-	-	1,024	154	1,178	-	-	1,178	-	-	-	-	-	-	-	-
5b.4.6	Security Staff Cost	-	-	-	-	-	-	1,880	282	2,162	-	-	2,162	-	-	-	-	-	-	-	37,474
5b.4.7	DOC Staff Cost	-	-	-	-	-	-	10,810	1,621	12,431	-	-	12,431	-	-	-	-	-	-	-	106,177
5b.4.8	Utility Staff Cost	-	-	-	-	-	-	4,180	627	4,807	-	-	4,807	-	-	-	-	-	-	-	60,896
5b.4	Subtotal Period 5b Period-Dependent Costs	-	4,722	-	-	-	-	18,129	3,416	26,266	-	-	26,266	-	-	-	-	-	-	-	204,547
5b.0	TOTAL PERIOD 5b COST	-	13,717	-	-	-	-	19,415	4,992	38,124	243	-	37,881	-	-	-	-	-	-	77,563	206,267
PERIOD 5 TOTALS		-	13,717	-	-	-	-	19,415	4,992	38,124	243	-	37,881	-	-	-	-	-	-	77,563	206,267
TOTAL COST TO DECOMMISSION		4,451	81,959	14,094	7,477	25,920	30,879	948,856	181,816	1,295,453	882,212	365,262	47,979	305,976	162,484	475	963	1,179	19,977,003	981,888	10,763,682

Table C
Fort Calhoun Station
SAFSTOR Decommissioning Cost Estimate
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours

TOTAL COST TO DECOMMISSION WITH 16.33 CONTINGENCY:	1,295,453	thousands of 2017 dollars
TOTAL NRC LICENSE TERMINATION COST 68.1 OR:	882,212	thousands of 2017 dollars
SPENT FUEL MANAGEMENT COST IS 28.2 OR:	365,262	thousands of 2017 dollars
NON-NUCLEAR DEMOLITION COST IS 3.7 OR:	47,979	thousands of 2017 dollars
TOTAL LOW-LEVEL RADIOACTIVE WASTE VOLUME BURIED (EXCLUDING GTCC):	163,921	cubic feet
TOTAL GREATER THAN CLASS C RADWASTE VOLUME GENERATED:	1,179	cubic feet
TOTAL SCRAP METAL REMOVED:	26,046	tons
TOTAL CRAFT LABOR REQUIREMENTS:	981,888	man-hours

End Notes:
n/a - indicates that this activity not charged as decommissioning expense
a - indicates that this activity performed by decommissioning staff
0 - indicates that this value is less than 0.5 but is non-zero
A cell containing " - " indicates a zero value

APPENDIX D

ISFSI DECOMMISSIONING

Table D
Fort Calhoun Station
ISFSI Decommissioning Cost Estimate
(thousands of 2017 dollars)

Activity Description	Removal Costs	Packaging Costs	Transport Costs	LLRW Disposal Costs	Other Costs	Total Costs	Burial Volume Class A (cubic feet)	Craft Manhours	Oversight and Contractor Manhours
Decommissioning Contractor									
Planning (characterization, specs and procedures)	-	-	-	-	186	186	-	-	1,000
Decontamination (activated disposition)	34	96	362	2,721	-	3,213	13,829	212	-
License Termination (radiological surveys)	-	-	-	-	724	724	-	5,327	-
Subtotal	**34**	**96**	**362**	**2,721**	**910**	**4,122**	**13,829**	**5,539**	**1,000**
Supporting Costs									
NRC and NRC Contractor Fees and Costs	-	-	-	-	352	352	-	-	776
Insurance					137	137	-	-	-
Property taxes					7	7	-	-	-
Corporate A&G					224	224	-	-	-
Non-Labor Overhead					146	146	-	-	-
Security Staff Cost					219	219	-	-	4,958
Oversight Staff Cost					258	258	-	-	3,761
Subtotal	**-**	**-**	**-**	**-**	**1,343**	**1,343**	**-**	**-**	**9,495**
Total (w/o contingency)	**34**	**96**	**362**	**2,721**	**2,252**	**5,465**	**13,829**	**5,539**	**10,495**
Total (w/25% contingency)	**43**	**120**	**452**	**3,401**	**2,815**	**6,831**			

The application of contingency (25%) is consistent with the evaluation criteria referenced by the NRC in NUREG-1757 ("Consolidated Decommissioning Guidance, Financial Assurance, Recordkeeping, and Timeliness," U.S. NRC's Office of Nuclear Material Safety and Safeguards, NUREG-1757, Vol. 3, Rev. 1, February 2012)

APPENDIX B

Threatened and Endangered Species Correspondence

your energy partner®
OPPD
Omaha Public Power District

October 24, 2018
18-EA-254

Ms. Rachel Simpson
Data Manager/GIS Specialist Nebraska Game and Parks Commission
Nebraska Natural Heritage Program
2200 N 33rd Street
Lincoln, Nebraska 68503

Subject: Information Request – Threatened and Endangered Species List
Omaha Public Power District, Fort Calhoun Station

Ms. Simpson:

Haley & Aldrich, Inc. is conducting an environmental analysis on behalf of Omaha Public Power District (OPPD) for the proposed decommissioning of the Fort Calhoun Station (FCS) located approximately 19 miles north of Omaha, Nebraska on the Missouri River (Project) (See Figure 1). The Project is currently in the planning stages and environmental review process. We are therefore respectfully requesting that your office review the Project relative to the potential impacts to threatened and endangered species in accordance with Section 7 of the Endangered Species Act and the Nebraska Nongame and Endangered Species Conservation Act. We also request an updated protected species list for the Project site.

FCS is a 1,500-megawatt thermal nuclear power plant that ceased operation in October 2016 and has plans for the decommissioning and removal of the buildings and paved surfaces within the power station footprint (see attached Figure 2). Some of the underground structures and utilities will be left in place and the main switchyard remain active. OPPD anticipates decommissioning to start in 2019, pending receipt of applicable permits and approvals from the Nuclear Regulatory Commission (NRC).

The Project Limit of Disturbance (LOD) as depicted in Figure 2 includes the entire area to be decommissioned at the FCS site. The Project LOD encompasses only those areas that were previously disturbed during construction in 1969. The Project does not propose any additional new ground disturbance and all decommissioned areas will be restored back to natural grassland habitat. In addition, no tree clearing is proposed. Acoustical studies were conducted at the site in July 2018 to detect any protected tree roosting bat species (*myotis*) in the vicinity of the Project site.

OPPD would also like to inquire about any recent wildlife studies conducted within the vicinity of the Project site applicable to activities related to decommissioning planning for

this Project. We would appreciate a copy of any recent studies your office feels would be informative during this process in order to review.

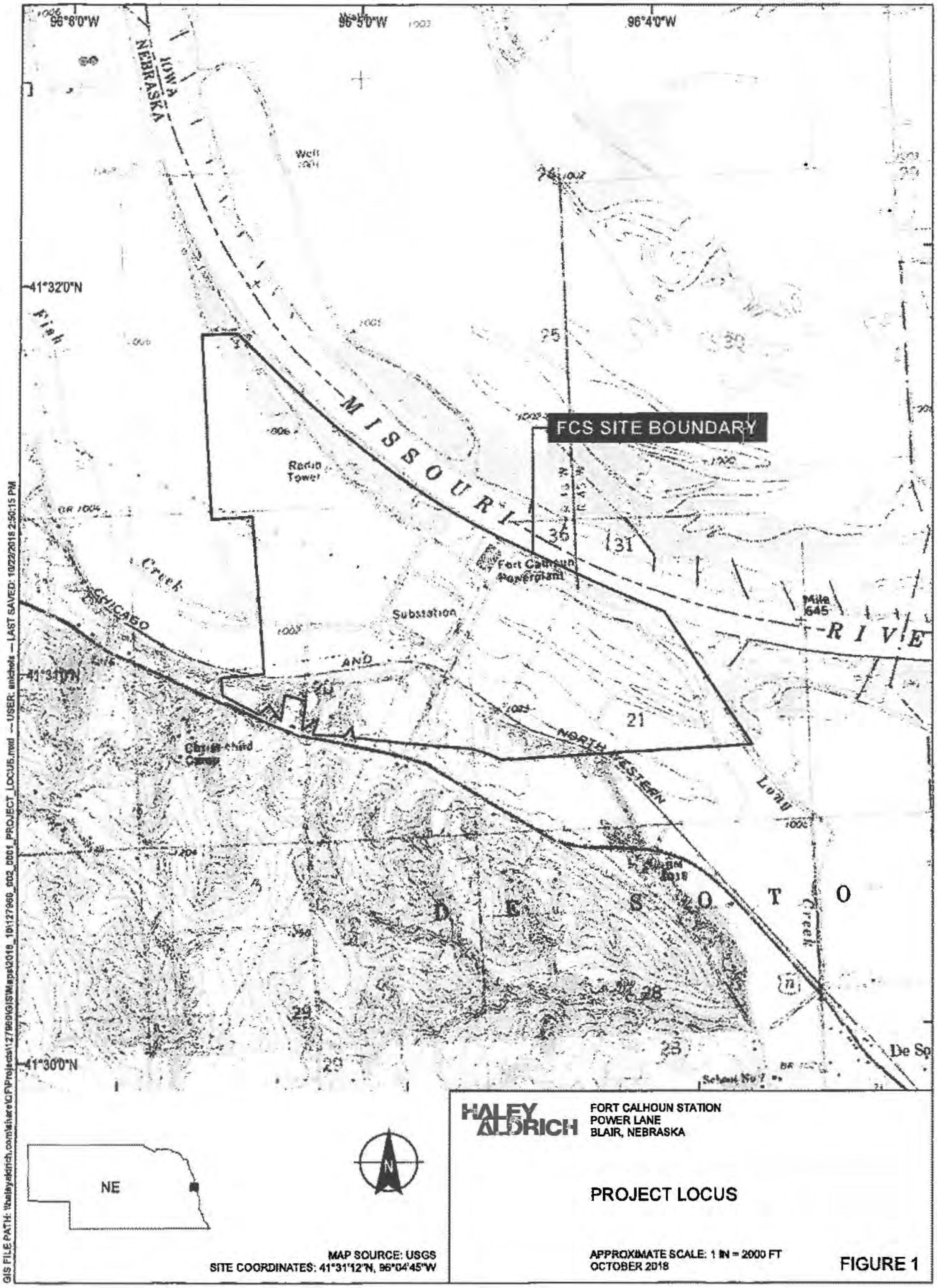
We understand the Nebraska Natural Heritage Program data is sensitive; therefore, any information provided to us will not be released to the public without permission from NNHP. If you have any questions or need additional information concerning this request please contact Patrick Finigan at 402-636-2521.

Sincerely,

Patrick Finigan
Environmental Affairs Administrator

Attachments:
Figure 1 – FCS Decommissioning Project, Site Location Map
Figure 2 – FCS Decommissioning Project, Decommissioning LOD

cc: A. Barker FCS
T. Maine FCS
Ms. Nadia Glucksberg, Haley & Aldrich (File No. 127960-003)


96°6'0"W
96°5'0"W
96°4'0"W
41°32'0"N
41°31'0"N
41°30'0"N
IOWA
NEBRASKA
MISSOURI
RIVER
FCS SITE BOUNDARY
Well
Radio Tower
Fort Calhoun Powerplant
Substation
Fish Creek
CHICAGO AND NORTHWESTERN
Long Creek
Mile 645
D E S O T O
De Soto
25
30
36
31
21
28
29
NE
MAP SOURCE: USGS
SITE COORDINATES: 41°31'12"N, 96°04'45"W
HALEY ALDRICH
FORT CALHOUN STATION
POWER LANE
BLAIR, NEBRASKA
PROJECT LOCUS
APPROXIMATE SCALE: 1 IN = 2000 FT
OCTOBER 2018
FIGURE 1
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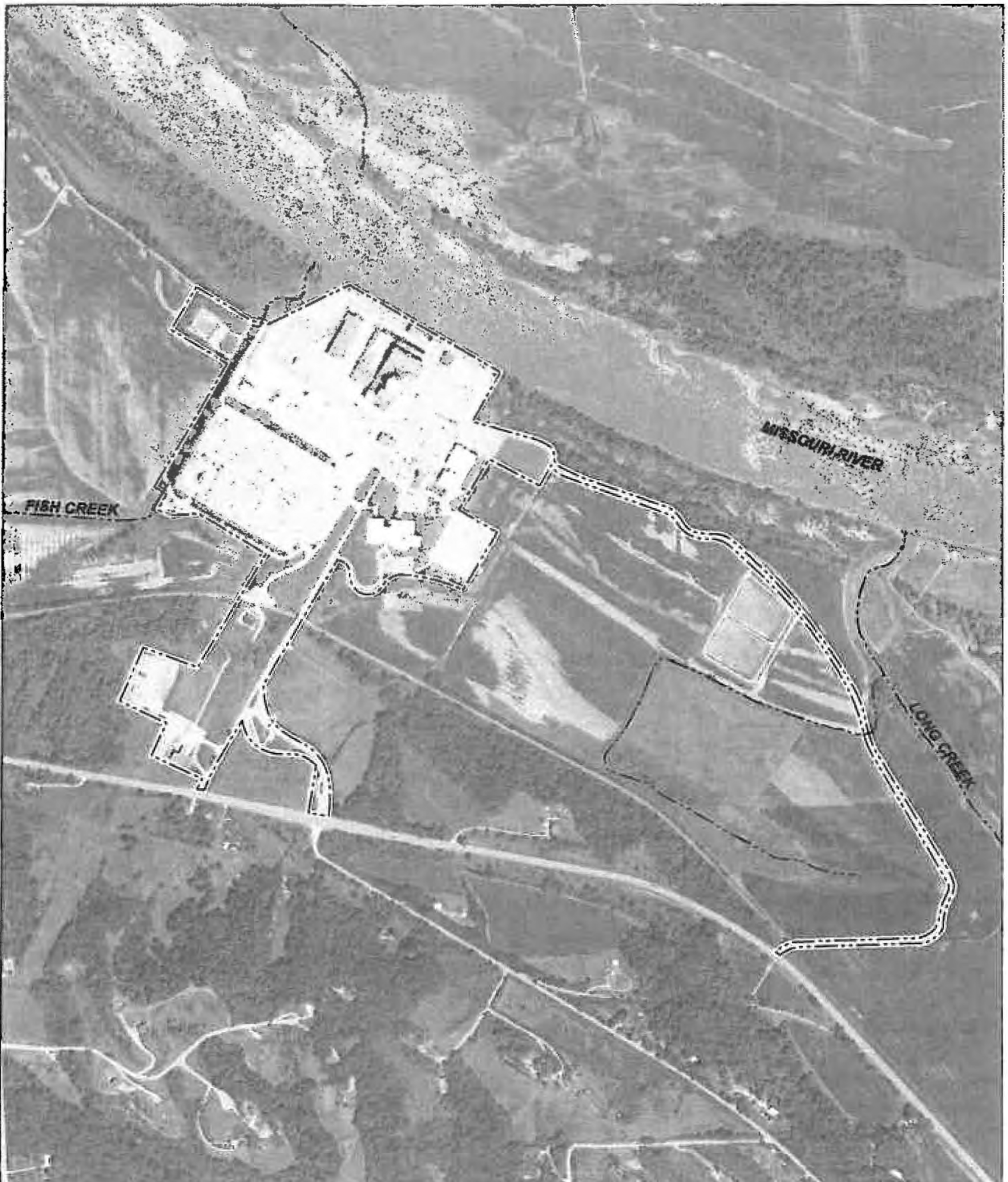

LEGEND

STREAM

LIMITS OF DISTURBANCE

NOTES
1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. STREAM DATA SOURCE: NATIONAL HYDROGRAPHY DATASET
3. AERIAL IMAGERY SOURCE: ESRI

N

0 500 1,000
SCALE IN FEET

HALEY ALDRICH

FORT CALHOUN STATION
POWER LANE
BLAIR, NEBRASKA

SITE PLAN

OCTOBER 2018

FIGURE 2

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APPENDIX C

Northern Long-Eared Bat Acoustic and Mist Net Surveys Report

Pesi 1236

NORTHERN LONG-EARED BAT ACOUSTIC AND MIST NET SURVEYS ON FORT CALHOUN STATION IN WASHINGTON COUNTY, NEBRASKA

28 September 2018

Submitted to:

Mr. John F. Cochner
U.S. Fish and Wildlife Service
Nebraska Ecological Services Field Office
9325 South Alda Road
Wood River, NE 68883

Ms. Carey Grell
Environmental Review Coordinator
Nebraska Game and Parks Commission
2200 N. 33rd Street
Lincoln, NE 68503

Prepared for:

HALEY ALDRICH

On behalf of:

your energy partner®
OPPD
Omaha Public Power District

Prepared by:

ESI

Environmental Solutions & Innovations, Inc.

4525 Este Avenue
Cincinnati, Ohio 45232
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Fax: (513) 451-3321
Stow, OH • Indianapolis, IN • Orlando, FL • Springfield, MO • Pittsburgh, PA • Teays Valley, WV

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1.0 Project Description

Omaha Public Power District (OPPD) is currently implementing decommissioning procedures at the Fort Calhoun Station (Project Area) in Washington County, Nebraska. In support of this effort, the Nuclear Regulatory Commission (NRC) is undertaking an Environmental Review (ER) to gather information for issuance of the requisite Environmental Impact Statement (EIS).

As the Project Area is within the range of the federally threatened northern long-eared bat (*Myotis septentrionalis*) and species records or highly suspected occurrence exist in Washington County and surrounding counties such as Douglas, Burt, and Dodge, Environmental Solutions & Innovations, Inc. (ESI) was contracted to detemine potential species impacts resulting from decommissioning activities. The Project Area encompasses approximately 660 acres (267 ha) with forested land-cover totaling approximately 137 acres (55 ha) and appears on the Modale, IA-NE USGS 7.5-minute topographic quadrangle map (Figure 1).

On 8 August 2018, a study plan was submitted to the U.S. Fish and Wildlife (USFWS) Nebraska Ecological Services Field Office and the Nebraska Game and Parks Commission (NGPC) requesting approval and site specific authorization to complete summer mist net surveys at one mist net and two acoustic detector sites to determine whether federally listed bats are present in the Project Area. Approval and site-specific authorization were received on 9 August 2018. Mist net and acoustic surveys were completed from 12 to 14 August 2018 in accordance with USFWS Federal Fish and Wildlife and Nebraska Game and Parks Commission (NGPC) Scientific and Education Permits. This report details the methods and results of the survey.

2.0 Basis for ESA Compliance

The Endangered Species Act (ESA) [16 U.S.C. 1531 et seq.] was codified into law in 1973. This law provides for the listing, conservation, and recovery of endangered and threatened species of plants and wildlife. Under the ESA, the USFWS is mandated to monitor and protect listed species.

Section 9 of the ESA prohibits the “take” of listed species unless otherwise specifically authorized by regulation. “Take” is defined by the ESA as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect” [16 U.S.C. 1532(19)].

Figure 1. Location of the Fort Calhoun Station Project in Washington County, Nebraska.

Project No. 1236

0 1.25 2.5 Miles

Base Map: USGS Topographic Map

ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

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USFWS further defines “harm” to include significant habitat modification or degradation [50 CFR §17.3]. Section 7(a) (2) of the ESA states that each federal agency shall insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in destruction or adverse modification of designated critical habitat. Federal actions include (1) expenditure of federal funds for roads, buildings, or other construction projects, and (2) approval of a permit or license, and the activities resulting from such permit or license. Compliance is required regardless of whether involvement is apparent, such as issuance of a federal permit, or less direct, such as federal oversight of a state-operated program. Actions of federal agencies that do not result in jeopardy or adverse modification, but that could result in a take, must also be addressed under Section 7. Take by a federal agency can be authorized through the Section 7 consultation process, culminating in an Incidental Take Statement (ITS) by the USFWS. The take must be Incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. One of the requirements to for project proponents under the ESA is to avoid and minimize impacts to listed species. If, through this process, take is avoided, then an ITS or ITP is not required.

The first step in the project consultation process under the ESA is to first determine whether suitable habitat is presence and if habitat is present, then to determine if listed species are present. The Fort Calhoun Station Project is within the range of the federally threatened northern long-eared bat. Northern long-eared bats are considered "tree bats” in summer and "cave bats” in winter. The use of caves in winter for hibernation also includes spring staging and autumn swarming activities that are typically associated with hibernacula. On 4 May 2015, the USFWS listed the northern long-eared bat as threatened with a 4(d) exemption.

3.0 Ecological Setting – Northern Long-eared Bat

3.1 Status

On 2 October 2013, the northern long-eared bat was proposed for listing by USFWS as endangered. On 16 January 2015, USFWS proposed listing the northern long-eared bat as threatened with 4(d) rule. On 2 April 2015, USFWS published notice in the Federal Register of its final decision to list the species as threatened and issued an interim 4(d) rule exempting certain activities from the ESA’s take prohibition. The listing decision and interim 4(d)

Federal Register Documents

78 FR 61045 61080; 2 October 2013: Proposed Listing: Endangered
80 FR 2371 2378; 16 January 2015: Proposed Listing: Threatened; Proposed 4(d) Rule
80 FR 17973 18033; 2 April 2015: Final Rule: Threatened; Interim 4(d) Rule
81 FR 1900 1922; 14 January 2016: Final 4 (d) Rule
81 FR 24707 24714; 27 April 2016: Final Rule: Designation of Critical Habitat Not Prudent

rule took effect 4 May 2015. A final 4(d) rule was announced on 14 January 2016 and took effect on 16 February 2016. On 27 April 2016, USFWS determined that designation of critical habitat was not prudent. Reasons for listing include population declines attributed to WNS, impacts to hibernacula, and impacts to summer habitat.

3.2 Regional Species Occurrence

The northern long-eared bat is estimated to occur within 75 of Nebraska's 93 counties, but believed to be absent in the southwestern-most portion of the state (https://outdoornebraska.gov/wp-content/uploads/2015/07/Northern-Long-eared-Bat.pdf, accessed 13 September 2018). In January 2016, USFWS estimated the northern long-eared bat population in Nebraska consisted of approximately 28,890 adult individuals (USFWS 2016). Additional information on life history and ecology of the species is provided in Appendix A.

4.0 Habitat Screening

Desktop analysis of the Project Area reveals potential suitable roosting habitat, in the form of forested land-cover, totaling approximately 137 acres (55 ha, Figure 2). Aerial imagery shows snags (dead trees) along the riparian corridor of the Missouri River, and large blocks of forested habitat on the northern and western Project area boundaries.

The likelihood of potential hibernacula was assessed for lands within 0.25 mile of the Project area using soil/geological surveys, aerial imagery, and a review of mine sites in operation as of 2003 (most recent data). Soils include silty loam of 17 to 30 percent slopes, and silty clay of 0 to 2 percent slopes, both of which are characteristic of the Missouri River floodplain. No quarries, mines, or exposed rock assemblages are present.

A site visit completed on 26 July 2018 determined that low to moderate roosting habitat for the northern long-eared bat was present within seven discrete forest patches spread throughout the Project area.

Based on the results of both desktop and field habitat assessments, acoustic sampling was conducted at two sites for two nights each, and mist netting was conducted at one site for three nights, three nets per night for a total of nine net nights.

Prjoect Boundary
Forest Habitat

N
W
E
S

Figure 2. Forest habitat on Fort Calhoun Station in Washington County, Nebraska.

Project No.
1236

0 0.3 0.6 Mile

Base Map: Esri World Imagery

ESI
ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

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5.0 Methods

Acoustic monitoring and mist netting were completed from 12 to 14 August 2018, in accordance with the 2018 USFWS *Range-wide Indiana Bat Survey Guidelines* (USFWS 2018), which are also applicable to northern long-eared bats.

5.1 Acoustic Monitoring

5.1.1 Level of Effort

Acoustic monitoring efforts are conducted in accordance with guidelines in the *2018 USFWS Range-wide Indiana Bat Summer Survey* (Appendix B, Table 1). Each night, acoustic units are moved within the designated forested polygons (which contain large pockets of eastern cottonwoods) to maximize the probability of detecting bats. Two sites were sampled for two nights for a total of four complete detector nights.

5.1.2 Qualified Personnel

Acoustic deployment is conducted by qualified individuals with experience in proper placement and programming of acoustic detectors. All calls are processed through Kaleidoscope Pro (Kpro) software (4.2, Wildlife Acoustics, Concord Massachusetts). All calls classified by Kpro as Myotis calls are visually vetted by expert acoustic identification specialists.

5.1.3 Detector Placement

Acoustic units are deployed within the Project area at locations which exhibit potentially suitable habitat characteristics, but where mist net surveys would not be the optimal means of detecting bat presence. In the Project Area, the riparian corridors along the Missouri River were identified as optimal acoustic sites. Appendix B, Table 2 provides detector locations and sampling dates. Detector locations are illustrated in Figure 3. Photographs of detector locations are provided in Appendix C, and detector deployment data sheets are provided in Appendix D.

5.2 Mist Netting

5.2.1 Level of Effort

Mist net efforts are conducted in accordance with guidelines in the *2018 USFWS Range-wide Indiana Bat Summer Survey* (Appendix B, Table 3). After each survey night, at the discretion of the on-site biologist, mist nets may be moved to alternate suitable locations in order to maximize the probability of northern long-eared bat capture in the Project Area. A total of **nine complete net nights** were sampled across nine separate net locations.

Acosutic Sampling Site   Prjoect Boundary

N W E S

Figure 3. Acoustic sampling sites on the Fort Calhoun Station Project in Washington County, Nebraska.

Project No. 1236

0 0.3 0.6 Mile

Base Map: Esri World Imagery

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

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5.2.2 Qualified Surveyors

Mist net surveys are completed by one or more biologists, including the team leader, who is federally permitted to handle northern long-eared bats.

5.2.3 Net Placement

Mist nets are set to maximize coverage of the flight paths used by northern long-eared bats along suitable travel corridors, foraging areas, and/or drinking areas. Riparian corridors are often used for travel or foraging; however, upland corridors (e.g., trails or access roads) also provide suitable sites.

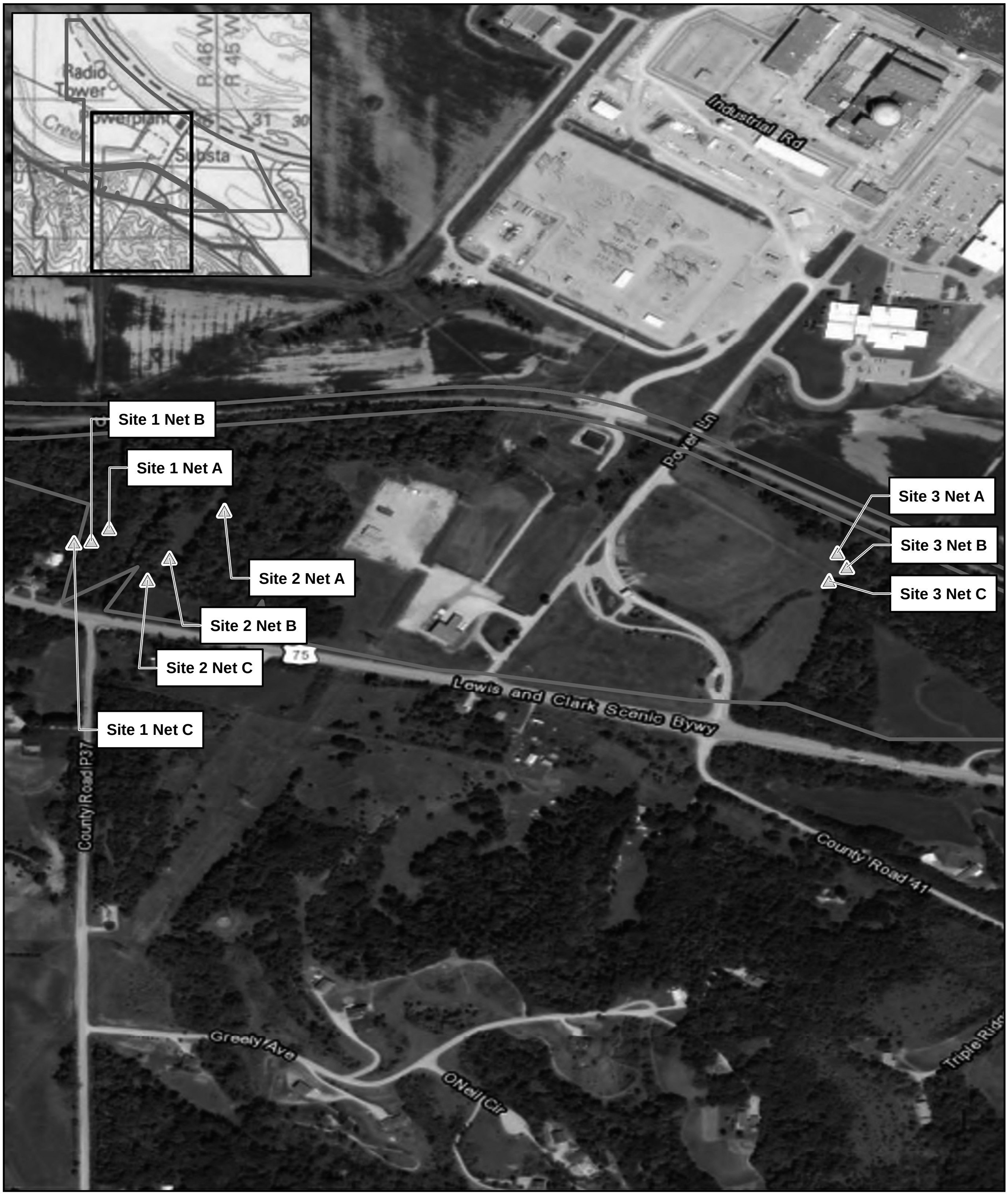
Site selection is based upon the extent of canopy cover, presence of an open flyway, and forest conditions near the site. The actual location and orientation of each net set is determined in the field by a permitted bat biologist. Locations of mist nets are provided in Figure 3 and coordinates are provided in Appendix B, Table 4. Photographs of nets are provided in Appendix C. Mist net capture data sheets are provided in Appendix D.

5.2.4 Bat Capture

Bats are live-caught in mist nets and released unharmed near the point of capture. Captured bats are identified to species, sex, age class, and reproductive condition. Weight and right forearm length of each individual are also recorded. Age is determined by examining the epiphyseal-diaphyseal fusion of long bones in the wing. Reproductive condition of female bats is recorded as pregnant (based on gentle abdominal palpation), lactating, post lactating, or non-reproductive. Time and location/net site of captured bats is recorded. Processing is typically completed within 30 minutes of the time each bat is removed from the net. Photographs are taken of all bats captured/identified as northern long-eared bats. Information is recorded on standardized data sheets.

5.2.5 Protocol for Addressing White-nose Syndrome

White-nose syndrome (WNS) is a disease that is killing millions of bats in the eastern United States. The disease, which was first found in New York, is spreading across the range of the northern long-eared bat. All current state and federal guidelines for WNS decontamination, containment, and avoidance are implemented during the bat capture process. Biologists are kept aware of all current and changing WNS regulations. Bat handling follows current WNS protocols set by the USFWS. Captured bats are examined for WNS damage to the wing and uropatagium (tail) membranes, using white and/or ultraviolet light. Wing damage is categorized using the Wing-Damage Index Used for Characterizing Wing Condition of Bats Affected by White-nose Syndrome established by Jon Reichard in 2008.



△ Mist Net Site Location ▭ Prjoect Boundary

Figure 4. Mist net sites on the Fort Calhoun Station Project in Washington County, Nebraska.

N W E S

Project No. 1236

0 0.1 0.2 Mile

Base Map: Esri World Imagery

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

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5.2.6 Habitat Characterization

Concurrent with mist netting, wooded habitats near the net site and the immediate surroundings are quality assessed for both the Indiana and northern long-eared bat. The emphasis of this assessment is habitat form: size and relative abundance of large trees and snags that could serve as roost trees, canopy closure, understory clutter/openness, water availability, and flight corridors. Habitat form is emphasized because northern long-eared bats roost in a variety of tree species.

Habitat characterization identifies components of both the canopy and subcanopy layers. All trees that reach into the canopy are canopy trees, regardless of diameter or size. Many smaller trees are often found in the canopy, and in some situations, the canopy can be composed entirely of smaller diameter trees. Habitat characterization identifies both dominant and subdominant elements of the canopy.

The subcanopy, or understory, vegetation layer is that portion of the forest structure between the ground vegetation (to approximately 2 feet [0.6 m]) and the canopy layers, usually beginning at about 24.9 feet (7.6 m). Vegetation in the understory may come from:

- Lower branches of overstory trees,
- Small trees that will grow into the overstory,
- Small trees and shrubs that are confined to the understory.

The amount of understory, or clutter, is also recorded to assess accessibility by northern long-eared bats. Habitat data are recorded on standardized data sheets (Appendix D).

5.2.7 Weather and Temperature

Weather conditions are monitored each night of survey to assure compliance with mist netting guidelines. Conditions recorded include temperature, wind speed and direction, and percent cloud cover. Any of a variety of standard mercury or electric thermometers is used to record temperature, wind speed is determined by use of the Beaufort wind scale, and cloud cover is visually estimated. Information is recorded on standardized data sheets (Appendix D).

6.0 Results

6.1 Acoustic Analysis

6.1.1 Analysis of Call Sequences

A total of 856 acoustic files were recorded during sampling at the two sites. These

files were identified and analyzed to species by Kpro (Appendix B, Table 5). Nine of species were recorded, including eight northern long-eared bat call sequences.

The maximum likelihood estimator in Kpro statistically supported the potential presence of six species: big brown bat (Eptesicus fuscus), eastern red bat (Lasiurus borealis), hoary bat (Lasiurus cinereus), northern long-eared bat, evening bat (Nycticeius humeralis), and tri-colored bat (Perimyotis subflavus) (Appendix B, Table 6).

Manual vetting was completed by an expert acoustic-identification specialist, per the 2018 guidelines. The Northern long-eared bat presence was confirmed at Site 1 by manual vetting (Appendix B, Table 7).

6.2 Mist Netting

6.2.1 Bat Capture

Nine complete net nights resulted in the capture of two eastern red bats: one adult male and one adult female.

6.2.2 Species Diversity

Of 13 bat species documented in Nebraska, only one was captured: eastern red bats. This is one of the most common species in the state and one of the most abundant species throughout the post-WNS landscape.

6.2.3 Occurrence by Sex and Age

One adult male and one adult female were captured and fully processed. Both individuals were non-reproductive at the time of capture.

6.2.4 White Nose Syndrome Scores

Both captured individuals were examined for WNS damage/scarring. Both individuals displayed no signs of wing damage (Wing Index Score = 0).

6.2.5 Habitat Characterization of the Net Site

Nets were placed across an unnamed stream in the southernmost portion of the Project Area. Forested habitat was predominantly young upland and lowland forest. Dominant canopy species comprised hackberry (*Celtis occidentalis*), cottonwoods (*Populus* sect. *Aigeiros*), and black locust (*Robinia pseudoacacia*). Subdominant species include the above in addition to Chinese privet (*Ligustrum sinense*) and northern red oak (*Quercus rubra*). The subcanopy ranged from open to completely cluttered with saplings and shrubs, and comprised black locust in addition to foxtail (*Alopecurus* spp.), stinging nettle (*Urtica dioica*), and blueberry (*Vaccinium* spp.).

Roosting potential was ranked each calendar night for both Indiana and northern long-eared bats based on the presence of large trees, hollows, and snags. Roosting

potential was ranked as low for Indiana bats on all three nights. Roosting potential for northern long-eared bats was ranked as low on 12 and 13 August 2018, and as moderate on 14 August 2018. Habitat data are summarized in Appendix B, Table 8.

Photographs of the mist net site are provided in Appendix C and habitat datasheets are provided in Appendix D.

7.0 Discussion/Conclusion

Acoustic monitoring and mist net surveys for federally listed bats were completed from 12 to 14 August 2018. Survey efforts complied with guidelines in the 2018 *Range-wide Indiana Bat Survey Guidelines* (USFWS 2018), which are also applicable to northern long-eared bats. A total of 856 recorded files were identified and analyzed to species by Kpro, including eight potential northern long-eared bat calls. Manual vetting of these calls determined that five call sequences were consistent with the federally listed northern long-eared bat.

Nine complete , mist net nights resulted in the capture of two adult eastern red bats. No federally listed species were captured.

On behalf of OPPD, in accordance with the Final 4(d) Rule for northern long eared bats, based on the lack of presence of identified maternity roosts, ESI respectfully requests that tree clearing may occur within the Project Area at any time of year, for a period of 5 years from the completion of surveys.

8.0 Literature Cited

USFWS. 2016. Programmatic biological opinion on final 4(d) rule for the northern long-eared bat and activities excepted from take prohibitions. U.S. Department of the Interior, Fish and Wildlife Service, Midwest Regional Office, Bloomington, Minnesota. 103 pp.

USFWS. 2018. Range-wide Indiana bat survey guidelines - April 2018. U.S. Department of the Interior, Fish and Wildlife Service. 61 pp.

APPENDIX A
LIFE HISTORY AND ECOLOGY OF THE NORTHERN LONG-EARED BAT

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LIST OF FIGURES

1.0 Northern Long-Eared Bat (*Myotis septentrionalis)*

1.1 Description

The northern long-eared bat is a medium-sized bat in the genus *Myotis*. *M. septentrionalis* is the eastern member of a group of long-eared *Myotis* that occurs across much of North America, and whose similarity has led to a complex taxonomy (van Zyll de Jong 1979). All are similar in overall appearance and ecology. At one point, *M. septentrionalis* was considered a subspecies of *M. keenii* (Keen's bat) (Fitch and Shump 1979), which is now restricted to the Pacific Northwest. Much of the older literature appearing under the name *M. keenii* actually refers *to M. septentrionalis*. Also included in this long-eared group are the southwestern bat (*M. auriculus*) and the long-eared bat (*M. evotis*).

The northern long-eared bat weighs about 5-8 grams (0.17-0.28 oz) at maturity and its right forearm measures about 34-38 millimeters (1.3 – 1.5 in). The wing membrane connects to the foot at the base of the first toe. The northern long-eared bat is most easily characterized by the long ears (17 mm [0.7 in]), which extend past the muzzle when laid forward, as well as a long and thin tragus (9 mm [0.4 in]) (Whitaker and Mumford 2009). The northern long-eared bats' pelage is typically colored a light to dark brown on the dorsal side and a light brown on the ventral side (Caceres and Barclay 2000, Whitaker and Mumford 2009). Ears and wing membranes are usually a dark brown.

1.2 Seasonal Ecology

The northern long-eared bat is a "tree bat" in summer and a "cave bat" in winter. During the summer, the species is forest dependent. As with the Indiana bat, there are four ecologically distinct components of the annual life cycle: winter hibernation, spring staging and autumn swarming, spring and autumn migration, and the summer season of reproduction (Figure 1).

1.2.1 Summer Roosting Ecology

The summer range of the northern long-eared bat is large and includes much of the eastern deciduous forestlands from the northern border of Florida north and west to Saskatchewan and east to Labrador (Caceres and Barclay 2000, Whitaker and Mumford 2009) (Figure 2). Distribution throughout the range is not uniform, and summer occurrences are more common in the northern and northeastern portions of the species' range than in southern and western portions (Caceres and Barclay 2000, Amelon and Burhans 2006). Historically, these areas were primarily forested. Through the southern portions of their range, they appear to be less abundant, and are thought of as rare in Alabama, South Carolina, and Georgia (Mumford and Cope 1964, Barbour and Davis 1969, Amelon and Burhans 2006, Whitaker and Mumford 2009, Timpone et

al. 2010). Northern long-eared bats likely colonized the High Plains when suppression of fire and the extirpation of bison allowed extensive bands of riparian vegetation to develop along streams that were formerly unforested (Sparks and Choate 1995, Sparks et al. 1999, Benedict et al. 2000, Sparks and Choate 2000, Benedict 2004, Sparks et al. 2011). Although occasionally captured/recorded in western portions of their range, they are uncommon when records are compared to eastern areas.

1.2.1.1 Males

Some males and non-reproductive females remain near their winter hibernacula throughout summer while others migrate varying distances. This may be due to a preference for cooler environments in the absence of pups (Barbour and Davis 1969, Amelon and Burhans 2006). Males can be caught at hibernacula on most nights during summer, although there may be a large turnover of individuals between nights.

Structurally, summer roosts used by males are similar to those used by maternity colonies. Trees used by males of the species are often smaller than those used by maternity colonies, perhaps because males are often solitary or form small groups and thus need less space or they may have different thermal requirements than females.

1.2.1.2 Females and Maternity Colonies

When female northern long-eared bats emerge from hibernation, they migrate to maternity colonies. The distance traveled from winter hibernacula to summer roosting areas is not known, although the species is considered to migrate shorter distances than Indiana bat (USFWS 2014). After parturition, pups usually achieve volancy by 21 days (Kunz 1971, Krochmal and Sparks 2007). As the offspring become volant, average number of bats using a maternity roost declines (Lacki and Schwierjohann 2001, Sparks 2003).

A wide variety of deciduous tree species, as well as occasional coniferous species, are used as nursery colonies indicating that it is tree form, not species that is important for roosts (Caceres and Barclay 2000, Carter and Feldhamer 2005). Maternity colonies are typically found in hollow trees and under bark although they also use bat-houses, buildings, and other anthropogenic structures (Amelon and Burhans 2006). The northern long-eared bat may choose either tree condition (hollow or suitable exfoliating bark), depending on the presence or availability within an area, though roost selection may possibly be influenced by competition or predation from other wildlife (Perry and Thill 2007, Perry et al. 2007). This species regularly uses both live and dead trees (Sasse and Pekins 1996, Foster and Kurta 1999, Lacki and Schwierjohann 2001, Sparks 2003, Timpone 2004, Whitaker et al. 2004b, Carter and Feldhamer 2005, Ford et al. 2006, Timpone et al. 2010, Johnson et al. 2012, Silvis et al. 2012, Johnson et al. 2013, Silvis et al. 2014).

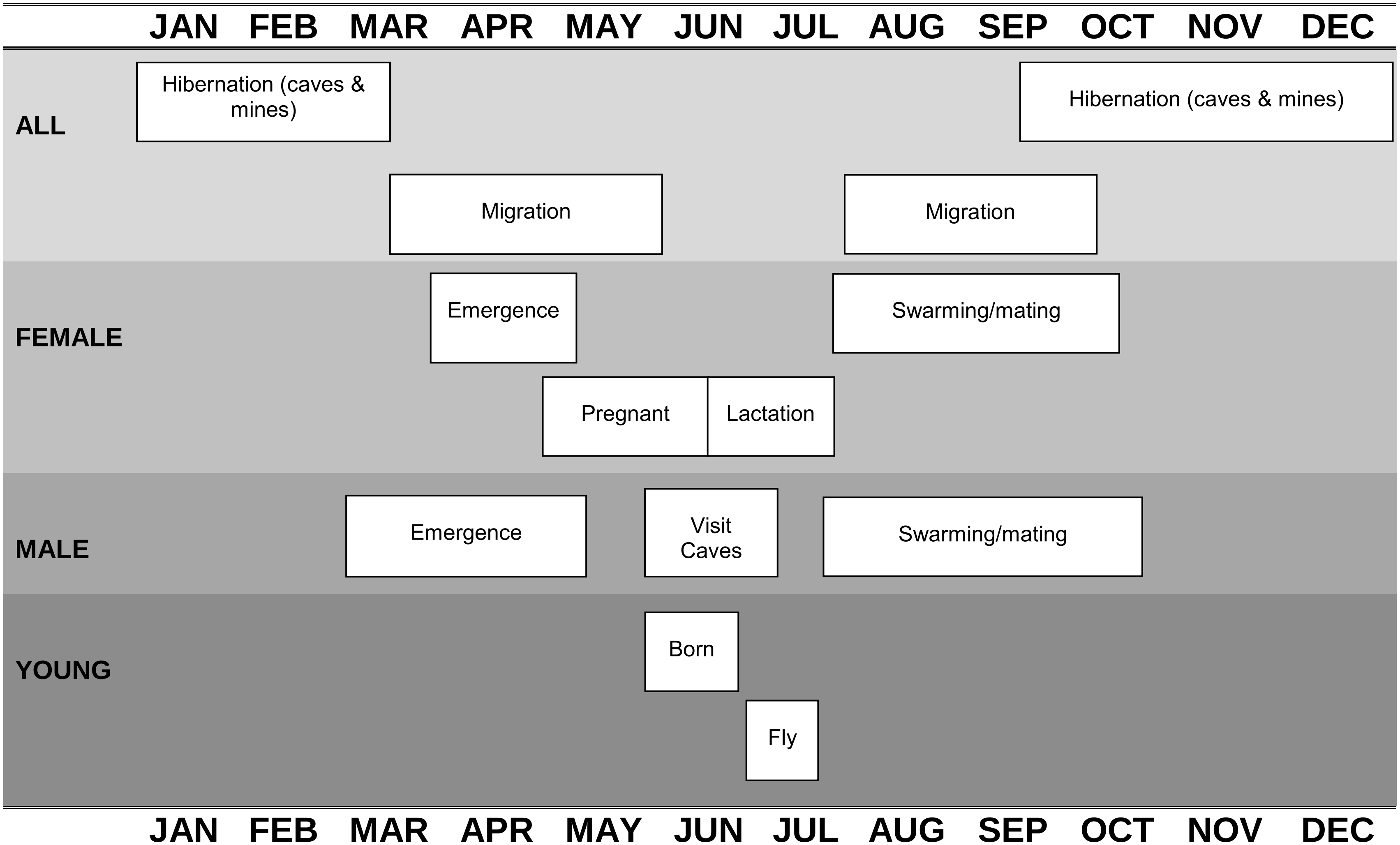
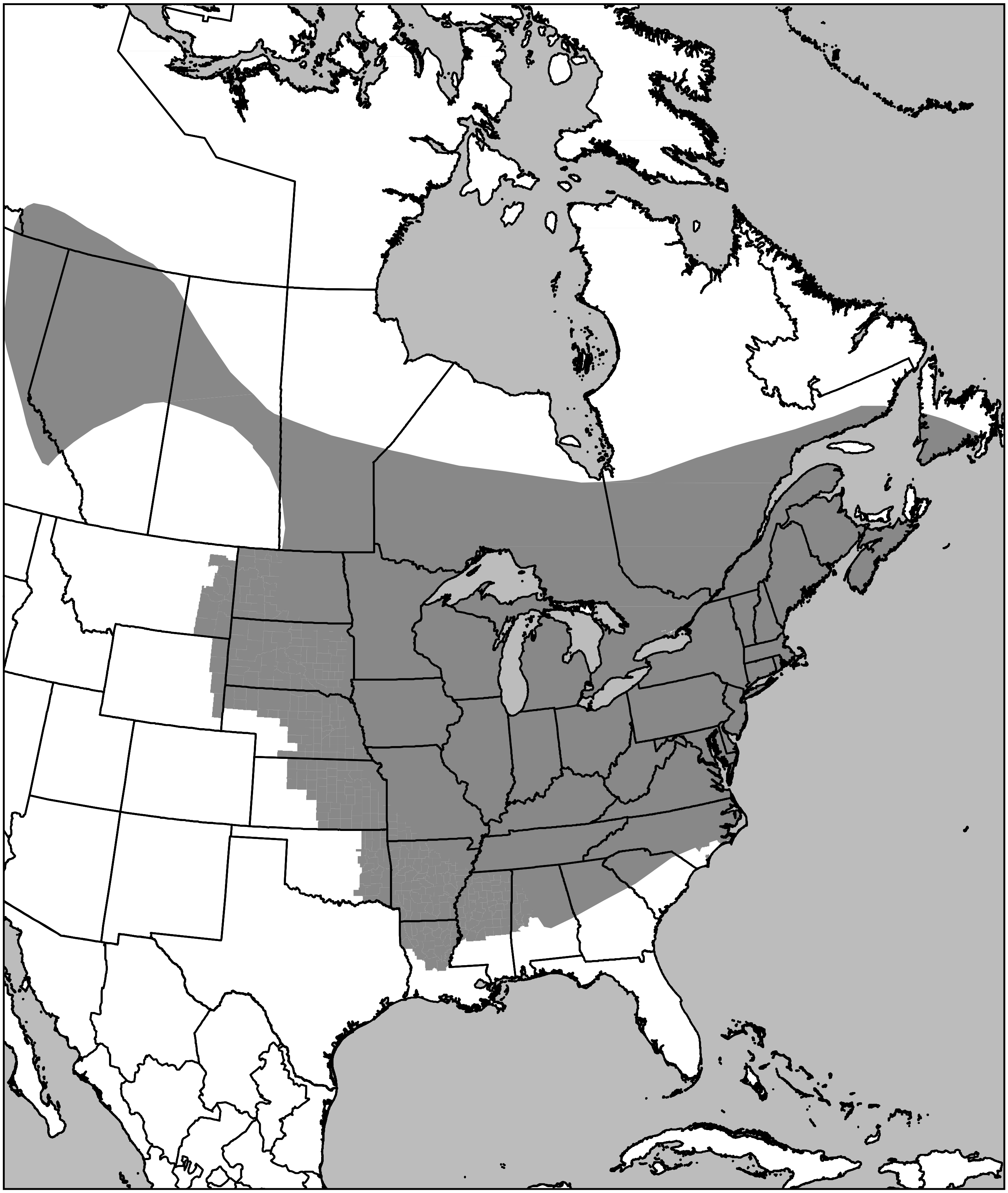


Figure 1. Seasonal chronology of northern long-eared bat activities



Northern Long-Eared Bat Range
State or Province Boundary

Figure 2. Rangewide distribution of the northern long-eared bat during summer.

N
W E
S

0 360 720 Miles

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Roost trees may be habitable for one to several years, depending on the species and condition of the tree. The species may also use several other natural or human-made structures as summer roost sites (e.g., bridges, barns/homes, utility poles, rocky cracks or crevices) (Cope et al. 1961, Barbour and Davis 1969, Cope et al. 1991, Sparks and Choate 1995, Caceres and Barclay 2000, Sparks and Choate 2000, Farrell Sparks et al. 2004, Whitaker et al. 2004a), and have been found in a mixed species colony with little brown bats in a hay barn in northeast Missouri (Timpone et al. 2010). Northern long-eared bats make extensive use of bat-houses when these structures are available (Whitaker et al. 2006).

A maternity colony typically consists of 30 to 60 individuals, although colonies containing up to 100 individuals have been observed (Whitaker and Mumford 2009). The number of individuals within a maternity colony decreases as the maternity season progresses, as fewer bats roost together during the post-lactation stage than during the pregnancy stage. Northern long-eared bats show low fidelity to roosts, switching every two to three days (Sasse and Pekins 1996, Timpone et al. 2010).

Females are pregnant when they arrive at maternity roosts and produce a single young per year, as is typical for the genus *Myotis* (Asdell 1964, Hayssen et al. 1993, Sparks et al. 1999, Krochmal and Sparks 2007). Parturition typically occurs between late May and early June (Caire et al. 1979, Krochmal and Sparks 2007, Whitaker and Mumford 2009).

Juveniles become volant between late June and early August (Caire et al. 1979, Sasse and Pekins 1996, Krochmal and Sparks 2007). As is the case with other species of bats in North America, mortality for northern long-eared bat is high during the first year (Caceres and Pybus 1997). Northern long-eared bats have been observed roosting in areas of increased solar heating, which increases their developmental rate and reduces the need to lower their body temperature and metabolic rate (i.e. enter a state of torpor) (Lacki and Schwierjohann 2001).

1.2.2 Food Habits and Foraging Ecology

The diet of northern long-eared bats varies substantially among ages and genders, and in relation to the availability of insects within different habitat types. Brack and Whitaker (2001) found that in Missouri and Indiana, lepidopterans constituted a large part of the northern long-eared bat's diet, as well as coleopterans, trichopterans, and dipterans. Northern long-eared bats have also been noted to feed on spiders, lepidopteran larvae, plecopterans, homopterans, hymenopterans, and a variety of other insects and arthropods by gleaning (Brack and Whitaker 2001, Feldhamer et al. 2009).

Northern long-eared bats typically emerge from roosting near dusk to forage over forested ponds and streams and in wooded areas before resting in a night roost (Kunz 1973). Northern long-eared bats often emerge a second time in early morning for another short bout of foraging before returning to their day roosts (Kunz 1973, Brack and Whitaker 2001). The species has been documented using both hawking and

gleaning foraging strategies (Griffith and Gates 1985, Faure et al. 1993, Brack and Whitaker 2001, Feldhamer et al. 2009). Gleaning bats capture prey from the substrate (often vegetation or the ground) and northern long-eared bats do more of this than other similar species with shorter ears (Faure et al. 1993). This likely explains the abundance of spiders in the diet (Brack and Whitaker 2001) and observations of light-tagged northern long-eared bats foraging close to the ground amid heavy foliage (LaVal et al. 1977, Caire et al. 1979).

Northern long-eared bats forage in areas that are relatively close to roosts and tend to prefer areas with higher clutter than roosting areas. Unpublished studies in suburban Indianapolis and along the Wabash River near Terre Haute, Indiana indicate that this species forages in almost exclusively forested areas within 0.6 mile of the roost (D. W. Sparks unpublished data). This coincides with studies from New Hampshire that show an average distance of 0.4 mile from roosting areas to foraging areas (Sasse and Pekins 1996). Henderson and Broders (2008) found that foraging areas on Prince Edward Island were comparatively more cluttered (i.e., had thicker understories) than roosting areas, although foraging areas were also found to be predominately forested. If a bat was found to forage in an open area, it was within 0.05 mile of a forest feature.

1.2.3 Winter Hibernation

Most hibernating and/or swarming records of northern long-eared bats are associated with caves and mines (Whitaker and Mumford 2009), but the species also uses similar structures including a hydro-electric dam in Michigan (Kurta and Teramino 1994, Kurta et al. 1997) and storm sewers in Kansas (Fleharty and Farney 1965) and Minnesota (Goehring 1954). The species is often found using recessed areas of hibernacula such as cracks, crevices, and broken stalactites (Whitaker and Hamilton 1998), and individuals leaving hibernacula are often covered with clay and mud (Caire et al. 1979, Whitaker and Mumford 2009). Based on the known behavior of other long-eared bats and the lack of suitable caves and mines within the High Plains , the population there likely hibernates in rock outcroppings (Sparks et al. 2011). This suggests that the species may hibernate in small numbers in a variety of locations.

The species selects areas within hibernacula that are relatively stable with a mean temperature of 9.1°C (32 to 48°F) (Brack 2007), and they will often return to the same hibernacula (Caceres and Barclay 2000). Northern long-eared bats prefer high humidity conditions with little to no air flow in the areas where they are hibernating (Fitch and Shump 1979, van Zyll de Jong 1979), which results in noticeable build-up of water droplets on their fur (Barbour and Davis 1969). Northern long-eared bats frequently share hibernacula with other bat species, such as the little brown bat and the eastern pipistrelle bat; however, they will often roost in different parts of the hibernaculum. Because they hibernate in hard-to-see places, the number of northern long-eared bats using a structure can be orders of magnitude greater than observed during interior studies (Whitaker and Rissler 1992).

2.0 Literature Cited

Amelon, S. and D. Burhans. 2006. Conservation assessment: *Myotis septentrionalis* (northern long-eared bat) in the Eastern United States. U.S. Department of Agriculture, Forest Service, General Technical Report NC-260: Conservation Assessments for Five Forest Bat Species in the Eastern United States.

Asdell, S. A. 1964. *Myotis sodalis*, Miller and Allen. Pages 99 *in* Patterns of mammalian reproduction, second edition. Cornell University Press, Ithaca, New York. 670 pp.

Barbour, R. W. and W. H. Davis. 1969. Bats of America. University Press of Kentucky, Lexington, Kentucky.

Benedict, R. A. 2004. Reproductive activity and distribution of bats in Nebraska. Western North American Naturalist 64:231–248.

Benedict, R. A., H. H. Genoways, and P. W. Freeman. 2000. Shifting distributional patterns of mammals of Nebraska. Pages 55-84 *in* Proceedings of the Nebraska Academy of Science. 26:55-84.

Brack, V., Jr. 2007. Temperatures and locations used by hibernating bats, including *Myotis sodalis* (Indiana Bat), in a limestone mine: implications for conservation and management. Environmental Management 40:739-746.

Brack, V., Jr. and J. O. Whitaker, Jr. 2001. Foods of the northern myotis, *Myotis septentrionalis*, from Missouri and Indiana, with notes on foraging. Acta Chiropterologica 3:203-210.

Caceres, M. C. and R. M. R. Barclay. 2000. *Myotis septentrionalis*. Mammalian Species 634:1-4.

Caceres, M. C. and M. J. Pybus. 1997. Status of the northern long-eared bat (*Myotis septentrionalis*) in Alberta. Wildlife Status Report 3:19 pp.

Caire, W., R. K. LaVal, M. L. LaVal, and R. Clawson. 1979. Notes on the ecology of *Myotis keenii* (Chiroptera, Vespertilionidae) in eastern Missouri. American Midland Naturalist 102:404-407.

Carter, T. C. and G. A. Feldhamer. 2005. Roost tree use by maternity colonies of the Indiana bats and the northern long-eared bats in southern Illinois. Forest Ecology and Management 219:259-268.

Cope, J. B., W. W. Baker, and J. Confer. 1961. Breeding colonies of four species of bats of Indiana. Proceedings of the Indiana Academy of Science 70:262-266.

Cope, J. B., J. O. Whitaker, Jr, and S. L. Gummer. 1991. Duration of bat colonies in Indiana. Proceedings of the Indiana Academy of Science 99:199-201.

Farrell Sparks, J. K., B. J. Foster, and D. W. Sparks. 2004. Utility pole used as a roost by a Northern Myotis, *Myotis septentrionalis*. Bat Research News 45:94.

Faure, P. A., J. H. Fullard, and J. W. Dawson. 1993. The gleaning attacks of the northern long-eared bat, *Myotis septentrionalis*, are relatively inaudible to moths. Journal of Experimental Biology 178:173-189.

Feldhamer, G. A., T. C. Carter, and J. O. Whitaker, Jr. 2009. Prey consumed by eight species of insectivorous bats from southern Illinois. American Midland Naturalist 162:43-51.

Fitch, H. S. and K. A. Shump, Jr. 1979. *Myotis keenii*. Mammalian Species 121:1-3.

Fleharty, E. D. and J. P. Farney. 1965. Second Locality record for *Myotis keenii* (Merriam) in Kansas. Transactions of the Kansas Academy of Science 68:200.

Ford, W. M., S. F. Owen, J. W. Edwards, and J. L. Rodrigue. 2006. *Robinia pseudoacacia* (Black Locust) as day-roosts of male *Myotis septentrionalis* (Northern Bats) on the Fernow Experimental Forest, West Virginia. Northeasten Naturalist 13:15-24.

Foster, R. W. and A. Kurta. 1999. Roosting ecology of the northern bat (*Myotis septentrionalis*) and comparisons with the endangered Indiana bat (*Myotis sodalis*). Journal of Mammalogy 80:659-672.

Goehring, H. H. 1954. *Pipistrellus subflavus obscurus*, *Myotis keenii*, and *Eptesicus fuscus fuscus* hibernating in a storm sewer in central Minnesota. Journal of Mammalogy 35:434-435.

Griffith, L. A. and J. E. Gates. 1985. Food habits of cave-dwelling bats in the central Appalachians. Journal of Mammalogy 66:451-460.

Hayssen, V., A. van Tienhoven, and A. van Tienhoven. 1993. Order Chiroptera, Family Vespertillonidae. Pages 141-166 *in* Asdell's patterns of mammalian reproduction - a compendium of species-specific data. Cornell University Press, Ithaca, NewYork. 1023 pp.

Henderson, L. E. and H. G. Broders. 2008. Movements and resource selection of the northern long-eared myotis (*Myotis septentrionalis*) in a forest–agriculture landscape. Journal of Mammalogy 89:952–963.

Johnson, J. B., W. M. Ford, and J. W. Edwards. 2012. Roost networks of northern myotis (*Myotis septentrionalis*) in a managed landscape. Forest Ecology and Management 266:223–231.

Johnson, J. B., J. H. Roberts, T. L. King, J. W. Edwards, W. M. Ford, and D. A. Ray. 2013. Genetic structuring of northern myotis (*Myotis septentrionalis*) at multiple spatial scales. Acta Theriologica 59:223-231.

Krochmal, A. R. and D. W. Sparks. 2007. Timing of birth and estimation of age of juvenile *Myotis septentrionalis* and *Myotis lucifugus* in west-central Indiana. Journal of Mammalogy 88:649-656.

Kunz, T. H. 1971. Reproduction of some vespertilionid bats in central Iowa. American Midland Naturalist 86:477-486.

Kunz, T. H. 1973. Resource utilization: Temporal and spatial components of bat activity in central Iowa. Journal of Mammalogy 54:14-32.

Kurta, A., J. Caryl, and T. Lipps. 1997. Bats and Tippy Dam: species composition, seasonal use, and environmental parameters. Michigan Acadamician XXIX:473-490.

Kurta, A. and J. A. Teramino. 1994. A novel hibernaculum and noteworthy records of the Indiana bat and eastern pipistrelle (Chiroptera: Vespertilionidae). American Midland Naturalist 132:410-413.

Lacki, M. J. and J. H. Schwierjohann. 2001. Day-roost characteristics of northern bats in mixed mesophytic forests. The Journal of Wildlife Management 65:482-488.

LaVal, R. K., R. L. Clawson, M. L. LaVal, and W. Caire. 1977. Foraging behavior and nocturnal activity patterns of Missouri bats, with emphasis on the endangered species *Myotis grisescens* and *Myotis sodalis*. Journal of Mammalogy 58:592-599.

Mumford, R. E. and J. B. Cope. 1964. Distribution and status of the Chiroptera of Indiana. American Midland Naturalist 72:473-489.

Perry, R. W. and R. E. Thill. 2007. Roost selection by male and female northern long-eared bats in a pine-dominated landscape. Forest Ecology and Management 247:220-226.

Perry, R. W., R. E. Thill, and D. M. Leslie, Jr. 2007. Selection of roosting habitat by forest bats in a diverse forested landscape. Forest Ecology and Management 238:156-166.

Sasse, D. B. and P. J. Pekins. 1996. Summer roosting ecology of northern long-eared bats (*Myotis septentrionalis*) in the White Mountain National Forest. Pages 91-101 *in* Bats and Forests Symposium (R. M. R. Barclay and R. M. Brigham, eds.), October 19-21, 1995. Research Branch, British Columbia Minister of Forests Research Program. Victoria, British Columbia, Canada.

Silvis, A., W. M. Ford, E. R. Britzke, N. R. Beane, and J. B. Johnson. 2012. Forest succession and maternity day roost selection by *Myotis septentrionalis* in a mesophytic hardwood forest. International Journal of Forestry Research. 8p.

Silvis, A., W. M. Ford, E. R. Britzke, and J. B. Johnson. 2014. Association, roost use and simulated disruption of *Myotis septentrionalis* maternity colonies. Behavioural Processes 103:283–290.

Sparks, D. W. 2003. How does urbanization impact bats? Ph.D. Dissertation. Indiana State University, Terre Haute, Indiana. 121 pp.

Sparks, D. W. and J. R. Choate. 1995. New distributional records for mammals in Kansas. Prairie Naturalist 27:185-191.

Sparks, D. W. and J. R. Choate. 2000. Distribution, natural history, conservation status, and biogeography of bats in Kansas. Pages 173-228 *in* Reflections of a naturalist: Papers honoring professor Eugene D. Fleharty (J. R. Choate, ed.). Fort Hays Studies, Special Issue 1:1-241.

Sparks, D. W., J. R. Choate, and R. J. Winn. 1999. Observations on reproduction in three species of bats. Prairie Naturalist 31:245-248.

Sparks, D. W., C. J. Schmidt, and J. R. Choate. 2011. Bats of Kansas. Publication Number 5, Indiana State University Center for North American Bat Research and Conservation. 62 pp.

Timpone, J. C. 2004. Roost-site selection of bats in the northeast Missouri with emphasis on the endangered Indiana bat (*Myotis sodalis*). Masters thesis, Southwest Missouri State University. 71pp.

Timpone, J. C., J. G. Boyles, K. L. Murray, D. P. Aubrey, and L. W. Robbins. 2010. Overlap in roosting habits of Indiana bats (*Myotis sodalis*) and northern bats (*Myotis septentrionalis*). American Midland Naturalist 163:115-123.

USFWS. 2014. Northern long-eared bat interim conference and planning guidance: USFWS Regions 2, 3, 4, 5, & 6. U.S. Department of Interior, Fish and Wildlife Service. 67 pp.

van Zyll de Jong, C. G. 1979. Distribution and systematic relationships of long-eared Myotis in western Canada. Canadian Journal of Zoology 57:987-994.

Whitaker, J. O., Jr and L. J. Rissler. 1992. Seasonal activity of bats at Copperhead Cave. Proceedings of the Indiana Academy of Science 101:127-134.

Whitaker, J. O., Jr. and W. J. Hamilton. 1998. Mammals of the eastern United States, Third Edition. Comstock Publishing Associates, a division of Cornell University Press. 583 pp.

Whitaker, J. O., Jr. and R. E. Mumford. 2009. Mammals of Indiana. Indiana University Press. Bloomington, Indiana, 661 pp.

Whitaker, J. O., Jr., D. W. Sparks, and V. Brack, Jr. 2004a. Bats of the Indianapolis International airport area, 1991-2001. Proceedings of the Indiana Academy of Science 113:151-161.

Whitaker, J. O., Jr., D. W. Sparks, and V. Brack, Jr. 2004b. Bats of the Indianapolis International airport area, 1991–2001. Proceedings of the Indiana Academy of Science 113:151-161.

Whitaker, J. O., Jr., D. W. Sparks, and V. Brack, Jr. 2006. Use of artificial roost structures by bats at the Indianapolis International Airport. Environmental Management 38:28-36.

APPENDIX B
TABLES

Table 1. USFWS Indiana and Northern Long-eared Bat Acoustic Survey Guidelines

2018 ACOUSTIC GUIDELINES

1. The number of acoustic sites required for a project:
   a. Linear Projects: 2 detector nights per 0.6-mile (1-km), or
   b. Non-linear Projects: 8 detector nights per 123-acres (0.5 square km).
2. Acoustic sites should be at least 656 feet (200 meters) apart.
3. A qualified biologist must identify detector sites, placing them in areas most suitable for detecting listed bats.
   a. forest-canopy openings
   b. near water sources
   c. wooded fence lines that are adjacent to large openings or connect two larger blocks of suitable habitat
   d. blocks of recently logged forest where some potential roost trees remain
   e. road and/or stream corridors with open tree canopies or canopy height of more than 33 feet (10 meters)
   f. woodland edges
4. The acoustic sampling period for each site must begin at sunset and end at sunrise (1 detector-night).
5. Use weatherproofing only when absolutely necessary.
6. Detector night is not valid when following weather conditions are observed during the first 5 hours of survey:
   a. Temperatures below 50º F (10º C),
   b. Sustained wind speeds greater than 9 miles/hour (4 meters/second; 3 on Beaufort scale), and
   c. Precipitation (rain and/or fog) that is intermittent or lasts in excess of 30 minutes.
7. Download and process calls using an approved acoustic analysis program. High-frequency (≥35 kHz) or myotid calls should be evaluated to either verify or reject the classification. At a minimum, for each detector site/night, all files from that site/night must be qualitatively reviewed if potential presence is suspected based on software analysis.
8. Acoustic files are saved and submitted to USFWS.

Source: U.S. Fish and Wildlife Service; 2018

Table 2. Location of acoustic detectors on the Fort Calhoun Nuclear Generating Station in Washington County, Nebraska.

Detector Location (Detector)	Date Sampled (2018)	Latitude	Longitude
Site 1, Night 1 (54U04217)	12 August	41º 31' 4.7742" N	96º 4' 14.0406" W
Site 2, Night 1 (54U05195)	12 August	41º 31' 35.508" N	96º 5' 14.172" W
Site 1, Night 2 (54U04217)	13 August	41° 31' 2.7438" N	96° 4' 7.2942" W
Site 2, Night 2 (54U05195)	13 August	41° 31' 40.9368" N	96° 5' 24.792" W

Table 3. USFWS Mist Net Survey Guidelines

2018 NETTING GUIDELINES

Midwest and Ozark-Central Recovery Units (AL, AR, IA, IL, IN, GA, KY, MI, MO, MS, OH, OK, central & western TN, and Lee County, VA)

9. Netting Season: generally 15 May to 15 August.
10. Equipment (Mist Nets): constructed of the finest, lowest visibility mesh commercially available – monofilament or black nylon – with the mesh size approximately 1½ inch (1¼ –1¾) (38 mm).
11. Net Placement: mist nets extend approximately from water or ground level to tree canopy and are bounded by foliage on the sides. Net width and height are adjusted for the fullest coverage of the flight corridor at each site. A "typical" net set consists of two (or more) nets "stacked" on top of one another; width may vary up to 60 feet (20 m).
12. Net Site Spacing:
    - Linear Projects – minimum of 2 net nights per 0.6 mile (1 km); 1 net night = 1 net set deployed for 1 night.
    - Non-linear Projects – minimum of 9 net nights per 123 acres (.5 km).
    - Nets must be spread through the sampling area
13. Minimum Level of Effort Per Net Site:
    - At least 1 net location (sets) per net site.
    - At least 2 (calendar) nights of netting per net site.
    - Maximum of 3 nights of consecutive netting at any given location; must change net locations or wait at least 2 calendar nights before resuming netting at same location.
    - Sample Period: begin at dusk and net for 5 hours (approximately 0200h).
    - Nets are monitored at approximately 10-minute intervals.
    - No disturbance near the nets between checks.
14. Weather: Negative surveys combined with any of the following conditions throughout all or most of a sampling period are likely to require an additional night of mist-netting:
    - Precipitation (rain and/or heavy fog) lasting >30 minutes or continuing intermittently during the survey period.
    - Temperatures <10°C (50°F).
    - Sustained wind >9 mi/hr (4 m/sec) (3 on Beaufort scale).

Source: U.S. Fish and Wildlife Service; 2018

Table 4. Location of mist nets on the Fort Calhoun Nuclear Generating Station in Washington County, Nebraska.

Mist Net ID	Night Netted (2018)	Latitude	Longitude
Night 1, Net A	12 August	41° 30' 53.0748" N	96° 5' 16.9398" W
Night 1, Net B	12 August	41° 30' 52.3764" N	96° 5' 17.8686" W
Night 1, Net C	12 August	41° 30' 51.6096" N	96° 5' 18.6174" W
Night 2, Net A	13 August	41° 30' 53.8302" N	96° 5' 11.1768" W
Night 2, Net B	13 August	41° 30' 51.573" N	96° 5' 13.977" W
Night 2, Net C	13 August	41° 30' 50.4612" N	96° 5' 15.0282" W
Night 3, Net A	14 August	41° 30' 51.8322" N	96° 4' 40.7634" W
Night 3, Net B	14 August	41° 30' 51.0654" N	96° 4' 40.3716" W
Night 3, Net C	14 August	41° 30' 50.4936" N	96° 4' 41.2428" W

Table 5. Bat calls identified by Kaleidoscope Pro's automated call identification on the Fort Calhoun Nuclear Generating Station in Washington County, Nebraska.

Acoustic Monitoring Site	COTO	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU	TABR	Total Bat Calls
Site 1, Night 1	0	215	7	7	7	4	2	0	36	6	6	290
Site 2, Night 2	0	153	3	40	51	2	1	0	14	3	7	274
Site 1, Night 2	0	131	12	13	16	4	5	0	38	4	9	232
Site 2, Night 2	0	56	1	0	3	0	0	0	0	0	0	60
Total by Species	0	55	23	60	77	10	8	0	88	13	22	856

COTO = *Corynorhinus townsendii* (Townsend's big-eared bat); **EPFU** = *Eptesicus fuscus* (big brown bat); **LABO** = *Lasiurus borealis* (eastern red bat); **LACI** = *Lasiurus cinereus* (hoary bat); **LANO** = *Lasiurus noctivagans* (silver-haired bat); **MYLU** = *Myotis lucifugus* (little brown bat); **MYSE** = *Myotis septentrionalis* (northern long-eared bat); **MYSO** = *Myotis sodalis* (Indiana bat); **NYHU** = *Nycticeius humeralis* (evening bat); **PESU** = *Perimyotis subflavus* (tri-colored bat); **TABR** = *Tadarida brasiliensis* (Mexican free-tailed bat).

Table 6. Maximum likelihood estimator for the Fort Calhoun Nuclear Generating Station in Washington County, Nebraska.

Acoustic Monitoring Site	COTO	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU	TABR
Site 1	1	0	0	0.9242254	1	0.4393174	0.0000003	1	0	0.0000215	0.9997
Site 2	1	0	0.0230432	0	0.5461343	0.6750747	0.1830601	1	0.0001121	0.0130829	1

Table 7. Bat calls manually vetted on the Fort Calhoun Nuclear Generating Station in Washington County, Nebraska

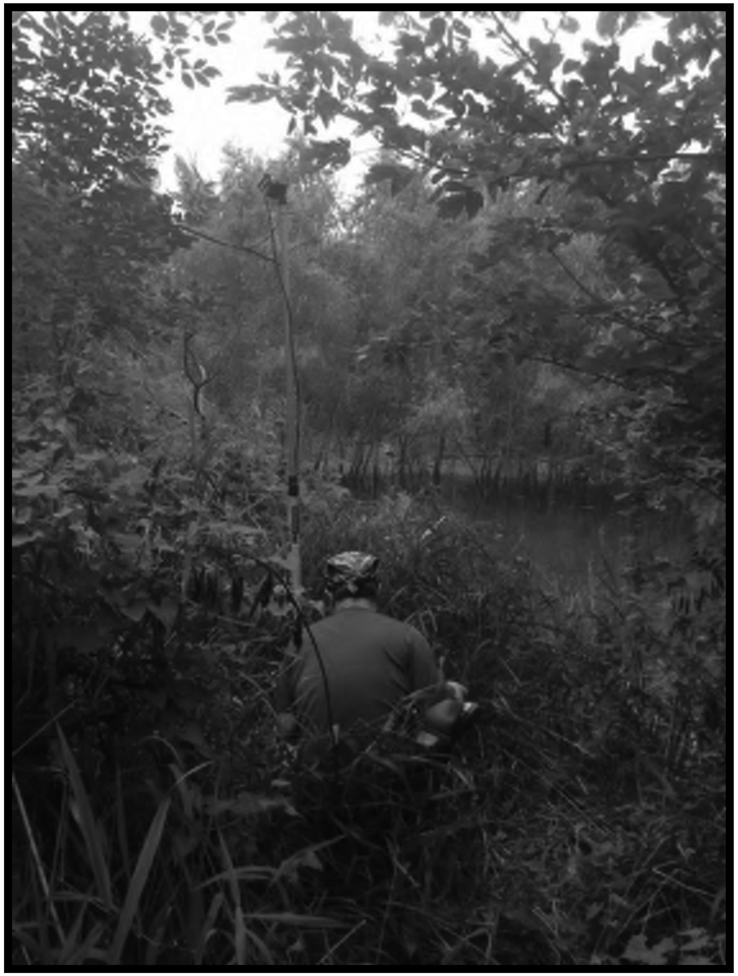
Acoustic Monitoring Site	COTO	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU	TABR	Total Bat Calls
Site 1, Night 1	0	204	3	7	3	0	1	0	25	5	0	248
Site 2, Night 2	0	157	6	38	22	0	0	0	12	2	0	162
Site 1, Night 2	0	105	9	10	3	0	4	0	27	4	0	237
Site 2, Night 2	0	49	1	0	0	0	0	0	0	0	0	50
Total by Species	0	515	19	55	28	0	5	0	64	11	0	697

Table 8. Mist net habitat characteristics on the Fort Calhoun Nuclear Generating Station in Washington County, Nebraska.

Site	Water Source		Tree Species			Canopy Closure	Clutter		MYSO Roost Tree		MSYE Roost Tree		Habitat Type	Herb. Cover
	Name	Distance (m)	Dominant Canopy	Subdominant Canopy	Subcanopy		Rating	Composition	Potential	Composition	Potential	Composition		
Site 1, Night 1	unnamed stream	0	*Populus sect. Aigeiros, Robinia pseudoacacia*	*Robinia pseudoacacia, Quercus rubra*	*Robinia pseudoacacia, Vaccinium spp.*	M	O	Shrubs & Saplings	L	Lrg trees	L	Lrg trees	YU, FE, S/R	S
Site 1, Night 2	unnamed stream	0	*Robinia pseudoacacia, Populus sect. Aigeiros, Celtis occidentalis*	*Ulmus rubra, Ligustrum sinense*	*Urtica dioica, Alopecurus spp.*	C	C	Shrubs	L	Lrg trees & snags	L	Lrg trees & snags	YL, FE, OF	D
Site 1, Night 3	unnamed stream	0	*Populus sect. Aigeiros, Robinia pseudoacacia*	*Robinia pseudoacacia, Asclepias spp.*	*Robinia pseudoacacia, Ligustrum sinense*	M	O	--	L	Lrg trees	M	Lrg trees	YL, WL	D

Tree/Shrub Species: foxtail grass (*Alopecurus* spp.), milkweed (*Asclepias* spp.), common hackberry (*Celtis occidentalis*), Chinese privet (*Ligustrum sinense*), cottonwood species (*Populus sect. Aigeiros*), northern red oak (*Quercus rubra*), black locust (*Robinia pseudoacacia*), slippery elm (*Ulmus rubra*), stinging nettle (*Urtica dioica*), blueberry (*Vaccinium* spp.)
Canopy Closure/Subcanopy Clutter: C = Closed; M = Moderate; O = Open
Roost Potential Rating: L = Low; M = Moderate; MYSO = Indiana bat (*Myotis sodalis*); MYSE = northern long-eared bat (*Myotis septentrionalis*)
Habitat Type: FE = Forest Edge; OF = Old Field; S/R = Stream/River; WL = Woodlot; YL = Young Lowland Forest; YU = Young Upland Forest
Herb (Herbaceous) Cover: D = Dense; S = Sparse

APPENDIX C
PHOTOGRAPHS



Acoustic Site 1, Night 1

Acoustic Site 1, Night 2

Acoustic Site 2, Night 1

Acoustic Site 2, Night 2

Site 1 Net A

Site 1 Net B

Site 1 Net C

Site 2 Net A

Site 2 Net B

Site 2 Net C

Site 3 Net A

Site 3 Net B


Latitude: 41.514026
Longitude: -96.078123
Elevation: 311.27m
Accuracy: 3.0m
Azimuth: 226° (SW)
Pitch: 8.1°
Time: 2018/08/14 20:08
Note: Calhoun Site3 NetC
Powered by AngleCam

Site 3 Net C

APPENDIX D
DATA SHEETS

ESI

2018 HABITAT ASSESSMENT

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

Project #: 1236 Date: 13 Aug 2018 State: NE County: Washington

Project Name: Fort Calhoun Site Name/#: C1F USGS Quad: ______

Permitted Biologist: ______ (full name) Other Field Staff: ______ (full name) State Permit #: ______

Federal Permit #: ______

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
A	Net	41 ° 31.8' 490 "N	-96 ° 0820' 290 "W		
B	Net	41 ° 31.8' 490 "N	-96 ° 0822' 810 "W		
C	Net	41 ° 31.2' 360 "N	-96 ° 0825' 050 "W		
		° ' "N	° ' "W		

Distance to closest water source (meters): ______ Type of water source: ______

Water source name: ______

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: ______ meters Channel Width: ______ meters Stream Width: ______ meters

Substratum: __Bedrock __Boulder __Cobble __Gravel __Sand __Silt/Clay

Still Water Present (Y/N): ______ Average Water Depth: ____m or cm Clarity (H,M,L): ____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)
Cottonwood
Black locust

Subdominant Canopy Species (< 40 cm/16" dbh)
Black locust
Northern red oak

Estimated dbh range: Lg: 50cm Sm: 40cm Estimated dbh range: Lg: 30 Sm: 10

Relative abundance of dominant vs. subdominant (ratio): 2:1

Estimated canopy closure: __Closed X Moderate __Open

Roost tree potential consists of: __Hollow X Large Trees __Snags __Neither

M. sodalis roost tree potential is: __High __Moderate X Low

Roost potential comments: No exfoliating bark, few snags

M. septentrionalis roost tree potential is: __High __Moderate X Low

Roost potential comments: Few snags

Subcanopy clutter: X Closed __Moderate __Open

Subcanopy consists largely of: __ Lower Branches of Canopy Trees X Saplings X Shrubs

Common Subcanopy Species: Black locust Hackberry ______

Check all that apply:

- __Mature Upland Forest
- X Young Upland Forest
- __Mature Lowland Forest
- __Young Lowland Forest
- __Recently Logged Forest
- X Forest Edge
- __Woodlot
- __Old Field
- __Crop/Pasture Land
- X Stream/River
- __Vernal Pool
- __Deepwater Lake/Pond
- Other ______

Herbaceous Cover: X Sparse __Moderate __Dense

ESI

BAT CAPTURE DATA

Project #: 1236
Date: 08.12.18
Project Name: Fort Calhoun
Site Name/#: Site 1
State: NE
County: Washington
GPS Unit #:
Camera #:
Permitted Biologist: James Gore (full name)
Other Field Staff: Stephanie Ellison (full name)
State Permit #:
Federal Permit #:

WEATHER DATA

Time (xxxx h)	Temp (°C)	Wind Speed (estimated – see chart)	% Cloud Cover (estimated)	Comments
21:27	27.78	1	5%	
21:46	24.44	1	5%	
23:13	21.67	1	10%	
23:52	21.67	0	0	
23:05	21.67	0	0	
1:09	20.56	0	0	

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Length (m)	Height (m)	Time Up (xxxx h)	Time Down (xxxx h)	Picture #	Waypoint #
A		41.5147430 °N	-96.0880390 °W	9	5	21:46	1:48		
B		41.5145490 °N	-96.0882910 °W	4	2.5	20:30	1:51		
C		41.5143360 °N	-96.0885050 °W	6	5	21:39	2:08		
		° ' "N	° ' "W						

Net Placement/Site Description:

Capt #	Net/ Trap	Species	Time	Age (Ad/Jv)	Sex (M/F)	Repro.[1]	Wt (g)	RFA (mm)	Belly[2] (F/M/E)	Wing Index* (0-3)	Comments Picture # /Guano/Hair Sample/Band #

[1] Reproductive Condition: Female = NR/PG/L/PL; Male = ↑/↓ (NR=Non-reproductive, PG=Pregnant, L=Lactating, PL=Post-Lactating; ↑=Ascended testes, ↓ Descende testes)
2 F=Full, M=Moderate, E=Empty
* Refer to table on the back

Revised June 2017

ESI

2018

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

HABITAT ASSESSMENT

Project #: 1236 **Date:** 08.13.18 **State:** NE **County:** Washington

Project Name: Fort Calhoun **Site Name/#:** Site 7 **USGS Quad:** ____

Permitted Biologist: James Gore (full name) Other Field Staff: Stephanie Ellison (full name) State Permit #: ____ Federal Permit #: ____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
A		41.5149530 °N	-96.0864380 °W		
B		41.5143260 °N	-96.0872160 °W		
C		41.5140170 °N	-96.0875080 °W		
		° ' "N	° ' "W		

Distance to closest water source (meters): ____ Type of water source: ____

Water source name: ____

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: ____ meters Channel Width: ____ meters Stream Width: ____ meters

Substratum: __Bedrock __Boulder __Cobble __Gravel __Sand __Silt/Clay

Still Water Present (Y/N): ____ Average Water Depth: ____ m or cm Clarity (H,M,L): ____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh):
- Black locust (Robinia pseudoacacia)
- Cottonwood (Aigeiros)
- Hackberry (Celtis occidentalis)

Subdominant Canopy Species (< 40 cm/16" dbh):
- Slippery Elm (Ulmus rubra)
- Chinese privet (Ligustrum sinense)

Estimated dbh range: Lg: 45cm Sm: 40cm Estimated dbh range: Lg: 20cm Sm: 5cm

Relative abundance of dominant vs. subdominant (ratio): 3:1

Estimated canopy closure: __Closed X Moderate __Open

Roost tree potential consists of: __Hollow X Large Trees X Snags __Neither

M. sodalis roost tree potential is: __High __Moderate X Low

Roost potential comments: ____

M. septentrionalis roost tree potential is: __High __Moderate X Low

Roost potential comments: ____

Subcanopy clutter: X Closed __Moderate __Open

Subcanopy consists largely of: __ Lower Branches of Canopy Trees __Saplings X Shrubs

Common Subcanopy Species: Stinging nettle foxtail ____

Check all that apply:
- __Mature Upland Forest
- __Young Upland Forest
- __Mature Lowland Forest
- X Young Lowland Forest
- __Recently Logged Forest
- X Forest Edge
- __Woodlot
- X Old Field
- __Crop/Pasture Land
- __Stream/River
- __Vernal Pool
- __Deepwater Lake/Pond
- Other riparian

Herbaceous Cover: __ Sparse __Moderate X Dense

2018

ESI

BAT CAPTURE DATA

Project #: 1236
Date: Aug 13, 2018
Project Name: Fort Calhoun
Site Name/#: Site 2
State: NE
County: Washington
GPS Unit #:
Camera #:
Permitted Biologist: James Gore (full name)
Other Field Staff: Stephanie Ellison (full name)
State Permit #:
Federal Permit #:

WEATHER DATA

Time (xxxx h)	Temp (°C)	Wind Speed (estimated – see chart)	% Cloud Cover (estimated)	Comments
20:15	27.2	0	100%	
21:05	26.1	1	100%	
21:49	24.2	1	90%	
[illegible]	22.7	1	100	
23:24	22.4	0	100%	
00:15	22.8	1	75%	
00:42	23	1	90%	

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Length (m)	Height (m)	Time Up (xxxx h)	Time Down (xxxx h)	Picture #	Waypoint #
A		41.5149530 °N	-96.0864380 °W	6	2.5	20:15	1:15		
B		41.5143260 °N	-96.0872160 °W	9	5	20:15	1:15		
C		41.5140170 °N	-96.0875080 °W	12	5	20:15	1:15		
		° ' "N	° ' "W						

Net Placement/Site Description:

Capt #	Net/ Trap	Species	Time	Age (Ad/Jv)	Sex (M/F)	Repro.[1]	Wt (g)	RFA (mm)	Belly[2] (F/M/E)	Wing Index* (0-3)	Comments Picture # /Guano/Hair Sample/Band #
1	A	LABO	[illegible]	Ad	F	NR	11.0	39.8		0	WIB: 30.5-19.5

[1] Reproductive Condition: Female = NR/PG/L/PL; Male = ↑/↓ (NR=Non-reproductive, PG=Pregnant, L=Lactating, PL=Post-Lactating; ↑=Ascended testes, ↓ Descende testes)
2 F=Full, M=Moderate, E=Empty
* Refer to table on the back
Revised June 2017

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

2018
HABITAT ASSESSMENT

Project #: 1236 **Date:** Aug 14th 2018 **State:** NE **County:** Washington

Project Name: Fort Calhoun **Site Name/#:** Site 3 **USGS Quad:** ____

Permitted Biologist: James Gore (full name) Other Field Staff: Stephanie Ellison (full name) State Permit #: ____ Federal Permit #: ____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
A		41.514398 °N	-96.07799 °W		
B		41.514185 °N	-96.07781 °W		
C		41.514026 °N	-96.078123 °W		
		° ' "N	° ' "W		

Distance to closest water source (meters): ____ Type of water source: ____

Water source name: ____

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: ____ meters Channel Width: ____ meters Stream Width: ____ meters

Substratum: __Bedrock __Boulder __Cobble __Gravel __Sand __Silt/Clay

Still Water Present (Y/N): ____ Average Water Depth: ____ *m or cm* Clarity (H,M,L): ____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh): Cottonwood; Black locust

Subdominant Canopy Species (< 40 cm/16" dbh): Black locust; Milkweed

Estimated dbh range: Lg: 75 Sm: 40 Estimated dbh range: Lg: 40 Sm: 20

Relative abundance of dominant vs. subdominant (ratio): 1:1

Estimated canopy closure: __Closed X Moderate __Open

Roost tree potential consists of: __Hollow X Large Trees __Snags __Neither

M. sodalis roost tree potential is: __High __Moderate X Low

Roost potential comments: ____

M. septentrionalis roost tree potential is: __High X Moderate __Low

Roost potential comments: ____

Subcanopy clutter: __Closed __Moderate X Open

Subcanopy consists largely of: __Lower Branches of Canopy Trees __Saplings __Shrubs

Common Subcanopy Species: Black locust; Cottonwood; ____

Check all that apply:

- __Mature Upland Forest
- __Young Upland Forest
- __Mature Lowland Forest
- X Young Lowland Forest
- __Recently Logged Forest
- __Forest Edge
- X Woodlot
- __Old Field
- __Crop/Pasture Land
- __Stream/River
- __Vernal Pool
- __Deepwater Lake/Pond
- Other Riparian

Herbaceous Cover: __Sparse __Moderate X Dense

2018

Property of: Environmental Solutions & Innovations, Inc.
4625 Este Avenue Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

BAT CAPTURE DATA

Project #: 1236
Date: Aug 14th, 2018
Project Name: Fort Calhoun
Site Name/#: Site 3
State: NE
County: Washington
GPS Unit #:
Camera #:
Permitted Biologist: James Goore (full name)
Other Field Staff: Stephanie Ellison (full name)
State Permit #:
Federal Permit #:

WEATHER DATA

Time (xxxx h)	Temp (°C)	Wind Speed (estimated – see chart)	% Cloud Cover (estimated)	Comments
20:12	23.3	1	99%	
21:05	21.8	0	99%	
[illegible]	[illegible]	0	100	[illegible] light rain
[illegible]	[illegible]	0	100	
[illegible]	[illegible]	0	[illegible]	
23:30	19.5	1	80%	
00:03	19.5	1	80%	

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Length (m)	Height (m)	Time Up (xxxx h)	Time Down (xxxx h)	Picture #	Waypoint #
A		41.514398 °N	-96.07799 °W	9	5	20:21			
B		41.514185 °N	-96.077881 °W	6	2.5	20:15			
C		41.514026 °N	-96.078123 °W	9	5	20:12			
		° ' "N	° ' "W						

Net Placement/Site Description:

Capt #	Net/ Trap	Species	Time	Age (Ad/Jv)	Sex (M/F)	Repro. [1]	Wt (g)	RFA (mm)	Belly[2] (F/M/E)	Wing Index* (0-3)	Comments Picture # /Guano/Hair Sample/Band #
A		LABO	23:30	Ad	M	↑	11.5	39.5	M	0	WIB-32.5-21

[1] Reproductive Condition: Female = NR/PG/L/PL; Male = ↑/↓ (NR=Non-reproductive, PG=Pregnant, L=Lactating, PL=Post-Lactating; ↑=Ascended testes, ↓ Descende testes)
2 F=Full, M=Moderate, E=Empty
* Refer to table on the back
Revised June 2017

ESI

Site 1 Calhoun

any of these:

DAILY DETECTOR DEPLOYMENT DATA CONT.

Nite 1 N 1

3. Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
S4U04217	41.51799321 °N	-96.07056690 °W	1730	0100			

Detector Placement/Site Description:

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. Place the detector properly, confirm the detector is: Initial each blank	X 5 feet from vegetative clutter on the ground in all directions	Y 33 feet from vegetation in front of the microphone	___ Microphone is angled at 45-75 degrees	X 50 feet from any potential or known roost
	X 656 feet from another detector	___ Parallel to woodland	If not, WHY?	
2. Make sure the gear is working	V Checked at 1650 (Time)			
3. Is detector water-proofed?	☒ Yes	☐ No	___ Initial	
4. Make sure the weather is not doing any of these:	X Too cold (<50 degrees F)	X Too windy (9 mph or more sustained)	X Precipitation for 30 minutes straight or intermittent the first 5 hours	

Nite 2 N 2

4. Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
	41.518661 °N	-96.072217 °W	1730	0100			

Detector Placement/Site Description:

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. Place the detector properly, confirm the detector is:	___ 5 feet from vegetative clutter on the ground in all directions	___ 33 feet from vegetation in front of the microphone	___ Microphone is angled at 45-75 degrees	___ 50 feet from any potential or known roost
	___ 656 feet from another detector	___ Parallel to woodland	If not, WHY?	
2. Make sure the gear is working	___ Checked at ___ (Time)			
3. Is detector water-proofed?	☐ Yes	☐ No	___ Initial	
4. Make sure the weather is not doing any of these:	___ Too cold (<50 degrees F)	___ Too windy (9 mph or more sustained)	___ Precipitation for 30 minutes straight or intermittent the first 5 hours	

If more than 4 detectors, use another data sheet.

2016

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

Site 2 Calhoun

any of these:

DAILY DETECTOR DEPLOYMENT DATA CONT.

N1

3. Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
S4U05195	41.52657 °N	-96.08727 °W	1830	0100			

Detector Placement/Site Description: Riparian

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. Place the detector properly, confirm the detector is: Initial each blank — X 5 feet from vegetative clutter on the ground in all directions; ___ 33 feet from vegetation in front of the microphone; ___ Microphone is angled at 45-75 degrees; X 50 feet from any potential or known roost; X 656 feet from another detector; ___ Parallel to woodland; If not, WHY?
2. Make sure the gear is working — X Checked at 1830 (Time)
3. Is detector water-proofed? ☒Yes ☐No ___ Initial
4. Make sure the weather is not doing any of these: X Too cold (<50 degrees F) X Too windy (9 mph or more sustained) X Precipitation for 30 minutes straight or intermittent the first 5 hours

N2

4. Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
S4U05195	41.527361 °N	-96.089758 °W	1750	0100			

Detector Placement/Site Description: Riparian

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. Place the detector properly, confirm the detector is: X 5 feet from vegetative clutter on the ground in all directions; X 33 feet from vegetation in front of the microphone; ___ Microphone is angled at 45-75 degrees; X 50 feet from any potential or known roost; X 656 feet from another detector; ___ Parallel to woodland; If not, WHY?
2. Make sure the gear is working — X Checked at 1750 (Time)
3. Is detector water-proofed? ☒Yes ☐No ___ Initial
4. Make sure the weather is not doing any of these: X Too cold (<50 degrees F) X Too windy (9 mph or more sustained) X Precipitation for 30 minutes straight or intermittent the first 5 hours

If more than 4 detectors, use another data sheet.

Revised April 2014

APPENDIX D

Cultural Resources Correspondence

History NEBRASKA

Preserving the past. Building the future.

18-EA-2559

November 5, 2018

Mr. Patrick Finigan
OPPD
444 South 16th Street Mall
Omaha, NE 68102-2247

RE: HP# 1810-138-01 Decommissioning of the Fort Calhoun Station, Fort Calhoun, NE

Dear Mr. Finigan,

Thank you for submitting the referenced project proposal for our review and comment. Our comment on this project and its potential to affect historic properties is required by Section 106 of the National Historic Preservation Act of 1966, as amended, and implementing regulations 36 CFR Part 800.

According to the information you have provided, there will be **no historic properties affected** by this project as planned. Should any changes in the project be made or in the type of funding or assistance provided through federal or state agencies, please notify this office of the changes before further project planning continues.

Please retain this correspondence and your documented finding in order to show compliance with Section 106 of the National Historic Preservation Act, as amended. If you have any questions, please contact me at 402-471-4773.

Sincerely,

Jill Dolberg

Jill E. Dolberg
Deputy State Historic Preservation Officer
History Nebraska

1500 R Street
Lincoln, NE 68508-1651
P: 402.471.3270
P: 800.833.6747
F: 402.471.3100
history.nebraska.gov

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OPPD

Omaha Public Power District

October 24, 2018
18-EA-255

Ms. Jill Dolberg
Deputy SHPO Officer History Nebraska
State Historic Preservation Office
1500 R Street
Lincoln, Nebraska 68508-1651

Subject: Information Request – Section 106 Review and Compliance
Omaha Public Power District, Fort Calhoun Station

Ms. Dolberg:

Haley & Aldrich, Inc. is conducting an environmental analysis on behalf of Omaha Public Power District (OPPD) for the proposed decommissioning of the Fort Calhoun Station (FCS) located approximately 19 miles north of Omaha, Nebraska on the Missouri River (Project). See Figure 1 attached. The Project is currently in the planning stages and environmental review process and continues to coordinate with the Nuclear Regulatory Commission. We are respectfully requesting that your office review the Project for clearance of cultural and/or historical resources in accordance with Section 106 of the National Historic Preservation Act.

FCS is a 1,500-megawatt thermal nuclear power plant that ceased operation in October 2016. The Project includes decommissioning all buildings and paved surfaces within the power station footprint, approximately 660 acres in size (Figure 2). Some of the underground structures and utilities including the water supply systems will be left in place and the main switchyard will remain active.

The Project Limit of Disturbance (LOD) as depicted on Figure 2 includes the area to be decommissioned at the FCS site. The LOD encompasses only those areas that were previously disturbed during construction in 1969. The Project does not propose any additional new ground disturbance and all decommissioned areas will be left as open fields, either seeded or available for industrial use. In addition, no tree clearing is proposed. OPPD anticipates decommissioning to start in 2019, pending receipt of applicable permits and approvals from the Nuclear Regulatory Commission (NRC).

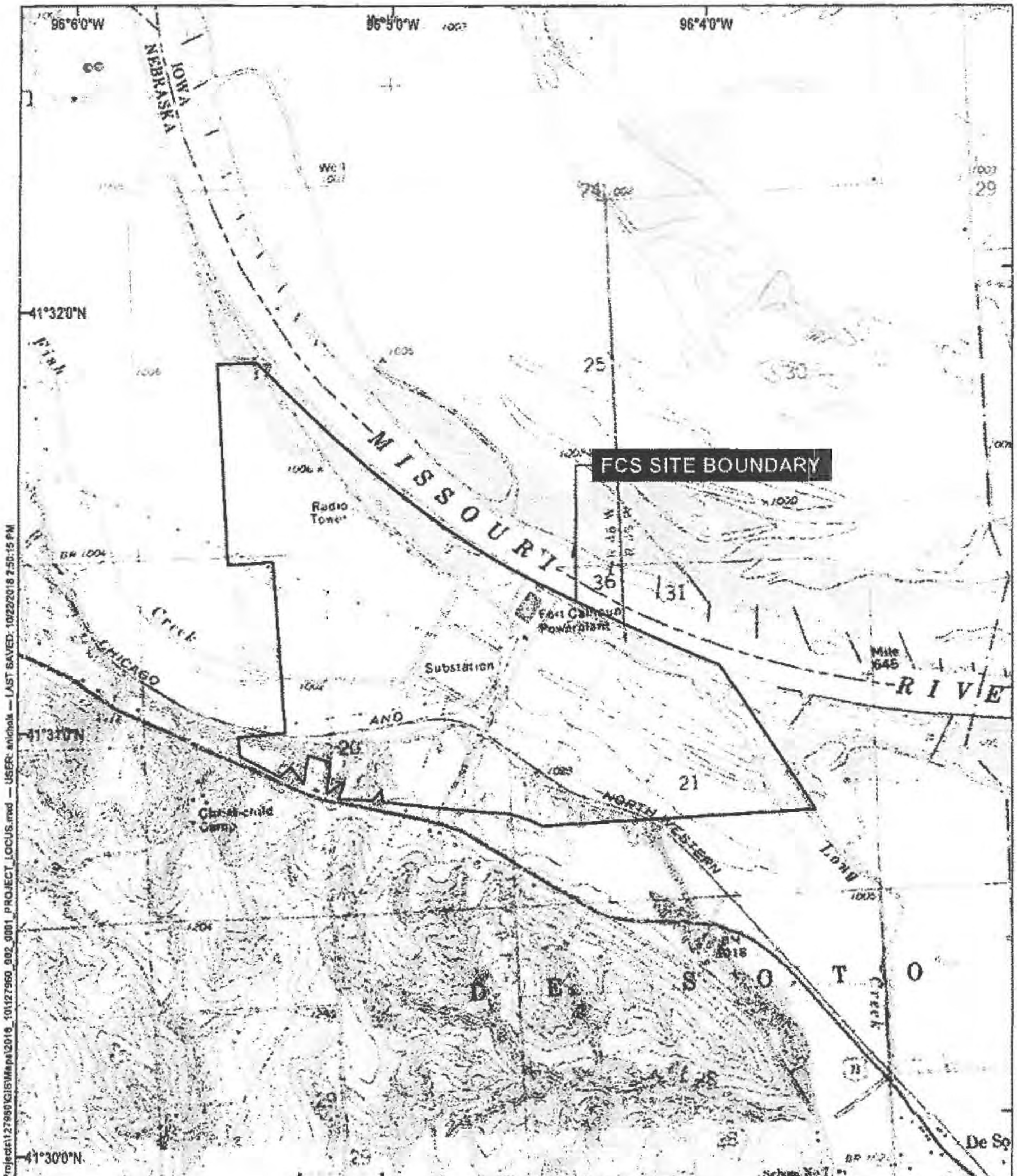
We understand that the Nebraska State Historic Preservation Office's (SHPO) data are sensitive; therefore, any information provided to us will not be released to the public without permission from the Nebraska SHPO. If you have any questions or need additional information concerning this request, please contact Patrick Finigan of OPPD at 402-636-2521.

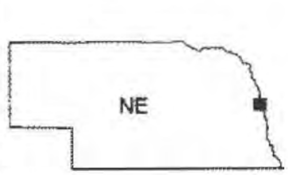
Sincerely,

Patrick Finigan
Environmental Affairs Administrator

Attachments:
Figure 1 – FCS Decommissioning Project, Site Location Map
Figure 2 – FCS Decommissioning Project, Decommissioning LOD

cc: A. Barker FCS
T. Maine FCS
Ms. Nadia Glucksberg, Haley & Aldrich (File No. 127960-003)





MAP SOURCE: USGS
SITE COORDINATES: 41°31'12"N, 96°04'45"W

HALEY ALDRICH

FORT CALHOUN STATION
POWER LANE
BLAIR, NEBRASKA

PROJECT LOCUS

APPROXIMATE SCALE: 1 IN = 2000 FT
OCTOBER 2018

FIGURE 1

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LEGEND

— - - — STREAM

LIMITS OF DISTURBANCE

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. STREAM DATA SOURCE: NATIONAL HYDROGRAPHY DATASET
3. AERIAL IMAGERY SOURCE: ESRI

N

0 500 1,000

SCALE IN FEET

HALEY ALDRICH

FORT CALHOUN STATION
POWER LANE
BLAIR, NEBRASKA

SITE PLAN

OCTOBER 2018

FIGURE 2

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Pesi 1236

NORTHERN LONG-EARED BAT ACOUSTIC AND MIST NET SURVEYS ON FORT CALHOUN STATION IN WASHINGTON COUNTY, NEBRASKA

28 September 2018

Submitted to:

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On behalf of:

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<u>Appendices:</u>

1.0 Project Description

Omaha Public Power District (OPPD) is currently implementing decommissioning procedures at the Fort Calhoun Station (Project Area) in Washington County, Nebraska. In support of this effort, the Nuclear Regulatory Commission (NRC) is undertaking an Environmental Review (ER) to gather information for issuance of the requisite Environmental Impact Statement (EIS).

As the Project Area is within the range of the federally threatened northern long-eared bat (*Myotis septentrionalis*) and species records or highly suspected occurrence exist in Washington County and surrounding counties such as Douglas, Burt, and Dodge, Environmental Solutions & Innovations, Inc. (ESI) was contracted to detemine potential species impacts resulting from decommissioning activities. The Project Area encompasses approximately 660 acres (267 ha) with forested land-cover totaling approximately 137 acres (55 ha) and appears on the Modale, IA-NE USGS 7.5-minute topographic quadrangle map (Figure 1).

On 8 August 2018, a study plan was submitted to the U.S. Fish and Wildlife (USFWS) Nebraska Ecological Services Field Office and the Nebraska Game and Parks Commission (NGPC) requesting approval and site specific authorization to complete summer mist net surveys at one mist net and two acoustic detector sites to determine whether federally listed bats are present in the Project Area. Approval and site-specific authorization were received on 9 August 2018. Mist net and acoustic surveys were completed from 12 to 14 August 2018 in accordance with USFWS Federal Fish and Wildlife and Nebraska Game and Parks Commission (NGPC) Scientific and Education Permits. This report details the methods and results of the survey.

2.0 Basis for ESA Compliance

The Endangered Species Act (ESA) [16 U.S.C. 1531 et seq.] was codified into law in 1973. This law provides for the listing, conservation, and recovery of endangered and threatened species of plants and wildlife. Under the ESA, the USFWS is mandated to monitor and protect listed species.

Section 9 of the ESA prohibits the "take" of listed species unless otherwise specifically authorized by regulation. "Take" is defined by the ESA as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" [16 U.S.C. 1532(19)].

Project Boundary

N
W E
S

Figure 1. Location of the Fort Calhoun Station Project in Washington County, Nebraska.

Project No. 1236

0 1.25 2.5 Miles

Base Map: USGS Topographic Map

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

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USFWS further defines “harm” to include significant habitat modification or degradation [50 CFR §17.3]. Section 7(a) (2) of the ESA states that each federal agency shall insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in destruction or adverse modification of designated critical habitat. Federal actions include (1) expenditure of federal funds for roads, buildings, or other construction projects, and (2) approval of a permit or license, and the activities resulting from such permit or license. Compliance is required regardless of whether involvement is apparent, such as issuance of a federal permit, or less direct, such as federal oversight of a state-operated program. Actions of federal agencies that do not result in jeopardy or adverse modification, but that could result in a take, must also be addressed under Section 7. Take by a federal agency can be authorized through the Section 7 consultation process, culminating in an Incidental Take Statement (ITS) by the USFWS. The take must be Incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. One of the requirements to for project proponents under the ESA is to avoid and minimize impacts to listed species. If, through this process, take is avoided, then an ITS or ITP is not required.

The first step in the project consultation process under the ESA is to first determine whether suitable habitat is presence and if habitat is present, then to determine if listed species are present. The Fort Calhoun Station Project is within the range of the federally threatened northern long-eared bat. Northern long-eared bats are considered "tree bats” in summer and "cave bats” in winter. The use of caves in winter for hibernation also includes spring staging and autumn swarming activities that are typically associated with hibernacula. On 4 May 2015, the USFWS listed the northern long-eared bat as threatened with a 4(d) exemption.

3.0 Ecological Setting – Northern Long-eared Bat

3.1 Status

On 2 October 2013, the northern long-eared bat was proposed for listing by USFWS as endangered. On 16 January 2015, USFWS proposed listing the northern long-eared bat as threatened with 4(d) rule. On 2 April 2015, USFWS published notice in the Federal Register of its final decision to list the species as threatened and issued an interim 4(d) rule exempting certain activities from the ESA’s take prohibition. The listing decision and interim 4(d)

> **Federal Register Documents**
>
> 78 FR 61045 61080; 2 October 2013: Proposed Listing: Endangered
> 80 FR 2371 2378; 16 January 2015: Proposed Listing: Threatened; Proposed 4(d) Rule
> 80 FR 17973 18033; 2 April 2015: Final Rule: Threatened; Interim 4(d) Rule
> 81 FR 1900 1922; 14 January 2016: Final 4 (d) Rule
> 81 FR 24707 24714; 27 April 2016: Final Rule: Designation of Critical Habitat Not Prudent

rule took effect 4 May 2015. A final 4(d) rule was announced on 14 January 2016 and took effect on 16 February 2016. On 27 April 2016, USFWS determined that designation of critical habitat was not prudent. Reasons for listing include population declines attributed to WNS, impacts to hibernacula, and impacts to summer habitat.

3.2 Regional Species Occurrence

The northern long-eared bat is estimated to occur within 75 of Nebraska's 93 counties, but believed to be absent in the southwestern-most portion of the state (https://outdoornebraska.gov/wp-content/uploads/2015/07/Northern-Long-eared-Bat.pdf, accessed 13 September 2018). In January 2016, USFWS estimated the northern long-eared bat population in Nebraska consisted of approximately 28,890 adult individuals (USFWS 2016). Additional information on life history and ecology of the species is provided in Appendix A.

4.0 Habitat Screening

Desktop analysis of the Project Area reveals potential suitable roosting habitat, in the form of forested land-cover, totaling approximately 137 acres (55 ha, Figure 2). Aerial imagery shows snags (dead trees) along the riparian corridor of the Missouri River, and large blocks of forested habitat on the northern and western Project area boundaries.

The likelihood of potential hibernacula was assessed for lands within 0.25 mile of the Project area using soil/geological surveys, aerial imagery, and a review of mine sites in operation as of 2003 (most recent data). Soils include silty loam of 17 to 30 percent slopes, and silty clay of 0 to 2 percent slopes, both of which are characteristic of the Missouri River floodplain. No quarries, mines, or exposed rock assemblages are present.

A site visit completed on 26 July 2018 determined that low to moderate roosting habitat for the northern long-eared bat was present within seven discrete forest patches spread throughout the Project area.

Based on the results of both desktop and field habitat assessments, acoustic sampling was conducted at two sites for two nights each, and mist netting was conducted at one site for three nights, three nets per night for a total of nine net nights.

Prjoect Boundary | Forest Habitat

Figure 2. Forest habitat on Fort Calhoun Station in Washington County, Nebraska.

N
W E
S

Project No.
1236

0 0.3 0.6 Mile

Base Map: Esri World Imagery

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

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5.0 Methods

Acoustic monitoring and mist netting were completed from 12 to 14 August 2018, in accordance with the 2018 USFWS *Range-wide Indiana Bat Survey Guidelines* (USFWS 2018), which are also applicable to northern long-eared bats.

5.1 Acoustic Monitoring

5.1.1 Level of Effort

Acoustic monitoring efforts are conducted in accordance with guidelines in the *2018 USFWS Range-wide Indiana Bat Summer Survey* (Appendix B, Table 1). Each night, acoustic units are moved within the designated forested polygons (which contain large pockets of eastern cottonwoods) to maximize the probability of detecting bats. Two sites were sampled for two nights for a total of four complete detector nights.

5.1.2 Qualified Personnel

Acoustic deployment is conducted by qualified individuals with experience in proper placement and programming of acoustic detectors. All calls are processed through Kaleidoscope Pro (Kpro) software (4.2, Wildlife Acoustics, Concord Massachusetts). All calls classified by Kpro as Myotis calls are visually vetted by expert acoustic identification specialists.

5.1.3 Detector Placement

Acoustic units are deployed within the Project area at locations which exhibit potentially suitable habitat characteristics, but where mist net surveys would not be the optimal means of detecting bat presence. In the Project Area, the riparian corridors along the Missouri River were identified as optimal acoustic sites. Appendix B, Table 2 provides detector locations and sampling dates. Detector locations are illustrated in Figure 3. Photographs of detector locations are provided in Appendix C, and detector deployment data sheets are provided in Appendix D.

5.2 Mist Netting

5.2.1 Level of Effort

Mist net efforts are conducted in accordance with guidelines in the *2018 USFWS Range-wide Indiana Bat Summer Survey* (Appendix B, Table 3). After each survey night, at the discretion of the on-site biologist, mist nets may be moved to alternate suitable locations in order to maximize the probability of northern long-eared bat capture in the Project Area. A total of **nine complete net nights** were sampled across nine separate net locations.

Acosutic Sampling Site   Prjoect Boundary

N W E S

Figure 3. Acoustic sampling sites on the Fort Calhoun Station Project in Washington County, Nebraska.

Project No. 1236	0 0.3 0.6 Mile Base Map: Esri World Imagery	ESI	ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

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5.2.2 Qualified Surveyors

Mist net surveys are completed by one or more biologists, including the team leader, who is federally permitted to handle northern long-eared bats.

5.2.3 Net Placement

Mist nets are set to maximize coverage of the flight paths used by northern long-eared bats along suitable travel corridors, foraging areas, and/or drinking areas. Riparian corridors are often used for travel or foraging; however, upland corridors (e.g., trails or access roads) also provide suitable sites.

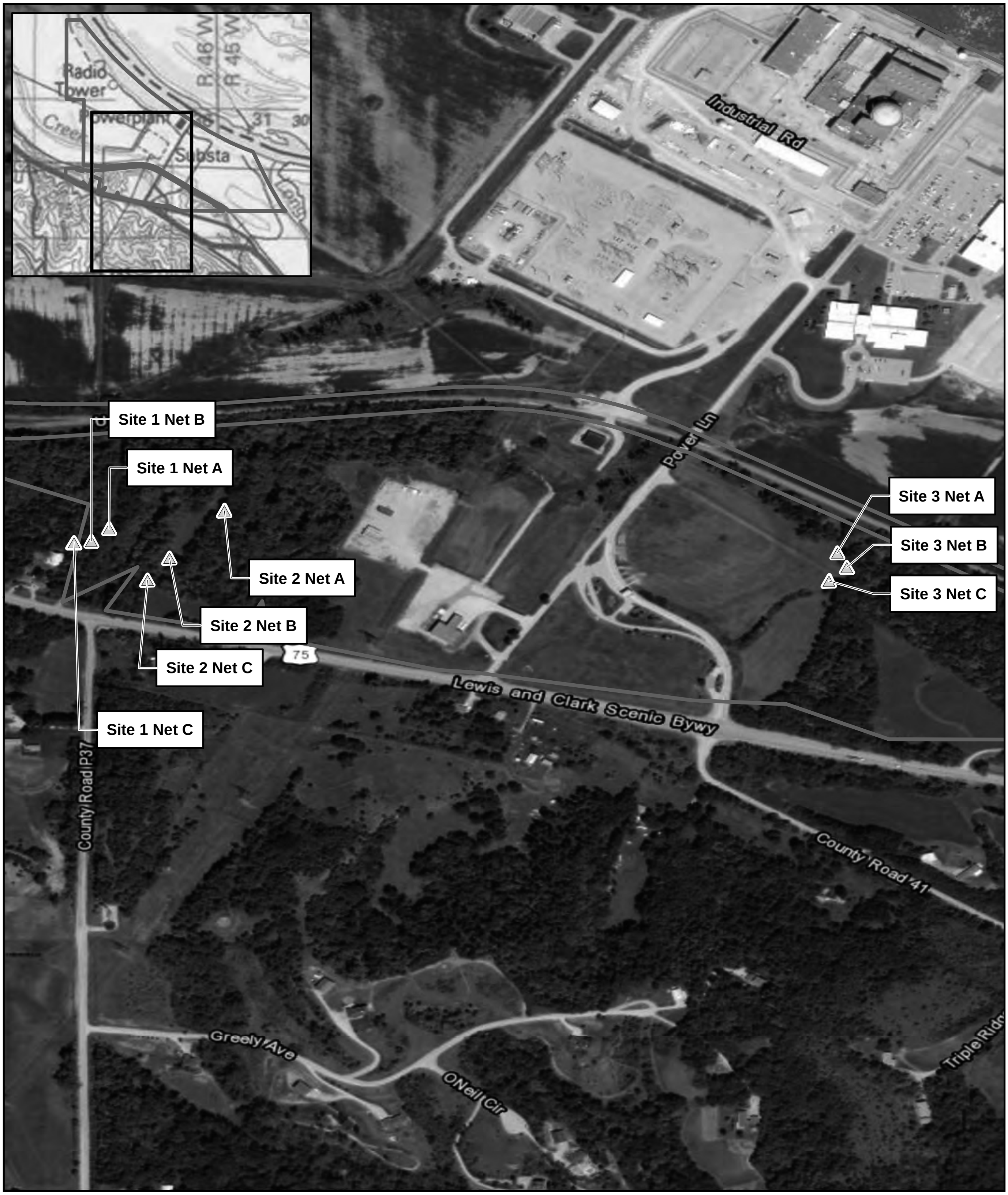
Site selection is based upon the extent of canopy cover, presence of an open flyway, and forest conditions near the site. The actual location and orientation of each net set is determined in the field by a permitted bat biologist. Locations of mist nets are provided in Figure 3 and coordinates are provided in Appendix B, Table 4. Photographs of nets are provided in Appendix C. Mist net capture data sheets are provided in Appendix D.

5.2.4 Bat Capture

Bats are live-caught in mist nets and released unharmed near the point of capture. Captured bats are identified to species, sex, age class, and reproductive condition. Weight and right forearm length of each individual are also recorded. Age is determined by examining the epiphyseal-diaphyseal fusion of long bones in the wing. Reproductive condition of female bats is recorded as pregnant (based on gentle abdominal palpation), lactating, post lactating, or non-reproductive. Time and location/net site of captured bats is recorded. Processing is typically completed within 30 minutes of the time each bat is removed from the net. Photographs are taken of all bats captured/identified as northern long-eared bats. Information is recorded on standardized data sheets.

5.2.5 Protocol for Addressing White-nose Syndrome

White-nose syndrome (WNS) is a disease that is killing millions of bats in the eastern United States. The disease, which was first found in New York, is spreading across the range of the northern long-eared bat. All current state and federal guidelines for WNS decontamination, containment, and avoidance are implemented during the bat capture process. Biologists are kept aware of all current and changing WNS regulations. Bat handling follows current WNS protocols set by the USFWS. Captured bats are examined for WNS damage to the wing and uropatagium (tail) membranes, using white and/or ultraviolet light. Wing damage is categorized using the Wing-Damage Index Used for Characterizing Wing Condition of Bats Affected by White-nose Syndrome established by Jon Reichard in 2008.



Mist Net Site Location   Prjoect Boundary

N
W E
S

Figure 4. Mist net sites on the Fort Calhoun Station Project in Washington County, Nebraska.

Project No. 1236

0 0.1 0.2 Mile

Base Map: Esri World Imagery

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

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5.2.6 Habitat Characterization

Concurrent with mist netting, wooded habitats near the net site and the immediate surroundings are quality assessed for both the Indiana and northern long-eared bat. The emphasis of this assessment is habitat form: size and relative abundance of large trees and snags that could serve as roost trees, canopy closure, understory clutter/openness, water availability, and flight corridors. Habitat form is emphasized because northern long-eared bats roost in a variety of tree species.

Habitat characterization identifies components of both the canopy and subcanopy layers. All trees that reach into the canopy are canopy trees, regardless of diameter or size. Many smaller trees are often found in the canopy, and in some situations, the canopy can be composed entirely of smaller diameter trees. Habitat characterization identifies both dominant and subdominant elements of the canopy.

The subcanopy, or understory, vegetation layer is that portion of the forest structure between the ground vegetation (to approximately 2 feet [0.6 m]) and the canopy layers, usually beginning at about 24.9 feet (7.6 m). Vegetation in the understory may come from:

- Lower branches of overstory trees,
- Small trees that will grow into the overstory,
- Small trees and shrubs that are confined to the understory.

The amount of understory, or clutter, is also recorded to assess accessibility by northern long-eared bats. Habitat data are recorded on standardized data sheets (Appendix D).

5.2.7 Weather and Temperature

Weather conditions are monitored each night of survey to assure compliance with mist netting guidelines. Conditions recorded include temperature, wind speed and direction, and percent cloud cover. Any of a variety of standard mercury or electric thermometers is used to record temperature, wind speed is determined by use of the Beaufort wind scale, and cloud cover is visually estimated. Information is recorded on standardized data sheets (Appendix D).

6.0 Results

6.1 Acoustic Analysis

6.1.1 Analysis of Call Sequences

A total of 856 acoustic files were recorded during sampling at the two sites. These

files were identified and analyzed to species by Kpro (Appendix B, Table 5). Nine of species were recorded, including eight northern long-eared bat call sequences.

The maximum likelihood estimator in Kpro statistically supported the potential presence of six species: big brown bat (Eptesicus fuscus), eastern red bat (Lasiurus borealis), hoary bat (Lasiurus cinereus), northern long-eared bat, evening bat (Nycticeius humeralis), and tri-colored bat (Perimyotis subflavus) (Appendix B, Table 6).

Manual vetting was completed by an expert acoustic-identification specialist, per the 2018 guidelines. The Northern long-eared bat presence was confirmed at Site 1 by manual vetting (Appendix B, Table 7).

6.2 Mist Netting

6.2.1 Bat Capture

Nine complete net nights resulted in the capture of two eastern red bats: one adult male and one adult female.

6.2.2 Species Diversity

Of 13 bat species documented in Nebraska, only one was captured: eastern red bats. This is one of the most common species in the state and one of the most abundant species throughout the post-WNS landscape.

6.2.3 Occurrence by Sex and Age

One adult male and one adult female were captured and fully processed. Both individuals were non-reproductive at the time of capture.

6.2.4 White Nose Syndrome Scores

Both captured individuals were examined for WNS damage/scarring. Both individuals displayed no signs of wing damage (Wing Index Score = 0).

6.2.5 Habitat Characterization of the Net Site

Nets were placed across an unnamed stream in the southernmost portion of the Project Area. Forested habitat was predominantly young upland and lowland forest. Dominant canopy species comprised hackberry (*Celtis occidentalis*), cottonwoods (*Populus* sect. *Aigeiros*), and black locust (*Robinia pseudoacacia*). Subdominant species include the above in addition to Chinese privet (*Ligustrum sinense*) and northern red oak (*Quercus rubra*). The subcanopy ranged from open to completely cluttered with saplings and shrubs, and comprised black locust in addition to foxtail (*Alopecurus* spp.), stinging nettle (*Urtica dioica*), and blueberry (*Vaccinium* spp.).

Roosting potential was ranked each calendar night for both Indiana and northern long-eared bats based on the presence of large trees, hollows, and snags. Roosting

potential was ranked as low for Indiana bats on all three nights. Roosting potential for northern long-eared bats was ranked as low on 12 and 13 August 2018, and as moderate on 14 August 2018. Habitat data are summarized in Appendix B, Table 8.

Photographs of the mist net site are provided in Appendix C and habitat datasheets are provided in Appendix D.

7.0 Discussion/Conclusion

Acoustic monitoring and mist net surveys for federally listed bats were completed from 12 to 14 August 2018. Survey efforts complied with guidelines in the 2018 *Range-wide Indiana Bat Survey Guidelines* (USFWS 2018), which are also applicable to northern long-eared bats. A total of 856 recorded files were identified and analyzed to species by Kpro, including eight potential northern long-eared bat calls. Manual vetting of these calls determined that five call sequences were consistent with the federally listed northern long-eared bat.

Nine complete , mist net nights resulted in the capture of two adult eastern red bats. No federally listed species were captured.

On behalf of OPPD, in accordance with the Final 4(d) Rule for northern long eared bats, based on the lack of presence of identified maternity roosts, ESI respectfully requests that tree clearing may occur within the Project Area at any time of year, for a period of 5 years from the completion of surveys.

8.0 Literature Cited

USFWS. 2016. Programmatic biological opinion on final 4(d) rule for the northern long-eared bat and activities excepted from take prohibitions. U.S. Department of the Interior, Fish and Wildlife Service, Midwest Regional Office, Bloomington, Minnesota. 103 pp.

USFWS. 2018. Range-wide Indiana bat survey guidelines - April 2018. U.S. Department of the Interior, Fish and Wildlife Service. 61 pp.

APPENDIX A
LIFE HISTORY AND ECOLOGY OF THE NORTHERN LONG-EARED BAT

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1.0 Northern Long-Eared Bat (*Myotis septentrionalis*)

1.1 Description

The northern long-eared bat is a medium-sized bat in the genus *Myotis*. *M. septentrionalis* is the eastern member of a group of long-eared *Myotis* that occurs across much of North America, and whose similarity has led to a complex taxonomy (van Zyll de Jong 1979). All are similar in overall appearance and ecology. At one point, *M. septentrionalis* was considered a subspecies of *M. keenii* (Keen's bat) (Fitch and Shump 1979), which is now restricted to the Pacific Northwest. Much of the older literature appearing under the name *M. keenii* actually refers *to M. septentrionalis*. Also included in this long-eared group are the southwestern bat (*M. auriculus*) and the long-eared bat (*M. evotis*).

The northern long-eared bat weighs about 5-8 grams (0.17-0.28 oz) at maturity and its right forearm measures about 34-38 millimeters (1.3 – 1.5 in). The wing membrane connects to the foot at the base of the first toe. The northern long-eared bat is most easily characterized by the long ears (17 mm [0.7 in]), which extend past the muzzle when laid forward, as well as a long and thin tragus (9 mm [0.4 in]) (Whitaker and Mumford 2009). The northern long-eared bats' pelage is typically colored a light to dark brown on the dorsal side and a light brown on the ventral side (Caceres and Barclay 2000, Whitaker and Mumford 2009). Ears and wing membranes are usually a dark brown.

1.2 Seasonal Ecology

The northern long-eared bat is a "tree bat" in summer and a "cave bat" in winter. During the summer, the species is forest dependent. As with the Indiana bat, there are four ecologically distinct components of the annual life cycle: winter hibernation, spring staging and autumn swarming, spring and autumn migration, and the summer season of reproduction (Figure 1).

1.2.1 Summer Roosting Ecology

The summer range of the northern long-eared bat is large and includes much of the eastern deciduous forestlands from the northern border of Florida north and west to Saskatchewan and east to Labrador (Caceres and Barclay 2000, Whitaker and Mumford 2009) (Figure 2). Distribution throughout the range is not uniform, and summer occurrences are more common in the northern and northeastern portions of the species' range than in southern and western portions (Caceres and Barclay 2000, Amelon and Burhans 2006). Historically, these areas were primarily forested. Through the southern portions of their range, they appear to be less abundant, and are thought of as rare in Alabama, South Carolina, and Georgia (Mumford and Cope 1964, Barbour and Davis 1969, Amelon and Burhans 2006, Whitaker and Mumford 2009, Timpone et

al. 2010). Northern long-eared bats likely colonized the High Plains when suppression of fire and the extirpation of bison allowed extensive bands of riparian vegetation to develop along streams that were formerly unforested (Sparks and Choate 1995, Sparks et al. 1999, Benedict et al. 2000, Sparks and Choate 2000, Benedict 2004, Sparks et al. 2011). Although occasionally captured/recorded in western portions of their range, they are uncommon when records are compared to eastern areas.

1.2.1.1 Males

Some males and non-reproductive females remain near their winter hibernacula throughout summer while others migrate varying distances. This may be due to a preference for cooler environments in the absence of pups (Barbour and Davis 1969, Amelon and Burhans 2006). Males can be caught at hibernacula on most nights during summer, although there may be a large turnover of individuals between nights.

Structurally, summer roosts used by males are similar to those used by maternity colonies. Trees used by males of the species are often smaller than those used by maternity colonies, perhaps because males are often solitary or form small groups and thus need less space or they may have different thermal requirements than females.

1.2.1.2 Females and Maternity Colonies

When female northern long-eared bats emerge from hibernation, they migrate to maternity colonies. The distance traveled from winter hibernacula to summer roosting areas is not known, although the species is considered to migrate shorter distances than Indiana bat (USFWS 2014). After parturition, pups usually achieve volancy by 21 days (Kunz 1971, Krochmal and Sparks 2007). As the offspring become volant, average number of bats using a maternity roost declines (Lacki and Schwierjohann 2001, Sparks 2003).

A wide variety of deciduous tree species, as well as occasional coniferous species, are used as nursery colonies indicating that it is tree form, not species that is important for roosts (Caceres and Barclay 2000, Carter and Feldhamer 2005). Maternity colonies are typically found in hollow trees and under bark although they also use bat-houses, buildings, and other anthropogenic structures (Amelon and Burhans 2006). The northern long-eared bat may choose either tree condition (hollow or suitable exfoliating bark), depending on the presence or availability within an area, though roost selection may possibly be influenced by competition or predation from other wildlife (Perry and Thill 2007, Perry et al. 2007). This species regularly uses both live and dead trees (Sasse and Pekins 1996, Foster and Kurta 1999, Lacki and Schwierjohann 2001, Sparks 2003, Timpone 2004, Whitaker et al. 2004b, Carter and Feldhamer 2005, Ford et al. 2006, Timpone et al. 2010, Johnson et al. 2012, Silvis et al. 2012, Johnson et al. 2013, Silvis et al. 2014).

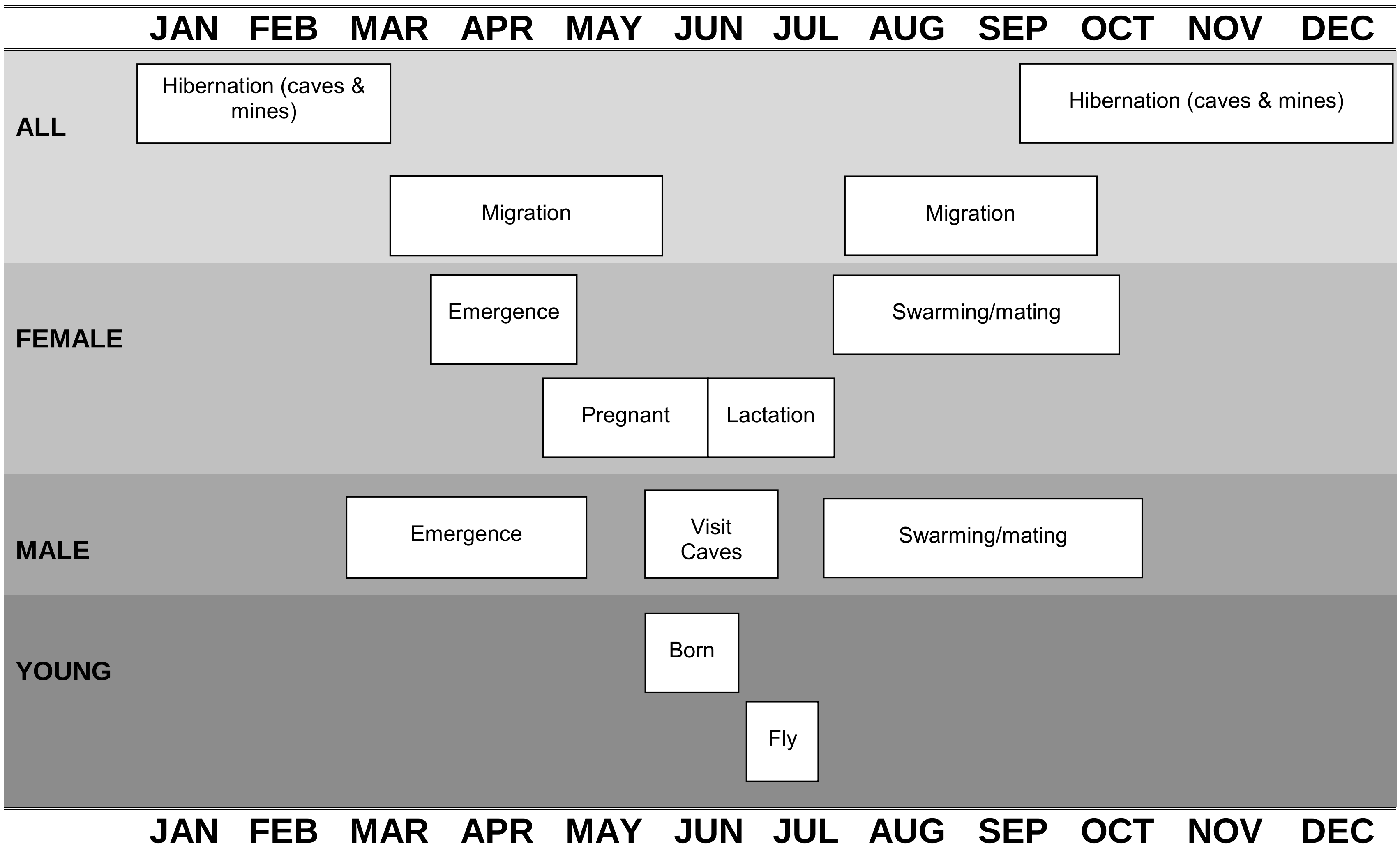

Figure 1. Seasonal chronology of northern long-eared bat activities

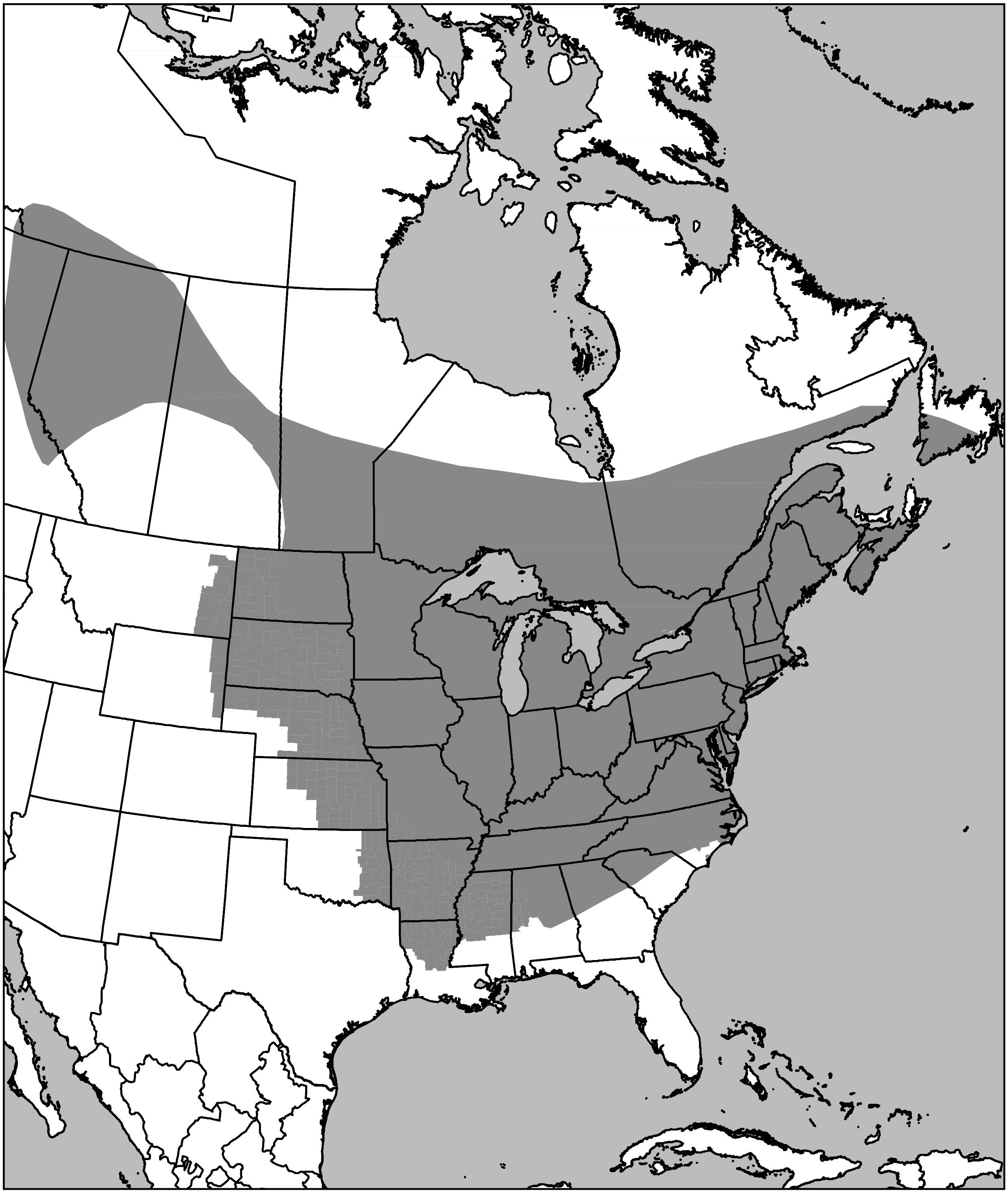

Figure 2. Rangewide distribution of the northern long-eared bat during summer.

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Roost trees may be habitable for one to several years, depending on the species and condition of the tree. The species may also use several other natural or human-made structures as summer roost sites (e.g., bridges, barns/homes, utility poles, rocky cracks or crevices) (Cope et al. 1961, Barbour and Davis 1969, Cope et al. 1991, Sparks and Choate 1995, Caceres and Barclay 2000, Sparks and Choate 2000, Farrell Sparks et al. 2004, Whitaker et al. 2004a), and have been found in a mixed species colony with little brown bats in a hay barn in northeast Missouri (Timpone et al. 2010). Northern long-eared bats make extensive use of bat-houses when these structures are available (Whitaker et al. 2006).

A maternity colony typically consists of 30 to 60 individuals, although colonies containing up to 100 individuals have been observed (Whitaker and Mumford 2009). The number of individuals within a maternity colony decreases as the maternity season progresses, as fewer bats roost together during the post-lactation stage than during the pregnancy stage. Northern long-eared bats show low fidelity to roosts, switching every two to three days (Sasse and Pekins 1996, Timpone et al. 2010).

Females are pregnant when they arrive at maternity roosts and produce a single young per year, as is typical for the genus *Myotis* (Asdell 1964, Hayssen et al. 1993, Sparks et al. 1999, Krochmal and Sparks 2007). Parturition typically occurs between late May and early June (Caire et al. 1979, Krochmal and Sparks 2007, Whitaker and Mumford 2009).

Juveniles become volant between late June and early August (Caire et al. 1979, Sasse and Pekins 1996, Krochmal and Sparks 2007). As is the case with other species of bats in North America, mortality for northern long-eared bat is high during the first year (Caceres and Pybus 1997). Northern long-eared bats have been observed roosting in areas of increased solar heating, which increases their developmental rate and reduces the need to lower their body temperature and metabolic rate (i.e. enter a state of torpor) (Lacki and Schwierjohann 2001).

1.2.2 Food Habits and Foraging Ecology

The diet of northern long-eared bats varies substantially among ages and genders, and in relation to the availability of insects within different habitat types. Brack and Whitaker (2001) found that in Missouri and Indiana, lepidopterans constituted a large part of the northern long-eared bat's diet, as well as coleopterans, trichopterans, and dipterans. Northern long-eared bats have also been noted to feed on spiders, lepidopteran larvae, plecopterans, homopterans, hymenopterans, and a variety of other insects and arthropods by gleaning (Brack and Whitaker 2001, Feldhamer et al. 2009).

Northern long-eared bats typically emerge from roosting near dusk to forage over forested ponds and streams and in wooded areas before resting in a night roost (Kunz 1973). Northern long-eared bats often emerge a second time in early morning for another short bout of foraging before returning to their day roosts (Kunz 1973, Brack and Whitaker 2001). The species has been documented using both hawking and

gleaning foraging strategies (Griffith and Gates 1985, Faure et al. 1993, Brack and Whitaker 2001, Feldhamer et al. 2009). Gleaning bats capture prey from the substrate (often vegetation or the ground) and northern long-eared bats do more of this than other similar species with shorter ears (Faure et al. 1993). This likely explains the abundance of spiders in the diet (Brack and Whitaker 2001) and observations of light-tagged northern long-eared bats foraging close to the ground amid heavy foliage (LaVal et al. 1977, Caire et al. 1979).

Northern long-eared bats forage in areas that are relatively close to roosts and tend to prefer areas with higher clutter than roosting areas. Unpublished studies in suburban Indianapolis and along the Wabash River near Terre Haute, Indiana indicate that this species forages in almost exclusively forested areas within 0.6 mile of the roost (D. W. Sparks unpublished data). This coincides with studies from New Hampshire that show an average distance of 0.4 mile from roosting areas to foraging areas (Sasse and Pekins 1996). Henderson and Broders (2008) found that foraging areas on Prince Edward Island were comparatively more cluttered (i.e., had thicker understories) than roosting areas, although foraging areas were also found to be predominately forested. If a bat was found to forage in an open area, it was within 0.05 mile of a forest feature.

1.2.3 Winter Hibernation

Most hibernating and/or swarming records of northern long-eared bats are associated with caves and mines (Whitaker and Mumford 2009), but the species also uses similar structures including a hydro-electric dam in Michigan (Kurta and Teramino 1994, Kurta et al. 1997) and storm sewers in Kansas (Fleharty and Farney 1965) and Minnesota (Goehring 1954). The species is often found using recessed areas of hibernacula such as cracks, crevices, and broken stalactites (Whitaker and Hamilton 1998), and individuals leaving hibernacula are often covered with clay and mud (Caire et al. 1979, Whitaker and Mumford 2009). Based on the known behavior of other long-eared bats and the lack of suitable caves and mines within the High Plains , the population there likely hibernates in rock outcroppings (Sparks et al. 2011). This suggests that the species may hibernate in small numbers in a variety of locations.

The species selects areas within hibernacula that are relatively stable with a mean temperature of 9.1°C (32 to 48°F) (Brack 2007), and they will often return to the same hibernacula (Caceres and Barclay 2000). Northern long-eared bats prefer high humidity conditions with little to no air flow in the areas where they are hibernating (Fitch and Shump 1979, van Zyll de Jong 1979), which results in noticeable build-up of water droplets on their fur (Barbour and Davis 1969). Northern long-eared bats frequently share hibernacula with other bat species, such as the little brown bat and the eastern pipistrelle bat; however, they will often roost in different parts of the hibernaculum. Because they hibernate in hard-to-see places, the number of northern long-eared bats using a structure can be orders of magnitude greater than observed during interior studies (Whitaker and Rissler 1992).

2.0 Literature Cited

Amelon, S. and D. Burhans. 2006. Conservation assessment: *Myotis septentrionalis* (northern long-eared bat) in the Eastern United States. U.S. Department of Agriculture, Forest Service, General Technical Report NC-260: Conservation Assessments for Five Forest Bat Species in the Eastern United States.

Asdell, S. A. 1964. *Myotis sodalis*, Miller and Allen. Pages 99 *in* Patterns of mammalian reproduction, second edition. Cornell University Press, Ithaca, New York. 670 pp.

Barbour, R. W. and W. H. Davis. 1969. Bats of America. University Press of Kentucky, Lexington, Kentucky.

Benedict, R. A. 2004. Reproductive activity and distribution of bats in Nebraska. Western North American Naturalist 64:231–248.

Benedict, R. A., H. H. Genoways, and P. W. Freeman. 2000. Shifting distributional patterns of mammals of Nebraska. Pages 55-84 *in* Proceedings of the Nebraska Academy of Science. 26:55-84.

Brack, V., Jr. 2007. Temperatures and locations used by hibernating bats, including *Myotis sodalis* (Indiana Bat), in a limestone mine: implications for conservation and management. Environmental Management 40:739-746.

Brack, V., Jr. and J. O. Whitaker, Jr. 2001. Foods of the northern myotis, *Myotis septentrionalis*, from Missouri and Indiana, with notes on foraging. Acta Chiropterologica 3:203-210.

Caceres, M. C. and R. M. R. Barclay. 2000. *Myotis septentrionalis*. Mammalian Species 634:1-4.

Caceres, M. C. and M. J. Pybus. 1997. Status of the northern long-eared bat (*Myotis septentrionalis*) in Alberta. Wildlife Status Report 3:19 pp.

Caire, W., R. K. LaVal, M. L. LaVal, and R. Clawson. 1979. Notes on the ecology of *Myotis keenii* (Chiroptera, Vespertilionidae) in eastern Missouri. American Midland Naturalist 102:404-407.

Carter, T. C. and G. A. Feldhamer. 2005. Roost tree use by maternity colonies of the Indiana bats and the northern long-eared bats in southern Illinois. Forest Ecology and Management 219:259-268.

Cope, J. B., W. W. Baker, and J. Confer. 1961. Breeding colonies of four species of bats of Indiana. Proceedings of the Indiana Academy of Science 70:262-266.

Cope, J. B., J. O. Whitaker, Jr, and S. L. Gummer. 1991. Duration of bat colonies in Indiana. Proceedings of the Indiana Academy of Science 99:199-201.

Farrell Sparks, J. K., B. J. Foster, and D. W. Sparks. 2004. Utility pole used as a roost by a Northern Myotis, *Myotis septentrionalis*. Bat Research News 45:94.

Faure, P. A., J. H. Fullard, and J. W. Dawson. 1993. The gleaning attacks of the northern long-eared bat, *Myotis septentrionalis*, are relatively inaudible to moths. Journal of Experimental Biology 178:173-189.

Feldhamer, G. A., T. C. Carter, and J. O. Whitaker, Jr. 2009. Prey consumed by eight species of insectivorous bats from southern Illinois. American Midland Naturalist 162:43-51.

Fitch, H. S. and K. A. Shump, Jr. 1979. *Myotis keenii*. Mammalian Species 121:1-3.

Fleharty, E. D. and J. P. Farney. 1965. Second Locality record for *Myotis keenii* (Merriam) in Kansas. Transactions of the Kansas Academy of Science 68:200.

Ford, W. M., S. F. Owen, J. W. Edwards, and J. L. Rodrigue. 2006. *Robinia pseudoacacia* (Black Locust) as day-roosts of male *Myotis septentrionalis* (Northern Bats) on the Fernow Experimental Forest, West Virginia. Northeasten Naturalist 13:15-24.

Foster, R. W. and A. Kurta. 1999. Roosting ecology of the northern bat (*Myotis septentrionalis*) and comparisons with the endangered Indiana bat (*Myotis sodalis*). Journal of Mammalogy 80:659-672.

Goehring, H. H. 1954. *Pipistrellus subflavus obscurus*, *Myotis keenii*, and *Eptesicus fuscus fuscus* hibernating in a storm sewer in central Minnesota. Journal of Mammalogy 35:434-435.

Griffith, L. A. and J. E. Gates. 1985. Food habits of cave-dwelling bats in the central Appalachians. Journal of Mammalogy 66:451-460.

Hayssen, V., A. van Tienhoven, and A. van Tienhoven. 1993. Order Chiroptera, Family Vespertillonidae. Pages 141-166 *in* Asdell's patterns of mammalian reproduction - a compendium of species-specific data. Cornell University Press, Ithaca, NewYork. 1023 pp.

Henderson, L. E. and H. G. Broders. 2008. Movements and resource selection of the northern long-eared myotis (*Myotis septentrionalis*) in a forest–agriculture landscape. Journal of Mammalogy 89:952–963.

Johnson, J. B., W. M. Ford, and J. W. Edwards. 2012. Roost networks of northern myotis (*Myotis septentrionalis*) in a managed landscape. Forest Ecology and Management 266:223–231.

Johnson, J. B., J. H. Roberts, T. L. King, J. W. Edwards, W. M. Ford, and D. A. Ray. 2013. Genetic structuring of northern myotis (*Myotis septentrionalis*) at multiple spatial scales. Acta Theriologica 59:223-231.

Krochmal, A. R. and D. W. Sparks. 2007. Timing of birth and estimation of age of juvenile *Myotis septentrionalis* and *Myotis lucifugus* in west-central Indiana. Journal of Mammalogy 88:649-656.

Kunz, T. H. 1971. Reproduction of some vespertilionid bats in central Iowa. American Midland Naturalist 86:477-486.

Kunz, T. H. 1973. Resource utilization: Temporal and spatial components of bat activity in central Iowa. Journal of Mammalogy 54:14-32.

Kurta, A., J. Caryl, and T. Lipps. 1997. Bats and Tippy Dam: species composition, seasonal use, and environmental parameters. Michigan Acadamician XXIX:473-490.

Kurta, A. and J. A. Teramino. 1994. A novel hibernaculum and noteworthy records of the Indiana bat and eastern pipistrelle (Chiroptera: Vespertilionidae). American Midland Naturalist 132:410-413.

Lacki, M. J. and J. H. Schwierjohann. 2001. Day-roost characteristics of northern bats in mixed mesophytic forests. The Journal of Wildlife Management 65:482-488.

LaVal, R. K., R. L. Clawson, M. L. LaVal, and W. Caire. 1977. Foraging behavior and nocturnal activity patterns of Missouri bats, with emphasis on the endangered species *Myotis grisescens* and *Myotis sodalis*. Journal of Mammalogy 58:592-599.

Mumford, R. E. and J. B. Cope. 1964. Distribution and status of the Chiroptera of Indiana. American Midland Naturalist 72:473-489.

Perry, R. W. and R. E. Thill. 2007. Roost selection by male and female northern long-eared bats in a pine-dominated landscape. Forest Ecology and Management 247:220-226.

Perry, R. W., R. E. Thill, and D. M. Leslie, Jr. 2007. Selection of roosting habitat by forest bats in a diverse forested landscape. Forest Ecology and Management 238:156-166.

Sasse, D. B. and P. J. Pekins. 1996. Summer roosting ecology of northern long-eared bats (*Myotis septentrionalis*) in the White Mountain National Forest. Pages 91-101 *in* Bats and Forests Symposium (R. M. R. Barclay and R. M. Brigham, eds.), October 19-21, 1995. Research Branch, British Columbia Minister of Forests Research Program. Victoria, British Columbia, Canada.

Silvis, A., W. M. Ford, E. R. Britzke, N. R. Beane, and J. B. Johnson. 2012. Forest succession and maternity day roost selection by *Myotis septentrionalis* in a mesophytic hardwood forest. International Journal of Forestry Research. 8p.

Silvis, A., W. M. Ford, E. R. Britzke, and J. B. Johnson. 2014. Association, roost use and simulated disruption of *Myotis septentrionalis* maternity colonies. Behavioural Processes 103:283–290.

Sparks, D. W. 2003. How does urbanization impact bats? Ph.D. Dissertation. Indiana State University, Terre Haute, Indiana. 121 pp.

Sparks, D. W. and J. R. Choate. 1995. New distributional records for mammals in Kansas. Prairie Naturalist 27:185-191.

Sparks, D. W. and J. R. Choate. 2000. Distribution, natural history, conservation status, and biogeography of bats in Kansas. Pages 173-228 *in* Reflections of a naturalist: Papers honoring professor Eugene D. Fleharty (J. R. Choate, ed.). Fort Hays Studies, Special Issue 1:1-241.

Sparks, D. W., J. R. Choate, and R. J. Winn. 1999. Observations on reproduction in three species of bats. Prairie Naturalist 31:245-248.

Sparks, D. W., C. J. Schmidt, and J. R. Choate. 2011. Bats of Kansas. Publication Number 5, Indiana State University Center for North American Bat Research and Conservation. 62 pp.

Timpone, J. C. 2004. Roost-site selection of bats in the northeast Missouri with emphasis on the endangered Indiana bat (*Myotis sodalis*). Masters thesis, Southwest Missouri State University. 71pp.

Timpone, J. C., J. G. Boyles, K. L. Murray, D. P. Aubrey, and L. W. Robbins. 2010. Overlap in roosting habits of Indiana bats (*Myotis sodalis*) and northern bats (*Myotis septentrionalis*). American Midland Naturalist 163:115-123.

USFWS. 2014. Northern long-eared bat interim conference and planning guidance: USFWS Regions 2, 3, 4, 5, & 6. U.S. Department of Interior, Fish and Wildlife Service. 67 pp.

van Zyll de Jong, C. G. 1979. Distribution and systematic relationships of long-eared Myotis in western Canada. Canadian Journal of Zoology 57:987-994.

Whitaker, J. O., Jr and L. J. Rissler. 1992. Seasonal activity of bats at Copperhead Cave. Proceedings of the Indiana Academy of Science 101:127-134.

Whitaker, J. O., Jr. and W. J. Hamilton. 1998. Mammals of the eastern United States, Third Edition. Comstock Publishing Associates, a division of Cornell University Press. 583 pp.

Whitaker, J. O., Jr. and R. E. Mumford. 2009. Mammals of Indiana. Indiana University Press. Bloomington, Indiana, 661 pp.

Whitaker, J. O., Jr., D. W. Sparks, and V. Brack, Jr. 2004a. Bats of the Indianapolis International airport area, 1991-2001. Proceedings of the Indiana Academy of Science 113:151-161.

Whitaker, J. O., Jr., D. W. Sparks, and V. Brack, Jr. 2004b. Bats of the Indianapolis International airport area, 1991–2001. Proceedings of the Indiana Academy of Science 113:151-161.

Whitaker, J. O., Jr., D. W. Sparks, and V. Brack, Jr. 2006. Use of artificial roost structures by bats at the Indianapolis International Airport. Environmental Management 38:28-36.

APPENDIX B
TABLES

Table 1. USFWS Indiana and Northern Long-eared Bat Acoustic Survey Guidelines

2018 ACOUSTIC GUIDELINES

1. The number of acoustic sites required for a project:
    a. Linear Projects: 2 detector nights per 0.6-mile (1-km), or
    b. Non-linear Projects: 8 detector nights per 123-acres (0.5 square km).
2. Acoustic sites should be at least 656 feet (200 meters) apart.
3. A qualified biologist must identify detector sites, placing them in areas most suitable for detecting listed bats.
    a. forest-canopy openings
    b. near water sources
    c. wooded fence lines that are adjacent to large openings or connect two larger blocks of suitable habitat
    d. blocks of recently logged forest where some potential roost trees remain
    e. road and/or stream corridors with open tree canopies or canopy height of more than 33 feet (10 meters)
    f. woodland edges
4. The acoustic sampling period for each site must begin at sunset and end at sunrise (1 detector-night).
5. Use weatherproofing only when absolutely necessary.
6. Detector night is not valid when following weather conditions are observed during the first 5 hours of survey:
    a. Temperatures below 50º F (10º C),
    b. Sustained wind speeds greater than 9 miles/hour (4 meters/second; 3 on Beaufort scale), and
    c. Precipitation (rain and/or fog) that is intermittent or lasts in excess of 30 minutes.
7. Download and process calls using an approved acoustic analysis program. High-frequency (≥35 kHz) or myotid calls should be evaluated to either verify or reject the classification. At a minimum, for each detector site/night, all files from that site/night must be qualitatively reviewed if potential presence is suspected based on software analysis.
8. Acoustic files are saved and submitted to USFWS.

Source: U.S. Fish and Wildlife Service; 2018

Table 2. Location of acoustic detectors on the Fort Calhoun Nuclear Generating Station in Washington County, Nebraska.

Detector Location (Detector)	Date Sampled (2018)	Latitude	Longitude
Site 1, Night 1 (54U04217)	12 August	41º 31' 4.7742" N	96º 4' 14.0406" W
Site 2, Night 1 (54U05195)	12 August	41º 31' 35.508" N	96º 5' 14.172" W
Site 1, Night 2 (54U04217)	13 August	41° 31' 2.7438" N	96° 4' 7.2942" W
Site 2, Night 2 (54U05195)	13 August	41° 31' 40.9368" N	96° 5' 24.792" W

Table 3. USFWS Mist Net Survey Guidelines

2018 NETTING GUIDELINES

Midwest and Ozark-Central Recovery Units (AL, AR, IA, IL, IN, GA, KY, MI, MO, MS, OH, OK, central & western TN, and Lee County, VA)

9. Netting Season: generally 15 May to 15 August.
10. Equipment (Mist Nets): constructed of the finest, lowest visibility mesh commercially available – monofilament or black nylon – with the mesh size approximately 1½ inch (1¼ –1¾) (38 mm).
11. Net Placement: mist nets extend approximately from water or ground level to tree canopy and are bounded by foliage on the sides. Net width and height are adjusted for the fullest coverage of the flight corridor at each site. A "typical" net set consists of two (or more) nets "stacked" on top of one another; width may vary up to 60 feet (20 m).
12. Net Site Spacing:
    - Linear Projects – minimum of 2 net nights per 0.6 mile (1 km); 1 net night = 1 net set deployed for 1 night.
    - Non-linear Projects – minimum of 9 net nights per 123 acres (.5 km).
    - Nets must be spread through the sampling area
13. Minimum Level of Effort Per Net Site:
    - At least 1 net location (sets) per net site.
    - At least 2 (calendar) nights of netting per net site.
    - Maximum of 3 nights of consecutive netting at any given location; must change net locations or wait at least 2 calendar nights before resuming netting at same location.
    - Sample Period: begin at dusk and net for 5 hours (approximately 0200h).
    - Nets are monitored at approximately 10-minute intervals.
    - No disturbance near the nets between checks.
14. Weather: Negative surveys combined with any of the following conditions throughout all or most of a sampling period are likely to require an additional night of mist-netting:
    - Precipitation (rain and/or heavy fog) lasting >30 minutes or continuing intermittently during the survey period.
    - Temperatures <10°C (50°F).
    - Sustained wind >9 mi/hr (4 m/sec) (3 on Beaufort scale).

Source: U.S. Fish and Wildlife Service; 2018

Table 4. Location of mist nets on the Fort Calhoun Nuclear Generating Station in Washington County, Nebraska.

Mist Net ID	Night Netted (2018)	Latitude	Longitude
Night 1, Net A	12 August	41° 30' 53.0748" N	96° 5' 16.9398" W
Night 1, Net B	12 August	41° 30' 52.3764" N	96° 5' 17.8686" W
Night 1, Net C	12 August	41° 30' 51.6096" N	96° 5' 18.6174" W
Night 2, Net A	13 August	41° 30' 53.8302" N	96° 5' 11.1768" W
Night 2, Net B	13 August	41° 30' 51.573" N	96° 5' 13.977" W
Night 2, Net C	13 August	41° 30' 50.4612" N	96° 5' 15.0282" W
Night 3, Net A	14 August	41° 30' 51.8322" N	96° 4' 40.7634" W
Night 3, Net B	14 August	41° 30' 51.0654" N	96° 4' 40.3716" W
Night 3, Net C	14 August	41° 30' 50.4936" N	96° 4' 41.2428" W

Table 5. Bat calls identified by Kaleidoscope Pro's automated call identification on the Fort Calhoun Nuclear Generating Station in Washington County, Nebraska.

Acoustic Monitoring Site	COTO	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU	TABR	Total Bat Calls
Site 1, Night 1	0	215	7	7	7	4	2	0	36	6	6	290
Site 2, Night 2	0	153	3	40	51	2	1	0	14	3	7	274
Site 1, Night 2	0	131	12	13	16	4	5	0	38	4	9	232
Site 2, Night 2	0	56	1	0	3	0	0	0	0	0	0	60
Total by Species	0	55	23	60	77	10	8	0	88	13	22	856

COTO = *Corynorhinus townsendii* (Townsend's big-eared bat); **EPFU** = *Eptesicus fuscus* (big brown bat); **LABO** = *Lasiurus borealis* (eastern red bat); **LACI** = *Lasiurus cinereus* (hoary bat); **LANO** = *Lasiurus noctivagans* (silver-haired bat); **MYLU** = *Myotis lucifugus* (little brown bat); **MYSE** = *Myotis septentrionalis* (northern long-eared bat); **MYSO** = *Myotis sodalis* (Indiana bat); **NYHU** = *Nycticeius humeralis* (evening bat); **PESU** = *Perimyotis subflavus* (tri-colored bat); **TABR** = *Tadarida brasiliensis* (Mexican free-tailed bat).

Table 6. Maximum likelihood estimator for the Fort Calhoun Nuclear Generating Station in Washington County, Nebraska.

Acoustic Monitoring Site	COTO	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU	TABR
Site 1	1	0	0	0.9242254	1	0.4393174	0.0000003	1	0	0.0000215	0.9997
Site 2	1	0	0.0230432	0	0.5461343	0.6750747	0.1830601	1	0.0001121	0.0130829	1

Table 7. Bat calls manually vetted on the Fort Calhoun Nuclear Generating Station in Washington County, Nebraska

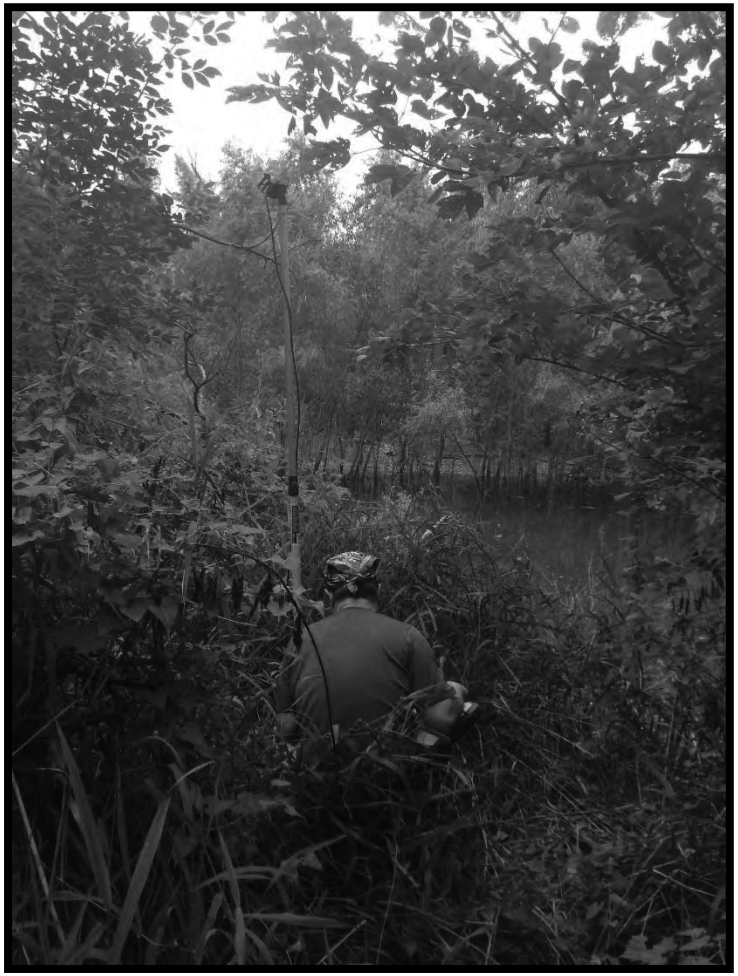
Acoustic Monitoring Site	COTO	EPFU	LABO	LACI	LANO	MYLU	MYSE	MYSO	NYHU	PESU	TABR	Total Bat Calls
Site 1, Night 1	0	204	3	7	3	0	1	0	25	5	0	248
Site 2, Night 2	0	157	6	38	22	0	0	0	12	2	0	162
Site 1, Night 2	0	105	9	10	3	0	4	0	27	4	0	237
Site 2, Night 2	0	49	1	0	0	0	0	0	0	0	0	50
Total by Species	0	515	19	55	28	0	5	0	64	11	0	697

Table 8. Mist net habitat characteristics on the Fort Calhoun Nuclear Generating Station in Washington County, Nebraska.

	Water Source		Tree Species				Clutter		**MYSO Roost Tree**		**MSYE Roost Tree**			
Site	Name	Distance (m)	Dominant Canopy	Subdominant Canopy	Subcanopy	Canopy Closure	Rating	Composition	Potential	Composition	Potential	Composition	Habitat Type	Herb. Cover
Site 1, Night 1	unnamed stream	0	*Populus sect. Aigeiros, Robinia pseudoacacia*	*Robinia pseudoacacia, Quercus rubra*	*Robinia pseudoacacia, Vaccinium spp.*	M	O	Shrubs & Saplings	L	Lrg trees	L	Lrg trees	YU, FE, S/R	S
Site 1, Night 2	unnamed stream	0	*Robinia pseudoacacia, Populus sect. Aigeiros, Celtis occidentalis*	*Ulmus rubra, Ligustrum sinense*	*Urtica dioica, Alopecurus spp.*	C	C	Shrubs	L	Lrg trees & snags	L	Lrg trees & snags	YL, FE, OF	D
Site 1, Night 3	unnamed stream	0	*Populus sect. Aigeiros, Robinia pseudoacacia*	*Robinia pseudoacacia, Asclepias spp.*	*Robinia pseudoacacia, Ligustrum sinense*	M	O	--	L	Lrg trees	M	Lrg trees	YL, WL	D

Tree/Shrub Species: foxtail grass (*Alopecurus* spp.), milkweed (*Asclepias* spp.), common hackberry (*Celtis occidentalis*), Chinese privet (*Ligustrum sinense*), cottonwood species (*Populus sect. Aigeiros*), northern red oak (*Quercus rubra*), black locust (*Robinia pseudoacacia*), slippery elm (*Ulmus rubra*), stinging nettle (*Urtica dioica*), blueberry (*Vaccinium* spp.)
Canopy Closure/Subcanopy Clutter: C = Closed; M = Moderate; O = Open
Roost Potential Rating: L = Low; M = Moderate; MYSO = Indiana bat (*Myotis sodalis*); MYSE = northern long-eared bat (*Myotis septentrionalis*)
Habitat Type: FE = Forest Edge; OF = Old Field; S/R = Stream/River; WL = Woodlot; YL = Young Lowland Forest; YU = Young Upland Forest
Herb (Herbaceous) Cover: D = Dense; S = Sparse

APPENDIX C
PHOTOGRAPHS



Acoustic Site 1, Night 1

Acoustic Site 1, Night 2

Acoustic Site 2, Night 1

Acoustic Site 2, Night 2

Site 1 Net A

Site 1 Net B

Site 1 Net C

Site 2 Net A

Site 2 Net B

Site 2 Net C

Site 3 Net A

Site 3 Net B


Latitude: 41.514026
Longitude: -96.078123
Elevation: 311.27m
Accuracy: 3.0m
Azimuth: 226° (SW)
Pitch: 8.1°
Time: 2018/08/14 20:08
Note: Calhoun Site3 NetC
Powered by AngleCam

Site 3 Net C

APPENDIX D
DATA SHEETS

2018

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4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT

Project #: 1236 **Date:** 12 Aug 2018 **State:** NE **County:** Washington

Project Name: Fort Calhoun **Site Name/#:** Site 1 **USGS Quad:** ______

Permitted Biologist: ______ (full name) Other Field Staff: ______ (full name) State Permit #: ______ Federal Permit #: ______

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
A	Net	41 ° 51[illegible]' 430 "N	-96 ° 0820' 390 "W		
B	Net	41 ° 5105' 490 "N	-96 ° 0822' 970 "W		
C	Net	41 ° 5103' 360 "N	-96 ° 0825' 050 "W		
		° ' "N	° ' "W		

Distance to closest water source (meters): ______ Type of water source: ______

Water source name: ______

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: ____ meters Channel Width: ____ meters Stream Width: ____ meters

Substratum: __Bedrock __Boulder __Cobble __Gravel __Sand __Silt/Clay

Still Water Present (Y/N): ____ *Average Water Depth:* ___ *m or cm* Clarity (H,M,L): ___

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)
- Cottonwood
- Black locust

Subdominant Canopy Species (< 40 cm/16" dbh)
- Black locust
- Northern red oak

Estimated dbh range: Lg: 50cm Sm: 10cm Estimated dbh range: Lg: 30 Sm: 10

Relative abundance of dominant vs. subdominant (ratio): 2:1

Estimated canopy closure: __Closed X Moderate __Open

Roost tree potential consists of: __Hollow X Large Trees __Snags __ Neither

M. sodalis roost tree potential is: __High __Moderate X Low

Roost potential comments: No exfoliating bark, few snags

M. septentrionalis roost tree potential is: __High __Moderate X Low

Roost potential comments: few snags

Subcanopy clutter: X Closed __Moderate __Open

Subcanopy consists largely of: __ Lower Branches of Canopy Trees X Saplings X Shrubs

Common Subcanopy Species: Black locust Hackberry ______

Check all that apply:
- __Mature Upland Forest
- X Young Upland Forest
- __Mature Lowland Forest
- __Young Lowland Forest
- __Recently Logged Forest
- X Forest Edge
- __Woodlot
- __Old Field
- __Crop/Pasture Land
- X Stream/River
- __Vernal Pool
- __Deepwater Lake/Pond
- Other ______

Herbaceous Cover: X Sparse __Moderate __Dense

2018

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ESI

BAT CAPTURE DATA

Project #: 1236

Date: 08.12.18

Project Name: Fort Calhoun

Site Name/#: Site 1

State: NE

County: Washington

GPS Unit #:

Camera #:

Permitted Biologist: James Gore (full name)

Other Field Staff: Stephanie Ellison (full name)

State Permit #:

Federal Permit #:

WEATHER DATA

Time (xxxx h)	Temp (°C)	Wind Speed (estimated – see chart)	% Cloud Cover (estimated)	Comments
21:27	27.78	1	5%	
21:46	24.44	1	5%	
23:13	21.67	1	10%	
23:52	21.67	0	6	
23:05	21.67	0	0	
1:09	20.56	0	0	

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Length (m)	Height (m)	Time Up (xxxx h)	Time Down (xxxx h)	Picture #	Waypoint #
A		41.5147430 "N	-96.0880390 "W	9	5	21:46	1:48		
B		41.5145490 "N	-96.0882910 "W	4	2.5	20:30	1:51		
C		41.5143360 "N	-96.0885050 "W	6	5	21:39	2:08		
		° ' "N	° ' "W						

Net Placement/Site Description:

Capt #	Net/ Trap	Species	Time	Age (Ad/Jv)	Sex (M/F)	Repro. 1	Wt (g)	RFA (mm)	Belly² (F/M/E)	Wing Index* (0-3)	Comments Picture # /Guano/Hair Sample/Band #

1 Reproductive Condition: Female = NR/PG/L/PL; Male = ↑/↓ (NR=Non-reproductive, PG=Pregnant, L=Lactating, PL=Post-Lactating; ↑=Ascended testes, ↓ Descende testes)
2 F=Full, M=Moderate, E=Empty
* Refer to table on the back

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2018

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HABITAT ASSESSMENT

Project #: 1236 **Date:** 08.13.18 **State:** NE **County:** Washington

Project Name: Fort Calhoun **Site Name/#:** Site 2 **USGS Quad:** ______

Permitted Biologist: James Gore (full name) Other Field Staff: Stephanie Ellison (full name) State Permit #: ______ Federal Permit #: ______

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
A		41.5149530 "N	-96.0864380 "W		
B		41.5143260 "N	-96.0872160 "W		
C		41.5140170 "N	-96.0875080 "W		
		° ' "N	° ' "W		

Distance to closest water source (meters): ______ Type of water source: ______

Water source name: ______

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: ____meters Channel Width: ____meters Stream Width: ____meters

Substratum: __Bedrock __Boulder __Cobble __Gravel __Sand __Silt/Clay

Still Water Present (Y/N): ____ *Average Water Depth:* ___*m or cm* Clarity (H,M,L): ___

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh):
Black locust (Robina pseudoacacia)
Cottonwood (Aigerios)
Hackberry (celtis occidentalis)

Subdominant Canopy Species (< 40 cm/16" dbh):
Slippery Elm (ulmus rubra)
Chinese privet (Ligustrum sinense)

Estimated dbh range: Lg: 45cm Sm: 40cm Estimated dbh range: Lg: 20cm Sm: 5cm

Relative abundance of dominant vs. subdominant (ratio): 3:1

Estimated canopy closure: __Closed X Moderate __Open

Roost tree potential consists of: __Hollow X Large Trees X Snags __Neither

M. sodalis roost tree potential is: __High __Moderate X Low

Roost potential comments: ______

M. septentrionalis roost tree potential is: __High __Moderate X Low

Roost potential comments: ______

Subcanopy clutter: X Closed __Moderate __Open

Subcanopy consists largely of: __Lower Branches of Canopy Trees __Saplings X Shrubs

Common Subcanopy Species: Stinging nettle foxtail ______

Check all that apply:

__Mature Upland Forest
__Young Upland Forest
__Mature Lowland Forest
X Young Lowland Forest
__Recently Logged Forest
X Forest Edge
__Woodlot
X Old Field
__Crop/Pasture Land
__Stream/River
__Vernal Pool
__Deepwater Lake/Pond
Other riparian

Herbaceous Cover: __Sparse __Moderate X Dense

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BAT CAPTURE DATA

Project #: 1236 **Date:** Aug 13, 2018

Project Name: Fort Calhoun **Site Name/#:** Site 2

State: NE **County:** Washington

GPS Unit #: ____ **Camera #:** ____

Permitted Biologist: James Gore (full name) Other Field Staff: Stephanie Ellison (full name)

State Permit #: ____ Federal Permit #: ____

WEATHER DATA

Time (xxxx h)	Temp (°C)	Wind Speed (estimated – see chart)	% Cloud Cover (estimated)	Comments
20:15	27.2	0	100%	
21:05	26.1	1	100%	
21:49	24.2	1	90%	
22:29	22.7	1	100	
23:24	22.4	0	100%	
00:15	22.8	1	75%	
00:42	23	1	90%	

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Length (m)	Height (m)	Time Up (xxxx h)	Time Down (xxxx h)	Picture #	Waypoint #
A		41.5149530 "N	-96.0864380 "W	6	2.5	20:15	1:15		
B		41.5143260 "N	-96.0872160 "W	9	5	20:15	1:15		
C		41.5140170 "N	-96.0875080 "W	12	5	20:15	1:15		
		° ' "N	° ' "W						

Net Placement/Site Description: ____

Capt #	Net/ Trap	Species	Time	Age (Ad/Jv)	Sex (M/F)	Repro.[1]	Wt (g)	RFA (mm)	Belly[2] (F/M/E)	Wing Index* (0-3)	Comments Picture # /Guano/Hair Sample/Band #
1	A	LABO	[illegible]	Ad	F	NR	11.0	39.8		0	WIB: 30.5-19.5

[1] Reproductive Condition: Female = NR/PG/L/PL; Male = ↑/↓ (NR=Non-reproductive, PG=Pregnant, L=Lactating, PL=Post-Lactating; ↑=Ascended testes, ↓ Descende testes)

2 F=Full, M=Moderate, E=Empty

* Refer to table on the back

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2018

HABITAT ASSESSMENT

Project #: 1236 **Date:** Aug 14th 2018 **State:** NE **County:** Washington

Project Name: Fort Calhoun **Site Name/#:** Site 3 **USGS Quad:** ______

Permitted Biologist: James Gore (full name) Other Field Staff: Stephanie Ellison (full name) State Permit #: ______ Federal Permit #: ______

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
A		41.514398 "N	-96.07799 "W		
B		41.514185 "N	-96.07781 "W		
C		41.514026 "N	-96.078123 "W		
		° ' "N	° ' "W		

Distance to closest water source (meters): ______ Type of water source: ______

Water source name: ______

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: ____ meters Channel Width: ____ meters Stream Width: ____ meters

Substratum: __Bedrock __Boulder __Cobble __Gravel __Sand __Silt/Clay

Still Water Present (Y/N): ____ Average Water Depth: ____ *m or cm* Clarity (H,M,L): ____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)	Subdominant Canopy Species (< 40 cm/16" dbh)
Cottonwood	Black locust
Black locust	Millkweed

Estimated dbh range: Lg: 75 Sm: 40 Estimated dbh range: Lg: 40 Sm: 20

Relative abundance of dominant vs. subdominant (ratio): 1:1

Estimated canopy closure: __Closed X Moderate __Open

Roost tree potential consists of: __Hollow X Large Trees __Snags __Neither

M. sodalis roost tree potential is: __High __Moderate X Low

Roost potential comments: ______

M. septentrionalis roost tree potential is: __High X Moderate __Low

Roost potential comments: ______

Subcanopy clutter: __Closed __Moderate X Open

Subcanopy consists largely of: __ Lower Branches of Canopy Trees __Saplings __Shrubs

Common Subcanopy Species: Black locust, [illegible]

Check all that apply:

- __Mature Upland Forest
- __Young Upland Forest
- __Mature Lowland Forest
- X Young Lowland Forest
- __Recently Logged Forest
- __Forest Edge
- X Woodlot
- __Old Field
- __Crop/Pasture Land
- __Stream/River
- __Vernal Pool
- __Deepwater Lake/Pond
- Other Riparian

Herbaceous Cover: __ Sparse __Moderate X Dense

2018

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BAT CAPTURE DATA

Project #: 1236 **Date:** Aug 14th, 2018

Project Name: Fort Calhoun **Site Name/#:** Site 3

State: NE **County:** Washington

GPS Unit #: ______ **Camera #:** ______

Permitted Biologist: James Gore (full name) Other Field Staff: Stephanie Ellison (full name)

State Permit #: ______ Federal Permit #: ______

WEATHER DATA

Time (xxxx h)	Temp (ºC)	Wind Speed (estimated – see chart)	% Cloud Cover (estimated)	Comments
20:12	23.3	1	99%	
21:05	21.8	0	99%	
21:59	22.5	0	100	light rain
[illegible]	[illegible]	0	100	
22:10	[illegible]	0	95	
23:30	19.5	1	80%	
00:03	19.5	1	80%	

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Length (m)	Height (m)	Time Up (xxxx h)	Time Down (xxxx h)	Picture #	Waypoint #
A		41.514398 "N	-96.07799 "W	9	5	20:21			
B		41.514185 "N	-96.077881 "W	6	2.5	20:15			
C		41.514026 "N	-96.078123 "W	9	5	20:12			
		° ' "N	° ' "W						

Net Placement/Site Description: ______

Capt #	Net/ Trap	Species	Time	Age (Ad/Jv)	Sex (M/F)	Repro.[1]	Wt (g)	RFA (mm)	Belly[2] (F/M/E)	Wing Index* (0-3)	Comments Picture # /Guano/Hair Sample/Band #
A		LABO	23:30	Ad	M	↑	11.5	39.5	M	0	WIB-32.5-21

[1] Reproductive Condition: Female = NR/PG/L/PL; Male = ↑/↓ (NR=Non-reproductive, PG=Pregnant, L=Lactating, PL=Post-Lactating; ↑=Ascended testes, ↓ Descende testes)
2 F=Full, M=Moderate, E=Empty
* Refer to table on the back
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2016

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ESI

Site 1 Calhoun

any of these:

DAILY DETECTOR DEPLOYMENT DATA CONT.

Nite 1 N 1

3. Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
54U04217	41.51799381 ° ' "N	-96.07056690 ° ' "W	1730	0100			

Detector Placement/Site Description:__________

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. Place the detector properly, confirm the detector is: Initial each blank	X 5 feet from vegetative clutter on the ground in all directions; X 656 feet from another detector	X 33 feet from vegetation in front of the microphone; ____ Parallel to woodland	____ Microphone is angled at 45-75 degrees; If not, WHY?	X 50 feet from any potential or known roost
2. Make sure the gear is working	Y Checked at 1650 (Time)			
3. Is detector water-proofed?	☒ Yes	☐ No	____ Initial	
4. Make sure the weather is not doing any of these:	X Too cold (<50 degrees F)	X Too windy (9 mph or more sustained)	X Precipitation for 30 minutes straight or intermittent the first 5 hours	

Nite 2 N 2

4. Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
	41.518661 "N	-96.072217 "W	1730	0100			

Detector Placement/Site Description:__________

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. Place the detector properly, confirm the detector is:	____ 5 feet from vegetative clutter on the ground in all directions; ____ 656 feet from another detector	____ 33 feet from vegetation in front of the microphone; ____ Parallel to woodland	____ Microphone is angled at 45-75 degrees; If not, WHY?	____ 50 feet from any potential or known roost
2. Make sure the gear is working	____ Checked at ____ (Time)			
3. Is detector water-proofed?	☐ Yes	☐ No	____ Initial	
4. Make sure the weather is not doing any of these:	____ Too cold (<50 degrees F)	____ Too windy (9 mph or more sustained)	____ Precipitation for 30 minutes straight or intermittent the first 5 hours	

If more than 4 detectors, use another data sheet.

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ESI Site 2 Calhoun

any of these:

DAILY DETECTOR DEPLOYMENT DATA CONT.

N1

3. Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
S4U05195	41.52653 °N	-96.08727 °W	1830	0100			

Detector Placement/Site Description: Riparian

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. Place the detector properly, confirm the detector is: Initial each blank	X 5 feet from vegetative clutter on the ground in all directions	___ 33 feet from vegetation in front of the microphone	___ Microphone is angled at 45-75 degrees	X 50 feet from any potential or known roost
	X 656 feet from another detector	___ Parallel to woodland	If not, WHY?	
2. Make sure the gear is working	X Checked at 1830 (Time)			
3. Is detector water-proofed?	☒ Yes	☐ No	___ Initial	
4. Make sure the weather is not doing any of these:	X Too cold (<50 degrees F)	X Too windy (9 mph or more sustained)	X Precipitation for 30 minutes straight or intermittent the first 5 hours	

N2

4. Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
S4U05195	41.527361 °N	-96.089758 °W	1750	0100			

Detector Placement/Site Description: Riparian

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. Place the detector properly, confirm the detector is:	X 5 feet from vegetative clutter on the ground in all directions	X 33 feet from vegetation in front of the microphone	___ Microphone is angled at 45-75 degrees	X 50 feet from any potential or known roost
	X 656 feet from another detector	___ Parallel to woodland	If not, WHY?	
2. Make sure the gear is working	X Checked at 1750 (Time)			
3. Is detector water-proofed?	☒ Yes	☐ No	___ Initial	
4. Make sure the weather is not doing any of these:	X Too cold (<50 degrees F)	X Too windy (9 mph or more sustained)	X Precipitation for 30 minutes straight or intermittent the first 5 hours	

If more than 4 detectors, use another data sheet.

area, it is a small plant and has chosen DECON as the decommissioning option, based on the updated environmental report, OPPD concludes that the impacts of FCS decommissioning on socioeconomic impacts are bounded by the GEIS.

5.1.13 Environmental Justice

Executive Order 12898 dated February 16, 1994, makes achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionally high and adverse human health and environmental effects of its programs, policies, and activities on minority populations and low-income populations of the United States.

Based on 2010 census date, the minority population within a 20-mile radius comprises 21.2% of the total population, and within a 50-mile radius is 16.6% of the total population. Douglas County is composed of greater than 10% black and 10% Hispanic populations. Thurston County is composed of the Omaha and Winnebago reservations. Native Americans comprised 55% of Thurston County's population according to 2010 data. Earlier census data found three counties in Nebraska (Thurston, Burt, and Douglas) and one in Iowa (Pottawattamie) within the 50 mile region exceeded the NRC thresholds defining low-income populations.

Section 4.13.3 of the GEIS reviewed environmental justice decommissioning impacts related to land use, environmental and human health, and socioeconomics. OPPD does not anticipate any offsite land disturbances during decommissioning, thus the land use impacts are not applicable for FCS. In addition as previously discussed in Section 5.1.12, it was determined that socioeconomic impacts from decommissioning are bounded by the GEIS. Potential impacts to minority and low-income populations would mostly consist of radiological effects. Based on the radiological environmental monitoring program data from FCS, the SEIS determined that the radiation and radioactivity in the environmental media monitored around the plant have been well within applicable regulatory limits. As a result, the SEIS found that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations (i.e., minority and or low income populations) in the region as a result of subsistence consumption of water, local food, fish, and wildlife.

Therefore, based on the updated environmental report, OPPD concludes that the impacts of FSC decommissioning on environmental justice are small and are bounded by the SEIS.

5.1.14 Cultural, Historic and Archeological Resources

Based on a review of the FCS property through the Nebraska State Historic Preservation Office (NSHPO) files and information provided by the applicant, the NRC concluded in Section 4.4.5 of the SEIS (Reference 8) that the potential impacts from decommissioning of FCS on historic and archaeological resources would be small. The NRC identified the section of the plant site that lies north of the rail spur and is bounded on the west by U.S. Highway 75 as having Moderate to-High Potential. It contains remnants of the former town of Desoto. Based on the impacts of past construction activities, the plant site being situated on floodplain alluvium, and having been developed since 1850, the section of the site that lies south of the current Union Pacific rail spur should be categorized as having No Potential for cultural resources, either prehistoric or historic. Environmental review procedures have been put in place at FCS regarding undertakings that