



Omaha Public Power District

**Fort Calhoun Station
Flood Recovery Action Plan 4.1
Plant and Facility Geotechnical and
Structural Assessment**

September 18, 2012

Revision 3

Final Report

Prepared for:
Omaha Public Power District
Fort Calhoun Station
9610 Power Lane
Blair, NE 68008

Prepared by:
HDR Engineering, Inc.
8404 Indian Hills Drive
Omaha, NE 68114

Security-Related and/or Personal Information Redacted

OPPD

Professional Engineer Seal

A study was conducted to support the Omaha Public Power District's Fort Calhoun Station Flood Recovery Action Plan 4.1, Plant and Facility Geotechnical and Structural Assessment. A team of professional engineers and scientists, listed in the Assessment Report, completed the review under my direction and control.

Date: September 18, 2012

Lawrence J. Cieslik, PE
Nebraska No.4876



Address of Licensed Engineer:
HDR Engineering
8404 Indian Hills Drive
Omaha, NE 68114
Phone: (402) 399-1000

Security-Related and/or Personal Information Redacted

OPPD

This Page Intentionally Left Blank

Preface

As the discovery process progressed, the Plant and Facility Geotechnical and Structural Assessment Report (Assessment Report) was periodically updated as indicated below. The issuance of the initial revisions of the Assessment Report was intended to provide early documentation of results. It was understood that subsequent revisions would add new information that would increase confidence in the results and conclusions. It is important to note that each revision includes the information contained in previous revisions.

- Revision 0, Issued 10/14/2011 – First issuance of report to OPPD by HDR. Revision 0 presented the results of preliminary assessments for each Priority 1 Structure.
- Revision 1, Issued 11/28/2011 – Incorporated results of geotechnical drilling program (including majority of data from subcontractors), geotechnical comparative analysis, and additional surveys and site monitoring. These data increased the confidence level in the conclusions for some structures.
- Revision 2, Issued 05/04/2012 – Incorporated results of the forensic investigations for Key Distress Indicators, early 2012 soil testing and investigation, and assessment of Priority 2 Structures.
- Revision 3, Issued 09/18/2012 – Incorporated responses to reviewer comments, along with additional soil testing and investigation (performed in mid-2012).

It should be noted that early revisions of the Assessment Report provided preliminary results and conclusions that may be clarified, revised, corrected, and/or confirmed in later sections of the Assessment Report. Therefore, all sections should be reviewed in their entirety before drawing any conclusions from this Assessment Report.

OPPD

This Page Intentionally Left Blank

Table of Contents

Executive Summary.....	1
Introduction	1
Scope and Purpose	1
Principal Findings of the Comparative Geotechnical Analysis	1
Key Distress Indicators	2
KDI #1 – Increased Flow into the Turbine Building Sump	2
KDI #2 – Pavement Failure and Surficial Void in Paved Access Area Between Intake Structure and Service Building	3
KDI #3 – Column Settlement in Maintenance Shop	3
Priority 1 and Priority 2 Structural Assessments	3
Recommendations for Structures Not Related to KDIs	5
Turbine Building South Switchyard	5
Fuel Oil Storage Tanks and Piping	5
Blair Water System	6
PA Paving, PA Sidewalks, and Outdoor Drives	6
Potable Water Piping	6
Sanitary Sewer System	6
Shooting Range	6
Sewage Lagoons	6
References	7

List of Tables

Table ES-1 - Summary of Structural Assessment	3
---	---

OPPD

This Page Intentionally Left Blank

EXECUTIVE SUMMARY

Introduction

Omaha Public Power District's (OPPD's) Fort Calhoun Station (FCS) is a 484-megawatt nuclear power plant (OPPD, September 25, 2011). FCS is located on the west bank of the Missouri River in northeastern Washington County, Nebraska. FCS is approximately 4 miles southeast of Blair, Nebraska, and approximately 19 miles north of Omaha, Nebraska.

The flooding of the Missouri River during the summer of 2011 "significantly challenged" the operation of FCS (OPPD, August 10, 2011). In response to this event, OPPD prepared a Flooding Recovery Action Plan that documented the actions necessary for the repair and restoration of FCS operations. This Fort Calhoun Station Plant and Facility Geotechnical and Structural Assessment Report (Assessment Report) has been prepared in response to FCS Flooding Recovery Action Plan 4.1 Element, Plant and Facility Geotechnical and Structural Assessment.

Scope and Purpose

The FCS Plant and Facility Geotechnical and Structural Assessment has been completed to identify and describe the geotechnical and structural effects of the 2011 flood on 28 Priority 1 Structures and 19 Priority 2 Structures at the FCS site. The Priority 1 Structures are those structures and systems that directly support plant operations. Priority 2 Structures are those structures and systems that do not directly support plant operations. Specifically, the purpose of this Assessment Report is to present HDR Engineering, Inc.'s (HDR's) assessment of changes to the soil and/or rock that supports the structures at FCS due to the 2011 Missouri River flood and/or the direct impacts of floodwater that may have negatively impacted those structures.

Revision 0 of this Assessment Report was submitted to OPPD on October 14, 2011. Revision 0 presented the results of preliminary assessments for each Priority 1 Structure. Revision 1 of this Assessment Report was submitted to OPPD on November 28, 2011, and provided updated information related to Priority 1 Structures. These assessments were incomplete in Revision 0 and Revision 1 because the forensic investigations and/or monitoring for most of the Priority 1 Structures were not completed by the submittal date. A draft of Revision 2 of this Assessment Report was submitted on December 28, 2011, and included updated results for Priority 1 Structures including additional monitoring data and the results of additional forensic investigations for the Key Distress Indicators (KDIs). Revision 2 also presented the results of the assessments for each of the Priority 2 structures. This final version of Revision 2 of the Assessment Report incorporates the findings of additional investigations of the KDIs along with comments received from OPPD on the draft document.

Principal Findings of the Comparative Geotechnical Analysis

Comparison of geotechnical data for pre- and post-flood investigations indicates that the observed scatter of data points is consistent with the relatively wide range of strength and stiffness and corresponding blow counts typically encountered in the alluvial soils within the Missouri River valley. Therefore, HDR concludes that there was no observable difference in the overall geotechnical conditions at the FCS site and that the foundation materials have not been disturbed or significantly weakened by the prolonged inundation caused by the 2011 flood. However, these findings are considered applicable only to those soils present below a depth of 10 feet (ft) at the site. The upper 10 ft were hydro-excavated to avoid damaging buried utilities. This upper layer may have been

disturbed from underseepage beneath the temporary levees or from the settlement of utility backfill during drawdown of the river level and groundwater.

Comparison of seismic refraction data from the pre- and post-flood investigations reveals similar magnitude of seismic wave velocities over the full depth of the overburden soils, and no observable differences between pre- and post-flood conditions were identified from this work.

Key Distress Indicators

During the FCS site visual assessments, three problem areas were observed that potentially indicated that the 2011 flood had changed the FCS site's geotechnical and physical character. These observed problem areas, referred to as KDIs, are the following:

1. Increased flow into the Turbine Building sump
2. Pavement failure and surficial void in the Paved Access Area between the Intake Structure and Service Building
3. Column settlement in the Maintenance Shop

Forensic investigations were undertaken in 2011 to better understand these KDIs. Additional investigations were necessary in 2012 to finalize the conclusions and recommendations for KDIs #1 and #3. A description of the geotechnical testing accomplished in 2012, a description of the analyses of the data collected in 2012, and the final conclusions and recommendations related to KDIs #1 and #3 are presented in Section 8.0 of the Assessment Report. Investigations and analyses related to KDI #2 were completed in 2011, and the final conclusions and recommendations for KDI #2 are presented in Section 4.2 of the Assessment Report.

KDI #1 – Increased Flow into the Turbine Building Sump

HDR recommends that OPPD perform remedial work to stop the unfiltered drainage of the groundwater into the broken sub-slab Turbine Building basement floor and equipment drainage system piping. The first priority is to permanently stop the drainage of unfiltered groundwater into the drainage system as quickly as possible to stop the potential for continued subgrade erosion. The most effective long-term solution is to abandon the existing drainage pipes by filling them with grout and then to construct an alternate drainage system. HDR believes that it is technically feasible to replace the existing system with an above-floor-slab drainage system. This option would facilitate monitoring and access to the system should repairs be necessary. Regardless of the method of remediation implemented, HDR recommends that a periodic monitoring program be initiated to verify that no unfiltered groundwater is pumped from beneath the Turbine Building or surrounding structures. The assurance that the unfiltered groundwater drainage into the Turbine Building sub-slab floor and equipment drain system has been permanently stopped will allow credible potential failure modes (CPFMs) 3a, 3b, and 3c to be ruled out with the exception of CPFM 3b for the Auxiliary Building and Containment. This is because the soils under the Auxiliary Building and Containment could not be tested for this assessment. In addition, CPFM 3b for the Turbine Building has not been evaluated for seismic loading for this Assessment Report. OPPD has informed HDR that it is using the services of an Appendix B structural engineering firm to evaluate these structures.

KDI #2 – Pavement Failure and Surficial Void in Paved Access Area Between Intake Structure and Service Building

OPPD conducted a pavement replacement program as part of scheduled 2011 flood repair activities. HDR has no further recommendations with respect to KDI #2.

KDI #3 – Column Settlement in Maintenance Shop

This column settlement (Column MG-15), began during the high water on the Missouri River in 2010, and accelerated during the 2011 Flood. This settlement has been found to be associated with KDI #1. During 2012, OPPD implemented physical modifications to remediate the distress in the Maintenance Shop. Helical piers were installed to bedrock, a new footing placed on these piers, and the void space beneath the floor slab filled with flowable fill concrete. These measures should prevent further settlement of Column MG-15.

Cracking and subsidence have been observed at the Maintenance Shop and Technical Support Center, and poorly compacted fill together with subsurface piping extending from the Turbine Building drain system may exist at the southwest corner of the Maintenance Shop. To date, only Column MG-15 in the Maintenance Shop has been repaired. We therefore recommend that OPPD continue to monitor the existing crack monitors in the Technical Support Center to note if any changes occur.

HDR has no further recommendations with respect to KDI #3.

Priority 1 and Priority 2 Structural Assessments

The results of the assessment for each of the Priority 1 and Priority 2 structures, with three exceptions, are presented in Table ES-1. The exceptions include the Auxiliary Building, Containment, and Turbine Building. For these structures, HDR recommends that OPPD employ the services of an Appendix B structural engineering firm to evaluate the Auxiliary Building and Containment for CPFM 3b, Loss of lateral support for pile foundation, related to the Triggering Mechanism of Subsurface Erosion/Piping (due to pumping), and to evaluate the Turbine Building for CPFM 3b for seismic loading.

Structure Name	Conclusion^A
Intake Structure	No impact due to 2011 flood
Auxiliary Building	Undergoing further investigations for loss of lateral pile support (CPFM 3b) by an Appendix B structural engineering firm
Containment	Undergoing further investigations for loss of lateral pile support (CPFM 3b) by an Appendix B structural engineering firm
Rad Waste Building	No impact due to 2011 flood
Technical Support Center	Recommended physical modifications ¹
Independent Spent Fuel Storage Installation (ISFSI)	No impact due to 2011 flood
Security Building	No impact due to 2011 flood
Turbine Building	Recommended physical modifications ¹ and undergoing further investigations for loss of lateral support (CPFM 3b) by an

Table ES-1 - Summary of Structural Assessment	
Structure Name	Conclusion^A
	Appendix B structural engineering firm
Security Barricaded Ballistic Resistant Enclosures (BBREs)	Recommended physical modifications ¹
Turbine Building South Switchyard	Recommended physical modifications ^{1,2}
Condensate Storage Tank	Recommended physical modifications ¹
Underground Cable Trench (Trenwa)	No impact due to 2011 flood
Circulating Water System	Recommended physical modifications ¹
Demineralized Water Tank, Pump House, and RO Unit	No impact due to 2011 flood
Raw Water Piping	Recommended physical modifications ¹
Fire Protection System Piping	Recommended physical modifications ¹
Waste Disposal Piping	Recommended physical modifications ¹
Fuel Oil Storage Tanks and Piping	Recommended physical modifications ^{1,3}
Main Underground Cable Bank, Auxiliary Building to Intake Structure	Recommended physical modifications ¹
Meteorological Tower and Miscellaneous Structures	No impact due to 2011 flood
Original Steam Generator Storage Building (OSGS)	No impact due to 2011 flood
Switchyard	No impact due to 2011 flood
Transmission Towers	No impact due to 2011 flood
Main Underground Cable Bank, MH-1 to Auxiliary Building	Recommended physical modifications ¹
River Bank	No impact due to 2011 flood
Blair Water System	Recommended physical modifications ^{1,4}
Demineralized Water System	Recommended physical modifications ¹
Camera Towers and High Mast Lighting	No impact due to 2011 flood
New Warehouse	No impact due to 2011 flood
Service Building	Recommended physical modifications ¹
Chemistry/Radiation Protection (CARP) Building	No impact due to 2011 flood
Maintenance Shop	Physical modifications implemented by OPPD. Recommended physical modifications ¹
Maintenance Fabrication Shop	No impact due to 2011 flood
PA Paving, PA Sidewalks, and Outdoor Drives	Recommended physical modifications ¹
Potable Water Piping	No impact due to 2011 flood
Sanitary Sewer System	Recommended physical modifications ^{1,5}
Maintenance Storage Building (Maintenance Shed)	No impact due to 2011 flood
Old Warehouse	No impact due to 2011 flood
Training Center	No impact due to 2011 flood
Administration Building	No impact due to 2011 flood
Hazardous Materials Storage Building (Hazmat Shed)	No impact due to 2011 flood

Table ES-1 - Summary of Structural Assessment	
Structure Name	Conclusion ^A
Maintenance Garage	No impact due to 2011 flood
Tertiary Building (Boat Storage)	No impact due to 2011 flood
Spare Transformer Pads	No impact due to 2011 flood
Shooting Range	Recommended physical modifications ⁶
Gravel Parking Lots	No impact due to 2011 flood
Sewage Lagoons	Recommended physical modifications ⁷
^A - "No impact due to 2011 flood" refers to the conclusion that the 2011 Missouri River flood did not impact the geotechnical and structural integrity of these structures because the potential for failure of these structures due to the flood is not significant. ¹ - HDR recommends that OPPD perform remedial work to stop the unfiltered drainage of the groundwater into the broken sub-slab Turbine Building basement floor and equipment drainage system piping. ² - HDR recommends that the settlement of the switch foundation slab located on the southwest corner of the west cable trench should be corrected. ³ - HDR recommends that the sand boil/piping feature observed in the Auxiliary Building in the missile shield room should be excavated to determine the extent of potential undermining; then the pipe trench should be backfilled as necessary with compacted granular material. ⁴ - HDR recommends that engineered fill should be placed in locations where soil subsidence has occurred. ⁵ - HDR recommends that the settled area around Sanitary Manhole MH-1 should be backfilled and compacted. ⁶ - HDR recommends that the base of the backstop berm should be rebuilt, dead vegetation should be removed, and reworked areas should be seeded and mulched. ⁷ - HDR recommends that the supply pipe connection with inlet pipe at the southeast corner of Cell No. 2 should be repaired and reconnected.	

Recommendations for Structures Not Related to KDIs

Recommendations for physical modifications related to the three KDIs are detailed in Section 9.4 of the Assessment Report. During the course of the assessment, eight structures were observed to be in need of physical modifications not related to one of the three KDIs. The recommendations for these eight structures are presented below. Background information can be found in the respective subsections of Sections 5.0 and 6.0 of the Assessment Report.

Turbine Building South Switchyard

Field observations indicated that the switch foundation slab located on the southwest corner of the west cable trench is currently settling on the east side adjacent to the conduit trench, resulting in tilting of the equipment. The settlement of the switch foundation slab located on the southwest corner of the west cable trench should be corrected.

Fuel Oil Storage Tanks and Piping

A sand boil/piping feature was observed in the Missile Shield room, which is adjacent to the Auxiliary Building. The sand boil/piping feature in the Missile Shield Room should be excavated to determine the extent of potential undermining; then the pipe trench should be backfilled as necessary with compacted granular material.

Blair Water System

New engineered fill should be placed in locations where soil subsidence has occurred. Apparent subsidence of less than 1 ft was observed in two locations overlying the Blair Water System trench alignment. These include the area at, and immediately surrounding, isolation valves DW 541 and DW 542 (within the traffic bollards located just north of Power Lane near the Training Center) and the area just south of Power Lane (near the Training Center) along the north side of the differentially settled transformer. The existing soils in these areas should be inspected prior to placement of additional engineered fill to identify soft, saturated zones. If soft, saturated soil zones are identified, these areas should be investigated to determine the extent of possible damages and repaired by filling to bring the subsided area to surrounding grade.

PA Paving, PA Sidewalks, and Outdoor Drives

Distressed pavement areas of the FCS site are scheduled for removal and replacement by OPPD as part of scheduled 2011 flood repair activities.

Potable Water Piping

Apparent subsidence of less than 1 ft was observed in two locations overlying the Potable Water Piping trench alignment. These include the area surrounding isolation valves DW 541 and DW 542 and the area just south of Power Lane (near the Training Center) along the north side of the differentially settled transformer. Additional backfill should be installed and compacted to support expected surface loads and to provide a minimum cover depth sufficient to protect the system from frost and expected surface loads. The existing soils in these areas should be inspected prior to placement of additional engineered fill to identify soft, saturated zones. If soft, saturated soil zones are identified, these areas should be investigated to determine the extent of possible damages and repaired prior to backfilling operations. Silt deposits left by the 2011 flood should be removed, and areas that will be filled should be scarified and compacted. Structural backfill should be placed to bring the earth back to grade.

Sanitary Sewer System

Settlement was observed at the surface on the south side of Sanitary Manhole MH-1. The settled area around the manhole should be backfilled and compacted.

Shooting Range

The base of the backstop berm should be rebuilt by adding fill material transitioning from the steep slope of the embankment to surrounding grades. In addition, dead vegetation, including the root balls, should be removed. Fill material should be constructed to match existing slope grades. Finally, reworked areas should be seeded and mulched.

Sewage Lagoons

The supply pipe along the bottom of Cell No. 2 was disconnected and displaced from the inlet pipe at the southeast corner of the cell. The pipe connection was broken near the cell lining. This connection should be repaired and reconnected.

References

OPPD. August 10, 2011. *Flooding Recovery Action Plan, Revision 0*. Document number LIC-11-0090.

OPPD. September 25, 2011. "Fort Calhoun Station." *OPPD.com*. Retrieved September 25, 2011. http://www.oppd.com/AboutUs/22_002696.

OPPD

OPPD

This Page Intentionally Left Blank

Table of Contents

Table of Contents

1.0	Introduction	1-1
1.1	Scope and Purpose.....	1-1
1.2	Assessment Report Organization, Content, and Revision History	1-3
1.2.1	Document Organization	1-3
1.2.2	Document Content	1-3
1.2.3	Revision History	1-4
1.3	Background	1-4
1.4	Assessment Process.....	1-7
1.5	Quality Assurance and Control.....	1-7
2.0	Site History, Description, and Baseline Condition.....	2-1
2.1	Geologic Setting.....	2-1
2.1.1	Historical Seismicity	2-1
2.1.2	Regional Seismicity and Faulting	2-2
2.1.3	Seismic Hazard	2-3
2.1.4	Site Geologic Hazards	2-3
2.2	Geomorphology and Physiographic Setting	2-8
2.2.1	Site Soils	2-10
2.2.2	Geomorphic Features	2-10
2.3	Hydrologic Baseline	2-10
2.3.1	Historic Missouri River Flooding.....	2-12
2.3.2	2011 Missouri River Basin Flood.....	2-14
2.3.3	Missouri River Flood Impact at FCS.....	2-16
2.3.4	Potential Flood Damages at FCS.....	2-27
2.4	Geotechnical Baseline	2-28
2.4.1	In-Situ Soil Characteristics	2-28
2.4.2	Rock Mass Characteristics.....	2-30
2.4.3	Groundwater	2-31
2.4.4	Ground Improvement Methods.....	2-32
2.4.5	Excavation and Backfill	2-33
2.5	Structural Baseline	2-33
2.5.1	Intake Structure	2-35
2.5.2	Auxiliary Building.....	2-36
2.5.3	Containment.....	2-37
2.5.4	Rad Waste Building.....	2-38
2.5.5	Technical Support Center	2-38
2.5.6	Independent Spent Fuel Storage Installation	2-39
2.5.7	Security Building	2-40
2.5.8	Turbine Building	2-41
2.5.9	Security Barricaded Ballistic Resistant Enclosures	2-42
2.5.10	Turbine Building South Switchyard	2-43
2.5.11	Condensate Storage Tank	2-45
2.5.12	Demineralized Water Tank, Pump House, and RO Unit	2-45
2.5.13	Meteorological Tower.....	2-46
2.5.14	Original Steam Generator Storage Building	2-48
2.5.15	Switchyard	2-48
2.5.16	Transmission Towers	2-52

Table of Contents

2.5.17	New Warehouse.....	2-53
2.5.18	Service Building	2-54
2.5.19	CARP Building	2-54
2.5.20	Maintenance Shop	2-55
2.5.21	Maintenance Fabrication Shop	2-56
2.5.22	Maintenance Storage Building (Maintenance Shed)	2-57
2.5.23	Old Warehouse	2-57
2.5.24	Training Center	2-58
2.5.25	Administration Building.....	2-58
2.5.26	Hazardous Material Storage Building.....	2-59
2.5.27	Maintenance Garage.....	2-60
2.5.28	Tertiary Building	2-60
2.5.29	Spare Transformer Pads.....	2-61
2.5.30	Shooting Range	2-61
2.6	Civil Baseline.....	2-62
2.6.1	Underground Piping Utilities.....	2-62
2.6.2	Underground Electrical Utilities	2-68
2.6.3	Underground Structures.....	2-70
2.6.4	Aboveground Structures	2-71
3.0	Assessment Process, Procedures, and Methods	3-1
3.1	Assessment Process.....	3-1
3.2	Assessment Process Steps	3-2
3.3	Field Observations	3-6
3.4	Identified Potential Failure Modes.....	3-7
3.5	Initial Screening of Potential Failure Modes	3-8
3.6	Potential Failure Modes Deemed Non-Credible for All Structures	3-9
3.7	Assessment Methods.....	3-11
4.0	Geotechnical Testing, Key Distress Indicators, and Geotechnical Comparative Analysis	4-1
4.01	Introduction	4-1
4.02	Testing Methods – 2011 and 2012.....	4-1
4.02.1	Geotechnical, Geophysical, and Pipe Video Inspection Work.....	4-1
4.02.1.1	Thiele Geotech, Inc.	4-2
4.02.1.2	American Engineering Testing, Inc.	4-5
4.02.1.3	Geotechnology, Inc.	4-5
4.02.1.4	Elite Pipeline Services.....	4-5
4.02.2	Survey and Monitoring Program.....	4-6
4.02.3	Groundwater versus River Level Mapping	4-6
4.03	Testing Accomplished in 2011	4-6
4.03.1	Geotechnical, Geophysical, and Pipe Video Inspection Work.....	4-6
4.03.1.1	Thiele Geotech, Inc.	4-6
4.03.1.2	American Engineering Testing, Inc.	4-7
4.03.1.3	Geotechnology, Inc.	4-7
4.03.1.4	Elite Pipeline Services.....	4-9
4.03.2	Survey and Monitoring Program.....	4-9
4.03.3	Groundwater versus River Level Mapping	4-10
4.04	Key Distress Indicators	4-11
4.1	KDI #1 – Increased Flow into the Turbine Building Sump.....	4-11
4.1.1	Physical Observations.....	4-13

Table of Contents

4.1.2	Triggering Mechanism.....	4-14
4.1.3	Structures and CPFMs Associated with Triggering Mechanism.....	4-15
4.1.4	KDI #1 Forensic Investigation	4-16
4.2	KDI #2 – Pavement Failure and Surficial Void in Paved Access Area Between Intake Structure and Service Building.....	4-24
4.2.1	Physical Observations.....	4-24
4.2.2	Triggering Mechanisms.....	4-24
4.2.3	Structures and CPFMs Associated with Triggering Mechanisms.....	4-26
4.2.4	Assessment Methods and Procedures.....	4-28
4.2.5	KDI #2 Forensic Investigation	4-29
4.3	KDI #3 – Column Settlement in Maintenance Shop	4-46
4.3.1	Physical Observations.....	4-47
4.3.2	Triggering Mechanisms.....	4-47
4.3.3	Structures and CPFMs Associated with Triggering Mechanisms	4-47
4.3.4	Assessment Methods and Procedures.....	4-49
4.3.5	Previous Investigations and Baseline Information.....	4-49
4.3.6	KDI #3 Forensic Investigation	4-49
4.4	Comparative Evaluation of Geotechnical Analyses.....	4-60
4.4.1	Site Conditions.....	4-61
4.4.2	Pre-Flood Investigations	4-61
4.4.3	Post-Flood Investigation.....	4-63
4.4.4	Interpretation of Penetration Resistance Data	4-64
4.4.5	Findings and Conclusions.....	4-65
4.4.6	Limitations.....	4-65
4.4.7	Test Standards.....	4-66
5.0	Priority 1 Structures	5.1-1
5.1	Intake Structure.....	5.1-1
5.1.1	Summary of Intake Structure	5.1-1
5.1.2	Inputs/References Supporting the Analysis	5.1-1
5.1.3	Assessment Methods and Procedures.....	5.1-3
5.1.4	Analysis.....	5.1-3
5.1.5	Results and Conclusions.....	5.1-10
5.1.6	Recommended Actions	5.1-10
5.1.7	Updates Since Revision 0	5.1-11
5.2	Auxiliary Building.....	5.2-1
5.2.1	Summary of Auxiliary Building.....	5.2-1
5.2.2	Inputs/References Supporting the Analysis	5.2-2
5.2.3	Assessment Methods and Procedures.....	5.2-3
5.2.4	Analysis.....	5.2-4
5.2.5	Results and Conclusions.....	5.2-10
5.2.6	Recommended Actions	5.2-10
5.2.7	Updates Since Revision 0	5.2-11
5.3	Containment.....	5.3-1
5.3.1	Summary of Containment	5.3-1
5.3.2	Inputs/References Supporting the Analysis	5.3-1
5.3.3	Assessment Methods and Procedures.....	5.3-2
5.3.4	Analysis.....	5.3-3
5.3.5	Results and Conclusions.....	5.3-9
5.3.6	Recommended Actions	5.3-9

Table of Contents

5.3.7	Updates Since Revision 0	5.3-10
5.4	Rad Waste Building.....	5.4-1
5.4.1	Summary of Rad Waste Building	5.4-1
5.4.2	Inputs/References Supporting the Analysis	5.4-1
5.4.3	Assessment Methods and Procedures.....	5.4-2
5.4.4	Analysis.....	5.4-2
5.4.5	Results and Conclusions.....	5.4-7
5.4.6	Recommended Actions	5.4-7
5.4.7	Updates Since Revision 0	5.4-7
5.5	Technical Support Center	5.5-1
5.5.1	Summary of Technical Support Center	5.5-1
5.5.2	Inputs/References Supporting the Analysis	5.5-1
5.5.3	Assessment Methods and Procedures.....	5.5-2
5.5.4	Analysis.....	5.5-2
5.5.5	Results and Conclusions.....	5.5-10
5.5.6	Recommended Actions	5.5-10
5.5.7	Updates Since Revision 0	5.5-11
5.6	Independent Spent Fuel Storage Installation	5.6-1
5.6.1	Summary of Independent Spent Fuel Storage Installation.....	5.6-1
5.6.2	Inputs/References Supporting the Analysis	5.6-2
5.6.3	Assessment Methods and Procedures.....	5.6-2
5.6.4	Analysis.....	5.6-3
5.6.5	Results and Conclusions.....	5.6-5
5.6.6	Recommended Actions	5.6-5
5.6.7	Updates Since Revision 0	5.6-5
5.7	Security Building	5.7-1
5.7.1	Summary of Security Building	5.7-1
5.7.2	Inputs/References Supporting the Analysis	5.7-2
5.7.3	Assessment Methods and Procedures.....	5.7-3
5.7.4	Analysis.....	5.7-3
5.7.5	Results and Conclusions.....	5.7-11
5.7.6	Recommended Actions	5.7-11
5.7.7	Updates Since Revision 0	5.7-12
5.8	Turbine Building	5.8-1
5.8.1	Summary of Turbine Building	5.8-1
5.8.2	Inputs/References Supporting the Analysis	5.8-1
5.8.3	Assessment Methods and Procedures.....	5.8-4
5.8.4	Analysis.....	5.8-4
5.8.5	Results and Conclusions.....	5.8-10
5.8.6	Recommended Actions	5.8-10
5.8.7	Updates Since Revision 0	5.8-11
5.9	Security Barricaded Ballistic Resistant Enclosures	5.9-1
5.9.1	Summary of Security Barricaded Ballistic Resistant Enclosures	5.9-1
5.9.2	Inputs/References Supporting the Analysis	5.9-1
5.9.3	Assessment Methods and Procedures.....	5.9-4
5.9.4	Analysis.....	5.9-4
5.9.5	Results and Conclusions.....	5.9-10
5.9.6	Recommended Actions	5.9-10
5.9.7	Updates Since Revision 0	5.9-11

Table of Contents

5.10 Turbine Building South Switchyard	5.10-1
5.10.1 Summary of Turbine Building South Switchyard	5.10-1
5.10.2 Inputs/References Supporting the Analysis	5.10-1
5.10.3 Assessment Methods and Procedures	5.10-2
5.10.4 Analysis	5.10-3
5.10.5 Results and Conclusions	5.10-14
5.10.6 Recommended Actions	5.10-14
5.10.7 Updates Since Revision 0	5.10-15
5.11 Condensate Storage Tank	5.11-1
5.11.1 Summary of Condensate Storage Tank	5.11-1
5.11.2 Inputs/References Supporting the Analysis	5.11-1
5.11.3 Assessment Methods and Procedures	5.11-3
5.11.4 Analysis	5.11-3
5.11.5 Results and Conclusions	5.11-14
5.11.6 Recommended Actions	5.11-14
5.11.7 Updates Since Revision 0	5.11-15
5.12 Underground Cable Trench	5.12-1
5.12.1 Summary of Underground Cable Trench	5.12-1
5.12.2 Inputs/References Supporting the Analysis	5.12-1
5.12.3 Assessment Methods and Procedures	5.12-3
5.12.4 Analysis	5.12-3
5.12.5 Results and Conclusions	5.12-13
5.12.6 Recommended Actions	5.12-13
5.12.7 Updates Since Revision 0	5.12-13
5.13 Circulating Water System	5.13-1
5.13.1 Summary of Circulating Water System	5.13-1
5.13.2 Inputs/References Supporting the Analysis	5.13-1
5.13.3 Assessment Methods and Procedures	5.13-3
5.13.4 Analysis	5.13-4
5.13.5 Results and Conclusions	5.13-8
5.13.6 Recommended Actions	5.13-9
5.13.7 Updates Since Revision 0	5.13-9
5.14 Demineralized Water Tank, Pump House, and RO Unit	5.14-1
5.14.1 Summary of Demineralized Water Tank, Pump House, and RO Unit	5.14-1
5.14.2 Inputs/References Supporting the Analysis	5.14-1
5.14.3 Assessment Methods and Procedures	5.14-2
5.14.4 Analysis	5.14-3
5.14.5 Results and Conclusions	5.14-10
5.14.6 Recommended Actions	5.14-10
5.14.7 Updates Since Revision 0	5.14-10
5.15 Raw Water Piping	5.15-1
5.15.1 Summary of Raw Water Piping	5.15-1
5.15.2 Inputs/References Supporting the Analysis	5.15-2
5.15.3 Assessment Methods and Procedures	5.15-3
5.15.4 Analysis	5.15-4
5.15.5 Results and Conclusions	5.15-12
5.15.6 Recommended Actions	5.15-12
5.15.7 Updates Since Revision 0	5.15-13

Table of Contents

5.16	Fire Protection System Piping	5.16-1
5.16.1	Summary of Fire Protection System Piping	5.16-1
5.16.2	Inputs/References Supporting the Analysis	5.16-1
5.16.3	Assessment Methods and Procedures.....	5.16-3
5.16.4	Analysis.....	5.16-4
5.16.5	Results and Conclusions.....	5.16-14
5.16.6	Recommended Actions	5.16-15
5.16.7	Updates Since Revision 0	5.16-15
5.17	Waste Disposal Piping	5.17-1
5.17.1	Summary of Waste Disposal Piping	5.17-1
5.17.2	Inputs/References Supporting the Analysis	5.17-1
5.17.3	Assessment Methods and Procedures.....	5.17-3
5.17.4	Analysis.....	5.17-4
5.17.5	Results and Conclusions.....	5.17-12
5.17.6	Recommended Actions	5.17-12
5.17.7	Updates Since Revision 0	5.17-12
5.18	Fuel Oil Storage Tanks and Piping.....	5.18-1
5.18.1	Summary of Fuel Oil Storage Tanks and Piping	5.18-1
5.18.2	Inputs/References Supporting the Analysis	5.18-1
5.18.3	Assessment Methods and Procedures.....	5.18-3
5.18.4	Analysis.....	5.18-4
5.18.5	Results and Conclusions.....	5.18-12
5.18.6	Recommended Actions	5.18-12
5.18.7	Updates Since Revision 0	5.18-13
5.19	Main Underground Cable Bank, Auxiliary Building to Intake Structure.....	5.19-1
5.19.1	Summary of Main Underground Cable Bank, Auxiliary Building to Intake Structure	5.19-1
5.19.2	Inputs/References Supporting the Analysis	5.19-1
5.19.3	Assessment Methods and Procedures.....	5.19-3
5.19.4	Analysis.....	5.19-4
5.19.5	Results and Conclusions.....	5.19-18
5.19.6	Recommended Actions	5.19-18
5.19.7	Updates Since Revision 0	5.19-19
5.20	Meteorological Tower and Miscellaneous Structures	5.20-1
5.20.1	Summary of Meteorological Tower and Miscellaneous Structures.....	5.20-1
5.20.2	Inputs/References Supporting the Analysis	5.20-1
5.20.3	Assessment Methods and Procedures.....	5.20-2
5.20.4	Analysis.....	5.20-3
5.20.5	Results and Conclusions.....	5.20-7
5.20.6	Recommended Actions	5.20-7
5.20.7	Updates Since Revision 0	5.20-8
5.21	Original Steam Generator Storage Building	5.21-1
5.21.1	Summary of Original Steam Generator Storage Building	5.21-1
5.21.2	Inputs/References Supporting the Analysis	5.21-1
5.21.3	Assessment Methods and Procedures.....	5.21-1
5.21.4	Analysis.....	5.21-2
5.21.5	Results	5.21-2

Table of Contents

5.21.6 Conclusions	5.21-2
5.22 Switchyard	5.22-1
5.22.1 Summary of Switchyard	5.22-1
5.22.2 Inputs/References Supporting the Analysis	5.22-3
5.22.3 Assessment Methods and Procedures.....	5.22-4
5.22.4 Analysis.....	5.22-5
5.22.5 Results and Conclusions.....	5.22-9
5.22.6 Recommended Actions	5.22-9
5.22.7 Updates Since Revision 0	5.22-10
5.23 Transmission Towers	5.23-1
5.23.1 Summary of Transmission Towers.....	5.23-1
5.23.2 Inputs/References Supporting the Analysis	5.23-1
5.23.3 Assessment Methods and Procedures.....	5.23-2
5.23.4 Analysis.....	5.23-6
5.23.5 Results and Conclusions.....	5.23-11
5.23.6 Recommended Actions	5.23-11
5.23.7 Updates Since Revision 0	5.23-12
5.24 Main Underground Cable Bank, MH-1 to Auxiliary Building	5.24-1
5.24.1 Summary of Main Underground Cable Bank, MH-1 to Auxiliary Building.....	5.24-1
5.24.2 Inputs/References Supporting the Analysis	5.24-1
5.24.3 Assessment Methods and Procedures.....	5.24-3
5.24.4 Analysis.....	5.24-4
5.24.5 Results and Conclusions.....	5.24-9
5.24.6 Recommended Actions	5.24-9
5.24.7 Updates Since Revision 0	5.24-10
5.25 River Bank	5.25-1
5.25.1 Summary of River Bank	5.25-1
5.25.2 Inputs/References Supporting the Analysis	5.25-1
5.25.3 Assessment Methods and Procedures.....	5.25-2
5.25.4 Analysis.....	5.25-3
5.25.5 Results and Conclusions.....	5.25-9
5.25.6 Recommended Actions	5.25-9
5.25.7 Updates Since Revision 0	5.25-10
5.26 Blair Water System	5.26-1
5.26.1 Summary of Blair Water System	5.26-1
5.26.2 Inputs/References Supporting the Analysis	5.26-1
5.26.3 Assessment Methods and Procedures.....	5.26-3
5.26.4 Analysis.....	5.26-4
5.26.5 Results and Conclusions.....	5.26-12
5.26.6 Recommended Actions	5.26-12
5.26.7 Updates Since Revision 0	5.26-13
5.27 Demineralized Water System.....	5.27-1
5.27.1 Summary of Demineralized Water System	5.27-1
5.27.2 Inputs/References Supporting the Analysis	5.27-2
5.27.3 Assessment Methods and Procedures.....	5.27-3
5.27.4 Analysis.....	5.27-3
5.27.5 Results and Conclusions.....	5.27-9
5.27.6 Recommended Actions	5.27-9

Table of Contents

	5.27.7 Updates Since Revision 0	5.27-10
	5.28 Camera Towers and High Mast Lighting	5.28-1
	5.28.1 Summary of Camera Towers and High Mast Lighting	5.28-1
	5.28.2 Inputs/References Supporting the Analysis	5.28-1
	5.28.3 Assessment Methods and Procedures.....	5.28-2
	5.28.4 Analysis.....	5.28-2
	5.28.5 Results and Conclusions.....	5.28-10
	5.28.6 Recommended Actions	5.28-10
	5.28.7 Updates Since Revision 0	5.28-10
6.0	Priority 2 Structures	6.1-1
	6.1 New Warehouse.....	6.1-1
	6.1.1 Summary of New Warehouse	6.1-1
	6.1.2 Inputs/References Supporting the Analysis	6.1-1
	6.1.3 Assessment Methods and Procedures.....	6.1-3
	6.1.4 Analysis.....	6.1-3
	6.1.5 Results and Conclusions.....	6.1-5
	6.2 Service Building	6.2-1
	6.2.1 Summary of Service Building	6.2-1
	6.2.2 Inputs/References Supporting the Analysis	6.2-1
	6.2.3 Assessment Methods and Procedures.....	6.2-3
	6.2.4 Analysis.....	6.2-4
	6.2.5 Results	6.2-9
	6.2.6 Conclusions	6.2-10
	6.3 Chemistry/Radiation Protection Building.....	6.3-1
	6.3.1 Summary of Chemistry/Radiation Protection Building.....	6.3-1
	6.3.2 Inputs/References Supporting the Analysis	6.3-1
	6.3.3 Assessment Methods and Procedures.....	6.3-2
	6.3.4 Analysis.....	6.3-2
	6.3.5 Results and Conclusions.....	6.3-5
	6.4 Maintenance Shop	6.4-1
	6.4.1 Summary of Maintenance Shop	6.4-1
	6.4.2 Inputs/References Supporting the Analysis	6.4-2
	6.4.3 Assessment Methods and Procedures.....	6.4-3
	6.4.4 Analysis.....	6.4-4
	6.4.5 Results	6.4-8
	6.4.6 Conclusions	6.4-9
	6.5 Maintenance Fabrication Shop	6.5-1
	6.5.1 Summary of Maintenance Fabrication Shop	6.5-1
	6.5.2 Inputs/References Supporting the Analysis	6.5-1
	6.5.3 Assessment Methods and Procedures.....	6.5-2
	6.5.4 Analysis.....	6.5-2
	6.5.5 Results and Conclusions.....	6.5-4
	6.6 PA Paving, PA Sidewalks, and Outdoor Drives	6.6-1
	6.6.1 Summary of PA Paving, PA Sidewalks, and Outdoor Drives	6.6-1
	6.6.2 Inputs/References Supporting the Analysis	6.6-1
	6.6.3 Assessment Methods and Procedures.....	6.6-3
	6.6.4 Analysis.....	6.6-3
	6.6.5 Results and Recommendations	6.6-11
	6.6.6 Conclusions	6.6-12

Table of Contents

6.7	Potable Water Piping	6.7-1
6.7.1	Summary of Potable Water Piping	6.7-1
6.7.2	Inputs/References Supporting the Analysis	6.7-1
6.7.3	Assessment Methods and Procedures.....	6.7-2
6.7.4	Analysis.....	6.7-3
6.7.5	Results and Recommendations	6.7-8
6.7.6	Conclusions	6.7-9
6.8	Sanitary Sewer System.....	6.8-1
6.8.1	Summary of Sanitary Sewer System.....	6.8-1
6.8.2	Inputs/References Supporting the Analysis	6.8-2
6.8.3	Assessment Methods and Procedures.....	6.8-3
6.8.4	Analysis.....	6.8-4
6.8.5	Results and Recommendations	6.8-9
6.8.6	Conclusions	6.8-10
6.9	Maintenance Storage Building	6.9-1
6.9.1	Summary of Maintenance Storage Building	6.9-1
6.9.2	Inputs/References Supporting the Analysis	6.9-1
6.9.3	Assessment Methods and Procedures.....	6.9-2
6.9.4	Analysis.....	6.9-2
6.9.5	Results and Conclusions.....	6.9-4
6.10	Old Warehouse	6.10-1
6.10.1	Summary of Old Warehouse.....	6.10-1
6.10.2	Inputs/References Supporting the Analysis	6.10-1
6.10.3	Assessment Methods and Procedures.....	6.10-2
6.10.4	Analysis.....	6.10-2
6.10.5	Results and Conclusions.....	6.10-5
6.11	Training Center	6.11-1
6.11.1	Summary of Training Center	6.11-1
6.11.2	Inputs/References Supporting the Analysis	6.11-1
6.11.3	Assessment Methods and Procedures.....	6.11-2
6.11.4	Analysis.....	6.11-2
6.11.5	Results and Conclusions.....	6.11-4
6.12	Administration Building	6.12-1
6.12.1	Summary of Administration Building	6.12-1
6.12.2	Inputs/References Supporting the Analysis	6.12-1
6.12.3	Assessment Methods and Procedures.....	6.12-2
6.12.4	Analysis.....	6.12-2
6.12.5	Results and Conclusions.....	6.12-4
6.13	Hazardous Material Storage Building.....	6.13-1
6.13.1	Summary of Hazardous Material Storage Building.....	6.13-1
6.13.2	Inputs/References Supporting the Analysis	6.13-1
6.13.3	Assessment Methods and Procedures.....	6.13-2
6.13.4	Analysis.....	6.13-2
6.13.5	Results and Conclusions.....	6.13-4
6.14	Maintenance Garage.....	6.14-1
6.14.1	Summary of Maintenance Garage	6.14-1
6.14.2	Inputs/References Supporting the Analysis	6.14-1
6.14.3	Assessment Methods and Procedures.....	6.14-2
6.14.4	Analysis.....	6.14-2