## 5.24 Main Underground Cable Bank, MH-1 to Auxiliary Building

### 5.24.1 Summary of Main Underground Cable Bank, MH-1 to Auxiliary Building

Baseline information for the Main Underground Cable Bank from MH-1 to the Auxiliary Building is provided in Section 2.0, Site History, Description, and Baseline Condition.

The portion of the Main Underground Cable Bank system covered under this section extends from Manhole MH-1 to the Auxiliary Building. MH-1 is located near the southeast corner of the Switchyard. A duct bank from the Switchyard connects to the north wall of MH-1. MH-2 is located east of MH-1 and west of the Old Warehouse. The duct bank between MH-1 and MH-2 is routed beneath the northwest corner of the new Maintenance Garage and the King Tut Wall. From MH-2, it is routed east and extends to MH-3, which is located inside the Rad Waste Building. Between MH-2 and MH-3, the duct bank crosses beneath the Old Warehouse addition, the site perimeter and security fences, and the Trenwa cable trench. From MH-3, the duct bank is routed to the south and out of the Rad Waste Building to MH-4. At MH-4, the cabling turns east 90° and extends east to the point where it turns 90° and terminates outside of the Auxiliary Building. Outside of the Auxiliary Building, the duct bank turns vertically upward and terminates above grade in a pull box. The top of the ducts that terminate in the pull box adjacent to the Auxiliary Building are set at el. 1005.0 ft, according to Drawing 11405-E-320. The duct bank between MH-4 and the Auxiliary Building runs adjacent to the face of the Auxiliary Building. A missile shield room addition to the Auxiliary Building was built subsequent to construction of the duct bank and is located directly over the Main Underground Cable Bank.

### 5.24.2 Inputs/References Supporting the Analysis

Table 5.24-1 lists references provided by OPPD and other documents used to support HDR's analysis.

**Table 5.24-1 - References for Main Underground Cable Bank, MH-1 to Auxiliary Building**

| Document Title | OPPD Document Number (if applicable) | Date | Page Number(s) |
|---|---|---|---|
| Underground Duct System | CE-79-3 (#60184) | 12/13/2002 | |
| Condition Report | CR 2011-7265 | 9/9/2011 | All |
| Diesel Generator Enclosure Plan & Details SH-1 | 13007.18-EC-18A-1 (#24002) | Unknown | |
| Site Plan Underground Ducts – Manholes-Outdoor Lighting-Fence Grounding | 11405-E-319 (#12582) | Unknown | |
| Underground Ducts & Manholes Sections & Details, SH 1 | 11405-E-320, Sht. 1 (#12583) | Unknown | |
| Underground Ducts & Manhole Sections & Details, SH 2 | 11405-E-321, Sht. 2 (#12584) | Unknown | |
| Underground Ducts & Manhole Sections & Details, SH 3 | 11405-E-322, Sht. 3 (#12585) | Unknown | |
| Naval Facilities Engineering Command, Design Manual 7.01, Soil Mechanics | | 9/1986 | All |

Detailed site observations—field reports, field notes, and inspection checklists—for the Main Underground Cable Bank from MH-1 to the Auxiliary Building, are provided in Attachment 8.

Observed performance and pertinent background data are as follows:

- As early as 1993, excessive flow into a sump in the Turbine Building basement was observed. Subsequently, this flow was attributed to unfiltered groundwater entering breaks in drainage pipes under the Turbine Building basement floor slab.
- In 1997 a void, estimated to be approximately 10 x 8 x 1 ft, was documented below the basement floor slab in the Turbine Building. For further information see Section 5.8. A more detailed discussion of this KDI is presented in Section 4.1.
- Settlement of a column in the Maintenance Shop, north of the Turbine Building, was documented by OPPD and HDR personnel. A condition report describing the event, condition, and related issues was created by OPPD and is on record. The Turbine Building and the Maintenance Shop are located east of the Auxiliary Building. A more detailed discussion of this KDI is presented in Section 4.3.
- The Main Underground Cable Bank (MH-4 to the Auxiliary Building) extends under the Auxiliary Building missile shield room.
- The Main Underground Cable Bank alignment, where it passes beneath the missile shield room, is located adjacent to fuel tank FO-1 and the associated fuel supply piping.
- A sand boil/piping feature was observed (originally reported in CR 2011-7265) near the southwestern corner of the Auxiliary Building, in the missile shield room. This room is located along the south wall of the Auxiliary Building and has an unfinished pea gravel floor surface. FO-1 is located outside the missile shield room, with fuel oil piping entering the room below floor elevation near the observed boil/piping feature.
- The Aqua Dam that surrounded much of the PA crossed the Main Underground Cable Bank.
- The Aqua Dam failed for a short period of time because it was damaged, which allowed floodwater to enter the area inside the perimeter of the Aqua Dam. Surfaces above the Main Underground Cable Bank were inundated when the Aqua Dam failed.
- [redacted]
- MH-1 was opened and pumped out by OPPD employees on September 7, 2011. The water level prior to beginning pumping activities was level to the bottom of the concrete manhole cover according to OPPD employees questioned during HDR's observation of pumping operations.
- MH-1 was also opened and pumped out by OPPD employees on September 13, 2011. An OPPD employee entered MH-1 and photographed the interior walls once the manhole was emptied. The employee noted that cracks adjacent to the cable duct openings were a pre-existing condition that existed prior to the 2011 flood.
- MH-1 pump discharge was routed to a large swale located along the east side of the switchyard. The water level was significantly lower than the rim and cover of the manhole at the time of initial pumping. Water levels in the swale had dropped an additional 1 ft or 2 ft lower at the time of the second pumping.
- Pumping operations to empty the manhole required emptying the connecting duct banks and adjoining manholes to the level of the connecting ducts.

- OPPD employees pumping MH-1 the first day stated that MH-2 had been pumped dry the day prior.
- Manhole pumping operations were performed after floodwater had receded to the point where the manholes were accessible.
- A swale crosses the duct bank east of MH-2. Minor localized surface erosion was observed along the banks of the swale north of the Maintenance Garage and where the swale crosses the duct bank.
- On September 13, 2011, Thiele Geotech was hydro-excavating for soil borings south of the new six-bay Maintenance Garage. At the time of field observations, vacuum excavations had proceeded to a 2-ft depth and exposed a reinforced gravel road section composed of Geogrid installed in 6-in. layers. Four layers of Geogrid were visible at the time of field observations. The lateral extents of the Geogrid reinforcement in the gravel surfaced areas are not known at this time.

## 5.24.3 Assessment Methods and Procedures

### 5.24.3.1 Assessment Procedures Accomplished

Assessments were made by walking the Main Underground Cable Bank alignment and observing surface features of the system (manholes) and the ground surface overlying the Main Underground Cable Bank. The surface assessment included using a fiberglass T-probe to hand probe the ground surface along the utility alignments and adjacent areas to determine relative soil strength. The assessment focused on identifying conditions indicative of potential flood-related impacts or damage to the utility as follows:

- Ground surface conditions overlying and immediately adjacent to the utility and its backfilled trench including scour, subsidence or settlement, lateral spreading, piping, and heave
- Soft ground surface areas (native soil, engineered fill, and/or limestone gravel pavement) as determined by probing
- Water accumulations and flows in subsurface system components (manholes and concrete cable encasement pipes)
- Damage to at-grade or above-grade system features and equipment
- Variance from normal installation conditions, including settled, tilted, or heaved system features and equipment
- Operation of the system and appurtenant equipment (i.e., is the system operational?)

Additional investigations were performed to further characterize the subsurface at the facility including areas where conditions indicative of potential flood-related impacts or damage was observed. These included the following:

- GPR. (Test reports were not available at the time of Revision 0.)
- Paved areas were evaluated with GPR and dynamic deflection methods (i.e., FWD). (Test reports were not available at the time of Revision 0.)

#### 5.24.3.2 Assessment Procedures Not Completed

Assessments of the Main Underground Cable Bank from MH-1 to the Auxiliary Building that were not completed include the following:

- The interior of underground cable bank manholes and connecting concrete-encased cable ducts were inspected only with visual observations that were possible from above and behind temporary safety railings. A manhole is a confined space as defined by OSHA regulations. In accordance with these regulations and OPPD FCS safety procedures, manhole entry requires a confined space entry permit and can only be performed by appropriately trained OPPD personnel.
- No excavation to inspect underground systems and conditions was performed. Unless field conditions are observed that might indicate problems, this assessment is not warranted.

### 5.24.4 Analysis

Identified PFMs were initially reviewed as discussed in Section 3.0. The review considered the preliminary information available from OPPD data files and from initial walk down observations. Eleven PFMs associated with five different Triggering Mechanisms were determined to be "non-credible" for all Priority 1 Structures, as discussed in Section 3.6. The remaining PFMs were carried forward as "credible." After the design review for each structure, the structure observations, and the results of available geotechnical, geophysical, and survey data were analyzed, a number of CPFMs were ruled out as discussed in Section 5.24.4.1. The CPFMs carried forward for detailed assessment are discussed in Section 5.24.4.2.

#### 5.24.4.1 Potential Failure Modes Ruled Out Prior to the Completion of the Detailed Assessment

The ruled-out CPFMs reside in the Not Significant/High Confidence category and for clarity will not be shown in the Potential for Failure/Confidence matrix.

**Triggering Mechanism 2 – Surface Erosion**

CPFM 2a – Undermining shallow foundation/slab/surfaces
CPFM 2c – Undermined buried utilities

Reasons for ruling out:

- No surface erosion was observed at the Main Underground Cable Bank manholes or on the ground surface overlying the alignment of this system's underground concrete cable encasements.
- Only localized and limited surface erosion was observed on the ground surface across the facility. The Main Underground Cable Bank system is constructed at depths sufficiently below potential scour depths indicated by surface erosion features observed in other areas.

**Triggering Mechanism 4 – Hydrostatic Lateral Loading (water loading on structures)**
CPFM 4c – Wall failure in flexure
CPFM 4d – Wall failure in shear
CPFM 4e – Excess deflection

Reasons for ruling out:

- This segment of the Main Underground Cable Bank system was not pumped while the site was inundated with water. Manholes in this segment (MH-1, MH-2, and MH-4) were not pumped until floodwater had receded to below ground surface elevations and the manholes were vehicle accessible. Prior to pumping, the system was flooded and not susceptible to hydrostatic loads.
- Underground structures are designed for hydrostatic pressures as a standard practice.
- According to OPPD staff, this system was pumped on numerous occasions in the past due to high groundwater conditions.

**Triggering Mechanism 6 – Buoyancy, Uplift Forces on Structures**
CPFM 6b – Cracked slab, loss of structural support
CPFM 6c – Displaced structure/broken connections

Reason for ruling out:

- This segment of the cable bank was not pumped while the site was inundated by flood water. Manholes in this segment (MH-1, MH-2, and MH-4) were not pumped until the water level had dropped. Prior to pumping, the system was flooded and therefore was not susceptible to uplift forces.

**Triggering Mechanism 7 – Soil Collapse (first time wetting)**
CPFM 7a – Cracked slab, differential settlement of shallow foundation, loss of structural support
CPFM 7b – Displaced structure/broken connections
CPFM 7c – General site settlement

Reason for ruling out:

- Soil supporting and surrounding the Main Underground Cable Bank system has been previously wetted. The peak flood elevation prior to 2011 was 1003.3 ft, which occurred in 1993.

**Triggering Mechanism 10 – Machine/Vibration-Induced Liquefaction**
CPFM 10a – Cracked slab, differential settlement of shallow foundation, loss of structural support
CPFM 10b – Displaced structure/broken connections
CPFM 10c – Additional lateral force on below-grade walls

Reasons for ruling out:

- Machine vibrations from the facility (turbine and various pumps) have historically occurred, and no indications of these CPFMs are evident.

- Pumps used on site during the flood event were too small to cause ground or structure vibrations sufficient to initiate soil liquefaction. Visible indications of liquefaction were not observed around the areas where the pumps were operating, and no evidence of liquefaction was reported to HDR.
- No structure movements indicative of soil liquefaction and resultant settlement were observed; no structure cracking or lateral movements were observed.

**Triggering Mechanism 11 – Loss of Soil Strength due to Static Liquefaction or Upward Seepage**

CPFM 11a – Cracked slab, differential settlement of shallow foundation, loss of structural support
CPFM 11b – Displaced structure/broken connections
CPFM 11c – Additional lateral force on below-grade walls

Reason for ruling out:

- Static liquefaction occurs when a relatively small disturbance precedes an instability that allows gravity to take over and produce large, rapid movements. This was not observed on site.

**Triggering Mechanism 12 – Rapid Drawdown**

CPFM 12a – River bank slope failure and undermining surrounding structures
CPFM 12b – Lateral spreading

Reason for ruling out:

- This condition pertains to slope instability associated with rapid drawdown of the river level. Since this segment of the Main Underground Cable Bank cable is well away from the river, the potential for these CPFMs is remote; these CPFMs are therefore ruled out.

**Triggering Mechanism 13 – Submergence**

CPFM 13a – Corrosion of underground utilities

Reason for ruling out:

- Underground utilities and structures are located below the design flood elevation for the facility. Groundwater elevations controlled by Missouri River water elevations, percolation of storm precipitation, and winter snow melt would be expected to contact underground improvements, including constructed steel and concrete facility elements. As such, steel and concrete site improvements are assumed to be designed to withstand the corrosive environment of groundwater and wetted soil.

**Triggering Mechanism 14 – Frost Effects**

CPFM 14a – Heaving, crushing, or displacement

Reasons for ruling out:

- Utility cabling is not rigid and not subjected to major damage due to frost-induced displacement.
- Manholes and the bottom of the duct banks are founded below frost level.

- Saturated soil conditions have occurred in the past. Conditions have not been changed due to flood conditions.

### 5.24.4.2 Detailed Assessment of Credible Potential Failure Modes

The following CPFMs are the only CPFMs carried forward for detailed assessment for the Main Underground Cable Bank from MH-1 to the Auxiliary Building as a result of the 2011 flood. This detailed assessment is provided below.

**Triggering Mechanism 3 – Subsurface Erosion/Piping**

CPFM 3a – Undermining and settlement of shallow foundation/slab/surfaces (due to pumping)

CPFM 3c – Undermined buried utilities (due to pumping)

The Triggering Mechanism and CPFMs could occur as follows: multiple potentially connected seepage paths exist in the soil backfill at the site, including soil backfill in utility trenches, granular trench bedding, broken building floor and condensate drains pipes, pre-existing defects/voids under pavement, etc. The paths may be exposed at some locations to the river floodwater (e.g., open ground along areas outside the perimeter of the Aqua Dam). This network of seepage paths is connected to several pumping sources: the sump pit in the Turbine Building, Manhole MH-5, and a series of surface pumps located inside the perimeter of the Aqua Dam. The pumps were operated for an extended period of time, maintaining a head differential on the seepage path networks. Gradient was sufficient to begin erosion of surrounding soil. The potential damage includes settlement of the Main Underground Cable Bank and manholes causing a loss of electrical connectivity.

Pumping of MH-1, MH-2, and MH-4 after floodwater receded created temporary and minor drawdown effects. The temporary drawdown would cause a head differential on the seepage path networks already created under higher head conditions, thus causing additional incremental or cyclical damages.

Below are field observations and data that support the likelihood of these CPFMs:

- Groundwater flows were observed flowing into the basement sump of the Turbine Building from floor and condensate drain pipes not designed to intercept groundwater. This condition has a recorded history dating back to 1993. The Main Underground Cable Bank terminates at the southeastern corner of the Auxiliary Building, which is directly adjacent to the Turbine Building.
- The area inside the perimeter of the Aqua Dam was pumped dry, creating a hydrostatic head between the areas inside and outside the perimeter of the Aqua Dam. The area inside the perimeter of the Aqua Dam was pumped from several locations, creating locations where suction increased the potential head differential between the areas inside and outside the perimeter of the Aqua Dam.
- A sand boil or piping condition was observed within the exposed floor of the auxiliary building.
- Manholes were pumped to remove water that accumulated due to the 2011 flood. This created a head differential.

Below are field observations and data that indicate these CPFMs are unlikely:

- Trench settlement along the alignment of the duct banks was not observed.

- Soil probing along the duct bank alignments indicated soils were generally firm and stable.

Below are data gaps (data still required to assess these CPFMs):

- GPR data and reports have not been delivered for assessment of subsurface conditions.

The following table describes observed distress indicators and other data that would increase or decrease the potential for degradation associated with these CPFMs for the Main Underground Cable Bank from MH-1 to the Auxiliary Building.

| Adverse (Degradation/Direct Floodwater Impact More likely) | Favorable (Degradation/Direct Floodwater Impact Less Likely) |
|---|---|
| The southwestern corner of the Turbine Building is located adjacent to the termination point of the duct bank. | |
| Water was pumped from several manholes. | Manholes were inundated during the flood event and were not pumped until floodwater had receded and the manholes were accessible. The manholes were only pumped for a short duration. |
| The area inside the perimeter of the Aqua Dam was pumped from several locations. | |
| Sand boil/piping feature observed in Auxiliary Building missile shield room. | |
| **Data Gaps:**<br>• GPR data were not available at the time of Revision 0 to assist in determining possible void areas or paths at the facility. | |

**Conclusion**

Significance

*Potential for Degradation/Direct Floodwater Impact*

Indicators for this CPFM have been observed in the Turbine Building and Auxiliary Building, which is directly adjacent to the Main Underground Cable Bank. The voids below the base slab in the Turbine Building are known to exist, with heavy flows of water being pumped from the sump. Because the 2011 flood caused increased flow through the broken drain pipes, the potential that the 2011 flood caused further and more rapid degradation due to these CPFMs is high.

*Implication*

The occurrence of these CPFMs could potentially cause the collapse of the Main Underground Cable Bank. However, the integrity of system of cables in the trench may not be impacted due to the flexibility of the cables. Therefore, the implication of the potential degradation for this CPFM is low.

Confidence

The extent of subsurface erosion and its potential impact to the Main Underground Cable Bank is not known due to the lack of data gathered on subsurface conditions. Because there is not enough information on the subsurface conditions at this time and the pumping in the Turbine Building could have caused subsurface erosion, the confidence for these CPFMs is low.

Summary

For CPFMs 3a and 3c, as discussed above, the potential for degradation is high because of the pumping in the Turbine Building and the sand boil/piping feature in the Auxiliary Building. This degradation could have caused enough erosion to impact the integrity or intended function of the structure. The combined consideration of the potential for degradation and the implications of that degradation to a structure of this type puts it in the "not significant" category. The data currently collected are not sufficient to rule out these CPFMs. Therefore, the confidence in the above assessment is low, which means more data or continued monitoring and inspections may be necessary to draw a conclusion.

## 5.24.5 Results and Conclusions

The CPFMs evaluated for the Main Underground Cable Bank from MH-1 to the Auxiliary Building are presented in the following matrix, which shows the rating for the estimated significance and the level of confidence in the evaluation.

| | Low Confidence (Insufficient Data) | High Confidence (Sufficient Data) |
|---|---|---|
| Potential for Failure **Significant** | | |
| Potential for Failure **Not Significant** | CPFM 3a<br>CPFM 3c | |

## 5.24.6 Recommended Actions

Further forensic investigations and physical modifications are recommended to address CPFMs 3a and 3c for the Main Underground Cable Bank. CPFMs 3a and 3c are associated with unfiltered flow of groundwater into the Turbine Building basement drain piping system (KDI #1). These recommendations are described in detail in Section 4.1.

Also, a review of the geophysical data when available should be done. The results of this review will be used to increase the confidence in the assessment results. At the time of Revision 0, groundwater levels had not yet stabilized to nominal normal levels. Therefore, it is possible that new distress indicators could still develop. If new distress indicators are observed before December 31, 2011, appropriate HDR personnel should be notified immediately to determine whether an immediate inspection and/or assessment should be conducted. Observation of new distress indicators may result in a modification of the recommendations for this structure.

## 5.24.7 Updates Since Revision 0

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. These assessments were incomplete in Revision 0 because the forensic investigation and/or monitoring for most of the Priority 1 Structures was not completed by the submittal date. This revision of this Assessment Report includes the results of additional forensic investigation and monitoring to date for this structure as described below.

### 5.24.7.1 Additional Data Available

The following additional data were available for the Main Underground Cable Bank from MH-1 to the Auxiliary Building for Revisions 1 and 2 of this Assessment Report:

- Results of KDI #1 forensic investigation (see Section 4.1)
- Additional groundwater monitoring well and river stage level data from OPPD
- Results of geophysical investigation by Geotechnology (see Attachment 6C)
- Results of geotechnical investigation by Thiele Geotech (see Attachment 6A)

### 5.24.7.2 Additional Analysis

The following analysis of additional data was conducted for the Main Underground Cable Bank from MH-1 to the Auxiliary Building:

- Groundwater monitoring well and river stage level data from OPPD.

  Data show that the river and groundwater have returned to nominal normal levels.

- Results of geophysical investigation report by Geotechnology

  Seismic refraction and seismic ReMi tests performed around the outside perimeter of the power block as part of KDI #2 identified deep anomalies that could be gravel, soft clay, loose sand, or possibly voids.

- Results of geotechnical investigation by Thiele Geotech

  Six test borings were drilled, with continuous sampling of the soil encountered, to ground truth the Geotechnology seismic investigation results as part of the KDI #2 forensic investigation. Test bore holes were located to penetrate the deep anomalies identified in the seismic investigation. The test boring data did not show any piping voids or very soft/very loose conditions that might be indicative of subsurface erosion/piping or related material loss or movement.

All of the SPT and CPT test results conducted for this Assessment Report were compared to similar data from numerous other geotechnical investigations that have been conducted on the FCS site in previous years. This comparison did not identify substantial changes to the soil strength and stiffness over that time period. SPT and CPT test results were not performed in the top 10 ft to protect existing utilities.

**Triggering Mechanism 3 – Subsurface Erosion/Piping**

CPFM 3a – Undermining and settlement of shallow foundation/slab/surfaces (due to pumping)
CPFM 3c – Undermined buried utilities (due to pumping)

Significance

*Potential for Degradation/Direct Floodwater Impact*

Indicators for this CPFM have been observed in the Turbine Building and Auxiliary Building, which is directly adjacent to the Main Underground Cable Bank. The voids below the base slab in the Turbine Building are known to exist with heavy flows of water being pumped from the sump. Since the 2011 flood caused increased flow through the broken drain pipes, the potential that the 2011 flood caused further and more rapid degradation due to this CPFM is high. The Turbine Building sump drainage is labeled KDI #1, and recommendations to address this issue have been made and implemented. In addition, a sand boil/piping feature in the Auxiliary Building missile shield room was noted during post flood inspections. Based on implementation and repair of issues associated with KDI #1 and instigation of assessment and necessary repairs in the missile shield room, the potential for degradation of this system is low.

*Implication*

The occurrence of this CPFM could cause the collapse of the Main Underground Cable Bank. However, the integrity of the system of cables in the trench might not be impacted due to the flexibility of the cables. Therefore, the implication of the potential degradation for this CPFM is low.

Confidence

The groundwater elevations have dropped to a level at which they no longer can impact the system. Based on maintenance and repair activities planned in conjunction with KDI #1 and in the missile shield room, confidence is high that problems associated with these CPFMs will be addressed by OPPD.

Summary

For CPFMs 3a and 3c, as discussed above, the potential for degradation is low because the pumping in the Turbine Building and the sand boil/piping feature in the Auxiliary Building are being addressed based on the recommendations for each. The combined consideration of the potential for degradation and the implications of that degradation to a structure of this type puts it in the "not significant" category. The data currently collected are sufficient to rule out this CPFM. Therefore, the confidence in the above assessment is high.

### 5.24.7.3 Revised Results and Recommendations

The CPFMs evaluated for the Main Underground Cable Bank from MH-1 to the Auxiliary Building are presented in the following matrix, which shows the rating for the estimated significance and the level of confidence in the evaluation. CPFMs 3a and 3c for the Main Underground Cable Bank from MH-1 to the Auxiliary Building are associated with KDI #1. Sections 4.1 and 8.3 presents the results of additional forensic investigation that was conducted to ascertain whether these CPFMs could be ruled out. The results of the additional forensic investigations show that if the recommendations for physical modifications in KDI #1 are implemented, this CPFM is ruled out. Therefore, these CPFMs are moved to the quadrant of the matrix representing "No Further Action Recommended Related to the 2011 Flood."

| | Low Confidence (Insufficient Data) | High Confidence (Sufficient Data) |
|---|---|---|
| Potential for Failure **Significant** | | |
| Potential for Failure **Not Significant** | | CPFM 3a<br>CPFM 3c |

### 5.24.7.4 Conclusions

In the assessment of the FCS Structures, the first step was to develop a list of all Triggering Mechanisms and PFMs that could have occurred due to the prolonged inundation of the FCS site during the 2011 Missouri River flood and could have negatively impacted these structures. The next step was to use data from various investigations, including systematic observation of the structures over time, either to eliminate the Triggering Mechanisms and PFMs from the list or to recommend further investigation and/or physical modifications to remove them from the list for any particular structure. Because all CPFMs for the Main Underground Cable Bank from MH-1 to the Auxiliary Building other than CPFMs 3a and 3c have been ruled out, and because CPFMs 3a and 3c will be ruled out when the physical modifications recommended for KDI #1 in Sections 4.1 and 8.3 are implemented, no Triggering Mechanisms and their associated PFMs will remain credible for the Main Underground Cable Bank from MH-1 to the

Auxiliary Building. HDR has concluded that the geotechnical and structural impacts of the 2011 Missouri River flood will be mitigated by the implementation of the physical modifications recommended in this Assessment Report. Therefore, after the implementation of the recommended physical modifications, the potential for failure of this structure due to the flood will not be significant.