5.8 Turbine Building

5.8.1 Summary of Turbine Building

Baseline information for the Turbine Building is provided in Section 2.0, Site History, Description, and Baseline Condition.

The Turbine Building is located within the PA, directly adjacent to the Auxiliary Building to the west, the Maintenance Shop to the north, and the Turbine Building South Switchyard to the south. The Service Building to the east was built integrally with the Turbine Building. The Circulation Water System extends under the Service Building and ties into the bottom of the Turbine Building foundation. The Turbine Building basement floor elevation is established at 990 ft (bottom of floor el. 987.5 ft), while the Service Building floor is established at an elevation of 1007.5 ft. The Service Building is supported by deep foundations. The bottom of the Circulation Water System is at an elevation of 969 ft and is supported by deep foundations. The Auxiliary Building basement floor elevation adjacent to the Turbine Building is established at 989 ft (bottom of mat el. 983.5 ft), and it also is supported by deep foundations. The Turbine Building South Switchyard was constructed at a grade of about 1004.5 ft, and the structures are supported on deep foundations. The Maintenance Shop floor is established at an elevation of 1007.5 ft and is supported on shallow foundations.

The Turbine Building is a multi-floored structure. From the top of the foundation mat at el. 990 ft to el. 1007.5 ft, the structure is cast-in-place reinforced concrete with integral pilasters that align with the steel columns above grade. From el. 1007.5 ft to the roof elevation, the structure consists of braced, rigid steel frames clad with precast concrete sandwich panels. The mat foundation is supported on a combination of 20-in.-diameter Class A steel pipe piles under the turbine generator mat foundation and 12-in.-diameter Class B concrete-filled steel pipe piles under the building mat foundation, all of which are driven to bedrock. Some Class B piles are designated as tension piles and include reinforcing dowels to provide positive tension connection to the foundation mat (see Table 5.8-1).

5.8.2 Inputs/References Supporting the Analysis

Table 5.8-1 lists references provided by OPPD and other documents used to support HDR's analysis.

Table 5.8-1 - References for Turbine Building

Document Title	OPPD Document Number (if applicable)	Date	Page Number(s)
2010 Turbine Building Structure Inspection	SE-PM-AE-1003	7/16/2009	All
Turbine Building 6" and 10" Floor Drain Pipe Breaks	(Summary of CR2009-1365)	Unknown	All
Design Basis Document – Geotechnical	PLDBD-CS-54	Unknown	All
Summary Report of Broken Floor Drain Pipes	NA	3/24/2009	All
Design Basis Document – External Flooding	PLDBD-CS-56	Unknown	All

Table 5.8-1 - References for Turbine Building			
Document Title	**OPPD Document Number (if applicable)**	**Date**	**Page Number(s)**
Work Order Package – 00350972 01 2010 Structural Inspection of the Turbine Building	Reference to Procedure SE-PM-AE-1003	Unknown	All
Turbine & Office Building Cross Section	11405-A-264	Unknown	Figure 1.2-7 H 12195
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 Turbine Building are provided in Attachment 8.

Observed performance and pertinent background data are as follows:

- The Turbine Building is a Class II structure and is designed to withstand an external hydrostatic load due to flooding of the Missouri River to el. 1007 ft (see PLDBD-CS-56).
- The below-grade structure is independent of the Auxiliary Building, with a 1.75-ft void (expansion joint) between the basement walls. The void is filled with sand below grade and covered with a metal closure plate at ground elevation (see 11405-A-264, Figure 1.2-7 H 12195).
- The Class A piles consist of pipe with 20-in. outside diameter and 1.031-in. wall thickness, which meets API Standard 5L Grade B (F_y = 35 ksi). The piles were driven open-ended to refusal on bedrock. An exploratory boring was drilled through the pipe 15 ft into the bedrock. If a void was encountered, the pile was underreamed and the pile advanced through the void.
- The Class A pile capacities were developed by load testing nonproduction piles for compression, tension, and lateral loads (see PLDBD-CS-54).
- The Class B piles consist of pipe with 12.57-in. outside diameter and 0.25-in. wall thickness, which meets ASTM A252 Grade 2 (F_y = 35 ksi). The piles were driven closed-ended to refusal on bedrock and filled with 4000-psi concrete (see PLDBD-CS-54).
- The soils below the structure were not densified by vibroflotation.
- The Turbine Building was protected from floodwater by an Aqua Dam, as well as by sandbags and portable pumps at the exterior overhead door on the south building face adjacent to the Turbine Building South Switchyard, for the majority of the 2011 flood. However, 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. Approximate river elevation during the period of the breach was 1006 ft.
- Condition report summaries listed in Attachment 2 document many areas of the structure where groundwater has infiltrated the building through previously monitored cracks in the concrete, wall penetrations, and conduit. Observations of the documented groundwater infiltration areas did not identify areas of structural concern.
- General observations of the interior of the structure indicated minor concrete cracking with both current water infiltration (damp to slight running water) and dry walls with signs of water infiltration that has occurred at an earlier time. The observed cracking has been previously recorded and monitored. There were small isolated areas of standing static water in low spots. However, the source of this static water was not found because no water movement was detected.

- Typical wall cracking observed consisted of vertical shrinkage cracks at the horizontal mid-span between pilasters. These are classic concrete shrinkage cracks between the very stiff pilaster elements that occur during the initial concrete curing period.
- The majority of the wall panels encompassed between the pilasters have vertical shrinkage cracks that were either damp to slightly running or show signs of previous water infiltration.
- There is a vertical crack that is full wall height on the north basement wall, approximately 1 ft west of column pilaster TC-9. During additional investigation, it was determined that the crack width at the top of the wall is approximately 0.0625 in. and extends through the thickness of the wall. The crack and the surrounding concrete at the top of the wall were dry with packed dirt/dust within the crack, indicating that the crack had existed long before the flood event.
- The 2010 structural inspection of the Turbine Building (see Reference to Procedure SE-PM-AE-1003) indicated that there was no evidence of significant structural deterioration and that previously installed crack monitors showed no signs of movement.
- The south exterior of the building adjacent to the Turbine Building South Switchyard was visually inspected, and no indications of soil subsidence were observed.
- A column footing in the Maintenance Shop in the first row of footings adjacent to the Turbine Building (Column MG-15) has settled about 2 in., and cracks in the nearby masonry partition walls indicate settlement of the floor slab.
- Below is a summary report of broken floor drain pipes with reference to CR2009-1365:
  - CR2009-1365 was created on March 24, 2009.
  - Two drain lines run parallel to each other: the 6-in. floor drain and the 10-in. waterbox drain. A vendor visually inspected the drain lines because undocumented water was observed draining into the sump pit from both lines. They found a break in the 10-in. drain at the branch tee from the VD-193 drain valve. They could not inspect the 6-in. floor drain because the line does not have a cleanout connection in this area and accessibility through floor drains is restricted by the drain trap at each location.
  - Review of system files shows that a break in the waterbox drain line has been known since at least 1993. In 1997, a repair was attempted by core drilling holes in the vicinity of the break and by pressure grouting to seal the pipe, according to the "Water Systems Report Card for Report Period April 1 Through June 30, 1997" (memo PED/EOS SYE 97-123):

    > "Repair of the Turbine Building Basement Drain line header was attempted during this period. The repair procedure consisted of core drilling holes in the vicinity of the leak and pressure grouting to seal the leak. Approximately 10 holes were drilled and it was estimated that a void of approximately 10 by 8 by 1 ft existed under the concrete slab. The void was filled with cement grout but the leak could not be stopped. Boroscope inspection of the pipe exterior performed through the core drills showed considerable pipe damage, in more than one location. The extent of the damage and concern over collapsing the line were determining factors in terminating the pressure grouting operation. FC ECN 97-213 was originated to request that a new drain header be installed."
- The grout was injected in the area by the VD-193 (FW-1A south return box tail valve). At some time later, the Turbine Building sump was cleaned out, and a slab of hardened grout was found in the sump, confirming the grout had flowed through the drain system into the sump. A recent inspection of the floor drains noted a considerable amount of grout in the floor drain south of the FW-3 Condensate Cooler. The drain looks to be almost fully restricted. It seems certain that this grout came from the 1997 effort, indicating that both lines were also broken at that time.
- Review of video taken from the sump on July 22, 2011, and subsequent visual observations indicate groundwater flowing into the sump from all five drain lines.

- OPPD personnel indicated that during an outage, the drain lines that discharge into the sump do not receive flow from the system.
- A majority of the drain lines are located below the mat foundation slab.
- OPPD personnel indicated that the drain lines were cleaned in 2011.

5.8.3 Assessment Methods and Procedures

5.8.3.1 Assessment Procedures Accomplished

Assessments of the Turbine Building included the following:

- Visual inspection of the accessible areas of the interior of the structure from the ground elevation of 1007.5 ft down to the basement floor elevation of 990 ft
- Visual inspection of the exterior of the structure, where accessible
- An assessment of collected survey data to date for indications of trends in the movement of the structure
- A review of previously referenced documents listed in Table 5.8-1.

Additional investigations were performed. These included the following noninvasive geophysical and invasive geotechnical investigations:

- GPR along portions of the basement floor. (Test reports were not available at the time of Revision 0.)
- Seismic surveys (seismic refraction and refraction micro-tremor) in the PA. (Test reports were not available at the time of Revision 0.)
- Video inspection of the drain pipes below the basement floor. (Test reports were not available at the time of Revision 0.)
- Geotechnical test borings in the PA. Note that OPPD required vacuum excavation for the first 10 ft of proposed test holes to avoid utility conflicts. Therefore, test reports will not show soil conditions in the upper 10 ft of test boring logs. (Test reports were not available at the time of Revision 0.)

5.8.3.2 Assessment Procedures Not Completed

Assessments of the Turbine Building that were not completed include the following:

- Core holes through the basement floor to measure the size of voids present

5.8.4 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 taken into the detailed assessment as "credible." After the design review for each structure, the structure observations and preliminary results of some of the geotechnical, geophysical, and survey data were analyzed, and a number of CPFMs were ruled out as discussed in Section 5.8.4.1. The CPFMs carried forward for detailed assessment are discussed in Section 5.8.4.2.

5.8.4.1 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 2b – Loss of lateral support for pile foundation

Reason for ruling out:

- Surface erosion was not identified near the Turbine Building during the field assessments.

Triggering Mechanism 3 – Subsurface Erosion/Piping
CPFM 3e – Loss of lateral support for pile foundation (due to river drawdown)

Reason for ruling out:

- The Turbine Building is at sufficient distance from the river and sufficient depth below the ground surface to be outside the zone of influence of the CPFM.

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:

- The Turbine Building is designed to withstand an external water load due to flooding of the Missouri River to el. 1007 ft (see PLDBD-CS-56). The peak flood elevation in 2011 was approximately 1006.9 ft, which is less than the structural design basis.
- No signs of structural distress due to lateral loads on the below-grade walls were observed.

Triggering Mechanism 5 – Hydrodynamic Loading
CPFM 5a – Overturning
CPFM 5b – Sliding
CPFM 5c – Wall failure in flexure
CPFM 5d – Wall failure in shear
CPFM 5e – Damage by debris
CPFM 5f – Excess deflection

Reasons for ruling out:

- The Turbine Building is located within the PA and was not subjected to high-velocity river or overland flows capable of producing sufficient hydrodynamic forces.
- No damage from floating debris was observed.
- The Turbine Building is sheltered from high velocity by the Maintenance Shop on the north (upstream) side, the Service Building on the east (river) side, and the Auxiliary Building on the west side.

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

Reasons for ruling out:

- The Turbine Building is designed to withstand an external water load due to flooding of the Missouri River to el. 1007 ft (see PLDBD-CS-56). The peak flood elevation in 2011 was approximately 1006.9 ft, which is less than the structural design basis.
- No signs of structural distress due to buoyancy were observed.

Triggering Mechanism 7 – Soil Collapse (first time wetting)
CPFM 7b – Displaced structure/broken connections
CPFM 7c – General site settlement
CPFM 7d – Piles buckling from down drag

Reason for ruling out:

- The building basement elevation of 990 ft is below the normal river elevation of approximately 992 ft. Therefore, the building foundation system is typically below normal groundwater elevations.

Triggering Mechanism 10 – Machine/Vibration-Induced Liquefaction
CPFM 10b – Displaced structure/broken connections

Reasons for ruling out:

- Permanent equipment that has the capacity to produce significant dynamic forces due to vibration is mounted on the base mat foundation slab of the structure. This structure is always below the river level regardless of the flood elevation.
- The turbine was not operated during the flood event.
- This is not a changed condition due to the flood. The Turbine Building has been operating under similar saturated soil conditions and machine vibrations.
- No broken structural connections or structural displacement were observed.
- Liquefaction was not observed to have occurred at the site.

Triggering Mechanism 10 – Machine/Vibration-Induced Liquefaction
CPFM 10c – Additional lateral force on below-grade walls

Reasons for ruling out:

- Permanent equipment that has the capacity to produce significant dynamic forces due to vibration is mounted on the base mat foundation slab of the structure. This structure is always below the river level regardless of the flood elevation.
- The turbine was not operated during the flood event.
- This is not a changed condition due to the flood. The Turbine Building has been operating under similar saturated soil conditions and machine vibrations.
- Liquefaction was not observed to have occurred at the site.

Triggering Mechanism 10 – Machine/Vibration-Induced Liquefaction
CPFM 10d – Pile/pile group instability

Reasons for ruling out:

- Permanent equipment that has the capacity to produce significant dynamic forces due to vibration is mounted on the base mat foundation slab of the structure. This structure is always below the river level regardless of the flood elevation.
- The turbine was not operated during the flood event.
- This is not a changed condition due to the flood. The Turbine Building has been operating under similar saturated soil conditions and machine vibrations.
- Liquefaction was not observed to have occurred at the site.

Triggering Mechanism 11 – Loss of Soil Strength due to Static Liquefaction or Upward Seepage
CPFM 11b – Displaced structure/broken connections
CPFM 11c – Additional lateral force on below-grade walls
CPFM 11d – Pile/pile group instability

Reason for ruling out:

- Liquefaction was not observed to have occurred at the site.

Triggering Mechanism 12 – Rapid Drawdown
CPFM 12a – River bank slope failure and undermining surrounding structures
CPFM 12b – Lateral spreading

Reason for ruling out:

- The Turbine Building is at sufficient distance from the river and sufficient depth below the ground surface to be outside the zone of influence of the CPFM.

Triggering Mechanism 13 – Submergence
CPFM 13b – Corrosion of structural elements

Reason for ruling out:

- The Turbine Building is designed to withstand an external water load due to flooding of the Missouri River to el. 1007 ft (see PLDBD-CS-56). The peak flood elevation in 2011 was approximately 1006.9 ft, which is less than the structural design basis. Therefore, structural elements being wetted by the 2011 flood were considered in the original design of the facility.

Triggering Mechanism 14 – Frost Effects
CPFM 14a – Heaving, crushing, or displacement

Reason for ruling out:

- The Turbine Building foundation is approximately 20 ft below grade and therefore not frost susceptible. In addition, frost-susceptible connecting utilities are also below frost level.

5.8.4.2 Detailed Assessment of Credible Potential Failure Modes

The following CPFMs are the only CPFMs carried forward for detailed assessment for the Turbine Building as a result of the 2011 flood. This detailed assessment is provided below.

Triggering Mechanism 3 – Subsurface Erosion/Piping
CPFM 3b -- Loss of lateral support for pile foundation (due to pumping)

The flow of groundwater into this drain piping system through the breaks in the pipes is one of the KDIs discussed in Section 4.

The Turbine Building has a documented history of a void below the foundation dating back to 1997. Conversations with OPPD personnel indicate that groundwater has been flowing at varying rates through these broken pipes into the sump from 1993 to the present day. The rate of flow into the sump is directly attributable to the hydraulic head of the groundwater because the observed flow rates have increased as the floodwater elevation increased. This drain pipe system was designed as a closed system; therefore, the pipes are not surrounded by appropriate filter systems to preclude the transportation of soils from the surrounding area under the slab. It is logical to assume that as the groundwater flows into the broken piping, the gradient is sufficient to erode the soil.

The Triggering Mechanism and CPFM could then occur as follows: the unfiltered seepage condition will remain until the breaks in the piping system are repaired, which means the potential for further erosion continues unarrested. Erosion could extend out, creating large voids under the Turbine Building mat foundation.

The following table describes observed distress indicators and other data that would increase or decrease the potential for degradation associated with this CPFM for the Turbine Building.

Adverse (Degradation/Direct Floodwater Impact More Likely)	Favorable (Degradation/Direct Floodwater Impact Less Likely)
Previously documented void under the mat foundation	There have been no observed signs of structural distress in the floor slab at the current loading conditions.
Documented breaks in the drain piping below the mat foundation	The dye injected below Column MG-15 in the Maintenance Shop was not detected in the Turbine Building sump.
Documented continual groundwater flow from the broken drain piping into the sump	—
The soil around the piling was not compacted to the same requirements as the material under the Class I structures (vibroflotation effort)	—

Adverse (Degradation/Direct Floodwater Impact More Likely)	Favorable (Degradation/Direct Floodwater Impact Less Likely)
Column MG15 in the Maintenance Shop has settled over 2 in. (MG column line is adjacent to the Turbine Building)	
Data Gaps: • The size and location of voids below the foundation	

Conclusion

Significance

Potential for Degradation/Direct Floodwater Impact

Indicators for this CPFM have been observed. A void below the mat foundation in the Turbine Building is known to exist, and groundwater is constantly flowing into the sump from all five drain lines. Because the 2011 flood caused increased groundwater flow through the broken drain pipes, the potential that the 2011 flood caused further and more rapid degradation due to this CPFM is high. It is possible that these voids extend beyond the Turbine Building.

Implication

The occurrence of this CPFM would have to be large to negatively impact the capacity of the piling supporting the building. Therefore, the implication of the potential degradation to the Turbine Building for this CPFM is low.

Confidence

This CPFM has two elements: 1) the breaks in the drain pipes allowing groundwater to flow into the sump pit and 2) the potential for voids to develop around the piling system. The flow of groundwater through breaks in the drain pipes has been documented. However, the extent of the associated voids is unknown. The data at hand are not sufficient to rule out this PFM or to conclude that physical modification to ensure that the pilings that support this building have lost capacity because of this CPFM. Therefore, the confidence in the above assessment is low, which means more data are needed to draw a conclusion.

Summary

For CPFM 3b, as discussed above, the potential for degradation is high because of the flow of groundwater through the drain pipes. This degradation would have to be large 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 "significant" category. The data currently collected are not sufficient to rule out this CPFM. Therefore, the confidence in the above assessment is low, which means more data or continued monitoring and inspections might be necessary to draw a conclusion.

5.8.5 Results and Conclusions

The CPFMs evaluated for the Turbine 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**	CPFM 3b	
Potential for Failure **Not Significant**		

5.8.6 Recommended Actions

The following actions are recommended for the Turbine Building.

Review the GPR data and video inspection footage to assess the impact on the piling system. Further forensic investigations and physical modifications are recommended to address CPFM 3b (KDI #1). These recommendations are described in detail in Section 4.1.3.

Continued monitoring is recommended to include a continuation of the elevation surveys of the previously identified targets on this structure and surrounding site. The purpose is to monitor for signs of structure distress and movement and changes in soil conditions around the structure. The results of this monitoring will be used to increase the confidence in the assessment results. Elevation surveys should be performed weekly for 4 weeks and biweekly until December 31, 2011. 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 or assessment should be conducted. Observation of new distress indicators might result in a modification of the recommendations for this structure.

5.8.7 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.

5.8.7.1 Additional Data Available

The following additional data were available for the Turbine Building for Revisions 1 and 2 of this Assessment Report:

- Results of KDI #1 forensic investigation (see Section 4.1)
- Results of the video inspection report by EPS (see Attachment 6D).
- Results of geophysical investigation by Geotechnology (see Attachment 6C).
- Results of geotechnical investigation by Thiele Geotech (see Attachment 6A).
- Results of continued survey by LRA (see Attachment 6E).

5.8.7.2 Additional Analysis

The following analysis of additional data was conducted for the Turbine Building:

- Results of the video inspection report by EPS.

  Video inspections performed in the drain pipes confirmed breaks in the pipes are allowing groundwater to infiltrate the pipes. Additionally, sediment could be observed suspended in the flowing water. During inspection, up to about 3 ft of sand was found in the sump pit.

- Results of geophysical investigation by Geotechnology.

  GPR tests performed on the Turbine Building floor identified anomalies which could be gravel, soft clay, or possibly voids. Additional ground truthing of the investigation results was performed as part of the KDI #1 forensic investigation.

- Results of geotechnical investigation by Thiele Geotech.

  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.

- Results of continued survey by LRA.

  Measurements to date compared to the original baseline measurements have not exceeded the accuracy range of the surveying equipment. Therefore continued deformation at the monitored locations due to the 2011 flood has not occurred.

Additional analysis related to CPFM 3b is discussed in Section 4.1 for KDI #1.

The CPFMs that could not be ruled out in Revision 0 are analyzed below based on the additional data available for Revisions 1 and 2 of this Assessment Report.

Triggering Mechanism 3 – Subsurface Erosion/Piping
CPFM 3b – Loss of lateral support for pile foundation (due to pumping)

CPFM 3b for the Turbine Building is associated with KDI #1. Section 4.1 and 8.3 presents the results of additional forensic investigation that was conducted to ascertain whether the CPFM could be ruled out. Based on the available information and without a quantitative analysis we find that the loss of lateral piling support shown by the collected data under the Turbine Building, over the limited areas suggested by the collected data, does not imply that a significant risk of piling failure is present in static conditions due to the presence of the existing NAS zones. We have ruled out CPFM 3b for the Turbine Building for static loading only. Seismic considerations have not been assessed for this report and we do not make any conclusion with respect to the effect of NAS zones on the loss of lateral support for the Turbine building pile foundation during seismic loading. HDR recommends that OPPD employ the services of an Appendix B consultant to evaluate the potential for loss of lateral support for the Turbine Building pile foundation during seismic loading. Assuming that this analysis shows that there is no issue with the seismic loading of the Turbine Building pile foundation; this CPFM is moved to the quadrant of the matrix representing "No Further Action Recommended Related to the 2011 Flood."

5.8.7.3 Revised Results

The CPFM evaluated for the Turbine Building are presented in the following matrix, which shows the rating for the 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 3b

5.8.7.4 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 Turbine Building other than CPFM 3b had been ruled out prior to Revision 1, and because CPFM 3b under static loading has been ruled out by the additional forensic investigations for KDI #1 (see Section 4.1 and 8.3) and assuming that the results of the evaluation of the loss of lateral support for the Turbine Building pile foundation during seismic loading shows no issue, no Triggering Mechanisms and their associated PFMs will remain credible for the Turbine Building. It is recommended that the physical modifications described in KDI #1 (Section 4.1 and Section 8.3) be implemented to stop the triggering mechanism. OPPD has informed HDR that they are utilizing the services of an Appendix B structural engineering firm to evaluate the potential for the loss of lateral support for the Turbine Building pile foundation.