2.4.4 Potential Dam Failures

CP COL 2.4(1) ~~Replace the content~~Add the following at the end of DCD Subsection 2.4.4~~ with the following~~. RCOL2_02.04-1

There are no surface water impoundments other than small farm ponds that could impact the SCR. The small farm ponds have negligible storage capacity and a breach would have no measurable effect. Failure of downstream dams, including Squaw Creek Dam, would not affect the CPNPP Units 3 and 4.

There are currently three reservoirs located on the main stem of the Brazos River: Possum Kingdom Lake, Lake Granbury, and Lake Whitney. Each of these reservoirs is within 150 river miles of the CPNPP site and most of the main stem Brazos River reservoir storage is concentrated along this reach. Because the site is located off-channel on a tributary of the Brazos River, the most conservative approach for the critical dam failure event would be for this reach of the Brazos River to flood by way of domino-type dam failure of upstream dams, and for flood waters to back up from the Brazos River and Paluxy River confluence onto the site by way of the Squaw Creek catchment. For the dam failure analysis, the peak flow of the probable maximum flood (PMF) coincident with assumed hydrologic domino-type dam failure of ~~three~~ upstream dams were analyzed at the Brazos River and the Paluxy River confluence. Morris Sheppard Dam and De Cordova Bend Dam are located within the portion of the Brazos River Basin identified as most significant for the dam failure analysis.~~; however, for conservatism, the failure of Hubbard Creek Dam, which impounds Hubbard Creek Reservoir, was also used in the dam failure analysis. Hubbard Creek Dam is located approximately 357 miles upstream of Morris Sheppard Dam and was chosen for the dam failure analysis based on its distance from Morris Sheppard Dam and greater storage capacity when compared to other upstream reservoirs in the region. Domino-type~~Dam failures are included coincident with PMF flows and transposed downstream without any attenuation. Thus, the closely confined basin geometry of this reach and the concentration of major reservoirs were used as the basis for determining this portion of the basin as the most significant for the dam failure analysis. RCOL2_02.04.04-5 RCOL2_02.04.04-5

Upstream dams are evaluated qualitatively to determine inclusion or exclusion from the critical dam failure scenario. The qualitative analysis considers both existing and future conditions, and is performed based on a comparison of distance from the confluence of the Paluxy River with the Brazos River, reservoir storage, dam height, and drainage area. Domino-type failures and simultaneous failures are postulated when applicable. RCOL2_02.04.04-5

For existing conditions the qualitative analysis identifies the potential controlling domino-type dam failure scenario including Hubbard Creek Dam, Morris Sheppard Dam, and De Cordova Bend Dam. For future conditions the qualitative analysis identifies the potential controlling domino-type dam failure scenario including Fort Phantom Hill Dam, proposed Cedar Ridge Reservoir Dam, Morris Sheppard Dam, and De Cordova Bend Dam. In addition Lake Stamford Dam is assumed to fail simultaneously with the Cedar Ridge Reservoir Dam. The two potential controlling scenarios are evaluated quantitatively to determine that future conditions provide the critical dam failure scenario. RCOL2_02.04.04-5

The guidance in Appendix B of NRC Regulatory Guide 1.59 is used as an alternative approach to determine the coincident PMF. The Brazos River watershed~~, locations for the three dams and CPNPP Units 3 and 4 are~~ for existing conditions is identified in Figure 2.4.4-201. There are no safety-related structures that could be affected by flooding due to dam failures. RCOL2_02.04.04-5

2.4.4.1 Dam Failure Permutations

SCR is located immediately downstream of the site. Squaw Creek is a tributary of the Paluxy River, which is a tributary of the Brazos River. Hubbard Creek Dam is located upstream of the site on a tributary of the Brazos River. Morris Sheppard Dam and DeCordova Bend Dam are located upstream of the site on the Brazos River. Lake Whitney Dam is located downstream of the site on the Brazos River.

Structural analysis of each structure has not been performed as part of this analysis. The potential backwater effects of dam failures on the Brazos River are examined assuming hydrologic failure of dams coincident with the PMF. The PMF is a more extreme event than the safe shutdown earthquake coincident with the peak of the 25-year flood, and the operating basis earthquake coincident with the peak of the one-half PMF or the 500-year flood. Seismic dam failure coincident with lesser flooding would result in lower flood elevations and has not been examined~~, except as noted below~~. RCOL2_02.04.04-5

Qualitative Assessment for Dam Failure Analysis

Potential dam failures have been considered for dams located in the Lake Whitney watershed. Lake Whitney Dam is located on the Brazos River approximately 56 river miles downstream from the confluence with the Paluxy River. The site is located on SCR approximately 5 river miles upstream from the confluence of the Brazos River and the Paluxy River.

The distance from the confluence, reservoir storage, dam height, and drainage area are used as the basis for a qualitative assessment of dams to determine dam failure permutations that would warrant a quantitative assessment. Considering existing conditions, information for dams located in the Lake Whitney watershed has been obtained from the National Atlas (Reference 2.4-274), supplemented with information obtained from the U.S. Army Corps of Engineers National Inventory of Dams database (2.4-222), and is provided in Table 2.4.4-201. Wheeler Branch Dam and the associated Paluxy River Channel Dam are recently completed structures and have not been included in the National Atlas. Data for these structures have been obtained from the Somervell County Water District (Reference 2.4-275) and the 2011 Brazos G Regional Water Plan (Reference 2.4-276). The locations of the dams are shown on Figure 2.4.4-204.

Existing Conditions RCOL2_02.04.04-5

Downstream Dams

There are three dams (Lake Pat Cleburne Dam, Cleburne State Park Lake Dam, and Lake Virginia Dam) located upstream from Lake Whitney but downstream from the confluence. The total maximum storage capacity of the three dams is approximately 71,000 ac.-ft. Failure effects of these structures would continue downstream to Lake Whitney. Failure effects at the confluence from any combination of these structures would not exceed more critical dam failure permutations discussed below.

There are a number of dams located upstream of the confluence in the Paluxy River watershed. Including the recently completed Wheeler Branch Dam and associated Paluxy River Channel Dam, the total maximum storage capacity is approximately 42,000 ac.-ft. Failure effects at the confluence from any combination of these structures would not exceed more critical dam failure permutations discussed below.

Brazos River Upstream Dams to Morris Sheppard Dam

Lake Granbury, formed by De Cordova Bend Dam, is the largest reservoir (136,823 ac.-ft normal storage capacity and 240,640 ac.-ft maximum storage capacity) in the immediate vicinity of the confluence and is located approximately 33 river miles upstream on the Brazos River. There are no other dams located on the Brazos River between Lake Granbury and the confluence.

Possum Kingdom Reservoir, formed by Morris Sheppard Dam, is the largest reservoir (the normal and maximum storage capacity is listed as 556,220 ac.-ft) immediately upstream from Lake Granbury. Morris Sheppard Dam is located on the Brazos River approximately 129 river miles upstream of De Cordova Bend Dam. Failure of Morris Sheppard Dam would enhance the postulated failure at De Cordova Bend Dam.

Upstream of Lake Granbury, Lake Palo Pinto Dam was also considered as a candidate that would enhance the postulated failure at De Cordova Bend Dam and the effects at the confluence. Although Lake Palo Pinto Dam is closer to Lake Granbury than Morris Sheppard Dam, Lake Palo Pinto (44,100 ac.-ft normal storage capacity and 170,735 ac.-ft maximum storage capacity) is significantly smaller. The quantitative assessment is based on breach flow and breach wave height and is dependent on the headwater and dam height. Additionally, the failure effects are transposed downstream without attenuation. The dam height of Morris Sheppard Dam is higher than Lake Palo Pinto Dam. Therefore, it would be more conservative to consider the added effects from Morris Sheppard Dam failure in the quantitative analysis. The other dams in the Brazos watershed between Morris Sheppard Dam and De Cordova Bend Dam do not exceed 20,000 ac.-ft and were not considered further.

Upstream Dams above Morris Sheppard Dam RCOL2_02.04.04-5

Upstream from Morris Sheppard Dam, there are seven dams (Graham Dam, Hubbard Creek Dam, Millers Creek Dam, Fort Phantom Hill Dam, Lake Stamford, John T. Montford Dam, and White River Dam) with reservoirs greater than 50,000 ac.-ft. Each of the seven dams is located on a separate tributary or multiple tributaries that precludes domino-type failure with dams other than Morris Sheppard Dam. Hubbard Creek Dam forms the reservoir with the greatest storage capacity (317,750 ac.-ft normal storage capacity and 720,000 ac.-ft maximum storage capacity), has the largest drainage area, and is located approximately 99 river miles upstream of Morris Sheppard Dam.

Only Graham Dam is located closer to Morris Sheppard Dam. However, even when considering the storage capacity of the reservoir formed by Eddleman Dam, which is connected to the reservoir formed by Graham Dam, the combined storage capacity is much less than the reservoir formed by Hubbard Creek Dam. Additionally, Hubbard Creek Dam has a greater dam height. Furthermore, the quantitative assessment failure effects are transposed downstream without attenuation. Therefore, it would be more conservative to consider the added effects from Hubbard Creek Dam failure in the quantitative analysis.

Only John T. Montford Dam has a dam height greater than Hubbard Creek Dam. However, John T. Montford Dam is approximately 351 river miles upstream from Morris Sheppard Dam, whereas Hubbard Creek Dam is 99 river miles upstream. Although the quantitative assessment does not consider attenuation, there would be significant attenuation over 351 river miles compared to 99 river miles if more rigorous methods were introduced. The Hubbard Creek Dam also has a greater drainage area of 1107 sq. mi, whereas the John T. Montford Dam drainage area is only 394 sq. mi The quantitative assessment includes the PMF flow for the local watershed, which is greater for the larger drainage area. The quantitative assessment does not attenuate the combined PMF and failure effects from the Hubbard Creek Dam. Therefore, it would be more conservative to consider the added effects from Hubbard Creek Dam failure in the quantitative analysis.

Hubbard Creek Dam is closer to Morris Sheppard Dam, has a greater dam height, has a larger drainage area, and has a greater storage capacity than Millers Creek Dam, Fort Phantom Hill Dam, Lake Stamford Dam, and White River Dam. Therefore, it would be more conservative to consider the added effects from Hubbard Creek Dam failure in the quantitative analysis. Considering existing conditions, the limiting dam failure permutation for additional quantitative analysis is the domino-type failure of Hubbard Creek Dam, Morris Sheppard Dam, and De Cordova Bend Dam.

Future Conditions

Future conditions have been considered based on the information provided in the 2011 Brazos G Regional Water Plan (Reference 2.4-276) and the Llano Estacado Regional Water Plan (Reference 2.4-277). There are nine alternatives in the

Brazos G Regional Water Plan and available details are provided in Table 2.4.4-202. There are three alternatives in the Llano Estacado Regional Water Plan and available details are provided in Table 2.4.4-203. The locations of the potential sites for each alternative are shown on Figure 2.4.4-204. Although potential sites are identified in the regional water plans, not all alternative potential sites are considered proposed dams as discussed below. RCOL2_02.04.04-5

The Brazos G Regional Water Plan identifies sites to assess the potential for development in the Brazos River watershed. Some of the potential sites have not been identified as recommended water management strategies and are not considered to be proposed reservoirs because there are no intentions or actions to develop the potential sites. There have been no efforts to perform design work, identify budgets, procure necessary property, or execute any type of construction activity for the South Bend Reservoir, the two Double Mountain Fork reservoir alternatives, the Lake Palo Pinto Off-Channel Reservoir, or the Throckmorton Reservoir. Therefore, these sites are not considered proposed reservoirs. Additionally, the two Double Mountain Fork reservoirs are not concurrent alternatives. The plan identifies either the east or west alternative as a potential site, but not both.

Proposed Dams

The Turkey Peak Reservoir is a recommended water management strategy and is considered a proposed reservoir. The Turkey Peak Reservoir (22,577 ac.-ft storage capacity) would be located approximately 3 river miles downstream from Lake Palo Pinto Dam. Turkey Peak Reservoir has been proposed to recover lost storage capacity of the reservoir formed by Lake Palo Pinto Dam due to sedimentation. A recent volume survey determined the reservoir storage capacity to be 63 percent of the normal capacity.

Turkey Peak Reservoir would have the same water surface elevation as the reservoir formed by Lake Palo Pinto Dam. Portions of the Lake Palo Pinto Dam would be removed to allow the two reservoirs to be connected at an upper elevation. Additionally, a pipe will connect the two reservoirs at a lower elevation. This configuration would reduce the failure effects of Lake Palo Pinto Dam compared to existing conditions because of the normal high tailwater on the downstream face of Lake Palo Pinto Dam. Although, the Turkey Peak Reservoir Dam would be higher than the Lake Palo Pinto Dam, the height would not be expected to exceed the height of Morris Sheppard Dam. Additionally, the combined storage capacity is much less than the storage capacity at Morris Sheppard Dam. Therefore, as previously discussed for the existing Lake Palo Pinto Dam, the failure effects from a combined Lake Palo Pinto Dam and Turkey Peak Reservoir Dam failure would not exceed the existing limiting dam failure permutation.

The Millers Creek augmentation is a recommended water management strategy and is considered a proposed alternative. The Millers Creek augmentation consists of a proposed diversion dam on Lake Creek and a proposed dam on

Millers Creek approximately 4 river miles downstream of the existing Millers Creek Dam. Both structures are to be located upstream of Morris Sheppard Dam. The diversion dam is a low head structure only 8 ft high and anticipated to maintain a small storage capacity. There are no downstream structures between the diversion dam and Morris Sheppard Dam. Therefore, dam failure of the diversion dam would not exceed the existing limiting dam failure permutation that includes Hubbard Creek Dam. RCOL2_02.04.04-5

The new Millers Creek Dam would have a water surface elevation just 18 ft below the existing Millers Creek Dam. Therefore, the new reservoir would back up to the existing dam, causing a normal high tailwater on the downstream face of the existing dam. This configuration would reduce the failure effects of the existing Millers Creek Dam compared to current conditions. The height of the new Millers Creek Dam would not be expected to exceed the height of Hubbard Creek Dam. Additionally, the combined storage capacity of the existing and new Millers Creek Dams is much less than the storage capacity at Hubbard Creek Dam. There are no downstream structures between the new Millers Creek Dam and Morris Sheppard Dam. Therefore, the failure effects from the combined existing and new Millers Creek Dam failures would not exceed the existing limiting dam failure permutation as previously determined.

The Cedar Ridge Reservoir is a recommended water management strategy and is considered a proposed reservoir. The Cedar Ridge Reservoir (227,127 ac.-ft storage capacity) would be located on the Clear Fork of the Brazos River approximately 172 river miles upstream from Morris Sheppard Dam. Fort Phantom Hill Dam (70,036 ac.-ft normal storage capacity and 127,000 ac.-ft maximum storage capacity) is located approximately 41 river miles upstream from the proposed Cedar Ridge Reservoir on a tributary of the Clear Fork of the Brazos River. Domino-type failure of Fort Phantom Hill Dam and Cedar Ridge Reservoir Dam would enhance the postulated dam failure effects at Morris Sheppard Dam.

Furthermore, Lake Stamford Dam (57,927 ac.-ft normal storage capacity and 150,000 ac.-ft maximum storage capacity) is located about 10 miles to the northwest of Cedar Ridge Reservoir on Paint Creek, a tributary of the Clear Fork of the Brazos River. Although it is not located upstream from Cedar Ridge Reservoir, Lake Stamford Dam is also located approximately 170 river miles upstream from Morris Sheppard Dam. Simultaneous failure of Lake Stamford Dam and Cedar Ridge Reservoir Dam would also enhance the postulated dam failure effects at Morris Sheppard Dam.

The three alternatives from the Llano Estacado Regional Water Plan are all proposed to be developed in series on the North Fork Double Mountain Fork of the Brazos River. Lake 7 (20,700 ac.-ft storage capacity) is proposed to be developed immediately upstream from McMillan Dam (4200 ac.-ft normal storage capacity and 8280 ac.-ft maximum storage capacity). Post Reservoir (56,000 ac.-ft storage capacity) is proposed to be developed approximately 41 river miles downstream from McMillan Dam. Diversion Reservoir (1000 ac.-ft storage capacity) is proposed to be developed approximately 21 river miles downstream of Post Reservoir and just upstream of the confluence with the South Fork Double Mountain Fork of the Brazos River. RCOL2_02.04.04-5

The three proposed reservoirs in conjunction with the existing reservoir formed by McMillan Dam contain relatively small storage capacities compared to the reservoir formed by John T. Montford Dam (115,937 ac.-ft normal storage capacity and 354,500 ac.-ft maximum storage capacity) on the South Fork and Double Mountain Fork of the Brazos River. Considering domino-type failure of the three proposed structures and the existing McMillan Dam, there would be some attenuation between each successive failure. Because John T. Montford Dam contains a much greater storage capacity and is considered as previously discussed, the three proposed structures have not been considered further.

Considering future conditions, the limiting dam failure permutation for additional quantitative analysis is the domino-type failure of Fort Phantom Hill Dam, Cedar Creek Reservoir Dam, Morris Sheppard Dam, and De Cordova Bend Dam along with the simultaneous failure of Lake Stamford Dam.

Pertinent Information for Upstream Dams

The considered upstream structures are described below. Reservoirs are assumed to be at ~~normal water surface elevations with no turbine discharges~~ their maximum historical water surface elevation or higher prior tot he onset of the PMF. Outlet, gated spillway, and turbine discharges are assumed to be unavailable to accomodate PMF flows. The gates at Morris Sheppard Dam and DeCordova Bend Dam are assumed to be closed. Wind setup for each reservoir is added to the maximum water surface elevation determined from the PMF combined with effects of upstream dam failures and transposed to the dam without attenuation. Failure of downstream structures would reduce the effects of dam failure and are not considered to fail. RCOL2_02.04.04-4 RCOL2_02.04.04-7 RCOL2_02.04.04-6

The elevations provided below are referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29), unless noted otherwise. The plant site grading plan is referenced to the North American Vertical Datum of 1988 (NAVD 88). Datum conversion is discussed in Subsection 2.4.4.3. RCOL2_02.04.04-7

Hubbard Creek Dam is an earthfilled embankment 15,150 ft in length with a maximum height of 112 ft or elevation 1208.0 ft. The service spillway is a circular concrete drop inlet structure that is gate controlled. The crest elevation of the drop inlet is 1176.5 ft and the top of the gates is at elevation 1185.0 ft. All water that enters the drop inlet is discharged through the embankment and exits downstream via a 22 ft diameter conduit. The normal pool elevation is 1183.0 ft. The emergency spillway is an excavated broad crested weir located near the left end of the dam. The 2000 ft long weir is at elevation 1194.0 ft. Also, incorporated in the emergency spillway is a 4000 ft long fuse plug with a crest elevation of 1197.0 ft (Reference 2.4-278).

According to the USGS gauge 08086400 Water-Data Report 2009 (Reference 2.4-279), the maximum recorded elevation for the reservoir is 1190.22 ft. RCOL2_02.04.04-7

Lake Stamford Dam is an earthfilled embankment 3600 ft in length with a maximum height of 78 ft or crest elevation 1436.8 ft. The service spillway is an excavated channel at the left end of the dam with an uncontrolled spillway crest 100 ft in length at elevation 1416.8 ft. The normal pool elevation is 1416.8 ft. The emergency spillway is a natural channel located at the right end of the embankment with a spillway crest elevation of 1425.8 ft (Reference 2.4-280).

According to the USGS gauge 08084500 Water-Data Report 2009 (Reference 2.4-281), the maximum recorded elevation for the reservoir is 1426.18 ft.

Fort Phantom Hill Dam is an earthfilled embankment 3740 ft in length with a maximum height of 84 ft. The spillway is a natural ground channel with an uncontrolled ogee crest 800 ft in length at elevation 1635.9 ft. The normal pool elevation is 1635.9 ft (Reference 2.4-282). Based on the USGS quadrangle for Hamby, TX (Reference 2.4-283) that encompasses Lake Fort Phantom Hill, there is a levee along the west side of the lake at elevation 1643 ft and approximately 6765 ft long.

According to the USGS gauge 08083500 Water-Data Report 2009 (Reference 2.4-284), the crest of the dam is 1650.0 ft and the maximum recorded elevation for the reservoir is 1639.50 ft.

According to the Brazos G Regional Water Plan (Reference 2.4-276), Cedar Ridge Reservoir will inundate approximately 6635 ac at the normal full pool elevation of 1489.0 ft. No other specific details for the proposed dam have been developed. Spillway details have not been developed and it is unknown how high above the full pool elevation the dam may be constructed. Therefore, it is assumed that the Cedar Ridge Reservoir Dam crest is at elevation 1510.0 ft, which is 21 ft above the normal full pool elevation. This is consistent with other dams in the region such as Lake Stamford Dam (20 ft above normal full pool elevation), Fort Phantom Hill Dam (14.1 ft above normal full pool elevation), and Hubbard Creek Dam (25 ft above normal full pool elevation). Based on the approximated location the crest length is estimated to be 4965 ft.

Morris Sheppard Dam is a concrete buttress dam with earthen dikes and has a maximum height of 189 ft or elevation 1024.0 ft. The service spillway is gate controlled with an ogee crest elevation of 987.0 ft and the top of gates elevation of 1000.0 ft. The dam impounds Possum Kingdom Lake at a normal pool elevation of 1000.0 ft (Reference 2.4-285). According to the Brazos River Authority Morris Sheppard Dam Breach Analysis Report (Reference 2.4-286), the total length of the concrete buttress section is 1640 ft. At the right abutment, the dam continues with a 1107 ft long earthen dike with a concrete core wall. In 1991 a 1400 ft long emergency spillway at elevation 1000.0 ft was completed at the south end of the concrete core wall. The top elevation of the concrete core wall is 1028.0 ft. Based on the Federal Energy Regulatory Commission Environmental Use and Inspection

Report (Reference 2.4-287), the spillway length is 707 ft with nine 73.6 ft wide gates. RCOL2_02.04.04-7

According to the USGS gauge 08088500 Water-Data Report 2008 (Reference 2.4-288), the maximum recorded elevation for the reservoir is 1003.60 ft and occurred prior to completion of the emergency spillway.

De Cordova Bend Dam is a concrete buttress dam with earth-filled sections and has a maximum height of 84 ft. The total length of the dam is 2200 ft. The spillway section is gate controlled with an ogee crest elevation of 658.0 ft. There are 16 tainter gates, each 36 ft wide and 35 ft high. Therefore, the top of gates elevation is 693.0 ft. The dam impounds Lake Granbury at a normal pool elevation of 693.0 ft (Reference 2.4-289). The top of the dam is elevation 706.5 ft (2.4-209). According to the NID database (2.4-222), the spillway section is 656 ft long.

According to the USGS gauge 08090900 Water-Data Report 2008 (Reference 2.4-290), the maximum recorded elevation for the reservoir is 693.60 ft.

Quantitative Assessment for Dam Failure Analysis

~~Hubbard Creek Dam is an earthfill structure 109 ft high, 12,580 ft long, with a 2000 ft long uncontrolled spillway. The spillway has a discharge capacity of 480,387 cfs. The impounded reservoir, Hubbard Creek Reservoir, has an estimated storage capacity of 317,750 ac-ft at normal water surface elevation. (2.4-222)~~

~~Morris Sheppard Dam is a concrete buttress structure 154 ft high, 2740 ft long, with a 729 ft long gated spillway. The spillway has a discharge capacity of 515,000 cfs. The impounded reservoir, Possum Kingdom Lake, has an estimated storage capacity of 556,220 ac-ft at normal water surface elevation. (2.4-222)~~

~~DeCordova Bend Dam is a concrete gravity structure 79 ft high, 2200 ft long, with a 656 ft long gated spillway. The spillway has a discharge capacity of 635,000 cfs. The impounded reservoir, Lake Granbury, has an estimated storage capacity of 136,823 ac-ft at normal water surface elevation. (2.4-222)~~

The coincident PMF flows are determined using the approach detailed in Appendix B of the NRC Regulatory Guide 1.59 (RG 1.59). Overtopping depth at each structure is determined using the standard broad crested weir flow equation.

$$Q = C \cdot L \cdot H^{1.5}$$

where

Q = flow (cfs)
C = weir flow coefficient (C = 2.6)
L = weir length (ft)
H = weir energy head (ft)

Wind Setup Analysis RCOL2_02.04.04-6

Wind setup is determined using the mathematical expression provided in the U.S. Army Corps of Engineers EM 1110-2-1420 (Reference 2.4-236).

S = U2 * F / (1,400 * D)

where

S = wind setup (ft)
U = average wind velocity over fetch distance (mph)
F = fetch distance (mi)
D = average depth of water generally along the fetch line (ft)

Wind speed is estimated based on the guidance of ANSI/ANS-2.8-1992 (2.4-229). As shown on Figure 2.4.3-210, the wind speed for CPNPP is 50 mph. However, the Brazos River watershed extends to areas of 60 mph. A two-year annual extreme mile wind speed of 60 mph is estimated for all upstream reservoirs. This is conservative and bounding for the expected range of values for the region.

The fetch distance is estimated to be the longest straight line fetch for the reservoir surface area at the maximum water surface elevation. The average depth of water is determined from the hydraulic depth using U.S. Geological Survey contours and supplemented with bathymetry maps from individual reservoir volumetric survey reports developed by the Texas Water Development Board.

Tailwater depth is determined for the overtopping flow at a downstream cross section using FlowMaster (2.4-241) and the Manning friction formula. A Manning coefficient of 0.025 is applied to the channel and overbank areas. Based on Chow (2.4-233), this is the minimum coefficient for main stream and flood plain areas. For the purpose of dam failure evaluation, it is conservative to use a lower coefficient because it results in a lower tailwater elevation. A lower tailwater elevation will maximize the water height component of the dam failure equation and the resulting dam failure flow or breach wave height. When it is determined that overtopping discharge is not independent of tailwater, the weir flow coefficient is reduced based on the guidance provided in the Federal Highway Administration Hydraulic Design Series Number 5 (2.4-223). A reduction of the weir flow coefficient is conservative and will increase the overtopping headwater elevation. RCOL2_02.04.04-7

The resulting overtopping dam failure flows are based on the St. Venant mathematical expression provided in the U.S. Army Corps of Engineers EM 1110-2-1420. (2.4-239).

$$Q = \frac{8}{27} \cdot W_b \cdot g^{0.5} \cdot Y_0^{1.5}$$

where

Q = flow (cfs)
W_b = width of breach (ft)
g = gravity coefficient (32.2 ft/sec2)
Y_o = initial depth (ft)

The expression assumes a rectangular cross section and is applied to concrete structures. A modified version of the expression, accounting for side slopes of a breach, is used for embankment sections. The following modified mathematical expression is provided in U.S. Army Corps of Engineers HEC-HMS documentation. (2.4-238).

$$Q = 1.7 \cdot W_b \cdot h^{1.5} + 1.35 \cdot S \cdot h^{2.5}$$

where

Q = outflow through the breach (cfs)
W_b = width of breach (ft)
h = smaller of the quantities: head difference between the reservoir interior water surface elevation and the tail water surface elevation, or head difference between reservoir interior water surface elevation and the breach bottom invert elevation (ft)
S = side slope of breach

~~Breach flows are estimated assuming no tail water to maximize the head difference and resulting breach flows.~~Alternatively, a breach wave heigh is computed using the method described in ANSI/ANS-2.8-1992 (2.4-229). RCOL2_02.04.04-7

h = 4 * (headwater - tailwater) / 9

where

h = breach wave height (ft)

Breach characteristics are estimated based on the guidance included in the U.S. Army Corps of Engineers RD-13 (2.4-240). Estimated breach flows or breach wave heights combined with additional spillway flows and overtopping flows are transposed to the next downstream structure without any attenuation. The transposed flow is combined with coincident PMF flow and a resulting overtopping depth and breach flow or breach wave height is then determined. RCOL2_02.04.04-7 RCOL2_02.04.04-7

Hubbard Creek Dam RCOL2_02.04.04-7

A coincident PMF of 600,000 cfs is estimated for the 1107 sq. mi drainage area of Hubbard Creek Dam. The antecedent reservoir elevation is assumed to be at the emergency spillway elevation of 1194.0 ft. This exceeds the maximum recorded water surface elevation. The emergency spillway and fuse plug overtopping elevation is determined to be 1207.4 ft, which does not exceed the dam crest elevation. RCOL2_02.04.04-7

Because the service spillway consists of a drop inlet structure interior to the reservoir, it is assumed the full capacity of the service spillway, 30,000 cfs, contributes to downstream flooding in addition to the PMF flow. The tailwater elevation is determined to be 1128.7 ft using the combined flow of 630,000 cfs. The tailwater is well below the spillway elevation.

The wind setup fetch distance is determined to be 11.4 mi using the USGS 1210 ft contour as the basis for the overtopping elevation. The average depth is determined to be 30.0 ft. The wind setup is determined to be 1.0 ft using a wind speed of 60 mph. Therefore, dam failure is evaluated using a headwater elevation of 1208.4 ft.

The following overtopping failures of Hubbard Creek Dam are considered:

- Overtopping failure of the main embankment dam
- Overtopping failure of the embankment fuse plug

A breach width of three times the dam height and 1:1 side slopes are assumed for the main dam. The breach flow is 490,000 cfs, accounting for tailwater. Breach flow is added to the combined PMF and service spillway flow for a total of 1,120,000 cfs. Alternatively, the breach wave height is 35.5 ft, accounting for tailwater.

The bottom of the fuse plug is determined to be at an elevation of 1170 ft, which is above the tailwater elevation. Therefore, no tailwater effects are considered for the fuse plug failure. The entire 4000 foot long fuse plug is assumed for the breach width along with 1:1 side slopes. The resulting breach flow is 1,640,000 cfs, which is added to the combined PMF and service spillway flow for a total of 2,270,000 cfs. Alternatively, the breach wave height is 17.1 ft.

The potential Hubbard Creek Dam failure effects to be considered (transposed downstream without attenuation to Morris Sheppard Dam) are a breach flow of 2,270,000 cfs from the fuse plug or a breach wave height of 35.5 ft from the main dam.

Lake Stamford Dam

A coincident PMF of 350,000 cfs is estimated for the 360 sq. mi drainage area of Lake Stamford Dam. The antecedent reservoir elevation is assumed to be at the dam crest elevation of 1436.8 ft, whichexceeds the maximum recorded water surface elevation. It is assumed the service and emergency spillway capacities are not available to accommodate any portion of the PMF. The overtopping elevation is determined to be 1448.0 ft. The tailwater elevation is determined to be 1409.1 ft for the PMF flow. The tailwater is well below the dam crest elevation. RCOL2_02.04.04-7

The wind setup fetch distance is determined to be 10.7 mi using the USGS 1450 ft contour as the basis for the overtopping elevation. The average depth is determined to be 27.7 ft.The wind setup is determined to be 1.0 ft using a wind speed of 60 mph. Therefore, dam failure is evaluated using a headwater elevation of 1449.0 ft.

Overtopping failure of Lake Stamford Dam is considered. A breach width of three times the dam height and 1:1 side slopes are assumed. Accounting for tailwater, the breach flow is 120,000 cfs. Breach flow is added to the PMF for a total of 470,000 cfs. Alternatively, the breach wave height is 17.8 ft, accounting for tailwater. The potential Lake Stamford Dam failure effects are to be considered for combination with the proposed Cedar Ridge Reservoir Dam failure effects and transposed downstream without attenuation to Morris Sheppard Dam.

Fort Phantom Hill Dam

A coincident PMF of 410,000 cfs is estimated for the 478 sq mi drainage area of Fort Phantom Hill Dam. The antecedent reservoir elevation is assumed to be at the levee crest elevation of 1643.0 ft. This exceeds the maximum recorded water surface elevation. It is assumed spillway capacity is not available to accommodate any portion of the PMF. The overtopping elevation is determined to be 1651.1 ft. The tailwater elevation is determined to be 1576.9 ft for the PMF flow. The tailwater is well below the levee and dam crest elevations.

The wind setup fetch distance is determined to be 7.9 mi using midway between the USGS 1650 ft and 1660 ft contours as the basis for the overtopping elevation. The average depth is determined to be 24.0 ft. The wind setup is determined to be 0.9 ft using a wind speed of 60 mph. Therefore, dam failure is evaluated using a headwater elevation of 1652.0 ft.

Because the levee is not as high, only overtopping failure of Fort Phantom Hill Dam is considered. A breach width of three times the dam height and 1:1 side slopes are assumed. The breach flow is 350,000 cfs, accounting for tailwater. Breach flow is added to the PMF for a total of 760,000 cfs. Alternatively, the breach wave height is 33.4 ft, accounting for tailwater. The potential Fort Phantom Hill Dam failure effects are transposed downstream without attenuation to the proposed Cedar Ridge Reservoir Dam.

Cedar Ridge Reservoir Dam

A coincident PMF of 810,000 cfs is estimated for the 2748 sq. mi drainage area of the proposed Cedar Ridge Reservoir Dam. Because the upstream dam failure effects include the Fort Phantom Hill Dam PMF of 410,000 cfs, only 400,000 cfs is added to the upstream dam failure effects to represent the contribution from the proposed Cedar Ridge Reservoir PMF. The antecedent reservoir elevation is assumed to be at the dam crest elevation of 1510.0 ft. RCOL2_02.04.04-7

The overtopping elevation is determined to be 1530.1 ft for the combined PMF and upstream dam failure effects flow of 1,160,000 cfs. The corresponding tailwater elevation is determined to be 1441.7 ft, which is well below the dam crest elevation.

Alternatively, the upstream dam failure breach wave height is added to the antecedent reservoir elevation to determine the corresponding flow. The flow is 2,500,000 cfs at an overtopping elevation of 1543.4 ft. The contributing portion of the proposed Cedar Ridge Reservoir coincident PMF is added for the combined PMF and upstream dam failure breach wave height of 2,900,000 cfs. The resulting overtopping elevation is determined to be 1547.0 ft. The corresponding tailwater elevation is determined to be 1471.3 ft, which is well below the dam crest elevation.

The wind setup fetch distance is determined to be 6.9 mi using the USGS 1550 ft contour as the basis for the overtopping elevation. The average depth is determined to be 68.2 ft. The wind setup is determined to be 0.3 ft using a wind speed of 60 mph. Therefore, dam failure is evaluated using a headwater elevation of 1530.4 ft for an overtopping flow of 1,160,000 cfs or 1547.3 ft for an overtopping flow of 2,900,000 cfs.

The following overtopping failure conditions of the proposed Cedar Ridge Reservoir Dam are considered:

- Overtopping flow of 1,160,000 cfs with a headwater elevation 1530.4 ft and a tailwater elevation 1441.7 ft
- Overtopping flow of 2,900,000 cfs with a headwater elevation 1547.3 ft and a tailwater elevation 1471.3 ft

A breach width of three times the dam height and 1:1 side slopes are assumed. Based on an overtopping flow of 1,160,000 cfs and accounting for tailwater, the breach flow is 710,000 cfs. Breach flow is added to the PMF and overtopping flow for a total of 1,870,000 cfs. Alternatively, the breach wave height is 39.5 ft, accounting for tailwater. Based on an overtopping flow of 2,900,000 cfs and accounting for tailwater, the breach flow is 560,000 cfs. Breach flow is added to the PMF and overtopping flow for a total of 3,460,000 cfs. Alternatively, the breach wave height is 33.8 ft, accounting for tailwater.

The potential Cedar Ridge Reservoir Dam failure effects to be considered (transposed downstream without attenuation to Morris Sheppard Dam) are a breach flow of 3,460,000 cfs or a breach wave height of 39.5 ft. When combined with the Lake Stamford Dam failure effects, the total upstream dam failure effects are 3,930,000 cfs or a wave height of 57.3 ft. The combined upstream dam failure effects exceed the potential failure effects from Hubbard Creek Dam. Therefore, the controlling dam failure scenario includes the domino-type failures Fort Phantom Hill Dam, proposed Cedar Ridge Reservoir Dam, Morris Sheppard Dam, and De Cordova Bend Dam. In addition Lake Stamford Dam is assumed to fail simultaneous with the Cedar Ridge Reservoir Dam. RCOL2_02.04.04-7

Morris Sheppard Dam

For the 13,310 sq. mi contributing drainage area of Morris Sheppard Dam, the greater 16,113 sq. mi contributing drainage area of De Cordova Bend Dam is used to determine the coincident PMF of 1,450,000 cfs is estimated. Although, the maximum historical elevation was recorded prior to construction of the emergency spillway, it is assumed the antecedent reservoir elevation is the maximum historical elevation of 1003.6 ft. Assuming the spillway gates are closed and overtopped by the antecedent reservoir elevation, the combined emergency spillway and gate overtopping flow is 40,000 cfs.

The upstream dam failure effects are added to the coincident PMF and antecedent reservoir elevation flow for a total overtopping flow of 5,420,000 cfs. The overtopping elevation is determined to be 1075.7 ft. The corresponding tailwater elevation is determined to be 973.0 ft, which is well below the spillway crest and top of gates elevations.

Alternatively, the upstream dam failure breach wave height is added to the antecedent reservoir elevation and combined with the coincident PMF to determine the corresponding flow. At an overtopping elevation of 1060.9 ft the flow is 3,670,000 cfs. The combined PMF and upstream dam failure breach wave height flow is 5,120,000 cfs. The resulting overtopping elevation is determined to be 1073.3 ft. The corresponding tailwater elevation is determined to be 970.3 ft, which is well below the spillway crest and top of gates elevations.

The wind setup fetch distance is determined to be 2.3 mi using the USGS 1080 ft contour as the basis for the overtopping elevation. The average depth is determined to be 120.5 ft. Thewind setup is determined to be 0.1 ft using a wind speed of 60 mph. Therefore, dam failure is evaluated using a headwater elevation of 1075.8 ft for an overtopping flow of 5,420,000 cfs or 1073.4 ft for an overtopping flow of 5,120,000 cfs.

~~For the Hubbard Creek Dam 1,107 sq. mi drainage area, a coincident PMF of 600,000 cfs is estimated. A breach width of three times the dam height and 1:1 side slopes is assumed. Considering the spillway capacity, breach flow, and remaining overtopping flow, the total outflow is estimated to be 1.4 million cfs.~~

~~The Hubbard Creek Dam breach total outflow is transposed to Morris Sheppard Dam without any attenuation and combined with the coincident PMF for the Brazos River. The downstream DeCordova Bend Dam 15,451 sq. mi contributing drainage area is used to estimate a coincident PMF of 1.5 million cfs. The total flow applied to Morris Sheppard Dam is 2.9 million cfs.~~

The following overtopping failures of Morris Sheppard Dam are considered:

- Overtopping failure of the spillway section.
- Overtopping failure of the embankment section.
- Overtopping failure of the buttress section at the left abutment.
- Overtopping failure of the buttress section between the spillway and embankment sections.

The overtopping failures of the buttress sections are eliminated without calculation. The left abutment buttress section has a much shorter crest length than the spillway section. Therefore, failure of the spillway section would result in a greater breach flow. The buttress section between the spillway and embankment sections is approximately the same length as the spillway, but the section depth is about half that of the spillway section. Therefore, failure of the spillway section would result in a greater breach flow. RCOL2_02.04.04-7

The following overtopping failure conditions of Morris Sheppard Dam are considered:

- Overtopping flow of 5,420,000 cfs with a headwater elevation 1075.8 ft and a tailwater elevation 973.0 ft.
- Overtopping flow of 5,120,000 cfs with a headwater elevation 1073.4 ft and a tailwater elevation 970.3 ft.

A breach width of the entire spillway section and vertical side slopes are assumed. Based on an overtopping flow of 5,420,000 cfs and accounting for tailwater, the breach flow is 1,240,000 cfs. Breach flow is added to the overtopping flow for a total of 6,660,000 cfs. Alternatively, the breach wave height is 45.7 ft, accounting for tailwater. Based on an overtopping flow of 5,120,000 cfs and accounting for tailwater, the breach flow is 1,250,000 cfs. Breach flow is added to the PMF and overtopping flow for a total of 6,370,000 cfs. Alternatively, the breach wave height is 45.9 ft, accounting for tailwater.

The bottom of the embankment section is determined to be at an elevation of 990 ft. This is above the tailwater elevation. Therefore, no tailwater effects are considered for the embankment section failure. A breach width of three times the dam height and 1:1 side slopes are assumed. Based on an overtopping flow of 5,420,000 cfs the resulting breach flow is 230,000 cfs. Breach flow is added to the overtopping flow for a total of 5,650,000 cfs. Alternatively, the breach wave height is 38.2 ft. Based on an overtopping flow of 5,120,000 cfs the resulting breach flow is 220,000 cfs. Breach flow is added to the overtopping flow for a total of 5,340,000 cfs. Alternatively, the breach wave height is 37.1 ft.

The potential Morris Sheppard Dam failure effects, transposed downstream without attenuation to De Cordova Bend Dam, to be considered are a spillway section breach flow of 6,660,000 cfs or a breach wave height of 45.9 ft. RCOL2_02.04.04-7

De Cordova Bend Dam

The Morris Sheppard Dam failure effects include the PMF for the Brazos River at De Cordova Bend Dam. Therefore, no additional flow is combined with the upstream failure effects. For the overtopping flow, the antecedent reservoir elevation is assumed to be at the dam crest elevation of 706.5 ft. Because of topography conditions around the reservoir, above elevation 700 ft. the reservoir is capable of spilling over low lying elevations along the south rim of the reservoir into the Brazos River well downstream from the dam. Based on the overtopping flow of 6,660,000 cfs and a reduced weir flow coefficient of 1.54, the headwater is determined to be 766.4 ft. The corresponding tailwater is determined to be 751.1 ft. Tailwater is determined for only the 4,670,000 cfs portion of total flow that overtops the dam and adjacent abutment areas. The remaining flow overtops the south rim of the reservoir.

Alternatively, for the breach wave height, it is assumed the antecedent reservoir elevation is the maximum historical elevation of 693.6 ft. The upstream dam failure breach wave height is added to the antecedent reservoir elevation to determine the corresponding flow. At an overtopping elevation of 739.5 ft the flow is 3,270,000 cfs. The corresponding tailwater elevation is determined to be 734.2 ft. Tailwater is determined for only the 2,750,000 cfs portion of total flow that overtops the dam and adjacent abutment areas. The remaining flow overtops the south rim of the reservoir. Although, the tailwater exceeds the dam crest elevation, it is determined that at the overtopping elevation the weir flow coefficient does not require reduction.

The wind setup fetch distance is determined to be 5.3 mi using the USGS 770 ft contour as the basis for the overtopping elevation. The average depth is determined to be 67.9 ft. Using a wind speed of 60 mph, the wind setup is determined to be 0.3 ft. Therefore, dam failure is evaluated using a headwater elevation of 766.7 ft for a total overtopping flow of 6,660,000 cfs or 739.8 ft for a total overtopping flow of 3,270,000 cfs.

~~The overtopping failure of the entire spillway section results in the greatest breach flow. Considering the breach flow and remaining overtopping flow, the total outflow is estimated to be 5.6 million cfs.~~

~~The Morris Sheppard breach total outflow is transposed to the DeCordova Bend Dam without any attenuation.~~ The following overtopping failures of DeCordova Bend Dam are considered:

- Overtopping failure of the spillway section.
- Overtopping failure of the embankment section.

The following overtopping failure conditions of De Cordova Bend Dam are considered: RCOL2_02.04.04-7

- Overtopping flow of 6,660,000 cfs with a headwater elevation 766.7 ft and a tailwater elevation 751.1 ft.
- Overtopping flow of 3,270,000 cfs with a headwater elevation 739.8 ft and a tailwater elevation 734.2 ft.

A breach width of the entire spillway section and vertical side slopes are assumed. Based on an overtopping flow of 6,660,000 cfs and accounting for tailwater, the breach flow is 70,000 cfs. Breach flow is added to the overtopping flow for a total of 6,730,000 cfs. Alternatively, the breach wave height is 7.0 ft, accounting for tailwater. Based on an overtopping flow of 3,270,000 cfs and accounting for tailwater, the breach flow is 20,000 cfs. Breach flow is added to the overtopping flow for a total of 3,290,000 cfs. Alternatively, the breach wave height is 2.5 ft, accounting for tailwater.

A breach width of three times the dam height and 1:1 side slopes are assumed for the embankment section. Based on an overtopping flow of 6,660,000 cfs and accounting for tailwater, the breach flow is 30,000 cfs. Breach flow is added to the overtopping flow for a total of 6,690,000 cfs. Based on an overtopping flow of 3,270,000 cfs and accounting for tailwater, the breach flow is 10,000 cfs. Breach flow is added to the overtopping flow for a total of 3,280,000 cfs. Alternatively, because of the tailwater effects, the embankment section breach wave heights are identical to those determined for the spillway section.

The overtopping failure of the entire spillway section results in the greatest breach flow. Because of the tailwater effects, the breach wave height was added to the downstream tailwater elevation to determine a corresponding flow. However, the result did not exceed the breach flow. Considering the breach flow and ~~remaining~~ overtopping flow, including overtopping flow spreading out beyond the abutments and spilling over the south rim of the reservoir, the total outflow is ~~estimated to be 6.7 million cfs~~determined to be 6,730,000. This flow is transposed downstream without any attenuation to the confluence of the Paluxy River near its confluence with Squaw Creek to determine the relevant water surface elevation. RCOL2_02.04.04-7

~~Morris Sheppard and DeCordova dams are main stream Brazos River dams upstream of the confluence with Squaw Creek. Domino type failure of these two dams would produce greater flooding than if simultaneous failure were to occur. Hubbard Creek Dam is the largest dam in the watershed above Morris Sheppard Dam. Including Hubbard Creek Dam in the domino type failure increases the flooding at the confluence more than other dam failure combination.~~ RCOL2_02.04.04-5

~~The volumes of water at other dams in the upstream watershed are not significant compared to the volume of the reservoir at Hubbard Creek Dam. As shown in Figure 2.4.4-201, Lake Stamford and White River Reservoir are more distant and located on different tributaries. Lake Stamford and White River Reservoir also~~

~~contain much less volume of water than Hubbard Creek Reservoir. Therefore, failure of either Lake Stamford or White River Reservoir dams in combination with the main stream dams would produce less flooding than inclusion of Hubbard Creek Dam. Because of the relative locations, flooding from simultaneous failure of all dams would not combine to create more severe flooding than that discussed.~~ RCOL2_02.04.04-5

~~As shown in Figure 2.4.4-201, Lake Palo Pinto is located on a tributary of the Brazos River between Morris Sheppard and DeCordova dams. Lake Palo Pinto contains a significantly smaller volume of water than Hubbard Creek Reservoir. Therefore, failure of Palo Pinto Dam in combination with the main stream dams would produce less flooding than inclusion of Hubbard Creek Dam. Because of the relative locations, flooding from simultaneous failure of dams would not combine to create more severe flooding than that discussed.~~

~~The volume of water, distance from the Brazos River and Paluxy River confluence, and the development potential of proposed reservoir sites were considered for the dam failure analyses. All but one of these potential reservoirs, the South Bend Reservoir, was found to contain less storage than Possum Kingdom Lake and were excluded from the dam failure analyses. The proposed South Bend Reservoir was not recommended as a water management strategy in the 2006 Brazos River Region G Water Plan (Reference 2.4-208), and therefore, was not included in the dam failure analyses. Also, there are no proposed main stem reservoirs downstream of Lake Whitney. Because of the relative locations and storage volume, flooding from simultaneous failure of dams at potential reservoir sites would not combine to create a more severe flooding than that discussed (see Subsection 2.4.1.2).~~

There are no safety-related facilities that could be affected by loss of water supply due to dam failure or water supply blockages due to sediment deposition or erosion during dam failure induced flooding. See Subsection 2.4.11. Landslide potential is addressed in Subsection 2.4.9. There are no safety-related structures that could be affected by waterborne objects. There are no on-site water control or storage structures located above site grade that may induce flooding.

2.4.4.2 Unsteady Flow Analysis of Potential Dam Failures

The methods identified are standard industry methods applied to artificially large floods. The approach described above is conservative and utilizes conservative coefficients resulting in a bounding estimate for dam failure considerations. Therefore, a full unsteady flow analysis to determine dam breach flows and resulting water surface elevations with greater certainty is determined to be unnecessary. Downstream reservoirs have no affect on the results of this analysis. Domino-type failures are included coincident with PMF flows and transposed downstream without any attenuation as discussed above. As discussed below the resulting dam failure flood wave has no effect at the site.

2.4.4.3 Water Level at Plant Site

The potential backwater effect from flooding on the Brazos River is examined based on the assumed hydrologic domino-type dam failures coincident with the PMF. As described above, the assumed hydrologic domino-type dam failures of ~~the Hubbard Creek Dam~~Fort Phantom Hill Dam, the proposed Cedar Ridge Dam, the Lake Stamford Dam, the Morris Sheppard Dam, and the DeCordova Bend Dam coincident with the PMF, is transposed to the confluence of the Paluxy River and the Brazos River without any attenuation. Squaw Creek is a tributary of the Paluxy River. Utilizing ~~FlowMaster~~HEC-RAS computer software (Reference ~~2.4-241~~2.4-234), the ~~Manning's friction method formula is used~~stream course model described in Subsection 2.4.3.3 is used as a basis to determine the water surface elevation at the confluence. RCOL2_02.04.04-7

~~The confluence cross section is determined based on USGS 7.5 minute topographic quadrangles containing 10 ft contour intervals. The bank full elevation of the Brazos River at the confluence is approximately elevation 560 ft msl. (2.4-214) The confluence cross section stations and elevations in ft msl are shown in Figure 2.4.4-202.~~ RCOL2_02.04.04-7

~~A Manning's roughness coefficient of n = 0.10 is estimated for the Brazos River channel based on published tables by Chow. (2.4-233) To account for variability and uncertainty of the Brazos River channel on the downstream side of the DeCordova Dam, sensitivity analyses were performed for Manning's roughness coefficient, channel geometry and channel slope.~~The HEC-RAS stream course model is appended to include cross sections for the Brazos River. The selected cross sections are identified in Figure 2.4.4-202. As discussed in Subsection 2.4.3.3, a Manning's Roughness coefficient of 0.15 is also used for the Brazos River. The peak flows from the HEC-HMS model described in Subsection 2.4.3 for the Paluxy River and Squaw Creek were included as inputs for the Brazos River tributaries. The transposed 6,730,000 cfs from the dam failure scenario is included as the Brazos River input. The HEC-RAS model was run using steady state conditions to determine the water surface elevation at the confluence.

The resulting maximum water surface elevation at the confluence of Brazos River and Paluxy River cross section is ~~774.99~~760.05 ft msl for the total transposed flow ~~of 6.7 million cfs~~combined with the peak tributary flows as shown in Figure 2.4.4-203. ~~CPNPP Units 3 and 4 safety-related facilities are located at elevation 822 ft msl, providing almost 47 ft of freeboard. Additionally, t~~The resulting water surface elevation is below the Squaw Creek Dam crest elevation of 796 ft. Therefore, coincident wind wave activity results would be equivalent to the wind wave activity for SCR (See Subsection 2.4.3.6). In the unlikely event of achieving the water surface elevation described above, possible headcutting on the downstream slope of Squaw Creek Dam could result in failure of the Squaw Creek Dam. However, failure would lower the water surface elevation of SCR. In the event of Squaw Creek Dam failure the fetch length determined by the wind wave activity in Subsection 2.4.3.6 would not be increased. RCOL2_02.04.04-7

Elevations are provided with reference to the National Geodetic Vertical Datum of 1929 (NGVD 29). The plant site elevation is referenced to the North American Vertical Datum of 1988 (NAVD 88). According to the National Geodetic Survey, the datum shift of NAVD 88 minus NGVD 29 is equal to between 0 and +0.66 in for the site. Therefore, it is conservative to account for a maximum conversion of +0.66 ft when comparing water surface elevations determined using NGVD 29 to elevations at the site in NAVD 88. Considering conversion, the confluence water surface elevation of 760.71 ft NAVD 88 is well below the CPNPP Units 3 and 4 safety-related structures elevation of 822 ft NAVD 88. RCOL2_02.04.04-7

2.4-272 Jones, K.F., J.E. Friddell, S.F. Daly, and C.M. Vuyovich, "Severe Winter Weather in the Continental U.S. and Global Climate Cycles," U.S. Army Corps of Engineers TR-04-19, October 2004.

2.4-273 Brazos River Authority, The Texas Clean Rivers Program 2009 Basin Highlights Report, Website, http://www.brazos.org/crpHistoricalReports.asp, accessed May 26, 2010. RCOL2_02.04.01-6

2.4-274 National Atlas, Website, http://nationalatlas.gov/, accessed April 2010. RCOL2_02.04.04-5 and 7

2.4-275 Somervell County Water District, Website, http://scwd.us/, accessed April 2010.

2.4-276 Brazos G Regional Water Planning Group, Brazos G Regional Water Planning Area, Initially Prepared 2011 Brazos G Regional Water Plan, March 2010.

2.4-277 Llano Estacado Regional Water Planning Group, Llano Estacado Regional Water Planning Area, Initially Prepared Regional Water Plan, March 2010.

2.4-278 Texas Water Development Board, Volumetric Survey of Hubbard Creek Reservoir, March 10, 2003.

2.4-279 U.S. Geological Survey, Water-Data Report 2009, 08086400 Hubbard Creek Reservoir nr Breckenridge, TX, Website, http://wdr.water.usgs.gov/, accessed May 2010.

2.4-280 Texas Water Development Board, Volumetric Survey of Lake Stamford, January 24, 2000.

2.4-281 U.S. Geological Survey, Water-Data Report 2009, 08084500 Lake Stamford near Haskell, TX, Website, http://wdr.water.usgs.gov/, accessed May 2010.

2.4-282 Texas Water Development Board, Volumetric Survey of Fort Phantom Hill Reservoir, March 10, 2003.

2.4-283 U.S. Geological Survey, Quadrangles, Website, http://www.usgs.gov, accessed April 2010.

2.4-284 U.S. Geological Survey, Water-Data Report 2009, 08083500 Fort Phantom Hill Reservoir near Nugent, TX, Website, http://wdr.water.usgs.gov/, accessed May 2010.

2.4-285 Texas Water Development Board, Volumetric Survey Report of Possum Kingdom Lake December 2004-January 2005 Survey, May 2006. RCOL2_02.04.04-5 and 7

2.4-286 Freese and Nichols, Inc., Brazos River Authority Morris Sheppard Dam Breach Analysis Report, September 2001.

2.4-287 Federal Energy Regulatory Commission, "Environmental and Public Use Inspection Report, Morris Sheppard (Possum Kingdom)", August 5, 1999.

2.4-288 U.S. Geological Survey, Water-Data Report 2008, 08088500 Possum Kingdom Lake near Graford, TX, Website, http://wdr.water.usgs.gov/, accessed May 2010.

2.4-289 Texas Water Development Board, Volumetric Survey Report of Lake Granbury July 2003 Survey, September 2005.

2.4-290 U.S. Geological Survey, Water-Data Report 2008, 08090900 Lake Granbury near Granbury, TX, Website, http://wdr.water.usgs.gov/, accessed May 2010.

2.4-291 National Geodetic Survey, Website, http://www.ngs.noaa.gov/TOOLS/Vertcon/vertcon.html, accessed May 2010. RCOL2_02.04.03-5

RCOL2_02.04.04-5

Table 2.4.4-201 (Sheet 1 of 8)
Information for Dams Upstream of Lake Whitney Dam

No.	Dam Name (inclusion/exclusion from dam failure analysis)	River	Distance (river mi)[1]	Drainage Area (sq mi)	Date Completed	Type[2]	Length[3] (ft)	Height[3] (ft)	Surface Area (ac)	Volume Capacity[4] Normal (ac-ft)	Volume Capacity[4] Maximum (ac-ft)
58	Running Water Draw Site 1 Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Running Water Draw	692	128	1975	RE	3208	65	1581	2170	25,120
57	Running Water Draw WS SCS Site 3 Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Running Water Draw	649	124	1979	RE	3250	55	233	4427	18,499
56	Lower Running Water Draw WS SCS Site 2 Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	N Fork Running Water Draw	618	30	1977	RE	3430	41	42	5429	7383
55	Lower Running Water Draw WS SCS Site 3 Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Running Water Draw	606	390	1982	RE	2500	37	54	8213	14,312
54	McMillan Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Double Mountain Fork Brazos R	577	236	1960	RE	1600	76	200	4200	8280

RCOL2_02.04.04-5

Table 2.4.4-201 (Sheet 2 of 8)
Information for Dams Upstream of Lake Whitney Dam

No.	Dam Name (inclusion/exclusion from dam failure analysis)	River	Distance (river mi)[1]	Drainage Area (sq mi)	Date Completed	Type[2]	Length[3] (ft)	Height[3] (ft)	Surface Area (ac)	Volume Capacity[4] Normal (ac-ft)	Volume Capacity[4] Maximum (ac-ft)
53	White River Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	White River	518	172	1963	RE	4400	80	1477	31,537	80,000
52	Big Tank Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	TR-Double Mtn Fk Brazos River	539	ns	1965	RE	600	65	ns	185	490
51	Parks Lake Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Tr-Green Creek	539	ns	1971	RE	1142	50	6	110	220
50	John T Montford Dam (excluded - smaller volume and drainage area, and farther distance compared to Hubbard Creek Dam)	Double Mountain Fork Brazos R	513	394	1994	RE	440	141	2884	115,937	354,500
49	Duck Creek WS SCS Site 7 Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Dockum Creek	502	12	1968	RE	2900	61	33	200	4712
48	Duck Creek WS SCS Site 5 Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Cottonwood Creek	500	22	1969	RE	2550	71	148	2249	7900

RCOL2_02.04.04-5

Table 2.4.4-201 (Sheet 3 of 8)
Information for Dams Upstream of Lake Whitney Dam

No.	Dam Name (inclusion/exclusion from dam failure analysis)	River	Distance (river mi)[1]	Drainage Area (sq mi)	Date Completed	Type[2]	Length[3] (ft)	Height[3] (ft)	Surface Area (ac)	Volume Capacity[4] Normal (ac-ft)	Volume Capacity[4] Maximum (ac-ft)
47	Duck Creek WS SCS Site 1 Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Duck Creek	502	20	1968	RE	3600	62	79	634	10,750
46	Hagins Panther Canyon Lake Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Damn)	Tr-Salt Fork Brazos River	483	ns	1969	RE	300	50	10	140	320
45	So Relle Lake Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Stinking Creek	453	ns	1964	RE	1000	50	40	412	1000
44	**Lake Stamford Dam (included based on future conditions)**	**Paint Creek**	**332**	**360**	**1953**	**RE**	**3600[5]**	**78[5]**	**4690**	**57,927**	**150,000**
43	Lake Trammel Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Sweetwater Creek	439	49	1915	RE	1160	59	160	2500	5890
42	Lake Sweetwater Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Bitter Creek	429	104	1930	RE	3030	58	221	2544	19,340

RCOL2_02.04.04-5

Table 2.4.4-201 (Sheet 4 of 8)
Information for Dams Upstream of Lake Whitney Dam

No.	Dam Name (inclusion/exclusion from dam failure analysis)	River	Distance (river mi)[1]	Drainage Area (sq mi)	Date Completed	Type[2]	Length[3] (ft)	Height[3] (ft)	Surface Area (ac)	Volume Capacity[4] Normal (ac-ft)	Volume Capacity[4] Maximum (ac-ft)
41	Lake Abilene Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Elm Creek	409	101	1921	RE	5040	64	583	45,000	45,000
40	Lake Kirby Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Cedar Creek	399	42	1928	RE	4200	50	780	7620	17,811
39	**Fort Phantom Hill Dam (included based on future conditions)**	**Big Elm Creek**	**375**	**478[6]**	**1938**	**RE**	**3740[6]**	**84**	**4246**	**70,036**	**127,000**
38	Lake Davis Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard	Dutchman Creek	347	ns	1959	RE	6864	32	ns	5395	19,000
37	Millers Creek Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Millers Creek	305	ns	1974	RE	8000	75	2882	29,171	131,000
36	Mexia Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Mexia Creek	307	ns	1950	RE	1660	52	ns	2070	3370
35	Williamson Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Sandy Creek	292	26	1923	CB	1064	96	1817	45,000	45,000

RCOL2_02.04.04-5

Table 2.4.4-201 (Sheet 5 of 8)
Information for Dams Upstream of Lake Whitney Dam

No.	Dam Name (inclusion/exclusion from dam failure analysis)	River	Distance (river mi)[1]	Drainage Area (sq mi)	Date Completed	Type[2]	Length[3] (ft)	Height[3] (ft)	Surface Area (ac)	Volume Capacity[4] Normal (ac-ft)	Volume Capacity[4] Maximum (ac-ft)
34	McCarty Lake Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Salt Prong Hubbard Creek	290	44	1942	RE	1250	50	263	2600	6696
33	Gonzales Creek Dam (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	Gonzales Creek	271	115	1948	RE	2700	50	954	11,400	38,242
32	Hubbard Creek Dam (excluded - future conditions more critical)	Hubbard Creek	261	1107	1962	RE	15,150[7]	112[7]	15,250	317,750	720,000
31	Eddleman Dam (excluded - smaller volume, height, and drainage area compared to Hubbard Creek Dam)	Flint Creek	218	42	1929	RE	4495	57	650	13,386	35,000
30	Graham Dam (excluded - smaller volume, height, and drainage area compared to Hubbard Creek Dam)	Salt Creek	219	42	1958	RE	4300	82	1900	39,000	105,000
29	**Morris Sheppard (included)**	**Brazos R**	**162**	**13,310**	**1941**	**CD**	**2747[8]**	**189[9]**	**17,624**	**556,220**	**556,220**
28	Lake Tucker Dam (excluded - small volume)	Russell Creek	126	24	1937	RE	900	97	81	1600	2500
27	Waddell Ranch Dam No 3 (excluded - small volume)	Joes Creek	110	ns	1975	RE	613	54	16	307	488
26	Lake Palo Pinto Dam (excluded - smaller volume and height compared to Morris Sheppard Dam)	Palo Pinto	104	471	1964	RE	1255	93	2661	44,100	170,735

RCOL2_02.04.04-5

Table 2.4.4-201 (Sheet 6 of 8)
Information for Dams Upstream of Lake Whitney Dam

No.	Dam Name (inclusion/exclusion from dam failure analysis)	River	Distance (river mi)[1]	Drainage Area (sq mi)	Date Completed	Type[2]	Length[3] (ft)	Height[3] (ft)	Surface Area (ac)	Volume Capacity[4] Normal (ac-ft)	Volume Capacity[4] Maximum (ac-ft)
25	Lake Mineral Wells Dam (excluded - small volume)	Rock Creek	91	63	1920	RE	1760	70	668	7065	16,356
24	Star Hollow Lake Dam (excluded - small volume)	Star Hollow Creek	84	ns	1967	RE	1120	54	92	1454	1959
23	Ruckers Creek WS SCS Site 1 Dam (excluded - small volume)	Rucker Creek	49	6	1968	RE	2080	50	33	133	2375
22	**De Cordova Bend Dam (included)**	**Brazos River**	**33**	**16,113[10]**	**1969**	**CBRE[10]**	**2200**	**84[10]**	**1350**	**136,823**	**240,640**
21	Safe Shutdown Impoundment Dam (excluded - adjacent to site)	Panther Branch	6	7	1977	ER	1520	70	7	367	900
20	Squaw Creek Dam (excluded - adjacent to site)	Squaw Creek	5	64	1977	RE	4690	152	3228	151,047	199,427
19	Paluxy River Channel Dam[11] (excluded - small volume)	Paluxy River	3	428	2007	PG	ns	8	9	35	35
18	Wheeler Branch Dam[11] (excluded - small volume)	Wheeler Branch	5	1.6	2007	RE	1750	80	180	4118	4118
17	Paluxy River WS SCS Site 5 Dam (excluded - small volume)	Germany Creek	39	160	1988	RE	1640	58	25	171	1604
16	Paluxy River WS SCS Site 1 Dam (excluded - small volume)	Tr-North Paluxy River	40	4	1984	RE	850	54	24	160	1512
15	Paluxy River WS SCS Site 6 Dam (excluded - small volume)	Straight Creek	38	5	1980	RE	1168	53	41	150	1211
14	Paluxy River WS SCS Site 3 Dam (excluded - small volume)	Tr-Paluxy River	39	2	1987	RE	865	51	16	110	821

RCOL2_02.04.04-5

Table 2.4.4-201 (Sheet 7 of 8)
Information for Dams Upstream of Lake Whitney Dam

No.	Dam Name (inclusion/exclusion from dam failure analysis)	River	Distance (river mi)[1]	Drainage Area (sq mi)	Date Completed	Type[2]	Length[3] (ft)	Height[3] (ft)	Surface Area (ac)	Volume Capacity[4] Normal (ac-ft)	Volume Capacity[4] Maximum (ac-ft)
13	Paluxy River WS SCS Site 9 Dam (excluded - small volume)	Tr- South Paluxy River	36	3	1984	RE	920	45	20	164	1107
12	Paluxy River WS SCS Site 12 Dam (excluded - small volume)	Tr- South Paluxy River	33	5	1985	RE	1240	45	25	123	1841
11	Paluxy River WS SCS Site 15 Dam (excluded - small volume)	Tr-Berry S Creek	25	12	1983	RE	1740	55	42	236	4064
10	Paluxy River WS SCS Site 16 Dam (excluded - small volume)	Goss Hollow	20	5	1980	RE	1848	53	32	200	2392
9	Paluxy River WS SCS Site 19 Dam (excluded - small volume)	Sycamore Creek	25	11	1981	RE	1910	64	38	200	4216
8	Paluxy River WS SCS Site 20 Dam (excluded - small volume)	Pony Creek	21	18	1981	RE	1950	74	65	200	6756
7	Paluxy River WS SCS Site 21 Dam (excluded - small volume)	Lallah Branch	21	16	1982	RE	2000	73	56	725	6140
6	Paluxy River WS SCS Site 23 Dam (excluded - small volume)	Rough Creek	18	5	1984	RE	1260	55	22	196	1762
5	Paluxy River WS SCS Site 25 Dam (excluded - small volume)	White Bluff Creek	11	11	1983	RE	2114	60	49	200	4485
4	Lake Virginia Dam3 (excluded - downstream dam and small volume)	11	11	1	1987	RE	845	56	47	898	1169
3	Cleburne State Park Lake Dam (excluded - downstream dam and small volume)	West Fork Camp Creek	17	ns	1940	RE	1300	62	ns	1450	2900

RCOL2_02.04.04-5

Table 2.4.4-201 (Sheet 8 of 8)
Information for Dams Upstream of Lake Whitney Dam

No.	Dam Name (inclusion/exclusion from dam failure analysis)	River	Distance (river mi)[1]	Drainage Area (sq mi)	Date Completed	Type[2]	Length[3] (ft)	Height[3] (ft)	Surface Area (ac)	Volume Capacity[4] Normal (ac-ft)	Maximum (ac-ft)
2	Lake Pat Cleburne Dam (excluded - downstream dam small volume)	Nolan River	52	100	1964	RE	5190	78	1550	25,600	66,700
1	Lake Whitney (excluded - downstream dam)	Brazos River	56	17,656	1951	REPG	17,695	159	23,560	627,100	2,100,400

NOTES:
Highlighted entries identify dams evaluated for the quantitative dam failure analysis. Bold type entries identify damsn included in the critical dam failure scenario.
Information obtained from National Atlas, unless otherwise noted.
ns = not specified

1. Distance in river miles from the dam to the confluence of the Brazos River and Paluxy River.
2. Type of dam:
   RE = Earth
   ER = Rockfill
   PG = Gravity
   CB = Buttress
3. Information obtained from the U.S. Army Corps of Engineers National Inventory of Dams database, unless otherwise noted.
4. Normal storage is the total storage below the normal retention level, including dead and inactive storage and excluding any flood control or surcharge storage. Maximum storage is the total storage below the maximum attainable water surface elevation, including any surcharge storage.
5. Information obtained from the Texas Water Development Board, Volumetric Survey of Lake Stamford, January 24, 2000.
6. Information obtained from the Texas Water Development Board, Volumetric Survey of Fort Phantom Hill Reservoir, March 10, 2003.
7. Information obtained from the Texas Water Development Board, Volumetric Survey of Hubbard Creek Reservoir, March 10, 2003.
8. Information obtained from Freeze and Nichols, Inc., Brazos River Authority Morris Sheppard Dam Breach Analysis Report, September 2001.
9. Information obtained from the Texas Water Development Board, Volumetric Survey Report of Possum Kingdom Lake December 2004-January 2005 Survey, May 2006.
10. Information obtained from the Texas Water Development Board, Volumetric Survey Report of Lake Granbury July 2003 Survey, September 2005.
11. Information obtained from Somervell County Water District and the 2011 Brazos G Regional Water Plan.

RCOL2_02.04.04-5

Table 2.4.4-202 (Sheet 1 of 2)
Information from the 2011 Brazos G Regional Water Plan for Strategies Upstream of Lake Whitney Dam

No.	Strategy Name (inclusion/exclusion from dam failure analysis)	Status[1]	River	Distance (river mi)[2]	Drainage Area (sq mi)	Type[3]	Length (ft)	Height (ft)	Surface Area (ac)	Volume Capacity (ac.-ft)
I	Double Mountain Fork West Reservoir (excluded - not proposed)	I	Double Mountain Fork of the Brazos River	433	1669	ns	ns	ns	6632	215,254
H	Double Mountain Fork East Reservoir (excluded - not proposed)	I	Double Mountain Fork of the Brazos River	403	1937	ns	ns	ns	10,814	280,814
G	Millers Creek Reservoir Augmentation (excluded - smaller volume, height, and drainage area, and farther distance compared to Hubbard Creek Dam)	R	Millers Creek	301	292	RE	ns	ns	2541	46,645
F	Millers Creek Reservoir Augmentation (excluded - smaller volume and height, and farther distance compared to Hubbard Creek Dam)	R	Lake Creek	337	ns	RE	5000	8	360	ns
E	Throckmorton Reservoir (excluded - not proposed)	I	North Elm Creek	278	82	ns	ns	ns	1161	15,900
D	**Cedar Ridge Reservoir (included)**	**R**	**Clear Fork of the Brazos River**	**334**	**2748**	**ns**	**ns**	**ns**	**6635**	**227,127**
C	South Bend Reservoir (excluded - not proposed)	I	Brazos River	228	13,168	RE	14,784	ns	29,877	771,604
B	Lake Palo Pinto Off-Channel Reservoir (excluded - not proposed)	I	Wilson Hollow	109	ns	RE	1550	ns	182	10,000 up to 22,000

RCOL2_02.04.04-5

Table 2.4.4-202 (Sheet 2 of 2)
Information from the 2011 Brazos G Regional Water Plan for Strategies Upstream of Lake Whitney Dam

No.	Strategy Name (inclusion/exclusion from dam failure analysis)	Status[1]	River	Distance (river mi)[2]	Drainage Area (sq mi)	Type[3]	Length (ft)	Height (ft)	Surface Area (ac)	Volume Capacity (ac.-ft)
A	Turkey Peak Reservoir (excluded - smaller volume and height compared to Morris Sheppard Dam)	R	Palo Pinto Creek	101	ns	ns	ns	ns	648	22,577

NOTES:
Highlighted entries identify dams evaluated for the quantitative dam failure analysis. Bold type entries identify damsn included in the critical dam failure scenario.
Information obtained from National Atlas, unless otherwise noted.
ns = not specified

1. Status of water management strategy in the 2011 Brazos G Regional Water Plan
   I = identified as potentially feasible water management strategy
   R = recommended water management strategy
2. Distance in river miles from the dam to the confluence of the Brazos River and Paluxy River.
3. Type of dam: RE = Earth

RCOL2_02.04.04-5

Table 2.4.4-203
Information from the Llano Estacado Regional Water Plan for Strategies Upstream of Lake Whitney Dam

No.	Strategy Name (inclusion/exclusion from dam failure analysis)	River	Distance (river mi)[1]	Drainage Area (sq mi)	Type[2]	Length (ft)	Height (ft)	Surface Area (ac)	Volume Capacity (ac.-ft)
L	Lake 7 (excluded - smaller volume compared John T. Montford Dam)	North Fork Double Mountain Fork Brazos River	580	ns	ns	ns	ns	ns	20,700
K	Post Reservoir (excluded - smaller volume compared John T. Montford Dam)	North Fork Double Mountain Fork Brazos River	536	ns	RE	5800	ns	2280	56,000
J	Diversion Reservoir (excluded - smaller volume compared John T. Montford Dam)	North Fork Double Mountain Fork Brazos River	515	ns	ns	ns	ns	ns	1000

NOTES:
ns = not specified

1. Distance in river miles from the dam to the confluence of the Brazos River and Paluxy River.I
2. Type of dam: RE = Earth

RCOL2_02.04.04-7

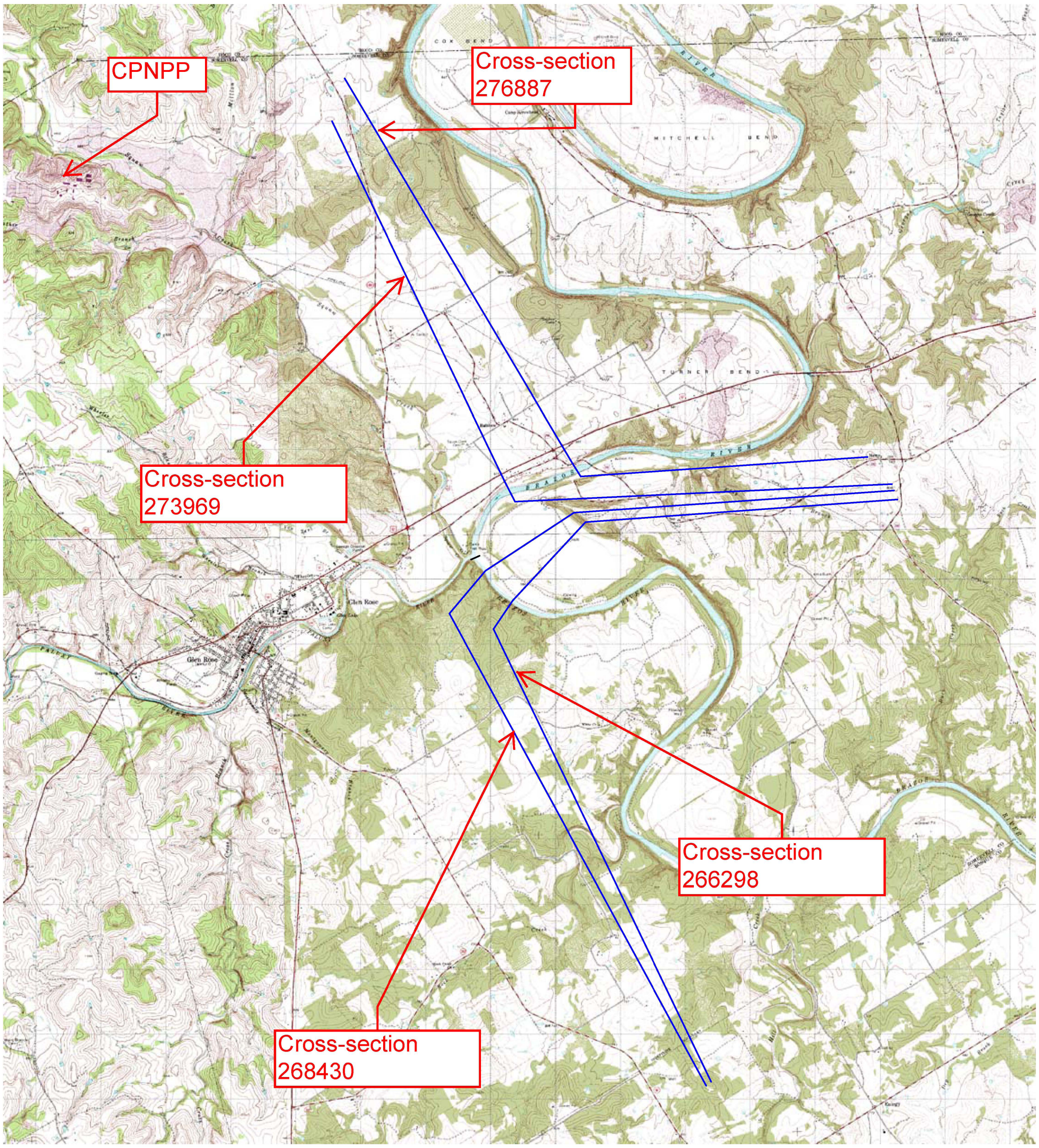

Figure 2.4.4-202 Brazos River - Paluxy River Confluence Cross Section

RCOL2_02.04.04-7

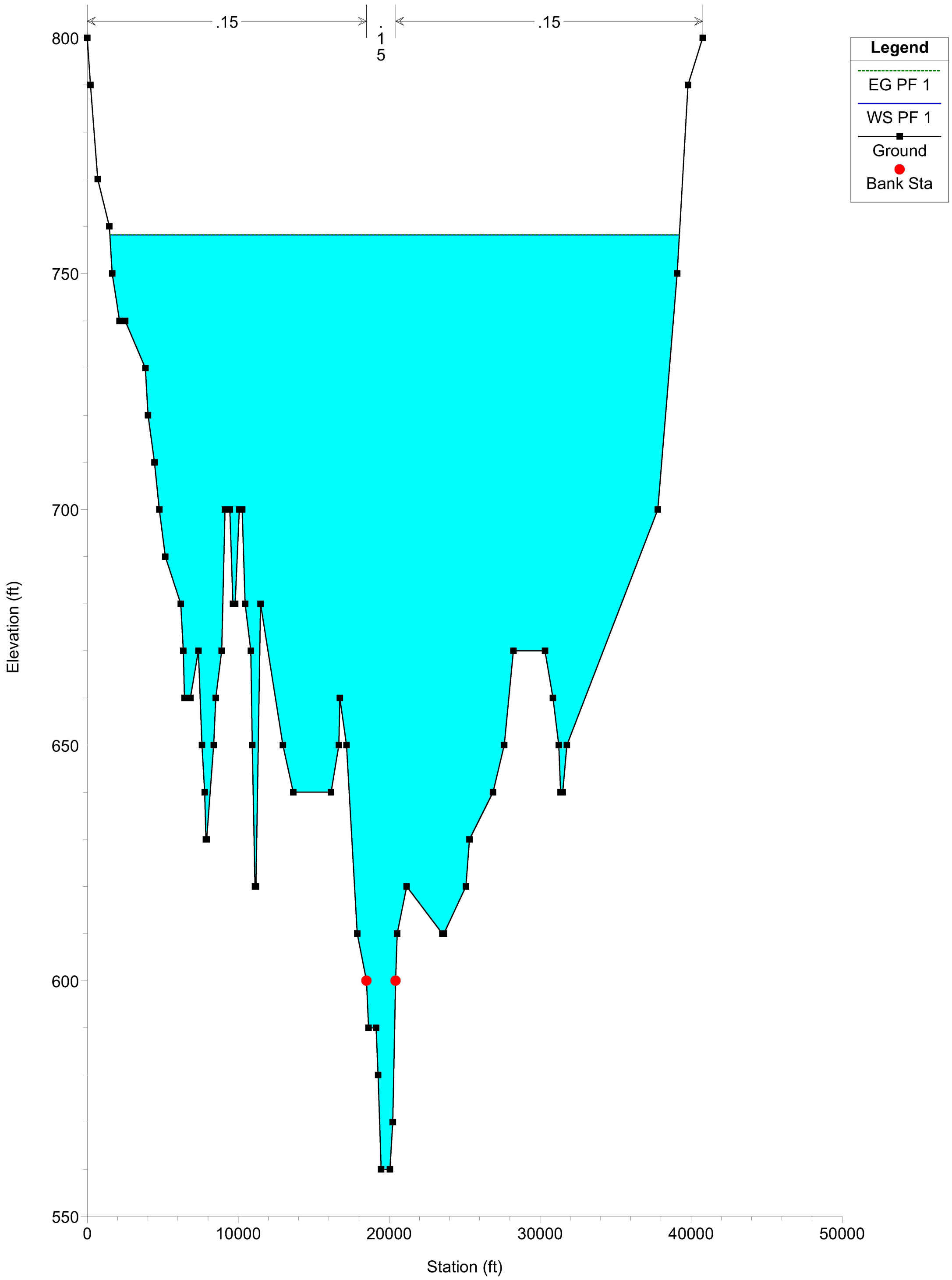

Figure 2.4.4-203 Water Surface Elevation at Brazos River - Paluxy River Confluence Cross Section for Hydrologic Domino Type Dam Failures Coincident with PMF

RCOL2_02.04.04-5

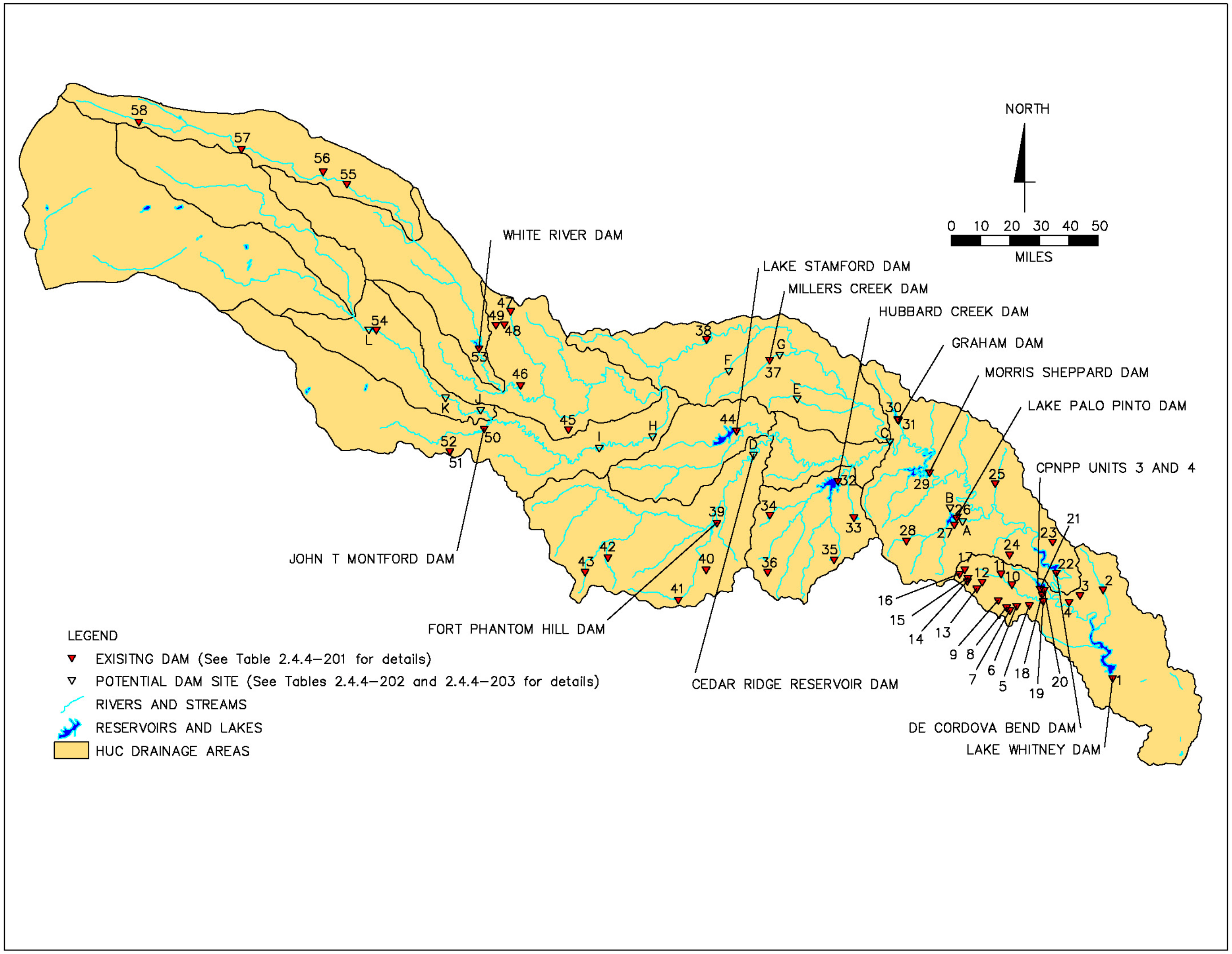

Figure 2.4.4-204 Dams Upstream of Lake Whitney Dam