Appendix I – Civil Engineering

Lower Guadalupe Feasibility Study (Guadalupe and Blanco Rivers), TX Integrated Draft Feasibility Report and Environmental Impact Assessment

August 2019



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EXECUTIVE SUMMARY

Several damages center were identified with in the study area however the damage centers that were the focus of this study were New Braunfels and Seguin, Wimberley, and San Marcos. The quantity and description developed below was based on protection and flows determined through Hydrology and Hydraulics analysis.

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Acronyms

Farm to Market (FM) County Road (CR) Roller Compacted Concrete (RCC)

1 Existing Conditions

1.1 Blanco Alternative

A dry-dam was selected as a structural measure to reduce the frequency of damaging levels of flood inundation. The site for the dry-dam structure will be located in the upper part of the Guadalupe River Basin on the Blanco River, approximately 24 miles upstream from the city of Wimberley, TX, in southeast Blanco County, Texas. See Figure 1.1.1 – Blanco County Overall Project Location. The existing topography is flat to mild, with grades ranging from 1 to 25 percent in gradient. Existing contours range in elevations from 1164 to 1305 North American Vertical Datum (NAVD) 1988. The footprint for the dam extends across the Blanco River in tree covered ranch land with some open pasture. Chimney Valley Road (County Road 407), an asphalt paved road extends through the center of the proposed dam site 2 and crosses the Blanco River near the proposed dam site. County Road (CR) 407 extends northwest along the south side of the Blanco River through the inundated flood zone for approximately 2 miles. Approximately 1.5 miles upstream from the proposed dam site CR 407 crosses the Blanco River at a low water crossing & culvert. Cox Road (CR 406), an asphalt paved road runs through the inundation flood zone from Ranch Road 165 south along the west side of the Blanco River for approximately 1.8 miles. CR 406 crosses the Blanco River at a low water crossing & culvert at approximately 1 mile south of Ranch Road 165. Existing power and fiber optic lines that run along CR 407 and CR 406 will need to be terminated and removed or abandoned in place, or relocate to remain in service. There is an existing in-service 36 inch natural gas line operated by Kinder Morgan Texas Pipeline LLC, which crosses the inundation foot print for approximately 2 miles. There is an abandoned 12.75 inch crude oil pipeline operated by Shell Pipeline Company LP, which crosses the inundation foot print for approximately 2 miles. At the northwest end of the inundated flood area Ranch Road 165, an asphalt paved road extends from southwest to northeast across the inundated flood zone and across two of the tributary creeks. Ranch Road 165 extends from the city of Blanco to the east and connects to Hwy 290 northeast of the inundated flood zone. Ranch Road 165 will need to be closed to traffic during all flood events or raised above the selected inundation flood year event. See Figure 1.1.2 -Blanco County Project Location.



Figure 1.1.1 – Blanco County Overall Project Location



Figure 1.1.2 – Blanco County Project Location

1.2 Hays Alternative

A dry-dam was selected as a structural measure to reduce the frequency of damaging levels of flood inundation. The site for the dry-dam structure will be located in the northern part of the Guadalupe River Basin on the Blanco River, approximately 14 miles upstream from the city of Wimberley, TX, in Hays County near the Hays/Comal/Blanco County Line. See Figure 1.2.1 – Hays County Overall Project Location. The site for the dam extends across the Blanco River in tree covered ranch land with some open pasture. The existing topography is steep in some areas, with grades ranging from 1 to 100 percent in gradient. Existing contour elevations range from 972 to 1210 NAVD88. The footprint for the dam crosses an unpaved dirt road. The unpaved road extends through the river at an unpaved low water crossing. The inundated flood zone covers tree covered ranch land with unpaved ranch roads extending throughout the area. One of the ranch roads at the far northwest end of the flood zone has an existing concrete low water crossing extending across the river. Existing utilities in the area were not verified due to the site being on private property. Utility services located within the inundation area would be terminated, abandoned and/or rerouted. See Figure 1.2.2 – Hays County Project Location.



Figure 1.2.1 – Hays County Overall Project Location



Figure 1.2.2 – Hays County Project Location

1.3 Comal Alternative (Bear Creek)

A dry-dam was selected as a structural measure to reduce the frequency of damaging levels of flood inundation. The site for the dry-dam structure will be located at Bear Creek. Bear Creek is located in the northern part of the Guadalupe River Basin just south of Canyon Lake in Comal County, Texas. Bear Creek is a tributary to the Guadalupe River. Bear Creek discharges into the Guadalupe River approximately 8.6 miles downstream of the Canyon Lake spillway. The site is located approximately 2 miles upstream Bear Creek from the Guadalupe River and Bear Creek convergence and 1.5 miles east of the intersection of Farm to Market (FM) 2722, a 24 foot wide 2-lane asphalt road and Bear Creek Trail, a 20 foot wide asphalt road. See Figure 1.3.1 for overall project location. The site extends across Bear Creek in a tree covered canyon. The existing topography is steep in some areas, with grades ranging from 1 to 80 percent in gradient. Existing contour elevations range from 774 to 1058 NAVD88. At the northwest end of the inundated flood area, Bear Creek Trail, extends from north to south across the inundated flood zone and across a tributary to the creek. Bear Creek Trail extends from FM 2722 southeast meandering through the tree covered canyons for approximately 1.76 miles then southwest for approximately 0.67 miles to FM 2722. Bear Creek Trail crosses the inundation footprint in 2 locations. Bear Creek Trail will need to be closed to traffic during all flood events

or raised above the selected inundation flood year event. Oso Arroyo, an unpaved private gravel road runs through the inundation footprint for approximately 1.2 miles, continuing through the dam footprint. There are 3 low water crossings along Oso Arroyo road. The site is not accessible from public roadways. Existing utilities in the area were not verified due to the site being on private property. However, wooden utilities poles and several structures can be identified from existing aerial imagery in the area. Utility services located within the inundation area would be terminated, abandoned and/or rerouted. See Figure 1.3.2 for project location.



Figure 1.3.1 – Comal County Overall Project Location



Figure 1.3.2 –Comal County Project Location

2 **Proposed Project Conditions**

2.1 **Proposed – Blanco County Alternative**

Three options were studied for the Blanco County site. Determined from H&H analysis, the maximum dam heights of 60, 65 and 73 feet were evaluated. The lengths of dam will be 1972, 2139, and 2457 feet. The base of the dams are 270, 290 and 322 feet in width. The following configurations for the dams are based on recommendations provided by the geotechnical department. The dams will be constructed of roller compacted concrete (RCC) and compacted earth fill. The outer shell will have a 6 foot thick RCC layer. The inner shell will be compacted earth fill. The dam will have a top crest width of 30 feet. The upstream and downstream side slopes will be at 2:1. A trapezoidal outlet will be constructed having a 20 foot flat bottom width at the existing channel flowline, with 1:1 side slopes extending to the crest of the dam. See attachments CF100, CF101, and CF102 for proposed dam site plan and typical sections. A concrete stilling basin will be required to dissipate the energy of the water at the outlet of each of the three dams. The stilling basin will have an approximate width of 80 feet. The stilling basin size was determined from structural recommendation. See Table 2.1 for the dam configuration quantities of each of the options at the Blanco site.

OPTION 1 ELEV 1232						
BLANCO 2 DAM SITE VOLUMES						
TOP ELEVATION 1232						
20 FT OPENING WITH 1:1 SIDE SLOPES						
2:1 BERM SLOPES						
LENGTH 1972 FT						
MAXIMUM HEIGHT 60 FT						
	QUANTITY	UNIT				
EARTH WORK FILL BENEATH RCC	206575.186	CY				
ROLLER COMPACTED CONCRETE	65030.829	CY				
STILLING BASIN (REINFORCED CONCRETE)	2,069	CY				
ACCESS ROAD REMOVAL	20,500	LF				
OPTION 2 ELEV 1237						
BLANCO 2 DAM SITE VOLUMES						
TOP ELEVATION 1237						
20 FT OPENING WITH 1:1 SIDE SLOPES						
2:1 BERM SLOPES						
LENGTH 2139 FT						
MAXIMUM HEIGHT 65 FT						
	QUANTITY	UNIT				
EARTH WORK FILL BENEATH RCC	252783.995	CY				
ROLLER COMPACTED CONCRETE	74399.361	CY				
STILLING BASIN (REINFORCED CONCRETE)	2,069	CY				
ACCESS ROAD REMOVAL	20,500	LF				

TABLE 2.1 Blanco Dam Site 2 (Three Options)

OPTION 3 ELEV 1245					
BLANCO 2 DAM SITE VOLUMES	BLANCO 2 DAM SITE VOLUMES				
TOP ELEVATION 1245					
20 FT OPENING WITH 1:1 SIDE SLOPES					
2:1 BERM SLOPES					
LENGTH 2457 FT					
MAXIMUM HEIGHT 73 FT					
	QUANTITY	UNIT			
EARTH WORK FILL BENEATH RCC	350014.7	CY			
ROLLER COMPACTED CONCRETE	83926.3	CY			
STILLING BASIN (REINFORCED CONCRETE)	2,069	CY			
ACCESS ROAD REMOVAL	20,500	LF			

The site can be accessed for construction by Ranch Road 165 and CR 407 (Chimney Valley Rd). See Figure 2.1 for proposed construction access route. Several construction material facilities are located within 25 miles of the project.



Figure 2.1 – Blanco Dam Site 2 Construction access route

2.2 Proposed – Hays County Alternative

Determined from H&H analysis, the Hays Dam Site 2 will have a maximum height of 110 feet. The dam is approximately 4090 feet long. The base of the dams is 362 feet wide at the channel centerline. The following configurations for the dam are based on geotechnical recommendations. The dams will be constructed of roller compacted concrete (RCC) and compacted earth fill. The outer shell will have a 6 foot thick RCC layer. The inner shell will be compacted earth fill. The dam will have a top crest width of 30 feet. The upstream and downstream side slopes will be at 2:1. A trapezoidal outlet will be constructed having a 20 foot flat bottom width at the existing channel flowline, with 1:1 side slopes extending to the crest of the dam. See attachment CF103 for proposed dam site plan and typical sections. A concrete stilling basin will be required to dissipate the energy of the water at the outlet. The stilling basin will have an approximate width of 80 feet. The stilling basin size was determined from structural recommendation. See Table 2.2 for the Hays dam configuration quantities.

OPTION 1 ELEV 1092					
HAYS 2 DAM SITE VOLUMES	HAYS 2 DAM SITE VOLUMES				
TOP ELEVATION 1092					
20 FT OPENING WITH 1:1 SIDE SLOPES					
2:1 BERM SLOPES					
LENGTH 4090 FT					
MAXIMUM HEIGHT 110 FT					
	QUANTITY	UNIT			
EARTH WORK FILL BENEATH RCC	366434.618	CY			
ROLLER COMPACTED CONCRETE	119788.1	CY			
STILLING BASIN (REINFORCED CONCRETE)	2,069	CY			
ACCESS ROAD	7,500	LF			

TABLE 2.2 Hays Dam Site 2

Due to the dam site being on private property, a temporary construction easement will be required for site access. See Figure 2.2 for proposed construction access route. Several construction material facilities are located within 25 miles of the project site.



Figure 2.2 – Hays Dam Site 2 Construction access route

2.3 **Proposed TSP Selection – Comal County Alternative Bear Creek**

The proposed dam at Bear Creek will have a maximum height of 75 feet. The height of the dam will be 70 feet at the spillway. The heights are based on H&H analysis. The dam is approximately 679 feet long. The base of the dams is 314 feet wide at the channel centerline. The configurations for the dam is based on geotechnical recommendations. The dam will be constructed of roller compacted concrete (RCC) and compacted earth fill. The outer shell will have a 6 foot thick RCC layer. The inner shell will be compacted earth fill. The dam will have a top crest width of 30 feet. The upstream and downstream side slopes will be at 2:1. The dam is 679 feet in length and has a spillway length of 400 feet. To allow for low flows to pass through the dam a 10 foot x 12 foot box culvert at 300 feet in length will be constructed at the existing channel flowline. See attachment CF104 for proposed site plan and typical sections. A concrete stilling basin will be required to dissipate the energy of the water at the outlet. The stilling basin will have an approximate width of 400 feet. The stilling basin size was determined from structural recommendation. See Table 2.3 for Bear Creek Option 1 configuration quantities.

A second alternative configuration was generated for the Bear Creek Dam at the same location as stated above comprised of just RCC material with a similar cross section as to the Dry Comal Creek flood retarding structure built by Comal County entity located on a tributary to the Comal River west of New Braunfels, TX. The heights, top of crest width, and length of dam would remain the same however the upstream and downstream slopes would vary from the first alternative. The upstream side would be a vertical wall and the downstream side would be 1:1 slope face. The 10 foot by 12 foot low flow box culvert would be reduced in length to 115 feet. See attachment CF105 for proposed site plan and typical section. The concrete stilling basin would be the same configuration as in the first alternative. See Table 2.4 for the revised quantities of a complete RRC dam.

OPTION 1 EARTHFILL CORE WITH RCC LINING AT ELEVATION 850						
BEAR CREEK DAM SITE VOLUMES						
TOP OF DAM ELEVATION 850						
SPILLWAY CREST ELEV 845						
2:1 BERM SLOPES						
LENGTH 679 FT						
SPILLWAY LENGTH 400 FT	SPILLWAY LENGTH 400 FT					
MAXIMUM HEIGHT 75 FT						
	QUANTITY	UNIT				
EARTH WORK FILL BENEATH RCC	142944.407	СҮ				
ROLLER COMPACTED CONCRETE	31556.754	СҮ				
STILLING BASIN (REINFORCED CONCRETE)	10,344	СҮ				
BOX CULVERT 10'X12'	300	LF				
ACCESS ROAD	8,500	LF				

Table 2.3 Comal Site Bear Creek Dam Option 1

Table 2.4 Comal Site Bear Creek Dam Option 2

OPTION 2 RCC DAM STRUCTURE AT ELEVATION 850		
BEAR CREEK DAM SITE VOLUMES		
TOP OF DAM ELEVATION 850		
SPILLWAY CREST ELEV 845		
BERM SLOPES: UPSTREAM – VERTICAL, DOWNSTREAM 1:1		
LENGTH 679 FT		
SPILLWAY LENGTH 400 FT		
MAXIMUM HEIGHT 75 FT		
	QUANTITY	UNIT
CONCRETE CUT-OFF WALL 679 FTx25 FT x2FT (LxHxT)	1257.41	CY
CONCRETE CUT-OFF WALL EXCAVATION (DISPOSAL)	1257.41	CY

ROLLER COMPACTED CONCRETE	115089.81	CY
EXCAVATION FOR RCC KEYIN (DISPOSAL)	26735.00	CY
DENTAL GROUT	10,026	SY
STILLING BASIN	10,344	CY
CULVERT 10'X12'	115	LF
ACCESS ROAD CONSTRUCTION	8,500	LF

Due to the proposed dam being on private property, a temporary construction easement will be required for site access. There is a private access gate at Oso Arroyo road, an unpaved gravel road that can be used to access the site if a construction easement is granted. See Figure 2.3 for proposed construction access route. Several construction material facilities are located within 20 miles of the project site.



Figure 2.3 – Bear Creek Construction Access Route

2.4 STRUCTURAL

In order to determine estimated quantities for the stilling basins of each of the alternatives, the assumption was made to compare a similar stilling basin of an existing project. Using the Lake Whitney spillway as a go-by, the stilling basin below each of the v-notch structure for the Blanco Dam Alternative and the Hays Dam Alternative would a width of 80 feet. The quantities estimated for these structures are shown on tables 2.1 and 2.2 respectfully.

Similarly using Lake Whitney as a go-by the stilling basin estimate on the Comal (Bear Creek Dam) site was based on a 400'-wide spillway therefore the stilling basin should be at least that wide. The 12' x 10' box culvert to be used as the low flow discharge through the dam at the existing river channel flowline would be a standard pre-cast shape structure that would meet the strength capacities for the amount of fill for the height of this dam. The quantities estimated for these structure are shown on tables 2.3 and 2.4.

3 *References

USACE Engineering Manuals/ Regulations/ Pamphlets

EM 1110-1-1002, Survey Markers and Monumentations, 1 March 2012
EM 1110-1-1005, Control and Topographic Surveying, 1 January 2007
EM 1110-1-1905, Bearing Capacity of Soils, 30 Oct 1992
EM 1110-2-38, Environmental Quality in Design of Civil Work Projects, 3 May 1971
EM 1110-2-1902, Slope Stability, 31 Oct 2003
EM 1110-2-2300, General Design and Construction Consideration for Earth and Rock-Fill Dams, 30 July, 2004
EM 1110-2-2502, Retaining and Flood Walls, 29 Sep 1989
EM 1110-2-2902, Conduits, Culverts and Pipes, CH1, 31 Mar 1998
EM 1110-3-136, Drainage and Erosion Control- Mobilization Construction, 9 Apr 1984

ETL 1110-2-583, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures, 30 April 2014

ER 1110-2-1150, Engineering and Design for Civil Works Projects, 31 August 1999

ER 1110-2-401, Operation, Maintenance, Repair, Replacement, and Rehabilitation

Manual for Projects and Separable Elements Managed By Project Sponsors,

30 September 1994

Note: USACE Guidance documents (EM, EP, ER, etc.) are available online through the USACE Publications website (<u>https://www.publications.usace.army.mil/</u>)









CF NEFS	LOWER GUADALUPE GUADALUPE RIVER BASIN	U.S. ARMY ENGINEER DISTRICT, CORPS OF ENGINEERS FORT WORTH, TEXAS	DESIGNED BY: L. GRIMMETT, P.E. DRAWN BY: L. GRIMMETT, P.E.	DATE: REV. NOVEMBER 2017 SOLICITATION NO.				
HEET ERENCE MBER: -104	BEAR CREEK ELEV 850 OPTION 1	ENGINEERING/ CONSTRUCTION DIVISION DESIGN BRANCH	REVIEWED BY: J. MCKENZIE, P.E. SUBMITTED BY: JAMES W. MCKENZIE, P.E. CHIEF, CIVIL SECTION	CONTRACT NO. FILENAME: \$\$CADD FILE NAME\$\$ PLOT DATE: \$\$DATE\$\$ PLOT SCALE:	5	DESCRIPTION	ACTION DAT	

TION B-B NTS INTERIM SUBMITTAL NOT FOR CONSTRUCTION	Image: state		875 870	
SHEET REFERENCE NUMBER: CF105	LOWER GUADALUPE GUADALUPE RIVER BASIN SITE PLAN BEAR CREEK ELEV 850 OPTION 2	U.S. ARMY ENGINEER DISTRICT, CORPS OF ENGINEERS FORT WORTH, TEXAS DESIGNED BY: L. GRIMMETT, P.E. DATE: NOVEMBER 2017 REV. NOVEMBER 2017 Image: Comparison of the comparison o	US ARMY CORPS	