APPENDIX 4
ENGINEERING

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A4-1 GENERAL

A4-1.1 Purpose of Engineering Appendix

This Engineering Appendix, a consolidated effort between Memphis, New Orleans, and Vicksburg Districts, presents the design assumptions and assessment of alternatives for flood control in the Mississippi River Alluvial Valley, Mississippi River Mainline Levees (MRL) Project. The purpose of this Engineering Appendix is to document the results of the engineering and environmental conditions in order to establish project alternative measures and recommendations that would minimize adverse impacts to the environment with the implementation of the proposed improvements to the MRL. The Mainline Levee System is an integral part of the overall Mississippi River and Tributaries Project (MR&T). The Mississippi River Commission (MRC), created by Congress in 1879, is responsible for accomplishment of work on the MR&T Project. After the 1973 flood, the MR&T Project Design Flowline was refined (see SEIS II Section 1.4) to include a new project flood flowline, the Refined 1973 Project Design Flood Flowline (amended in 1996) that enables levee deficiencies along the main stem levee to be identified.

The proposed work includes addressing 69 miles of deficient levees and floodwalls within the Memphis District, 49 miles of deficient levees within Vicksburg District, and 123 miles of deficient levees and floodwalls within New Orleans District. This work consists of 143 work items proposed for construction; 35 items in the Memphis District, 16 in the Vicksburg District, and 92 in the New Orleans District.

The MR&T Project is extensive in scope and involves a number of Tributary basins and related project reports in all three districts. The Final Environmental Impact Statement for Mississippi River and Tributaries Projects, dated February 1976, lists and discusses various project reports that are pertinent to the MRL portion of the overall project. This document was placed on file with the Council on Environmental Quality on April 8, 1976. Subsequently, USACE supplemented the 1976 EIS with Supplement No. 1, Mississippi River and Tributaries Project, Mississippi River Mainline Levee Enlargement and Seepage Control of 1998 (1998 SEIS). The 1998 SEIS also references project reports that provide additional information about the MR&T Project.

A4-2 HYDROLOGY/HYDRAULICS

A4-2.1 Description of Mississippi River Basin and Project Area

The Mississippi River has the third largest drainage basin in the world, exceeded in size only by the watersheds of the Amazon and Congo Rivers. It drains 41 percent of the 48 contiguous states of the United States. The basin covers more than 1,245,000 square miles, includes all or parts of 31 states and two Canadian provinces, and roughly resembles a funnel which has its spout at the Gulf of Mexico. Waters from as far east as New York and as far west as Montana contribute to flows in the lower (main stem) river.

The main stem Mississippi River channel below Cairo, Illinois, carries runoff from about 922,000 square miles of drainage area concentrated at Cairo by the upper Mississippi and Ohio Rivers. Between Cairo and the Gulf of Mexico, the Mississippi River system flow is augmented by runoff from about 324,000 square miles of intervening drainage area.

The lower alluvial valley of the Mississippi River is a relatively flat plain of about 35,000 square miles bordering the river. The area would be overflowed during times of high water if not for man-made protective works. This valley begins just below Cape Girardeau, Missouri, is roughly 600 miles in length, varies in width from 30 to 125 miles, includes parts of seven states--Missouri, Illinois, Tennessee, Kentucky, Arkansas, Mississippi, and Louisiana, and extends to the Gulf of Mexico.

The project area includes the portion of the basin extending from Cape Girardeau, Missouri, south to Head of Passes, Louisiana, at the Gulf of Mexico. The flood plain area is confined on the west by levees and high ground and on the east by levees and the Loess Hills which follow the Ohio and Mississippi Rivers from the vicinity of Cairo, Illinois, to below New Orleans, Louisiana. Besides the Upper Mississippi and Ohio Rivers, other major tributaries within the project area are the St. Francis River, Obion-Forked Deer River, Arkansas/White, River Red River, Yazoo River, and Big Black River. Precipitation occurring within project boundaries produces runoff which reaches the Mississippi River main stem via the above-named major tributaries or via minor drainage ways. The Mississippi River in its lower valley flows through one of the most fertile regions on earth. The area is noted for its highly productive agricultural economy. It has also become industrialized.

A4-2.2 Description of Mississippi River Basin and Project Area

A4-2.2.1 Morphology

As is typical of streams flowing through alluvial valleys, the Lower Mississippi River over time has developed a highly sinuous course, creating numerous meander loops and bends. It has also shifted its channel from time to time so that parts of the alluvial plain have been reworked many times, thus contributing to the complexity of the soil structure and hydrology of the area. This meandering has also produced a number of oxbow lakes.

Flooding in the lower alluvial valley usually occurs in the winter and spring (first six months of the calendar year). This is a result of the spring rains and the melting of the snow pack in the Upper Mississippi River basin. However, in recent years, increased precipitation during summer months has resulted in prolonged flood events that extend well into the summer

An extensive system of stream gages has been installed on the Mississippi River and its tributaries. The period of record for the older gages extends back into the 1800's. At certain gages discharge measurements have been made over a span of many years, permitting estimation of discharge as a function of stage at these locations. Selected gages in the project area are shown in Table A4-1. Gages in Table A4-1 used in this study for statistical analysis of wetlands by hydrologic criteria are noted, along with the period of record used in the study.

Table A4-1. Project Area Gages

Gage Location	River Mile AHP	Corps Dist. ****	Data Type S=Stage D=Disch	Used in Wetland Determination X=Used	Study Period of Record ***
Cape Girardeau (Upper Miss)	52.1*	MVS	s	X	1962-2018
Cairo (Ohio)	2.0**	MVM	s	X	1962-2018
Hickman	922.0	MVM	S,D	X	1962-2018
New Madrid	889.0	MVM	s	X	1962-2018
Caruthersville	846.4	MVM	s	X	1962-2018
Osceola	783.5	MVM	s	X	1962-2018
Memphis, Beale	735.9	MVM	s		
Memphis WB	734.7	MVM	S,D	X	1962-2018
Helena	663.1	MVM	S,D	X	1962-2018
Rosedale	592.2	MVK	s	X	1962-2014
Ark City	554.1	MVK	S,D	X	1962-2018
Greenville	531.5	MVK	s	X	1962-2018
Lake Providence	487.2	MVK	s	X	1962-2018
Vicksburg	435.7	MVK	S,D	X	1962-2018
St. Joseph	396.4	MVK	s	X	1962-1996
Natchez	363.3	MVK	S,D	X	1962-2018
Knox Landing	313.7	MVN	s	X	1962-2018
Tarbert Landing	306.3	MVN	S,D		1962-2018
Red River Landing	302.7	MVN	s	X	1962-2018
Baton Rouge	228.4	MVN	s	X	1962-2018
Donaldsonville	175.4	MVN	s	X	1962-2018
Reserve	138.7	MVN	s		1962-2018
Carrollton (New Orleans)	102.8	MVN	s	X	1962-2018
West Pointe A La Hache	48.7	MVN	s	X	1962-2018
Venice	10.7	MVN	s		1962-2018

* on Upper Mississippi River, miles above mouth of Ohio River

** on Ohio River, miles above mouth of Ohio (mouth of Ohio River is at Mile 953.8 AHP)

*** Additional data available. The period of record was limited based on the effects of cutoffs and changes in operation of Old River Control Structure on river flowlines.

**** MVS-St. Louis District, MVM-Memphis District, MVK-Vicksburg District, MVN-New Orleans

Examples of the range of discharges and elevations in the project area are presented in Tables A4-2 and A4-3.

Table A4-2. Maximum and Minimum Discharges for Selected Gages

Location	Maximum Discharge (1000 CFS)	Year	Minimum Discharge (1000 CFS)	Year
Hickman	2100	2011	69	1936
Memphis	2213	2011	78	1936
Helena	2310	2011	81	1936
Arkansas City	2472*	1927	88	1939
Vicksburg (Bridge)	2278**	1927	94	1936
Natchez	2046	1937	100	1936
Tarbert Landing	1977	1937	85	1939

* Estimated
** Estimated assuming no crevasses

Table A4-3. Maximum and Minimum Elevations for Selected Gages

Gage Location	Max Gage	Maximum Elev. Ft, NGVD	Year	Min Gage	Minimum Elev. Ft, NGVD	Year	Difference in Elev. Ft
Cape Girardeau	48.0	352.6	1993	0.6	305.4	1909	47.2
Cairo	59.5	330.0	1937	-1.0	269.5	1871	60.5
Hickman	51.5	316.2	1937	-0.7	264.1	1988	52.1
New Madrid	48.0	303.5	1937	-1.5	254.0	1988	49.5
Caruthersville	46.0	281.5	1937	-0.1	234.8	1939	46.7
Osceola	50.9	260.3	1937	-10.3	199.1	1988	61.2
Memphis	48.7	232.6	1937	-10.7	173.2	1988	59.4
Helena	60.2	201.9	1937	-4.2	137.5	1988	64.4
Arkansas City	60.4	157.1	2011	-5.1	91.6	1936	64.3
Vicksburg (Bridge)	57.1	103.3	2011	-7.0	39.2	1940	63.0
Natchez	61.8	79.4	2011	-1.7	15.6	1940	59.7
Knox Landing	63.1	63.1	1983	8.2	8.2	1956	54.9
Red River Landing	63.4	63.4	2011	2.9	2.9	1895	58.0
Baton Rouge	47.3	47.3	1927	-0.1	-0.1	1894	47.4
Carrollton Gage (New Orleans)	21.3	21.3	1922	-1.6	-1.6	1872	22.9

A4-2.3 History of Flood Control and Mississippi River Flooding

A4-2.3.1 Overview

The Mississippi River has always been a threat to the security of the valley through which it flows. The need for more substantial Federal participation in improvements of the river for navigation and flood control was generally recognized by 1879. The necessity for coordination of engineering operations through a centralized organization was apparent. That year, on June 28, Congress established the Corps of Engineers Mississippi River Commission (CEMRC), which had as its assigned duties"... to take into consideration and mature such plan or plans and estimates as will correct, permanently locate, and deepen the channel and protect the banks of the Mississippi River; improve and give safety and ease to the navigation thereof; prevent destructive floods; promote and facilitate commerce, trade, and the postal service."

The first survey performed under the CEMRC occurred during 1879-1880. The survey revealed a system of levees for the most part constructed along the top of the natural levees of the river.

The flood of 1916 resulted in passage of the first Flood Control Act, approved March 1, 1917. This act authorized the construction of levees for the control of floods and affirmed the policy of local cooperation.

The flood of 1927 was the most disastrous in the history of the lower Mississippi River Valley. This disaster awakened the national conscience to the dire need for flood control in the lower valley. Out of it grew the Flood Control Act of 1928, which committed the Federal Government to a definite program of flood control. The present project dates from that act.

The act of 1928 authorized the expenditure of $325,000,000 for construction of a Federal project to provide flood control in the alluvial valley of the lower Mississippi River from Cairo, Illinois, to Head of Passes, Louisiana, and navigation from Cairo to New Orleans, Louisiana.

A4-2.3.2 Flood Control Measures

The Mississippi River Levees are designed to protect the alluvial valley from extreme flood events by confining flow to the leveed floodway, except where it enters the natural backwater areas or is diverted intentionally into the floodway areas. The mainline levee system, comprised of levees, floodwalls, and various control structures, is approximately 1,600 miles long.

When major floods occur and the carrying capacity of the Mississippi River leveed channel is exceeded, additional conveyance through the Birds Point-New Madrid Floodway and relief outlets through the Atchafalaya Basin Floodway, Morganza Floodway, and Bonnet Carre Floodways are utilized as well as the storage capacity of flat lowlands at the junctions of tributaries with the Mississippi River. These and other tributary areas, commonly referred to as backwater areas, are in effect mid-river reservoirs that store water during major floods. They may be protected from lesser floods by levee systems that are overtopped by the major floods. The backwater levees are designed to overtop prior to the project flood peak such that the storage made available in a timely fashion will reduce the level of the Project Design Flood (PDF), thus resulting in lesser levee grades along the mainline levee.

A4-2.3.3 Major Historical Mississippi River Floods

The Mississippi Valley is subject to frequent and severe floods. Major floods on the Lower Mississippi River may result from flooding on the Upper Mississippi River, or the Ohio River, or both, augmented by contributions from other major tributaries of the Lower Mississippi River. The flood season on the Mississippi River is usually from the middle of December through July. Major floods on the Ohio River generally occur between the middle of January and the middle of April. Major floods from the Upper Mississippi and Missouri Rivers usually occur between the middle of April and the last of July; from the Arkansas and White Rivers between the first of April and the end of June.

The floods of 1913 through 1997 were described in the 1998 SEIS I, and will not be included in this report. The major floods which have occurred since 1997 are described in the following paragraphs.

Flood of 2008.

This high water event was caused by a combination of massive amounts of melting snow from the winter thaw and large amounts of rainfall. The conditions that contributed to the 2008 flood-fight began to develop during the winter months. Snowfall was much above normal across a significant portion of the Midwest north of the Ohio River. Snowfall was four to six times above average from eastern Iowa to eastern Wisconsin. Wisconsin received record snowfall amounts resulting in a record snowpack for the state. At the end of February, Madison, WI had accumulated 89.8 inches of snow, smashing the previous seasonal snowfall record of 76.1 inches of snow in the winter of 1977-1978. Rockford, IL had accumulated 66.1 inches of snow by the end of February, making this the second snowiest season on record. The winter of 2007-2008 was the 18th snowiest season in Chicago with 50.9 inches of snow measured at Chicago O'Hare Airport. At the end of February, 4 or more inches of snow blanketed the northern two-thirds of the region. This snow pack began to rapidly melt in late February which triggered higher river stages in early March.

Heavy rains throughout south central Missouri and southern Illinois during March 08 caused flooding along the MR&T system in Missouri and Illinois. The Central Mississippi River valley received above normal precipitation from 17 March through 20 March due to a slow-moving frontal boundary that propagated from the Southern Plains to the Ohio River valley. Several low pressure systems developed along the front and advected warm, moist air from the Gulf of Mexico across the Central Mississippi River valley, which resulted in heavy rainfall throughout the region. Missouri, Illinois, and Arkansas received the greatest amounts of rainfall with maximum precipitation totals ranging from 12 to 13 inches. The heavy rain across the Central Mississippi River valley lead to flash flooding and river flooding during the remainder of March. To compound the excess runoff from the Central Mississippi River valley, another heavy rain event from 4 April through 5 April deposited 2 to 3 inches of rainfall across the Lower Mississippi River valley. Repeated rainfall events continued throughout the months of April and May, resulting in major flooding on small tributaries and filled much of the flood control storage within USACE reservoirs.

The numerous heavy precipitation events during March and April 2008 increased stages along the Mississippi River at Arkansas City, Greenville, Vicksburg, and Natchez. As a result, all four stations began to experience significant rises in stages in March. Greenville was the first station to exceed it Phase I flood stage on 26 March, followed by Arkansas City and Natchez on 29 March, and Vicksburg on 31 March. All four stations continued to experience rises in stage throughout April. On 6 Aril, Natchez exceeded its Phase II flood stage, followed by Greenville on 7 April, Vicksburg on April 12, and Arkansas City on 13 April. During the high water event, Arkansas City crested at 45.4 feet (NGVD) on 16 April, Greenville crested at 57.4 feet (NGVD) on 17 April, Vicksburg crested at 50.9 feet (NGVD) on 20 April, and Natchez crested at 57.0 feet (NGVD) on 24 April. On 26 April and 2 May, Arkansas City fell below its Phase II and Phase I flood stages, respectively. Greenville fell below its Phase II flood stage on 28 April and its Phase I flood stage on 4 May. Vicksburg fell below its Phase II flood stage on 1 May and its Phase II flood stage on 8 May. Finally, Natchez fell below its Phase II and Phase I flood stages on 6 May and 18 May, respectively. Overall, the Mississippi River between Arkansas City and Natchez was above Phase I or Phase II flood stage for 54 days during 2008.

The New Orleans District Emergency Operations Center (EOC) activated from 14 March to 21 May 2008 in response to rising Mississippi River levels due to heavy rains and snow received during March over the basin. The event impacted the Mississippi River and Tributaries Project (including the Atchafalaya Basin) in southern Louisiana. The MR&T Project saved 425,000 acres from inundation in Louisiana.

The Bonnet Carre' Spillway was operated for the first time in 11 years. The spillway located 28 miles above New Orleans, on the east bank, is the southernmost floodway in the MR&T system. It can divert a portion of the river's floodwaters via Lake Pontchartrain into the Gulf of Mexico, thus allowing high water to bypass New Orleans and other nearby river communities. The structure's maximum rated capacity is 250,000 CFS through 350 bays. The first spillway bays were opened on April 11, 2008 after approval from the President of the Mississippi River Commission. The Bonnet Carre' Spillway maximum discharge rate was 160,000 CFS via 160 bays that were open on 22 April 2008. The process of closing the bays started on 1 May and the final bays were closed on 8 May. The operation of the spillway reduced the stage at New Orleans from approximately 17.7 ft NGVD to 17.0 ft NGVD.

The Old River Control Complex, which is located approximately 80 miles north of Baton Rouge, was built to prevent the Mississippi River from changing its course to the Atchafalaya River. The Complex was operated as normal during the flood, maintaining the 70/30 flow distribution between the Mississippi and Atchafalaya Rivers at the latitude of Old River. At the crest of the flood the complex was diverting 481,000 cfs from the Mississippi River to the Atchafalaya River; 170,000 cfs through the Sidney A. Murray Jr. Hydroelectric Station, 170,000 cfs through the Low Sill Structure and 141,000 cfs through the Auxiliary Structure. The Old River Control Complex is designed to pass 620,000 cfs to the Atchafalaya River during a project flood.

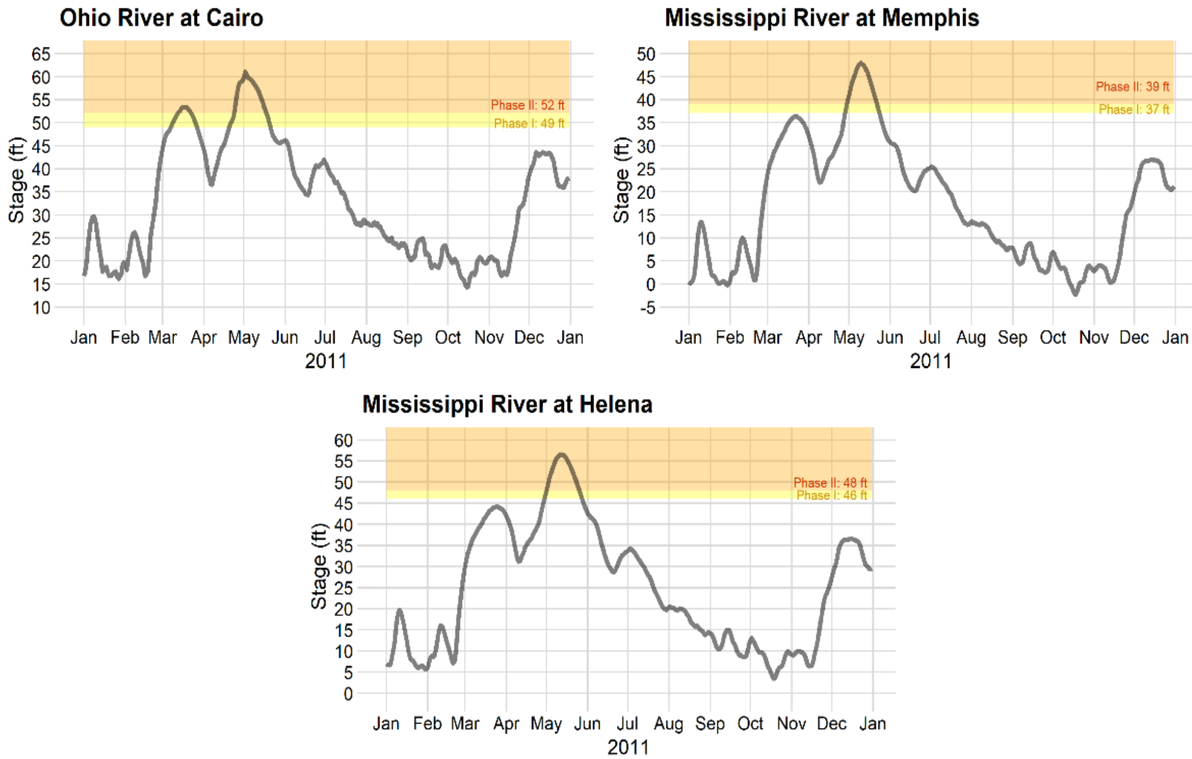
Flood of 2011.

The Mississippi River flood in 2011 resulted in significant and damaging floods after a frontal boundary separating cool, dry winter air, and warm, moist Gulf of Mexico air stalled over the central United States. Typically, the frontal boundary separating the two air masses migrates northward with the retreat of cool, winter air during spring. However, from April to May 2011, the frontal boundary stalled, creating severe weather and significant flooding from heavy rainfall. In fact, the Middle Mississippi and Ohio River valleys received nearly 300 percent of normal precipitation during April, with states such as Arkansas and Missouri receiving up to 20 inches of rainfall. Although the heaviest rain occurred over the Middle Mississippi and Ohio River valleys, the Upper Mississippi River valley maintained extremely wet soil conditions and experienced heavy snow during the start of the year, resulting in substantial runoff amounts. Additionally, snowmelt was delayed due to colder than normal temperatures, which allowed the high water, normally attributed to snowmelt, to coincide with high water, normally attributed to April rains. Consequently, excessive runoff from the Upper Mississippi River valley only compounded the heavy rainfall in the Middle Mississippi River valley during April. During May, the Lower Mississippi River valley experienced one of the most damaging floods as record-setting flows continued south towards the Gulf of Mexico.

The large amount of snow melt and precipitation that occurred during April and May produced record-breaking flows and stages at the confluence, nearing the project design flows on the Mississippi and Ohio Rivers. The flood of 2011 was the largest flood of record at Cairo and produced the highest flows ever recorded from Cairo to Helena. The stages seen at Cairo triggered the activation of the Birds Point New Madrid Floodway (BPNMF) to alleviate stress on the MR&T system and other projects adjacent to and upstream of the Floodway. The Frontline Levee provides protection to a grade equivalent to 62.5 feet on the Cairo gage, except for the fuseplug sections which provide protection equivalent to 60.5 feet on the Cairo gage. The Setback Levee provides authorized protection to a grade equivalent to 65.5 feet on the Cairo gage. Full loading of the Setback Levee occurs during operation of the BPNMF during a Project Design Flood. The 1965 FCA provides for operation of the BPNMF when floods reach 58.0 feet and are projected to exceed 60.0 feet on the Cairo gage.

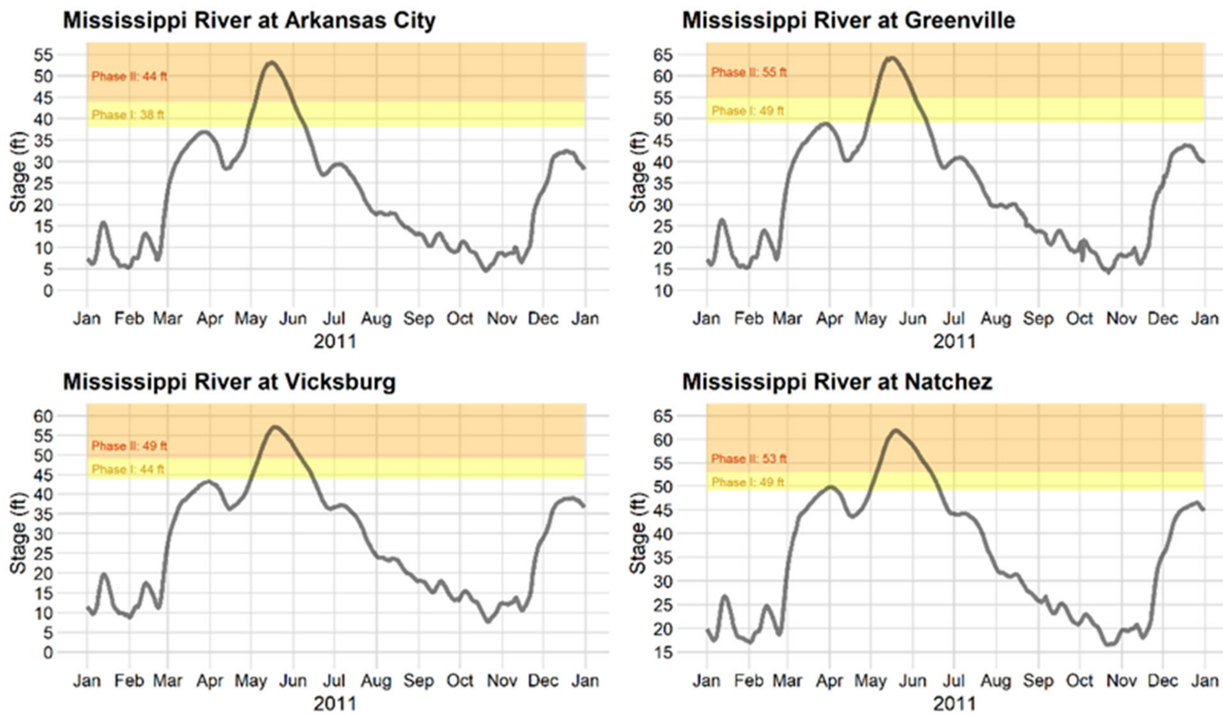
For the Project Design Flood (PDF), the BPNMF operational design contains three crevasses. The Inflow Crevasse is 11,099 feet in length and Inflow/Outflow #1 and Inflow/Outflow #2 are each 5,500 feet in length. The BPNMF is designed to convey about 550,000 cfs of the total PDF of 2,360,000 cfs. In 2011, about 9,400 feet of the Inflow Crevasse was operated on 2 May 2011 at 21:02 CST by artificially crevassing the top 11 feet of that portion of the upper fuseplug. This event conveyed approximately 400,000 cfs through the BPNMF. Following the breaching of the Inflow Crevasse, Inflow/Outflow #1 and #2 were breached on 5 and 3 May 2011, respectively. Due to lack of explosive material, Inflow/Outflow #1 did not operate properly but eventually created a crevasse that was only 690 feet long. At Inflow/Outflow Crevasse #2, 4,500 feet of the total 5,500 feet detonated. The activation of the floodway is estimated to have reduced the 2011 peak stage at Cairo by approximately 1.3 feet. Because the BPNMF is only operating during major floods such as the 1937 and 2011 events, it is estimated that the frequency of operation or overtopping of the Frontline Levee is approximately 1/80 ACE. The flood of 2011 holds the highest stage record at Cairo of 61.7 feet and saw 122 days above flood stage (Figure A4-1). Additionally, Cairo was above Phase I flood stage for 48 days and above Phase II flood stage for 33 days during 2011. Cairo exceeded its Phase I flood stage from 8 March through 26 March and again from 20 April through 20 May. Cairo exceeded its Phase II flood stage from 13 March through 22 March and again from 24 April through 18 May. The crest date for the 2011 flood at Cairo, IL was on 2 May 2011. Memphis, TN had a maximum stage of 48.0 feet (the second highest stage on record) and experienced 45 days above flood stage. Memphis, TN was above its Phase I flood stage for 25 days and above its Phase II flood stage for 22 days during 2011. Memphis, TN surpassed its Phase I floods stage from 29 April through 24 May and its Phase II flood stage from 30 April through 22 May. At Helena, AR the maximum stage reached 56.5 feet (fourth highest stage on record) and was in flood stage for 33 days. Helena, AR remained above its Phase I flood stage for 27 days, from 30 April through 27 May, and above its Phase II flood stage for 23 days, from 2 May through 25 May.

Figure A4-1. 2011 Memphis District Ohio and Mississippi River Stages



Stages along the Lower Mississippi River, at Arkansas City, Greenville, Vicksburg, and Natchez, were already relatively high as excessive runoff from the Upper Mississippi River increased stages during March 2011 (Figure A4-2). Then, continuous, heavy precipitation events during April and May exacerbated the flooding, resulting in stages increasing dramatically at Arkansas City, Greenville, Vicksburg, and Natchez. On 29 April, the Mississippi River at Arkansas City and Greenville exceeded their Phase I flood stage thresholds; whereas, the Mississippi River at Vicksburg and Natchez exceeded their Phase I flood stage thresholds on 1 May. Not even a week later, Arkansas City and Greenville surpassed their Phase II flood stage thresholds on 5 May. Then on 6 and 7 May, the Mississippi River at Vicksburg and Natchez exceeded their Phase II flood stages. Arkansas City crested at 53.1 feet (NGVD) on 16 May, Greenville crested at 64.2 feet (NGVD) on 17 May, and Vicksburg and Natchez crested at 57.1 and 61.8 feet (NGVD), respectively, on 19 May. The flood of 2011 produced the second highest stage on record at Greenville and the highest stages on record at Vicksburg and Natchez. Although the flood of 2011 involved significantly high stages, the high water receded relatively quickly. The Mississippi River between Arkansas City and Natchez was above Phase I flood stage or Phase II flood stage for only 53 days in 2011, and by the end of June, all four stations were below their Phase I flood stages.

Figure A4-2. 2011 Vicksburg District Mississippi River Stages



The majority of New Orleans districts flood gauge records were nearly matched by the 2011 flood event. They ranked in second, or third, with the 1927 flood or the 1973 flood being the record holder for most metrics.

At the crest of the flood, the complex was diverting 671,000 cfs from the Mississippi River to the Atchafalaya River; 131,000 cfs through the Sidney A. Murray Jr. Hydroelectric Station, 307,000 cfs through the Low Sill Structure and 233,000 cfs through the Auxiliary Structure. The Old River Control Complex is designed to pass 620,000 cfs to the Atchafalaya River during a project flood.

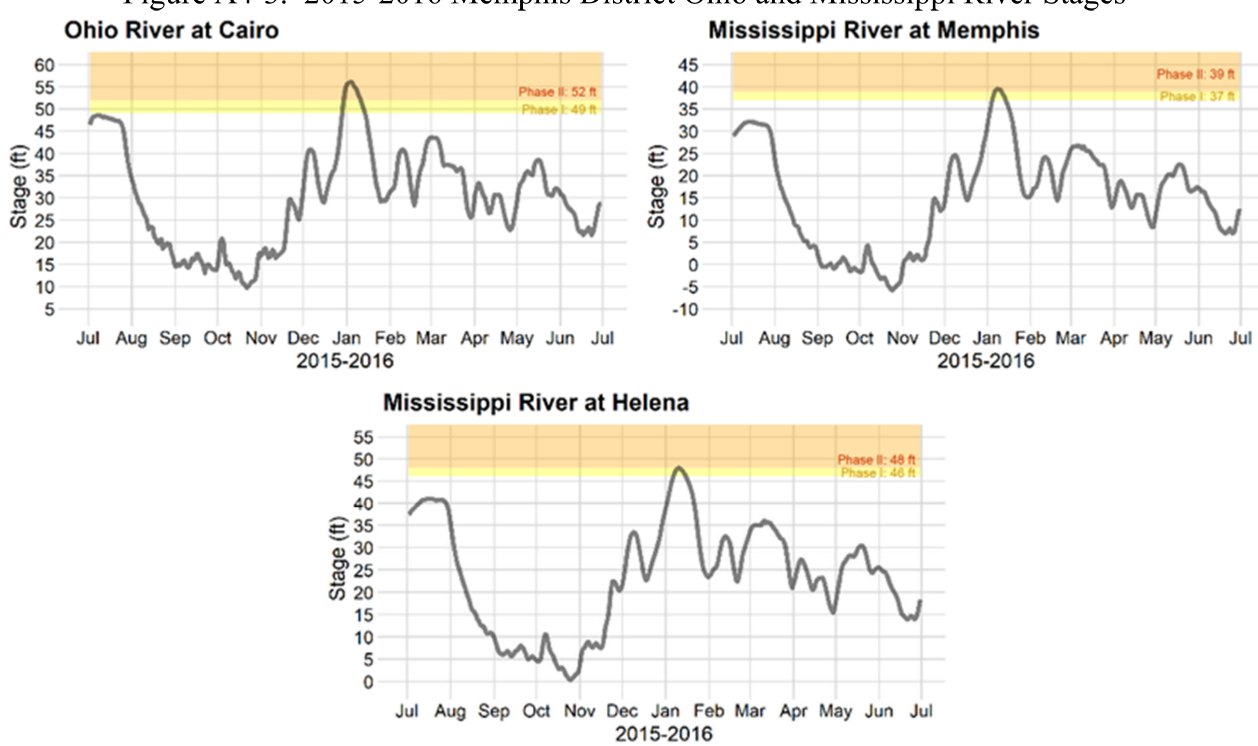
Both the Morganza and Bonnet Carre diversion structures were operated. Morganza was operated 14 May 2011 to 27 June 2011, with a peak flow of 180,000 cfs. This was the second time Morganza had been used for flood management. Stages downstream at Morgan City reached the 2^{nd} highest elevation recorded at 10.33’, coming 0.1 ft shy of the record elevation in 1973, the only other time Morganza was operated. Bonnet Carre was operated 9 May 2011 to 20 June 2011, with a peak flow of 316,000 cfs. This exceeded the maximum design flow of the spillway by 66,000 cfs, no major issues were experienced and showcased Bonnet Carre can perform beyond its intended design.

Flood of 2015/2016.

A multi-day heavy rainfall event deposited copious amounts of rainfall across the Lower Mississippi River valley from 21 October 2015 through 27 October 2015. The heavy rainfall event was associated with a stationary frontal boundary that extended across the southeastern United States and allowed tropical moisture to stream into the region ahead of the upper level system. States such as Arkansas, Louisiana, and Mississippi received up to 12 inches of rainfall. Soon after, a squall line of heavy rain and severe thunderstorms propagated over the southeastern United States from 23 December 2015 through 26 December 2015, which deposited up to 5 inches of rainfall across the Lower Mississippi River valley. These back to back heavy rain events caused flooding along the Lower Mississippi River that began in December 2015 and lasted throughout January 2016.

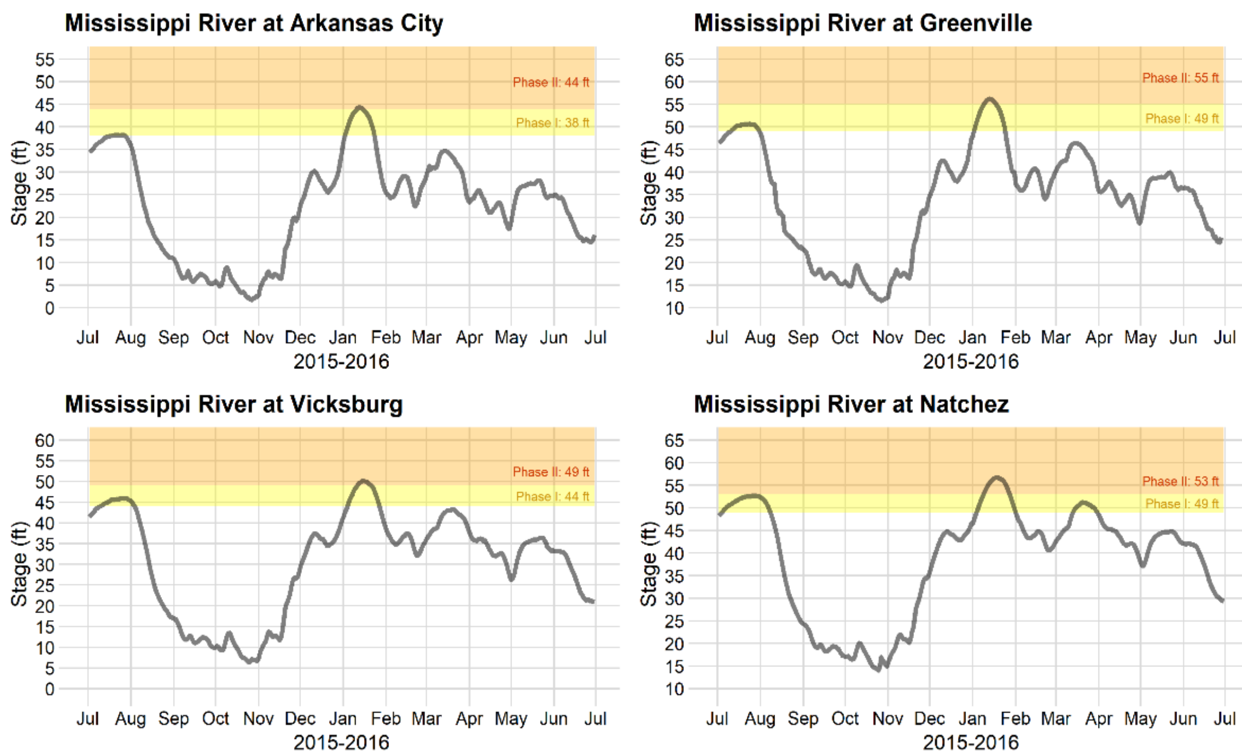
As a result of the above average precipitation across the Upper and Middle Mississippi River basins, December 2015 was, at the time, the wettest winter on record in the continental United States. Precipitation was near average for the greater portion of the Ohio River basin, but the area near the confluence of the Ohio and Mississippi rivers saw above average precipitation. These rains resulted in a brief high crest at Cairo on 4 January 2016 with high water receding by mid-January. The 2016 flood produced the seventh highest stage, 56.1 feet, at Cairo and saw 34 days above flood stage (Figure A4-3). Additionally, Cairo remained above its Phase I flood stage for 23 days, from 29 December 2015 through 13 January 2016, and above its Phase II flood stage for 11 days, from 30 December 2015 through 10 January 2016. Memphis, TN and Helena, AR experienced stages that were at or outside the top 20 stages per period of record at both locations and the days above flood stage were minimal.

Figure A4-3. 2015-2016 Memphis District Ohio and Mississippi River Stages



The heavy rainfall during December 2015 prompted rises along the Mississippi River between Arkansas City and Natchez (Figure A4-4). Greenville exceeded its Phase I flood stage on 2 January 2016, Arkansas City exceeded it Phase I flood stage on 3 January 2016, and Vicksburg and Natchez exceeded their Phase I flood stages on 4 January. Stages on the Mississippi River continued to rise quickly, and the Mississippi River at Greenville exceeded its Phase II flood stage on 9 January. Natchez exceeded its Phase II flood stage on 10 January, and Arkansas City and Vicksburg exceeded their Phase II flood stages on 11 January. Soon after, Arkansas City crested on 12 January at 44.3 feet, NGVD, Greenville crested on 13 January at 56.2 feet, NGVD, Vicksburg crested on 15 January at 50.2 feet, NGVD, and Natchez crested on 18 January at 56.7 feet, NGVD. Arkansas City then fell below its Phase II flood stage on 15 January and its Phase I flood stage on 24 January. Greenville fell below its Phase II flood stage on 18 January and its Phase I flood stage on 24 January. Vicksburg fell below its Phase II flood stage on 21 January and its Phase I flood stage on 27 January. Natchez fell below its Phase II flood stage on 28 January and its Phase I flood stage on 1 February. Overall, the Mississippi River between Arkansas City and Natchez remained above Phase I flood stage for 26 days during 2016.

Figure A4-4. 2015-2016 Vicksburg District Mississippi River Stages



In the New Orleans District, river stages rose above and fell below the Major flood stage of 56 ft at Red River Landing on 9 January and 29 January, respectively. It peaked on 16 January 2016 at 60.57 ft. The Bonnet Carre Spillway was operated for a total of 23 days, this was the second shortest opening of BCS with 210 bays open and a maximum flow of 203,000 cfs.

Flood of 2018.

During February 2018, an upper level high pressure developed over the eastern United States and an upper level low pressure system developed over the western United States. This synoptic weather pattern resulted in frontal boundaries stalling over the Mississippi and Ohio River valleys. The stalled fronts produced substantial amounts of precipitation over the Middle and Lower Mississippi River valleys, with some basins in these regions receiving almost 400 percent of normal precipitation during the month of February.

During February 2018, the Lower Mississippi River valley received more than 8 inches above normal monthly precipitation. As a result, the Mississippi River at Arkansas City, Greenville, Vicksburg, and Natchez began to experience rises in stage. Arkansas City exceeded its Phase I flood stage on 3 March and did not fall below its Phase I flood stage until 23 March. Greenville also exceeded its Phase I flood stage on 3 March and did not fall back below its Phase I flood stage until 24 March. Vicksburg exceeded its Phase I flood stage on 3 March and continued to experience rises in stage, until it exceeded its Phase II flood stage on 12 March. Vicksburg fell below its Phase II flood stage on 21 March and its Phase I flood stage on 27 March. Natchez exceeded its Phase I flood stage on 2 March and its Phase II flood stage on 8 March. Natchez fell below its Phase II flood stage until 27 March and briefly fell below its Phase I flood stage from 1 April through 7 April, before stages once again exceeded its Phase I flood stage on 8 April. Due to continuous heavy rain events, Natchez remained above its Phase I flood stage until 9 May. During the 2018 flood event, Arkansas City and Greenville both crested on 14 March at 42.9 feet (NGVD) and 54.8 feet (NGVD), respectively. Vicksburg crested at 49.9 feet (NGVD) on 15 March, and Natchez crested at 57.0 feet (NGVD) on 17 March. The Mississippi River between Arkansas City and Natchez remained above Phase I or Phase II flood stage for 68 days during the 2018 flood event.

This event ranks 10^{th} highest flows on record at 1,444,000 cfs. It was close enough that Morganza's operation was looking probable and preparations to operate were discussed. However, the need to operate was not realized.

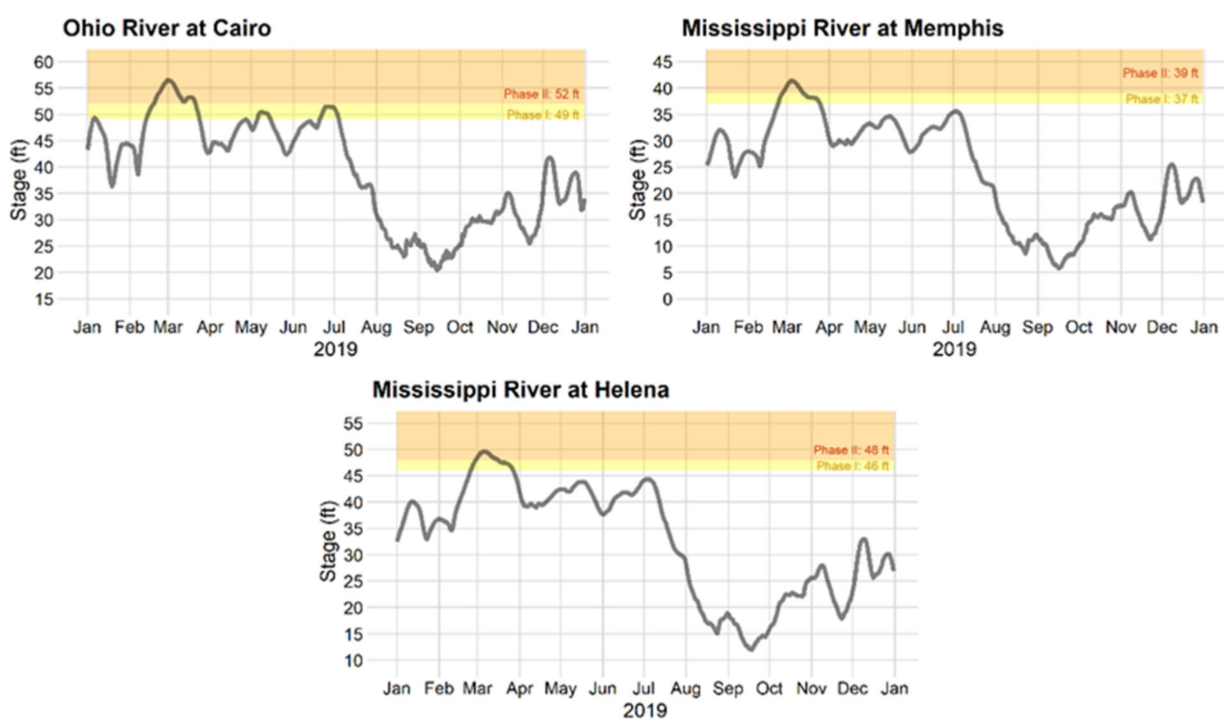
The 2018 flood event was significant enough to necessitate the operation of the Bonnet Carre Spillway. The spillway was operated for 23 days, tying the second shortest on record in 2016. The spillway performed as designed, passing a maximum flow of 196,000 cfs with 183 bays opened.

Flood of 2019.

The Mississippi River flood of 2019 was not the product of a single heavy precipitation event. From January through July, heavy rainfall events were frequent. In fact, the first seven months of 2019 were the wettest start of any year for the United States in the twentieth century, with some areas receiving anywhere from 4 inches to 20 inches above normal precipitation. Unfortunately, the steady spring rainfalls throughout the Mississippi River valley occurred subsequent to an abnormally wet winter, which resulted in soils remaining completely or nearly saturated and above normal stream flow persisting during the spring months. Then anomalously warm temperatures during the months of May and June prompted rapid snowmelt across the Upper Mississippi valley that, in conjunction with more rainfall, exacerbated and prolonged the flooding in the Middle and Lower Mississippi River valleys. Overall, flooding along the Lower Mississippi River began as early as 8 January and significant falls in stage did not occur until July.

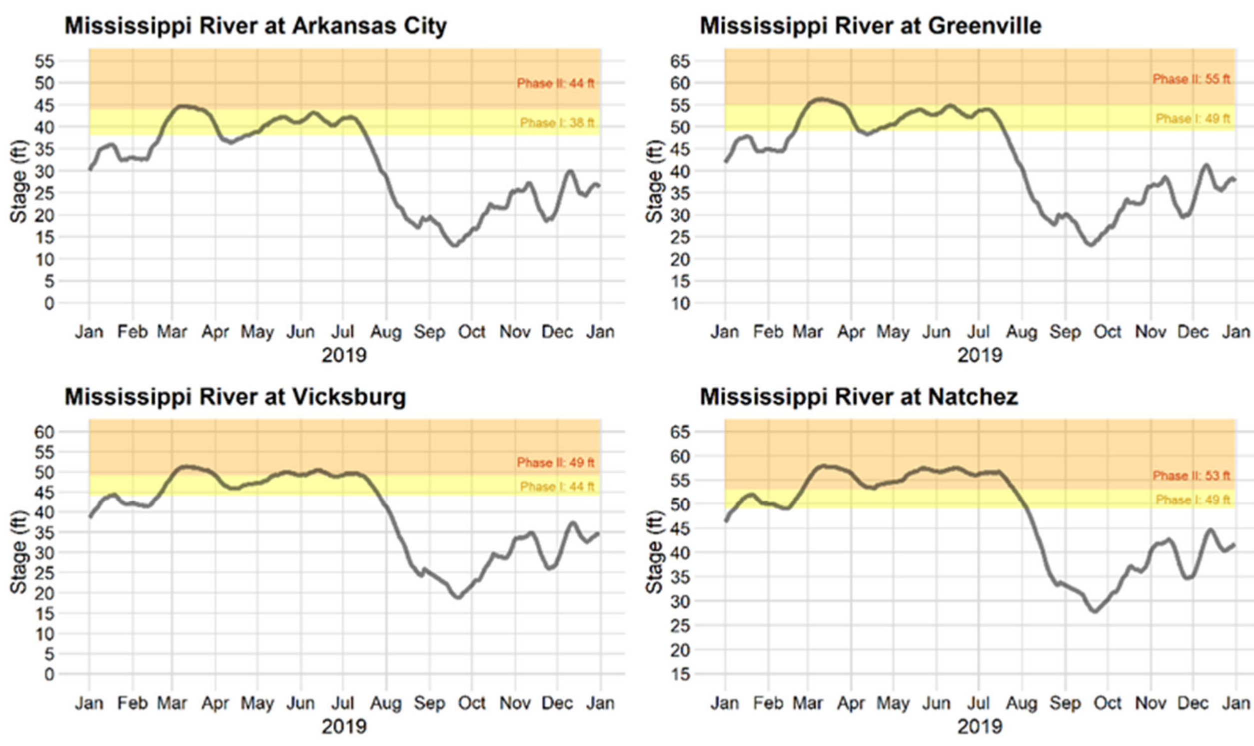
The flood of 2019 broke numerous crest records and is the longest flood on record for both consecutive and cumulative days above flood stage between Cairo and Helena (Figure A4-5). The flooding between Cairo and Helena resulted from above normal precipitation in the Upper Mississippi and Ohio River valleys and rapid snow-melt. In fact, the precipitation in the Upper Mississippi and Ohio River basins was recorded as the highest ever from June 2018 to July 2019. Then increased frost depths in the Upper Mississippi and Missouri Basins, combined with above-average precipitation resulted in almost 100 percent runoff from the rain on snow, which resulted in a historic flood event along the Missouri River and Upper Mississippi River. This large amount of flooding from the Missouri, Upper Mississippi River, and Ohio River basins resulted in an extensive flood event below the confluence of the Ohio and Mississippi rivers. The peak stage at Cairo, IL reached 56.5 feet (third highest on record) with 193 total days above flood stage. Flooding was consecutive for 156 days at Cairo, IL. Cairo remained above its Phase I flood stage for 65 days and above its Phase II flood stage for 30 days throughout the spring of 2019. The crest of the 2019 flood at Cairo, IL was on 1 March 2019. Flooding in the Upper portion of the LMR quickly leveled off with a peak stage of 41.4 feet at Memphis, TN (ninth highest on record) and 49.6 feet at Helena, AR (ninetieth highest on record).

Figure A4-5. 2019 Memphis District Ohio and Mississippi River Stages



On 22 February, the Mississippi River at Arkansas City reached a Phase I flood stage of 38.58 feet (NGVD), before increasing to a Phase II flood stage of 44.27 feet (NGVD) on 5 March, and eventually cresting on 12 March at 22.71 feet (NGVD) (Figure A4-6). On 20 February, the Mississippi River at Greenville reached a Phase I flood stage of 49.21 feet (NGVD). Greenville then continued to experience rises in stage and obtained a Phase II flood stage of 55.32 feet (NGVD) on 3 March. On 12 March, the Mississippi River at Greenville crested at 56.28 feet (NGVD). The Mississippi River at Vicksburg reached a Phase I flood stage on 20 February of 44.11 feet (NGVD) and continued to experience rises in stage, obtaining a Phase II flood stage of 49.23 feet (NGVD) on 2 March. Vicksburg then crested on 13 March at 51.41 feet (NGVD) and remained in a Phase II flood stage for the rest of March. The Mississippi River at Natchez obtained a Phase II flood stage of 53.42 feet (NGVD) on 26 February and crested at 57.86 feet (NGVD) on 12 March. The Mississippi River at Arkansas City, Greenville, Vicksburg, and Natchez remained above Phase I and II flood stages from February through July, with all four stations not falling below flood stage until August. Overall, Arkansas City and Greenville were above Phase I flood stage for 126 and 137 days, respectively. Vicksburg was above Phase I flood stage for 162 days and Phase II flood stage for 89 days. Natchez was above Phase I flood stage for 208 days and Phase II flood stage for 150 days.

Figure A4-6. 2019 Vicksburg District Mississippi River Stages



The flood of 2019 broke numerous crest records and is the longest flood on record for both consecutive and cumulative days above flood stage at and below Red River Landing. Precipitation in the Upper Mississippi and Ohio River basins was recorded as the highest ever from June 2018 to July 2019. There were two separate peak flood events. This resulted in the operation of Bonnet Carre Spillway twice within one year, the first time this had ever happened.

Although Morganza Spillway was not operated for this flood event, the spillway was put into a 10 day opening process public notice. This notice allows parties to prep for the flood which includes; capping oil wells, moving cattle, and equipment. All forecasts showed that river stages would be on the cusp of needing to operate. However the need to operate never materialized.

For Bonnet Carre, the first opening required 206 total bays open to relieve the swollen Mississippi downstream. The peak flow calculated was 213,000 cfs diverted to Lake Pontchartrain. Bonnet Carre would continue to operate for 44 days. Closing was accomplished, however issues with control while setting needles at higher stages became a concern, to implement a closing stage restriction.

The second opening was accelerated due to heavy local rainfall in excess of 8 inches along the lower Mississippi. Below is the forecast for that day. This event pushed for the scheduled opening to happen Friday 10 May 2019 instead of Monday 14 May 2019 as anticipated early that week. This is the first time local rainfall has impacted the operation of Bonnet Carre Spillway. Due to the severity of rainfall, 60 bays were opened that Friday, in total the second event would see 168 bays open. With a maximum calculated flow of 163,000 cfs. The opening on 10 May 2019 would be the longest continuous opening for the Bonnet Carre Spillway beating the previous record of 75 by three days. Combined the spillway for the flood event of 2019 was opened 122 days.

Summary of Floods.

Historically, the Mississippi River valley floods most often in the spring months, but recent trends indicate floods are occurring more frequently and are lasting well in to the summer months. Maximum observed discharges at key stations on the Mississippi River for the floods of 1999 through 2019 described above are presented in Table A4-4 and Table A4-5, with maximum stages presented in Table A4-6. Additionally, Bonnet Carre and Morganza operations are presented in Tables A4-7 and A4-8.

Table A4-4. Maximum Discharges for Selected Floods 1999-2019

Gage Location	Maximum Discharges (1000 CFS)						
	Years						
	2008	2009	2011	2016	2017	2018	2019
Hickman	1411	1295	2100	1516	1338	1404	1502
Memphis WB	1426	1290	2213	1561	1377	1552	1671
Helena	1553	1413	2130	1553	1417	1528	1620

Table A4-5 (Cont.)

Gage Location	Maximum Discharges (1000 CFS)						
	Years						
	2008	2009	2011	2016	2017	2018	2019
Arkansas City	1,990	1,512	2,290	1,820	1,650	1,750	1,815
Vicksburg	1,810	1,565	2,300	1,860	1,628	1,773	1,882
Natchez	1,949	1,601	2,220	1,941	1,592	1,770	1,871
Tarbert Landing	1,456	1,277	1,619	1,415	1,222	1,444	1,445

Table A4-6. Maximum Discharges at Tarbert Landing for Selected Floods 1927-2020

RANK	YEAR	RED RIVER LANDING STAGE (FT., NGVD)	TARBERT LANDING DISCHARGE (CFS) *	BONNET CARRE' OPERATED	MORGANZA OPERATED
1	1927	61.02	1,779,000	YES	NO
2	2011	63.13	1,619,000	YES	YES
3	1945	59.89	1,520,000	YES	NO
4	1973	58.20	1,498,000	YES	YES
5	1997	61.30	1,480,000	YES	NO
6	1983	60.40	1,470,000	YES	NO
7	2008	60.71	1,456,000	YES	NO
8	1950	57.19	1,456,000	YES	NO
9	2019	61.88	1,445,000	YES	NO
10	2018	61.09	1,444,000	YES	NO
11	1937	58.99	1,436,000	YES	NO
12	1979	59.06	1,419,000	YES	NO
13	2016	60.57	1,415,000	YES	NO
14	2020	61.35	1,346,000	YES	NO
15	2009	57.89	1,277,000	YES	NO
16	2017	57.72	1,222,000	NO	NO

Table A4-7. Maximum Stages for Selected Floods 1999-2019.

Gage Location	Maximum Stages (Feet) Years						
	2008	2009	2011	2016	2017	2018	2019
Cape Girardeau	42.3	38.9	46.1	48.7			
Cairo	53.8	51.0	61.7	56.1	52.1	54.8	56.5
Hickman	47.7	44.7	54.2	49.4	45.8	47.2	49.1
New Madrid	41.4	39.1	48.3	43.0	39.7	41.9	42.9
Caruthersville	40.8	38.3	47.6	42.6	39.4	40.9	42.4
Memphis	37.7	34.7	48.0	39.5	35.9	39.4	41.4
Helena	47.0	43.7	56.5	48.0	44.7	47.4	49.6
Arkansas City	45.4	40.4	53.1	44.3	42.1	42.9	44.7
Vicksburg	50.9	47.6	57.1	50.2	48.5	49.9	51.5
Natchez	57.0	54.4	61.8	56.7	54.9	57.0	57.9
Red River Landing	60.7	58.1	63.4	60.7	57.7	61.2	62.0
Baton Rouge	43.2	40.9	45.0	43.3	40.6	43.8	44.2
New Orleans	17.0	16.6	17.4	17.1	16.5	17.0	17.3

Table A4-8. Bonnet Carre Historical Operations

Bonnet Carre' Openings				
Year	Opening Date	# of days open	# of bays	max flow
1937	30-January	48	285	211,000
1945	23-March	57	350	318,000
1950	10-February	38	350	223,000
1973	8-April	75	350	195,000
1975	14-April	13	225	110,000
1979	18-April	45	350	191,000
1983	20-May	35	350	268,000
1997	17-March	31	298	243,000
2008	11-April	31	160	160,000
2011	9-May	42	330	316,000
2016	10-January	22	210	203,000
2018	8-March	22	183	196,000
2019	27-February	44	206	213,000
2019	10-May	78	168	163,000
2020	3-Apr	28	90	81,000

Table A4-9. 2011 Morganza Operation

Date	Computed Flow in cfs	Date	Computed Flow in cfs
5/14/2011	21000	6/6/2011	41000
5/15/2011	96000	6/7/2011	24000
5/16/2011	158000	6/8/2011	15400
5/17/2011	170000	6/9/2011	7400
5/18/2011	180000	6/10/2011	7300
5/19/2011	179000	6/11/2011	7048
5/20/2011	179000	6/12/2011	6736
5/21/2011	178000	6/13/2011	6428
5/22/2011	175000	6/14/2011	6125
5/23/2011	173000	6/15/2011	5708
5/24/2011	160000	6/16/2011	5301
5/25/2011	140000	6/17/2011	4960
5/26/2011	121000	6/18/2011	4571
5/27/2011	120000	6/19/2011	4086
5/28/2011	119000	6/20/2011	3620
5/29/2011	109000	6/21/2011	3270
5/30/2011	98000	6/22/2011	2931
5/31/2011	97000	6/23/2011	2514
6/1/2011	86000	6/24/2011	2119
6/2/2011	76000	6/25/2011	1827
6/3/2011	65000	6/26/2011	1549
6/4/2011	64000	6/27/2011	1360
6/5/2011	61000		

A4-2.4 Hydrologic and Hydraulic Analyses for Environmental Study

Water surface elevations are not likely to be affected by the proposed projects. It is a reasonable assumption for pre- and post-project elevations used in habitat evaluations to be the same. In order to assess environmental impacts associated with raising the levees or reducing seepage underneath the levees, hydrologic and hydraulic analyses were conducted to identify wetlands as well as waterfowl and terrestrial habitat. After the areas were identified, changes associated with project construction were identified. Water surface elevation or flowline impacts due to the proposed projects will be evaluated for each project as they progress to the design phase.

A4-2.4.1 Hydrologic Criteria and Statistical Computations

Two types of hydrologic evaluation were performed for the study to facilitate environmental analyses.

A4-2.4.1.1 Waterfowl Habitat

Waterfowl feeding habitat is defined as areas that are inundated by up to 18 inches of water. The Mississippi River stages generally increase during the waterfowl season of 1 November to 28 February. Mean monthly stages increase by 10 or more feet at most gaging locations during this period. The maximum and minimum stages during the winter waterfowl season were determined by the computer program ENVIRO-DUCK. The ENVIRO-DUCK program was initially developed by the Vicksburg District with the cooperation of the Fish and Wildlife Service (FWS). It was based on a food energy model developed by the FWS. ENVIRO-DUCK was later updated and modified by Dr. Mickey Heitmeyer for the Memphis District. As input the program requires the beginning and ending dates of the waterfowl season, and the period-of-record to be used in the analysis. The program also requires a stage-area curve, which it uses to calculate the daily acres inundated (resting) and the daily acres of feeding habitat. Using this information the program calculates the daily resting and feeding acres available, sums these for each year, and calculates the average acres available during each year. The program also calculates the annual mean, minimum, and maximum stages during the waterfowl season. Finally, it calculates the mean, minimum and maximum stages during the entire period-of-record during the waterfowl season.

The areal extent of available waterfowl habitat was determined with the FESM flood mapping tool. Water surface profiles for the minimum and maximum stages were used to map the upper and lower bounds of the waterfowl habitat. The NASS crop cover for 2018 for the seven states in the study area were merged into a single coverage, and clipped to the project area. The FESM tool produces a TIFF file. The maximum extent TIFF file was converted to a polygon file, which was then used to clip the NASS crop layer to produce the land-use of available waterfowl habitat.

A4-2.4.1.2 Terrestrial Habitat Evaluations

To identify areas for terrestrial habitat evaluations the elevation equaled or exceeded 5, 10, 25, 50, 75, 90, and 95 percent of the time annually (annual exceedence duration) for the period of record was computed. The elevations were determined by the SAS UNIVARIATE program. The 5, 10, 25, 50, 75, 90 and 95 percent elevations were determined for each of the 25 gage locations. The SAS UNIVARIATE program computed this duration intervals for each year, each decade, each month, and each season.

The mean annual 50 percent duration interval was used to determine mink habitat. The mean 50 percent duration elevation provided a water surface profile for the FESM mapping tool to represent where permanent water sources were located throughout the landscape.

Wood ducks breed in the spring (March-May); therefore, the 75 percent duration during the spring season was used to determine available wood duck habitat. This duration elevation across the 25 gage locations provided a water surface profile which was used by the FESM mapping tool to determine the areal extent of wood duck habitat.

A4-3 DESIGN ASSUMPTIONS FOR PROPOSED WORK ITEMS

A4-3.1 General

The purpose of the MRL SEIS II is to provide a full and fair discussion of environmental impacts associated with the currently identified authorized remaining work required to complete the MR&T MRL Feature, and shall inform decision makers and the public of the reasonable alternatives which would avoid or minimize significant adverse environmental impacts associated with the project, or even enhance the quality of the human environment on the MRL through implementation of the project in a more environmentally friendly way.

The basis of design for the 143 Work Items described in SEIS II were prepared separately for each district by design professionals, utilizing team members with expertise in Engineering (Geotechnical, Civil, Hydraulic, and Structural), Relocations, Real Estate, Environmental, and

Cultural Resources. Individual districts implemented different design strategies to recommend the preferred design solution required to address the MRL deficiencies for each of the individual Work Items. Each of the 3 districts utilized data on hand, relying on past MRL design experience, performance data obtained during past flood events, and, when available, geotechnical or topographical survey data. The purpose of this section is to identify the assumptions made and the methodology used when estimating the extents project limits, estimated quantities required, and Right-of Way (ROW) requirements, and for all Work Items included in the MRL Supplemental Environmental Impact Statement (SEIS) II.

A4-3.2 Work Item Identification

Over the past twenty years since the finalization of the 1998 SEIS, USACE has determined that various sections (reaches) of the mainline levee system are deficient in varying amounts, and that certain remedial measures need to be undertaken at these locations to control seepage and to raise and stabilize the levee to protect the MAV against the PDF and maintain the structural integrity of the MRL system.

Through evaluation of information and data obtained from levee inspections, seepage analyses, research, studies, and engineering assessments, USACE has concluded that certain levee reaches do not meet the federally-authorized design grade due to effects from various changed conditions, including, but not limited to consolidation of levee materials, subsidence, and changes in river conditions and survey datums over time. Additionally, advances in geotechnical mapping, data collected from recent high water events, and subsequent seepage analyses that have taken place since the finalization of the 1998 SEIS, have revealed the need for additional seepage control measures and the construction of other authorized project features to protect the structural integrity and stability of the MRL system.

In 2017, USACE completed a risk-assessment of all known deficient segments of the MRL, including both unconstructed Work Items assessed in the 1998 SEIS and remaining deficiencies that had been identified since the 1998 SEIS was published. These levee segments were prioritized based on risk, which is a measure of the likelihood and consequences of uncertain future events. In this case risk was represented by a levee breach resulting from an overtopping or underseepage issue that would be addressed by an MRL construction item. The consequences of a breach at each construction item location were represented by loss of life estimates developed during USACE levee risk assessments for each levee segment, with some adjustment to account for the proximity of population centers to specific construction items within each levee segment. The likelihood of a breach at each construction item location was estimated using processes consistent with the USACE Levee Risk Screening Tool, with some adjustment to better incorporate the vast amount of performance data available for the MRL systems.

A risk index was calculated for each construction item by multiplying the adjusted loss of life number by the estimated annual likelihood of breach. This risk index was used to develop a preliminary risk ranking. A final risk ranking was developed by the prioritization team based upon the preliminary ranking as well as other factors from the USACE levee risk assessment, such as whether or not the addressed failure mode was identified as a risk driver during the USACE levee risk assessment, the USACE district's assessment of the validity of the risk ranking for items within their area of responsibility, and how effectively a proposed MRL construction project would reduce overall risk.

The districts have collectively identified a total of 143 additional Work Items located in numerous reaches of the MRL system that were not identified in the 1998 SEIS and require the construction of remedial measures necessary to control seepage and/or raise and stabilize deficient sections of the existing levees and floodwalls. The 143 Work Items constitute the proposed action for this SEIS II.

A4-3.3 Proposed Types of Work

The proposed 143 Work Items are summarized into the following categories: levee enlargements, floodwall deficiencies, slope flattenings, seepage berms, and relief wells. Some Work Items contain multiple deficiencies (e.g., grade deficiency and seepage issues) in need of being addressed.

- Levee enlargements are conducted in locations where the existing levee is not at the authorized grade. Depending on the location of the project, these raises may occur on the landside, riverside, or straddle the existing levee section. There are 101 Work Items containing grade deficiencies averaging approximately 2 feet in height.
- Floodwalls, typically located in urban settings, have stability concerns or height deficiencies that need to be addressed. There are 22 Work Items requiring floodwalls with grade deficiencies or in need of stabilization.
- Flattening the slopes of the levee can reduce the chances of levee slides along those reaches of the MRL that are experiencing recurring slides and in need of repairs beyond ordinary operation and maintenance. There are 7 Work Items in need of slope flattening.
- Seepage berms are constructed on the landside of the levee using impervious soils to reinforce existing top stratum and to reduce underseepage pressure near the toe of the levee. Upon construction, berms are turfed and mowed to prevent erosion or encroachment of undesired vegetation. There are 14 Work Items in need of seepage berms.
- Relief wells are vertically installed wells consisting of a well screen surrounded by a filter material designed to prevent in-wash of foundation materials into the well. Relief wells intercept underseepage and provide a controlled outlet for the water while minimizing material transport underneath the levee. There are 12 Work Items that are in need of relief wells.

The following sections discuss the methodology used in planning the 143 Work Items that were included in the SEIS II.

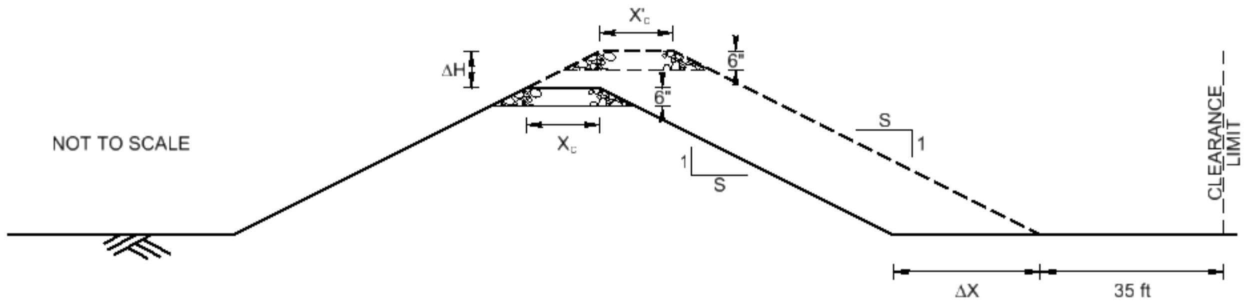
A4-3.3.1 Levee Enlargements

All of the known levee height deficiencies that have been identified within the 3 USACE Districts since the SEIS I were considered for inclusion in this document. Only Work Items with height deficiencies greater than 1' were considered for construction.

A4-3.3.1.1 Memphis District

The levee crown survey used for this effort dates from 2009. This survey included an elevation shot on the levee crown roughly every 20-30 ft. At each elevation shot, the surveyed elevation was compared to the authorized grade for the levee at that location to determine whether or not the levee needed to be raised. These authorized grade values were interpolated between individual points spaced roughly every levee mile. At each location where the surveyed levee crown elevation fell below the interpolated authorized grade elevation, an attempt was made to estimate the gravel and earthwork quantities that would be required to raise the levee up to authorized grade. The levee raise was assumed to be a “one sided” raise as shown below in Figure A4-7. To simplify the calculations, it was assumed that the levee crown would be widened by 5 ft as part of the levee raise and that the levee itself was 25 ft tall with a 6 inch layer of gravel on the crown.

Figure A4-1. Assumed Geometry for Levee Raise



$$X_C = Existing\ Crown\ Width$$
$$X'_C = Proposed\ Crown\ Width$$
$$\Delta H = Proposed\ Levee\ Raise$$
$$\Delta X = Distance\ from\ Existing\ Toe\ to\ Proposed\ Toe$$
$$= (\Delta H)(S) + (X'_C - X_C)$$
$$\leq 15\ ft\ in\ most\ cases$$
$$35\ ft = Haul\ Road +\ Material\ Processing + Staging$$

Based on these assumptions, the required footprint for a generic levee raise (H < 3 ft) was estimated to be roughly a 50 ft wide strip along the levee toe for the entire length of the raise (measured parallel to the levee centerline). The earthwork and gravel quantities were estimated using the average end area method.

Based on these assumptions, the required footprint for a generic levee raise (H < 3 ft) was estimated to be roughly a 50 ft wide strip along the levee toe for the entire length of the raise (measured parallel to the levee centerline). The earthwork and gravel quantities were estimated using the average end area method.

A4-3.3.1.2 Vicksburg District

For the only known potential deficiency in Mississippi, MRL Item 443-L, the MS Delta LiDAR data was used to create an existing ground surface. Using both aerial imagery and contours produced by the LiDAR surface, the apparent line of protection was identified and compared to the authorized grade.

For reach of deficient levee that was examined in Louisiana, the Morville-Blackhawk Reach, the 2009 National Levee Database Centerline survey was used. The centerline shots from the NLD survey were used to create a 3D linear feature in CADD. A comparative geometry report was then created relating the elevation and offset of the 3D feature to the existing baseline. This allowed the team to establish an existing elevation at every 100' baseline station. The report was pulled into excel, and standard excel tools were used to compare the elevations to the authorized grade. Numerous reaches with deficiencies greater than 1' were identified and divided into projects.

A4-3.3.1.3 New Orleans District
Landside shifts were assumed, wherever possible. If not, a straddle was assumed, and finally a flood side shift would be assumed if neither a landside or straddle enlargement were feasible.

A4-3.3.2 Seepage Remediation
Historical flood performance data and seepage analyses were used to determine if seepage remediation measures were anticipated for each Work Item. In order to perform seepage analyses, borings or cone penetrometer test (CPT) at or near the project site are required. Where borings or CPTs were not available, historical performance data governed the decision making process. Specifically, if seepage had been observed at a location during past flood events, it was assumed that seepage remediation measures would be warranted in the future when soil borings and CPTs were collected.

A4-3.3.2.1 Memphis District
All of the seepage remediation projects included in MVM were assumed to be relief well projects, as is typical in the Memphis District. The typical center-to-center spacing for MVM's relief wells ranges from 50 ft up to roughly 300 ft. Therefore, the total length of each seepage remediation project was divided by an estimated average well spacing of 200 ft to determine the approximate number of wells required for each project. Each well was assumed to be 100 ft in total length. Relief well projects typically generate small quantities of spoil (from the collector ditch), so no borrow requirement was included for these projects.

A4-3.3.2.2 Vicksburg District
Where it was determined that seepage remediation was needed, seepage berms were typically preferred over relief wells due to project life expectancy and recurring maintenance costs associated with relief wells. When seepage berms were recommended, they were assumed to be 300' wide, 6' thick at the levee toe, 3' thick at the berm crown, and have a 1:100 slope. These dimensions represent the most conservative seepage berms used within the Vicksburg District. None of the projects included the extensive borings and lab testing data needed to precisely size the seepage berms needed, and therefore it is likely that the design solution recommended for construction will vary from the conservative assumptions used in this exercise.

For the project sites in Mississippi, borings were available and a seepage analysis was performed for each site. The historical flood performance was also analyzed and compared to the results of the seepage analysis. Where seepage remediation was proposed, seepage berms were used where it was possible. There were several instances where homes or major roadways were too close to the levee to allow a 300' seepage berm to be constructed. Relief wells were used for seepage remediation in these locations. In areas where 300' seepage berms were currently in place, relief wells were added to increase the seepage remediation capacity.

For the project sites in Louisiana, soil borings were not available for most of the proposed project locations. Historical flood performance was used to assume the need for seepage remediation measures for these locations. Seepage berms were used extensively for seepage remediation due to their long service life and lack of maintenance cost. Relief wells were also used in reaches where environmental constraints such as homes and industrial apparatuses were present.

A4-3.3.2.3 New Orleans District
In the New Orleans District, it was assumed that seepage berms would be installed where conditions allowed. In these locations, the PDT estimated a 200' wide berm with a height of approximately 3' above existing ground level, as is typical in the New Orleans District. In areas where berms were not feasible, relief well spacing of 150' was assumed.

A4-3.3.3 Slope Flattening
Areas with recurring levee slides require measures beyond ordinary operation and maintenance repairs. In these locations, the slopes of the levee would be flattened to reduce the chances of slide recurrence. There are 7 Work Items in need of slope flattening, all of which occur in the Memphis District.

A4-3.3.3.1 Memphis District
For levee slope flattening projects, a simple "infinite slope" analysis was used to estimate the factor of safety against sliding:

$$FS = \frac{\tan(\varphi)}{\tan(\beta)}$$

Where

FS= Factor of safety against sliding

φ = Friction angle for clay soil under drained (i.e. long term) loading

β = Angle of levee slope = $tan^{-1}(\frac{1\,V}{?\,H})$

Analyzing shallow levee slides using this approach assumes that the slide resulted from a fully drained loading condition in a clay embankment. In other words, the excess pore water pressures generated by the application of the load (in this case, the weight of the levee slope itself) have all had sufficient time to dissipate. Thus, the clay in the levee loses its apparent cohesion as the negative porewater pressures dissipate over time, and its shear strength becomes completely dependent on friction along the slip surface. Figure 31 in WES Technical Report 3-604 provides a useful correlation between plasticity index (PI) and drained friction angle (φ') for clay soils. Based on these values, the friction angle of a fully drained clay may be expected to vary from about 32° down to 18° as the PI increases. However, back-analysis of shallow slides that have occurred on MVM's levees in the past indicates that these friction angles may sometimes drop to values as low as 11°. These extremely low friction angles are most likely due to the effects of water that has infiltrated the slope and saturated the material along the slip surface. Levees built from high plasticity clays (CH) tend to develop large cracks during the dryer months as the clay loses moisture and begins to shrink. These cracks may then serve as conduits to allow water from either rainfall or flood events to find its way down below the surface of the levee slope. Thus, levee constructed from CH materials have both a lower drained friction angle and a greater tendency to allow water to saturate the levee slope through shrinkage cracks.

For levee slopes where shallow slides have already developed, FS may be assumed to be 1.0. In the worst cases, the friction angle (φ') of the clay in the levee slope may be as low as 11°. Thus, the factor of safety for a levee slope with an existing shallow slide may be written as:

$$1.0 = \frac{\tan(11°)}{\tan(\beta_0)}$$

Where

β_0= The angle of the existing (pre-failure) levee slope

Based on Table 6.1b in EM 1110-2-1913, the required FS for a levee slope under Long Term (i.e. fully drained) loading is 1.4. So, in order to bring a 1V:3H (β_0 = 18.4°) levee slope with a FS of 1.0 up to the required FS of 1.4, we will need to flatten the slope (i.e. reduce β_0 down to β_1). Using the equation for the FS of an infinite slope, we can express this as:

$$1.4 - 1.0 = \frac{\tan(\varphi)}{\tan(\beta_1)} - \frac{\tan(\varphi)}{\tan(\beta_0)}$$

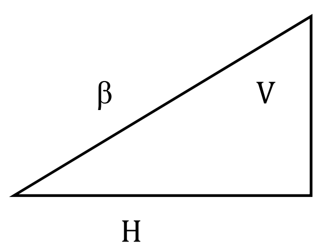
$$(1.4 - 1.0) = \frac{\tan(\varphi)\tan(\beta_0) - \tan(\varphi)\tan(\beta_1)}{\tan(\beta_1)\tan(\beta_0)}$$

$$(1.4 - 1.0)\tan(\beta_1)\tan(\beta_0) = \tan(\varphi)\tan(\beta_0) - \tan(\varphi)\tan(\beta_1)$$

$$(1.4 - 1.0)\tan(\beta_1)\tan(\beta_0) = \tan(\varphi)\left(\tan(\beta_0) - \tan(\beta_1)\right)$$

$$\frac{1.4 - 1.0}{\tan(\varphi)} = \frac{(\tan(\beta_0) - \tan(\beta_1))}{\tan(\beta_1)\tan(\beta_0)}$$

For any given slope, the angle of the slope, β, can be expressed as $\beta = tan^{-1}(\frac{V}{H})$ as shown in Figure 2 below:



Earthen slopes are frequently described in terms of their horizontal length per foot of vertical rise, such as 1V:3H. Therefore, assuming V = 1 ft, the expression can be simplified to $\beta = tan^{-1}(\frac{1}{H})$. Substituting this expression into the equation developed above yields:

$$\frac{1.4 - 1.0}{\tan(\varphi)} = \frac{\frac{1}{H_0} - \frac{1}{H_1}}{\frac{1}{H_1 - H_0}}$$

$$\frac{1.4 - 1.0}{\tan(\varphi)} = \frac{H_1 H_0}{H_0} - \frac{H_1 H_0}{H_1}$$

$$\frac{1.4 - 1.0}{\tan(\varphi)} = H_1 - H_0$$

Based on the infinite slope equation noted above, $tan\varphi$ = $tan\beta$ for any slope having a factor of safety of 1.0. Also, $tan\beta = \frac{1}{H_0}$ as shown above. Therefore, substituting this expression into the equation above yields:

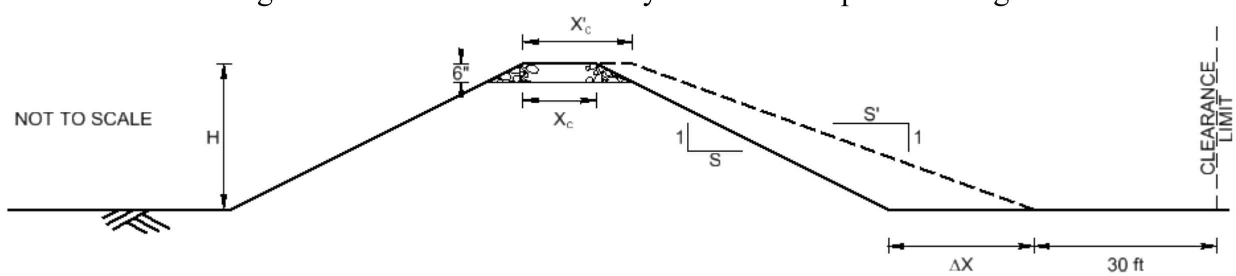
$$\frac{1.4 - 1.0}{\frac{1}{H_0}} = H_1 - H_0$$

Simplifying this equation yields a generalized relationship for the change in H required to increase the FS from 1.0 to some higher value of FS_{Req}:

$$FS_{Req} \times H_0 = H_1$$

For example, if a 1V:5H slope failed (i.e. reached FS = 1.0) and it was to be repaired and brought up to a FS of 1.4, the 1V:5H slope would need to be flattened out to 1V:7H. The Memphis District has observed persistent shallow slope failures in slopes as flat as 1V:5H. Therefore, to simplify the process of estimating the required footprint for the slope flattening projects included in this SEIS, it was assumed that the "H" value of every slope would be increased by 2. The levee height, H in Figure A4-8 below, was assumed to be 25 ft.

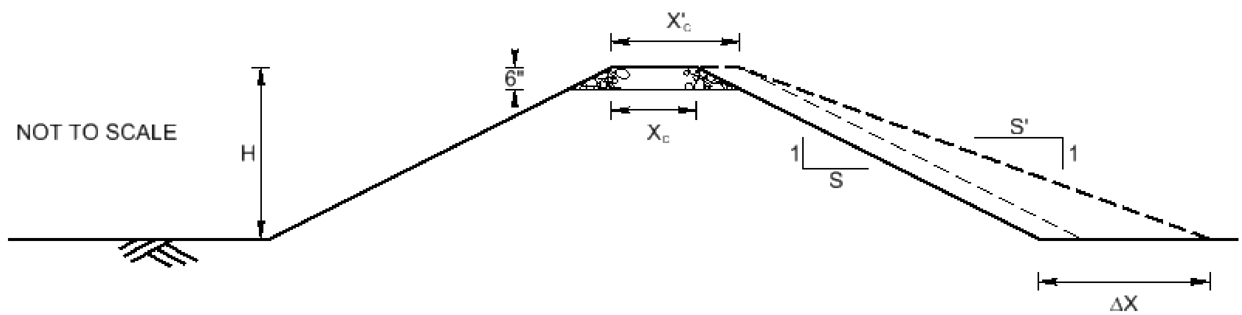
Figure A4-2. Assumed Geometry for Levee Slope Flattening



$$H = Height\ of\ Levee$$
$$\Delta X = Distance\ from\ Existing\ Toe\ to\ Proposed\ Toe$$
$$= (H)(S' - S) + (X'_C - X_C)$$
$$\leq 70\ ft\ in\ most\ cases$$
$$30\ ft = Haul\ Road + MAterial\ Processing + Staging$$

Based on these assumptions, the required footprint for a generic levee slope flattening project was estimated to be roughly a 100 ft wide strip along the levee toe for the entire length of the slope (measured parallel to the levee centerline). The earthwork and gravel quantities were estimated using the average end area method as shown below in Figure A4-9.

Figure A4-3. Estimated Earthwork Quantities for Levee Slope Flattening



$$A = H(X'_C - X_C) + \tfrac{1}{2}(H)[\Delta X - (X'_C - X_C)]$$

$$[Assume\ X'_C - X_C = 5ft\ \ and\ \ \Delta X \leq 70\ ft\ in\ most\ cases]$$

$$\therefore A = H(5\ ft) + \tfrac{1}{2}(H)(70\ ft - 5\ ft)$$

$$= H(5\ ft) + \tfrac{1}{2}H(65\ ft)$$

$$= (37.5ft)(H)$$

$$[Assume\ H = 25\ ft\ tall\ for\ all\ MVM\ levees]$$

$$\therefore A = (37.5\ ft)(25\ ft)$$

$$= 937.5\,\frac{ft^3}{ft}$$

$$= 35\frac{yd^3}{ft}\quad (Note\ that\ this\ is\ compacted\ yd^3)$$

$$Req'd\ \ Borrow = 35\frac{yd^3}{ft} \times 1.3\ for\ shrinkage\ and\ handling$$

$$Req'd\ Borrow = 45\frac{yd^3}{ft}$$

A4-3.3.4 Floodwalls

Urban areas typically require floodwalls rather than levees to reduce impacts to residences and businesses. These floodwalls can have stability concerns or height deficiencies that need to be addressed. There are 22 Work Items requiring floodwalls with grade deficiencies or in need of stabilization. 21 of these items are in the New Orleans District and 1 is in the Memphis District.

A4-3.3.4.1 Memphis District

The Cairo floodwall was the only floodwall project in the Memphis District. Because of the complexity and the tremendous uncertainty related to the scope of this project, a simple offset of 100 ft on either side of the floodwall was assumed for the footprint.

A4-3.3.4.2 New Orleans District

Assumptions for Floodwall construction in the New Orleans District are as follows.

- Floodwall Stability and Floodwall Overtopping assumed demolition of existing floodwall and construction of a new floodwall.

- Walls for overtopping deficiency:
    - Both T-walls and I-walls considered.
    - Replacement wall sections will be along the existing alignment – no shift.
    - All walls replaced with a T-wall section.
    - Piles were assumed to be 60-ft long based on past experience with other recent T-wall projects.

- Walls for stability deficiency:
    - Only I-walls considered.
    - Replacement wall sections will be along the existing alignment – no shift.
    - I-walls will not pass a Phase 3 assessment.
    - Quantities were prorated based on a replacement section at Dumaine Street construction project.

A4-3.3.5 Quantity Computations

The following sections discuss the general methodology in determining quantities for common items on the project specific quantity sheets that were used to generate the cost estimate for each work item. For sections that reference CADD or 3D modeling, Bentley's MicroStation and InRoads SelectSeries4 software suite was used.

A4-3.3.5.1 Earthwork Quantities

To determine earthwork quantities for the project features identified herein, three dimensional CADD modeling techniques were used. As the resulting earthwork volumes were used to determine necessary borrow area sizes and footprints, this was the first task that was pursued by the design team.

LiDAR data was first used to create a terrain model of the existing ground at the identified sites. In order to reduce the number of files and processing time in generating the existing surface models, an exclusive terrain model was not created for each site: multiple adjacent projects share an existing ground model.

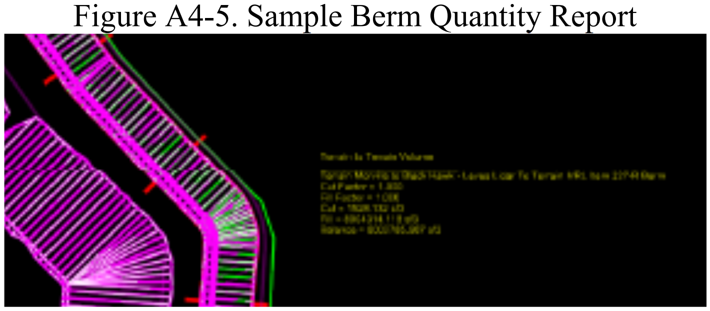
Levee enlargements were modeled using the roadway design tools in Bentley's InRoads SS4. It was assumed that all enlargements will be made on the riverside of the existing levee. Horizontal geometries for the new levee centerline were assumed by offsetting the existing centerline of the levee by 10’-15’. This value approximates the offset that would be required to meet the seep line design parameter of the MRL with a 1-2’ deficiency. Vertical geometries were developed by keying in the Refined 1973 MR&T Project Flood Flowline for each corresponding reach and adding 3’ to it to account for freeboard. A corridor was then created along the new centerline and the standard MRL riverside template was dropped at 20’ intervals to generate a 3D mesh. A standard overbuild of 0.7’ was assumed for all enlargements. Each corridor was examined to ensure that all design requirements were met, and quantity reports were generated. The resulting quantities are presented in cubic yards (CY) in the individual project quantity sheets. A sample corridor model cross section is shown below in Figure A4-10.

Figure A4-4. Sample Corridor Cross Section

This methodology results in a very precise volume calculation for levee enlargement material. However, it is likely that upon completion of final design surveys and additional effort on alignment optimization, the final enlargement quantity could be lower than the quantities shown herein.

Berms were modeled using similar procedures to the levee enlargements. Berm dimensions, crown elevations, slopes, and limits were provided to the civil modelers by the geotechnical designers. All berms were modeled using the dimensions provided against an existing ground surface pulled from LiDAR data. Quantity reports were generated using surface to surface triangle volumes as well. A sample berm quantity report is shown below in Figure A4-11.The quantities for the berms that were modeled is also very precise, but the validity of assumptions about berm dimensions and locations will likely result in large changes, both increases and decreases, to the quantities of berm material shown herein.

Figure A4-5. Sample Berm Quantity Report



A4-3.3.5.2 Access Ramps and Borrow Crossings
Locations and counts of access ramps were determined using aerial imagery and LiDAR contours where possible. A typical MRL access ramp contains between 2,000 and 3,000 CY of material, so an average of 2,500 CY per ramp was used for estimation purposes. Borrow area crossings were accounted for in a similar manner. If borrow access required fill placement across a low area, typically an existing borrow area, a standard crossing quantity of 10,000 CY was included for each crossing. Two 48" pipes were also included in the quantities if existing water was present at an identified crossing location.

A4-3.3.5.3 Relief Wells
Relief well locations, spacing, and quantities were estimated by the geotechnical members of the PDT using well spacing and specifications typically employed in each District.

A4-3.3.5.4 Ditch Excavation
If the levee enlargement or berms impacted adjacent local drainage ditching, new ditching was included in the quantity sheet. New drainage ditch alignments were laid out in CADD around the berm footprint and tying back into existing drainage. If relief wells were required, nearby drainage was identified that could carry the flow of the relief wells away from the levee, and an alignment was developed that connected the relief wells to said drainage. The lengths of each of these alignments were then measured, and a typical trapezoidal cross section was applied. The assumed ditch dimensions are provided with each excavation quantity in the quantity sheets.

A4-3.3.5.5 Proposed Borrow Area Footprints
Once required earthwork quantities were established for an enlargement and corresponding berms (if required), that material requirement was converted into an acreage sufficient to provide the required amount of borrow material. It was assumed that 8' of suitable material would be available in all proposed borrow areas, which equates to about 12,900 CY of material per AC. To account for losses due to clearing and grubbing, compaction, handling, unsuitable material discover, and site grading requirements, contingencies were added to each project's borrow requirement. Because some the aforementioned losses are fixed in size, larger contingencies were used on smaller projects, while smaller contingencies were used on larger projects. The selected contingencies range from 40% on projects with greater than 500,000 CY of embankment material to 100% on projects with less than 150,000 CY of embankment material. Once size requirements were finalized, locations were selected by the PDT with input from engineering, environmental, cultural resource, and regulatory PDT members. During future project design, the size and location of these borrow areas would be adjusted to adequately facilitate project construction and to incorporate landowner input or data obtained on-the-ground.

A4-3.3.5.6 Clearing and Grubbing Footprints
With completed footprints of the proposed levee enlargements, berms, and borrow areas, the PDT selected haul roads and made a combined footprint of the entire impacted area for each project. Aerial imagery was used to distinguish different areas within the impacted footprint that may require different types of clearing equipment and measured in CADD. Corresponding acreages are presented in the individual project quantity sheets.

A4-3.3.5.7 Turf Establishment
Footprints for turf establishment were determined by measuring the footprints of proposed embankment discussed in previous paragraphs using CADD.

A4-3.3.5.8 Silt Fence
The linear footage of silt fence for each project was determined by measuring the perimeter of the combined footprint, which included all haul roads and borrow areas. It is common for silt fence to not be required around the entire borrow area, but without a case by case assessment by state storm water control agencies, it is difficult to conclude which sites would require silt fence around the entire perimeter and which ones would only require it adjacent to embankment construction. Therefore, the more conservative number was used to estimate project costs.

A4-3.3.5.9 Stone Resurfacing
Stone surfacing quantities were determined by multiplying the centerline lengths for each enlargement project by the standard application rate for crushed stone surfacing: 0.49 TN/lf. This application rate assumes a 7” thick by 16’ wide application of crushed stone and a unit weight of stone of 105 pcf. Since existing gravel surfacing will also have to be removed and stockpiled, the linear footage of the enlargement was also provided in the quantity sheets. If ramps exist on the project that will require replacement and resurfacing, the same application rate was used with assumed length of 250’ per ramp.

A4-3.3.5.10 Demolition
All demolition items (structures, pavement, and abandoned utilities) shown in the quantity sheets were identified and measured using aerial imagery and CADD. Google’s Street View was also used in determining additional information about demolition items where possible.

A4-3.3.5.11 Cattle Guards
All cattle guard replacements used to develop construction cost estimates were identified using aerial imagery and Google’s Street View.

A4-4 REAL ESTATE REQUIREMENTS
A4-4.1 General
The estimated Real Estate requirements for the construction of the 143 proposed Work Items and future operation, maintenance, and repair are complex due to the various construction improvement methods identified within this SEIS II. The following sections discuss the assumptions and limiting conditions used in preparing the Real Estate cost estimates by each District.

A4-4.1.1 Memphis District
There are 35 proposed Work Items within the Memphis District. There are 7 Work Items to be located along the west bank of the Ohio River in Pulaski County, Illinois and Alexander County, Illinois. There are 6 Work Items to be located along the east bank of the Mississippi River in Fulton County, Kentucky, Lake and Dyer County, Tennessee. There are 22 items to be located along the west bank of the Mississippi River extending from Cape Girardeau County, Missouri south to Phillips County, Arkansas. The Work Items consist of raising the grade of the existing

MRL system to control overtopping at various locations; the installation of relief wells along with associated drainage works to control seepage at various locations; the replacement of an existing floodwall in Cairo, Illinois; the construction of a levee that would extend from an existing floodwall to tie-in to high ground in Hickman, Kentucky; and the flattening of the landside or riverside of existing levees in order to increase the base width of the levee at various locations.

It is estimated that 547.50 acres (total acreage to be acquired) of land outside of existing MR&T Project right-of-way will need to be acquired by the respective Non-Federal Sponsors for construction of the proposed Work Items and subsequent compensatory mitigation of unavoidable environmental losses. Of this total acreage to be acquired, 9.80 acres are located in Illinois, 0.40 acres in Kentucky, 365.30 acres in Tennessee, 78.40 acres in Missouri, and 93.60 acres in Arkansas. The real estate interest to be acquired will be perpetual easement. Mitigation lands to offset environmental losses will be acquired in fee title by USACE using a standard USACE estate and/or purchasing of credits from available mitigation banks. It is anticipated that acquisition of the permanent flood control easements to be acquired will impact approximately 43 total ownerships. Five of the ownerships are in Illinois, 2 in Kentucky, 12 in Tennessee, 10 in Missouri, and 14 in Arkansas. Acquisition of any and all real estate interest to accommodate construction of the Work Items and provided for future operation and maintenance requirements will be the full responsibility of the Non-Federal Sponsor at no cost to USACE. Rights-of-way requirements for the construction of each Work Item will be depicted on maps and forwarded by USACE to the Non-Federal Sponsors for their use in acquiring the necessary real estate interests.

Real Estate Cost Estimates for each separate Work Item have been prepared by USACE. Preparation of the each estimate was based on the following assumptions and limiting conditions: (a) acreages utilized for the preparation of each Work Item estimate were furnished by others and assumed reliable; (b) the number of ownerships impacted are only estimated and were determined by analyzing digital aerial imagery and noting fence lines, roads, and changes in land use patterns; (c) no acquisition of any additional real estate interest over the existing MR&T Project rights-of-way will be required; (d) the existing public road network in conjunction and any existing or newly acquired rights-of-way will be used to access the construction area of the Work Items; (e) property titles are assumed to have marketable title, free and clear of any or all liens or encumbrances; (f) no physical inspection of the MR&T Project lands to be acquired was performed. Inspection was made by visual analysis of most current available aerial imagery; (g) land and damage costs were not prepared in accordance with provisions found in either the Uniform Standards of Professional Appraisal Practice (USPAP) or Uniform Appraisal Standards for Federal Land Acquisition (UASFLA) and should not be construed to be an accurate appraisal to determine actual market value; (h) estimates are predicated on the assumption that there are no potential hazardous, toxic, or radiological waste materials located in the proposed lands to be acquired; (i) real estate rights-of-way and fee title acquisition costs are based on historical data along with prior knowledge and experiences in acquisitions of various MR&T Project levee improvements of the same nature and scope.

A4-4.1.2 Vicksburg District

There are 16 separate proposed Work Items within the MR&T Project jurisdiction of the Vicksburg District. There are 5 Work Items located in the state of Mississippi and 12 in the state of Louisiana. In Mississippi, there are 4 Work Item are located in Bolivar County and 1 Work Item is located in Warren County, Mississippi. The remaining 12 Work Items are located in Concordia Parish Louisiana. The Work Items range from MR&T Project berm construction and/or enlarging an existing berm to control seepage, levee raising, installation of relief wells to control seepage. Several Work Items consist of a combination of levee raising, berm construction and/or enlarging an existing berm, or installation of relief wells.

It is estimated that approximately 923 acres of land (total acreage to be acquired) outside of existing MR&T Project rights-of-way will need to be acquired by the respective Non-Federal Sponsors to accommodate construction of the Work Items and mitigation of environmental losses. Of this total acreage to be acquired, 224 acres are located in Mississippi and 699 acres in Louisiana. The principal real estate interest to be acquired will be perpetual flood control easement using a USACE standard estate. Approximately 49 acres of temporary rights-of-way will be required for Work Item construction and a standard USACE estate will be used by the Non-Federal Sponsor for acquisition of these temporary easement rights. Mitigation lands to offset environmental losses will be acquired in fee title by USACE using a standard USACE estate and/or purchasing of credits from available mitigation banks. It is anticipated that acquisition of the easements to be acquired will impact approximately 15 ownerships in Mississippi and 35 in Louisiana. Acquisition of any and all real estate interests to accommodate Work Item construction and provided for future operation and maintenance requirements will be the full responsibility of the Non-Federal Sponsor at no cost to USACE. Right-of-way requirements for construction of each Work Item will be depicted on maps and forwarded by USACE to the Non-Federal Sponsors for their use in acquiring the necessary real estate interests.

Real Estate Cost Estimates for each separate Work Item have been prepared by USACE. Preparation of the each Work Item estimate was based on the following assumptions and limiting conditions: (a) mapping utilized in calculating acreages and estimating the number of impacted ownerships were furnished by others and assumed reliable; (b) ownership information, notable real property improvements, and existing levee rights-of-way were developed from available online sources, tax maps, digital aerial imagery, quadrangle maps and are only estimated; (c) no acquisition of any additional real estate interest over the existing levee rights-of-way will be required; (d) access to and within the project items will be by the use of the public road network in conjunction with any existing or newly acquired rights-of-way; (e) property titles are assumed marketable, free and clear of any or all liens or encumbrances; (f) no physical inspection of the project lands was performed. Inspection was made by visual analysis of most current available aerial imagery; (g) land and damage cost were not prepared in accordance with provisions found in either the Uniform Standards of Professional Appraisal Practice (USPAP) or Uniform Appraisal Standards for Federal Land Acquisition (UASFLA) and should not be construed to be an accurate appraisal to determine actual market value; (h) estimates are predicated on the assumption that there are no potential hazardous, toxic, or radiological waste materials located in the proposed rights-of-way; (i) real estate rights-of-way acquisition costs are based on historical data along with prior knowledge and experiences in acquisitions of various levee improvement of the same nature and scope.

A4-4.1.3 New Orleans District

Assumptions and Limiting Conditions under which the Real Estate cost estimates for the proposed Work Items within the New Orleans District were prepared are as follows:

There are 92 Work Items within the jurisdiction of the New Orleans District, located in 13 Parishes across the state of Louisiana. The Work Items consist of raising the grade of the existing MRL system to control overtopping at various locations, replacing existing floodwalls at various locations; the installation of relief wells along with associated drainage works to control seepage at various locations. Maps and acreages that are included in this DSEIS2 were furnished by USACE, Engineering Division at the New Orleans District.

It is estimated that a total of 333 acres of additional perpetual right of way and 26.5 acres of Temporary Work Area Easement outside of the existing MR&T Project rights-of-way will need to be acquired by various Non-Federal Sponsors for construction of the work items. The New Orleans District estimated the perpetual flood protection levee easements would be required from approximately 1,509 landowners and a standard temporary work area easement would be required from approximately 60 landowners. Mitigation lands to offset environmental losses will be acquired in Fee, Excluding Oil and Gas (USACE approved standard estate) and/or purchasing of credits from available mitigation banks.

Real Estate Cost Estimates for each separate Work Item have been prepared by USACE and are based on the following assumptions and limiting conditions: (a) mapping and acreages utilized in preparation of each work item estimate were furnished by others and assumed reliable; (b) the number of ownerships impacted are estimated using digital aerial imagery, online assessor data (where available) and noting apparent ownership boundaries marked by fences, roads and changes in land use; (c) no acquisition of any real estate interest over the existing levee rights-of-way will be required; (d) the existing public road network in conjunction and any existing or newly acquired rights-of-way will be used to access the construction of the work items; (e) title to the property required for the project is assumed to be marketable, and the property is appraised free and clear of all liens and encumbrances; (f) no physical inspection of the MR&T project lands to be acquired was performed; (g) it is assumed that all land required for the project is free of hazardous, toxic and/or radioactive waste; (h) it is assumed that all work along existing floodwalls in the New Orleans area will avoid major improvements, and no relocations of businesses will be required.

A4-5 COST ENGINEERING

A4-5.1 General Assumptions

The following assumptions were agreed upon by the PDT to develop a comprehensive cost estimate for the 143 work items and associated compensatory mitigation activities proposed in SEIS II.

- Annual funding will be estimated at $35M to the MRL Program. That funding will be divided as follows: $22.5M for the New Orleans District, $6.25M each for the Vicksburg and Memphis Districts.
- For project scheduling purposes, a standard time of 18 months will be assumed to complete design, real estate acquisition, and relocation portions of projects. Construction durations will vary by project.

- Work item naming will be correlated with adjacent river miles. For work items whose total costs exceed projected annual funding allotments, the river mile will be used with numerical sub-item naming utilized to specify individual items within the parent project item (i.e. Item 500-L Phase 1, etc.).
- All three (3) Districts estimated their individual E&D and S&A percentages independently. Based on the findings from each district, it was agreed upon that 25% would be used for E&D and 15% would be used for S&A for the project.

A4-5.2 General Estimate Notes (For Construction Accounts

As described in Section 4.3, proposed project designs and quantity computations were generated using various assumptions and on-hand data. Cost estimates have been generated for these proposed work items, and were derived using historical bid unit prices, cost book items, quotes, detailed calculations, crew-based unit pricing, etc. Since the majority of the features involved earthwork, and haul distances were the main variable, M2 crews were built to produce unit costs for several haul distances, using the latest version of MCACES (version 4.3), with appropriate contractor overheads applied.

Quantities for embankment and other major bid items were furnished by the Geotechnical, Structural, and Civil design team members. Other quantities were computed by the cost engineer, using spreadsheets and the design data furnished.

- Memphis District Notes:
  - Levee work (grade raises & slope flattening:
    - Mobilization & demobilization were entered as a lump sum, which varied, depending on the size of the job. Environmental protection and Silt fence were included in each estimate, as well as aggregate surfacing for the levee roadways, and turfing for the levee embankment.
    - Borrow area clearing - Based on google earth images, the area to be cleared appears to be only grass or fields. However, since borrow area locations are not finalized, and some access roads may need clearing, it was assumed 25% of the borrow area may need medium clearing.
    - Embankment – Borrow area was assumed to need unwatering. Haul distances were estimated by using the EIS GIS Maps furnished for this study (website), put together by MVD.
  - Relief Wells:
    - The number of these were computed based on an average well spacing of 200'. The cost per well was based on historical pricing (escalated using CWCCIS factors) in MVM, and includes ditching and all associated work w/ a well job. The total cost for the wells is probably conservative, because seldom is an entire study reach required to have wells.
  - Flood Walls:
    - Only 1 floodwall was in the MVM boundaries, and it was broken up into 3 contracts, due to assumed funding limitations. The Cairo Floodwall was estimated in June 2018, w/ very limited design data. That estimate was then escalated, and an additional cost added, in case the need for some type of deep

foundation work was determined once detailed geotechnical information was available. The additional cost was over $1500 / LF of floodwall. It was assumed the old floodwall would be demolished. See file, FLOODWALL CAIRO, CT for additional information.

  - General Estimate Notes:
    - Labor rates used for work in MO, IL, and KY were union rates, while those in AR and TN were what we refer to as “Valley” rates. Union rates are the published Davis Bacon rates for those states, and are higher than the “Valley” rates which are usually based on typical contractor wages paid in those states. Union rates were taken from a recent job in MO, since that is where most of our “Union” work is done in this estimate. “Valley” rates were made to match MVK rates, since they were real similar to ours anyway.
    - Fuel rates used were those for MO average at the time of the estimate.
    - The Arkansas payroll taxes and insurance provided within the M2 software was used in the cost estimate, since AR had the most jobs in it.
    - A total markup of about 31% was used for the Contractor’s Overheads. This includes field office overhead, home office, profit, and bond (applied in that order). A typical earthwork general contractor was assumed to do most of this work, and 12% was used here to cover supervision, surveys, and miscellaneous costs. Home office percent was set at 9%. Profit was set at 9%, and bond was set at 1%. Subcontractor’s markups were the same, w/ the exception of bond, which was 0%, since we don’t require the subcontractors to bond.
    - The project covers parts of 5 states, so an average sales tax rate was used of 8%.

- Vicksburg District Notes:
  - Levee work (grade raises & seepage berms):
    - Mobilization & demobilization were calculated by estimating the actual contractor’s cost to haul the equipment, set it up, and remove from the site.
    - Borrow area clearing - Based on google earth images, the area to be cleared was determined to be grass/ fields or wooded areas to determine the amount of clearing/grubbing work required. In addition, where clearing and grubbing was required for levees and berms, topsoil and organic material was removed and hauled to the borrow area.
    - Embankment – Borrow areas were assumed to need dewatering. Haul distances were estimated by using aerial imagery. Generally the operation at the borrow area controlled the operation and hauling and spreading the material was modified to match this production rate. The main difference on each site was the number of trucks in the hauling crews to maintain the excavation production rate.
  - Relief Wells:
    - The number of relief wells was computed based on an average well spacing of 200’. The cost per well was calculated by using historical knowledge to estimate the equipment, labor and materials need to construct a typical 100’ deep well.
  - General Estimate Notes:
    - Labor rates used for work in MS and LA were derived from US Department of Labor Wage Determinations in these states and Wage Determinations from past contracts. Labor rates in these states are essentially the same.

        - The payroll taxes and insurance provided within the M2 software was used in the cost estimate.
        - Mark ups varied slightly because Job Office Overhead was estimated for each prime contractor using estimated durations and cost. Job office overhead, home office overhead, profit, bond and Mississippi contractor's tax, where applicable, were applied in that order. A typical earthwork general contractor was assumed to do most of this work. Home office percent was set at 9%. Profit was set at 9% and bond was set at 1%. Subcontractor's markups were the same, w/ the exception of bond, which was 0%, since we don't require the subcontractors to bond.
        - MVK has work items in Louisiana and Mississippi, so an average sales tax rate of 9% Louisiana. In Mississippi contractors do not have to pay sales tax on federal jobs but must pay a contractor's tax on the total contract of 3.5%.

- New Orleans District Notes:
    - Properties:
        - Latest Labor template was used.
        - Latest Equipment template was used. MII Equipment 2018 Region 03. Change back to 2016.
        - Latest Cost Book was used. 2016 MII English Cost Book
        - Average of Fuel Prices Quotes for the last year.
        - CMR: 2.125
        - Sales Tax: 9%

    - Markups:
        - Field Office Overhead was calculated by taking the average of relevant MRL jobs.
        - Home Office Overhead was assumed to be 9%.
        - Profit was assume to be 9%.
        - Bond was assume to be 1%.
        - Subcontractor was assumed to be 15%.
        - Overtime: Assume a 6 day work week with a 10 hour day.

    - Mobilization:
        - The mobilization and demobilization cost is assume to be 5% of the cost of prime.
        - The mobilization and demobilization will be calculated per contract.

    - Borrow Area Development:
        - Borrow areas were assumed to have a 15' depth
        - Borrow areas were assumed to have a waste depth of 2'.
        - Borrow areas were assumed to have light and heavy clearing and grubbing. Light clearing and grubbing quantity was assumed to occur on 75% of the total borrow area acres. Heavy clearing and grubbing was assumed to occur on 25% of the total borrow area acres.
        - Access roads were assumed to be 0.5 mile long and 20' wide.

- It was assumed that some light clearing would be needed in order to construct the access road.
- The quantity unit of measure is bank cubic yards. A 1.25 multiplier was added to the in-place quantity.

- Embankment, Compacted Fill:
  - The haul distance was assumed to be an average of 10 miles. The unit of measure for the haul item is Loose Cubic Yards. A 1.5 multiplier was added to the in-place quantity.
  - A standard protection rate of 125 Cy/hr was used.
  - 2 Truck wash down rack were assumed to be needed.
  - Standard testing will be done to embankment material.
  - Production Rate Adjustment: Most levee reaches are relatively short. Since the reaches are short and the CY quantity is low, the production will be lowered from average production used throughout estimate. Embankment material will be placed in layers called lifts, and tests of individual lifts which can take a few days. Due to these circumstances, production rate was lowered.

- Silt Fence:
  - Price quote was sought from contractors within the last year. The price is an install price.

- Clearing and Grubbing:
  - The clearing and grubbing was assumed to be light. The production rate that was used is a standard rate.

- Fertilizing, Seeding, and Mulching:
  - Fertilizing, Seeding and Mulching: Price quote was sought from contractors within the last year. The price is an install price.
  - Assumed that Lime and Sulfur Soil Amendment are needed. Lime Soil Amendment quantity was calculated multiplying the AC quantity by 1. Sulfur Soil Amendment quantity was calculated multiplying the AC quantity by .5. Units will be in Tons. Fertilizing will multiply the quantity AC by 300. Units will be lbs.

- Roadway:
  - Road way is 35' wide and projects with roadways would involve demo of existing roadway and placement of prime coat, 4-in Type B asphalt, tack coat, and 2-in Type A asphalt. Sand and Aggregate were assumed to by 1' each base.

- Floodwall:
  - MVN Structures Section provided the Dumaine St. Floodwall job that was done in 2017 as a Floodwall Template. The length of Pipe Piles, Sheet piles and the dimensions of Stem, Base Slab, and Stabilization slab were taken from this job. Concrete Material price was taken from historical data. Sheet piles and Pipe Piles material prices was taken from historical data.

- To find which jobs required Concrete Slope Pavement, structures provided the as built drawing. Quantities was calculated between google earth and as built drawings. If an as-built drawing did not have slope pavement, then it was not included in the project. Concrete Material price was taken from historical data.
- Traffic Control was added as needed.

A4-5.3 Scope of Work

The 143 proposed work items consist of seepage berms, relief wells, floodwalls, levee grade raises, and levee slope stabilization (slope flattening). Estimates of the scope of work and quantities required were generated using the protocols described in Sections A4-4.3. For a detailed description of each item of work, see Appendix 1 of the SEIS II.

A4-5.4 Contingencies and Escalation

Contingencies were computed using the Standard Risk Analysis (ARA) template, by a member of the Cost MCX recently. The PDT met on Jan 28 - 29, 2020 to discuss and fill out the risk register. See Section 4.5.8 of this report) for the Risk Report and Results of the Risk Analysis.

No escalation was applied in the supporting M2 estimates, only in the TPCS tables, which uses the EM 1110-2-1304, Civil Works Construction Cost Index System factors.

A4-5.5 Cost Account Notes (Non-Construction)

01 Lands and Damages Feature - Real Estate Division provided information for this feature. Section A4-4.4 outlines how this information was derived.

02 Relocations Feature - Relocations were primarily roadways and utilities. Roadway paving was assumed for levee reaches that required a grade raise where an existing paved road sits atop the levee. In MVM, utility relocations were estimated as a percent of construction cost, since underground utilities are not visible on aerial photography, and the exact extent of the work is not known at this time. This should be conservative, since levee grade raise's and slope flattening's probably won't disturb most existing underground utilities. In MVK and MVN relocations were estimated by an initial assessment of existing utilities and estimating required relocations cost. These cost were estimated using historical costs.

06 Fish and Wildlife Facilities – this cost was provided by USACE biologists and represents the anticipated costs of implementing the proposed compensatory mitigation plan detailed in Appendix 20 of SEIS II.

11 Levees and Floodwalls – see Section A4-4.5.2 for general construction assumptions.

30 Planning Engineering & Design (PED) - The estimated cost for this account is 25% percent of the total construction costs, as is typical for these type projects. Since many of these contracts are similar, the rate should be fairly low.

31 Construction Management - Construction management costs are for the supervision and administration of a contract and include project management and contract administration costs. The estimated cost for this account is 15 percent of the total construction costs as is typical for these type projects. Again, this was the rate provided by the senior PM for this project.

A4-5.6 Schedule

The project schedule will cover the lifecycle phases of the plan (Planning Phase, Pre-construction Engineering and Design (PED) Phase, and the Construction Phase). The PDT assumed there would be limitations on annual Federal funding, and this is what dictated the schedule. While many reaches could be built in a year, Real Estate, Relocations, and Planning Engineering & Design, would occur before construction begins, for each contract. After the PDT decided a schedule for the proposed work, the midpoint of that time span was chosen (for escalation purposes, in TPCS), and the prerequisite activities were assumed to be done 1 or 2 years before that, for each construction contract. See TPCS for actual midpoints for each feature.

The TPCS has been computed in order to provide cost to the non-federal sponsor for each respective district based on the proposed Work Items within the districts. These summaries display incremental costs. The TPCS was developed on March 31, 2020 and includes the estimated costs, constant dollar costs and fully funded costs through project completion. This estimate supports the project scope and schedule developed in this report. The estimated total project cost for the recommended activities presented in the appendix is $8,949,504,000. The TPCS for each of the estimates prepared are presented in Section 4.5.9.

A4-5.7 References

References used in the development of the cost estimate and this section of the appendix, are as follows:

- Cost Engineering Regulations/Guidance:

ER 1110-1-1300	26 Mar 93	Engineering and Design Cost Engineering Policy
ER 1110-2-1302	06 Jun 16	Civil Works Cost Engineering
EM 1110-2-6058	30 Sep 17	Civil Works Cost Engineering Manual (Draft)

Cost Engineering Support for Smart Planning webinar (3 Apr 2014)

- Planning/Design Regulations:

ER 1105-2-100	22 Apr 00	Planning Guidance Notebook
ER 1110-2-1150	31 Aug 99	E & D for Civil Works Projects

A4-5.8 Risk Analysis for Cost Estimate

				Project Cost			Project Schedule			Other Information				Cost Model: COST			Schedule Model: Schedule Model			Cost due to Schedule Risk: Cost From Schedule			TOTAL Cost			TOTAL Schedule			
CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Likelihood ©	Impact ©	Risk Level ©	Likelihood (S)	Impact (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Responsibility/ POC	Affected Project Component	Low Variance (Min)	Likely (C)	High Variance (80%H)	Low Variance (S) (Min)	Likely (S)	High Variance (S) (80%H)	Low Variance (CS) (Min)	Likely Added Cost (CS)	High Variance (CS) (80%H)	Event Prob (PC)	Event Prob (PCS)	Simulated Cost (C) + (CS)	Event Prob (PS)	Simulated Sched (S)	Risk Quantification Discussions	Suggested Risk Reduction Measures
Organizational and Project Management Risks (PM)																													
PM1	Mississippi River Tributaries Project Levee Deficiency Issues	Project includes some 143 work items from Cape Girardeau to Gulf	Mitigations include grade deficiency, seepage control (berms or relief wells), slope flattening (scour prevention and slides), floodwall stability and environmental compensatory mitigation. Combined project between 3 districts (Memphis, Vicksburg and New Orleans).	Unlikely	Negligible	Low	Very Likely	Negligible	Low	Triangular	Triangular												100%	100%	$0	100%	0 Mo		
PM2	Supplemental Environmental Impact Statement	Purpose of this Study is for development of the overall Environmental Impact Statement and public input in the process.	This is Supplement Number 2 for the Mississippi River Levees Project. If individual projects are outside the EIS individual NEPA will be developed for specific project. An economic evaluation is not required as part of this study. A detailed cost estimate is requested to provide for Congressional Information and budgetary purposes. The MRL program does not have a 902 funding limit	Unlikely	Negligible	Low	Very Likely	Negligible	Low	Triangular	Triangular												100%	100%	$0	100%	0 Mo		
PM3	Staffing	MRL Projects are a priority for the districts.	Districts have shared workload with other districts or with A/E support for assistance to meet accelerated schedules. Overall resources have been available and staffing has not been a risk concern.	Unlikely	Negligible	Low	Very Likely	Negligible	Low	Triangular	Triangular												100%	100%	$0	100%	0 Mo		
PM4	Accelerated Schedules	2018 supplemental funding did accelerate several project schedules.	In general out year FY budget allows for sufficient time to plan and staff accordingly. Overall low risk.	Unlikely	Negligible	Low	Very Likely	Negligible	Low	Triangular	Triangular												100%	100%	$0	100%	0 Mo		
PM5	Staff Turnover	Staff turnover over the next 50years plus is guaranteed.	Turnover is likely to cause inefficiencies and result in lost institutional knowledge. Marginal cost growth over the next 50years is likely due to that inefficiency, re-learning of lessons and lost knowledge.	Very Likely	Negligible	Low	Very Likely	Negligible	Low	Triangular	Triangular												100%	100%	$0	100%	0 Mo		
PM6	Timeliness of Review	Projects undergone several iterations of review (IEPR, ATR, etc.).	Project schedules lay out review requirements and are not a schedule risk.	Unlikely	Negligible	Low	Very Likely	Negligible	Low														100%	100%	$0	100%	0 Mo		
PM7	Established Project	The MRL program has been in operation for the last 50 plus years (post 1973 flood).	Project is well developed and pitfalls are know and work arounds developed. Overall project cycle is well understood as long as wholesale staff turnover is not experienced.	Unlikely	Negligible	Low	Very Likely	Negligible	Low														100%	100%	$0	100%	0 Mo		
PM8				Unlikely	Negligible	Low	Very Likely	Negligible	Low														100%	100%	$0	100%	0 Mo		
Contract Acquisition Risks (CA)																													
CA1	MATOC	A limited pool of qualified contractors has lead to regional MRL MATOCs.	MATOC's insure qualified contractors potentially limiting cost competition. Current baseline cost estimate do not completely capture MATOC contracting acquisition strategy. Risks CA1 and CA2 are mutually exclusive.	Likely	Significant	High	Unlikely	Negligible	Low	Triangular				$0	$0	$50,147,050							100%	100%	$0	100%	0 Mo	Assume Worst Case (WC) 5% construction cost increase due to limited MATOC design competition.	
CA2	Small Business and 8(a) Contracting	Much of the MRL program is executed thru Small Business set asides.	Baseline estimates assume full and open pricing and do not reflect Small Business inefficiencies. Small Business goals are typically 25%. Assume similar goals for this project with 10% to 20% cost increase on those small business contracts. Risks CA1 and CA2 are mutually exclusive.	Very Likely	Significant	High	Unlikely	Negligible	Low	Uniform				$5,014,705	$0	$15,044,115							100%	100%	$0	100%	0 Mo	Baseline estimate subcontracting support runs between 5% and 15%. Assume Best Case(BC) 5% additional subcontracting at 10% premium for Small Business Goals. Assume WC 10% additional subcontracting at 15% additional cost.	
CA3	Design Build	Levee and Floodwall work is not typically Design Build.	Design Build is not likely to provide benefits for this type of project. Design Build is unlikely.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
CA4				Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
General Technical Risks (TR)																													
TR1	Design Criteria	All designs incorporate current design requirements.	Currently no pending design criteria changes are known.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
TR2	Level of Design - Floodwalls	Floodwall design is highly conceptual.	Floodwall design was based on a cross section based on typical cross section dependent on height. Limited design refinement and overall MODERATE cost risk. Memphis floodwall in Cairo has changed from a gravity wall to an inverted "T" with additional real estate requirement. Ground improvements and deep foundations are also assumed required. Utility Relocations and temporary flood protection prove problematic. District have experience with temporary flood protection. New Orleans will replace deficient floodwall with new higher floodwall. HESCO basket temporary protection will be deployed as needed during construction.	Likely	Moderate	Medium	Possible	Significant	Medium	Uniform	Uniform			-$4,839,540	$0	$12,098,850	12 Months	0 Months	24 Months	$1,079,515	$0	$2,159,030	100%	100%	$0	100%	0 Mo	Assume BC -2% Cost savings for MVM and MVK floodwalls and WC 5% Cost increase for MVM and MVK floodwalls. Assume 12 - 24 month schedule impacts for design development delays with PED cost impacts	
TR3	Level of Design - I-Wall	New Orleans I-Wall assumes in place replacement	I-Walls will be replaced with T-Wall that will require additional real estate which may prove especially difficult in the French Quarter. Site constraints and utility relocations would likely result in HIGH cost risk. HESCO basket temporary protection will be deployed as needed during construction.	Likely	Significant	High	Very Likely	Significant	High	Uniform	Uniform			$12,502,920	$0	$31,257,300	12 Months	0 Months	36 Months	$2,788,920	$0	$8,366,760	100%	100%	$0	100%	0 Mo	Assume BC 2% Cost savings for MVN floodwalls and WC 5% Cost increase for MVN floodwalls. Assume 12 - 36 month schedule impacts for design development delays with PED cost impacts	

				Project Cost			Project Schedule			Other Information				Cost Model: COST			Schedule Model: Schedule Model			Cost due to Schedule Risk: Cost From Schedule			TOTAL Cost			TOTAL Schedule			
CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Likelihood ©	Impact ©	Risk Level ©	Likelihood (S)	Impact (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Responsibility/ POC	Affected Project Component	Low Variance (Min)	Likely (C)	High Variance (80%H)	Low Variance (S) (Min)	Likely (S)	High Variance (S) (80%H)	Low Variance (CS) (Min)	Likely Added Cost (CS)	High Variance (CS) (80%H)	Event Prob (PC)	Event Prob (PCS)	Simulated Cost (C) + (CS)	Event Prob (PS)	Simulated Sched (S)	Risk Quantification Discussions	Suggested Risk Reduction Measures
TR4	Level of Design - Grade Deficiency	Grade Deficiency will require increases in height (while maintaining side slopes).	Cross sections have been developed for the grade deficiencies. Limited number of cross sections have been developed but geography is fairly flat. Overall design General Technical Risk for Deficiency is LOW.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
TR5	Level of Design - Slope Flattening	Stability and or scour issues to be addressed by slope flattening, an increase in width only.	Cross section is dependent on soil strength of specific reaches. Until local borings and lab results are complete and updated stability analysis run, cross section uncertainty remains. Slope flattening has been assumed for long reaches and is likely overstated. Design refinement will likely eliminate reaches requiring work. Overall LOW cost risk due to design conservatism. Schedule Risk of cummulative 12month delay with associated PED.	Likely	Negligible	Low	Possible	Moderate	Medium								0 Months	0 Months	12 Months	$0	$0	$4,474,351	100%	100%	$0	100%	0 Mo	Schedule Risk of cummulative 12month delay with associated PED.	
TR6	Level of Design - Seepage Control	Berms and Relief wells for seepage control.	Memphis district has assumed all relief wells due to availability of real estate. Berms were preferred for Vicksburg and New Orleans with Relief wells only where berms were not practical. Berm sizes and relief wells will be highly dependent on local geology. Until that testing data design is likely to change. Vicksburg has thought design to be worst case were included but additional areas may be discovered. Overall New Orleans and Vicksburg feel cost neutral, Memphis is likely worst case (conservative assumptions).	Likely	Marginal	Medium	Unlikely	Negligible	Low	Triangular				-$2,716,360	$0	$2,716,360							100%	100%	$0	100%	0 Mo	Assume +/- 2% cost variation for all other features.	
TR5				Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
TR6				Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
Civil/Site Design (CV)																													
CV1	Borrow Material	New Orleans assumed haul locations have been assumed (10mile haul distances). Memphis and Vicksburg attempted to find suitable borrow sites and base design/estimate around those assumptions.	Suitability of borrow material may be in question requiring either additional acreage and mitigation. MVN Historically has operated successfully obtaining borrow through GF or NFS provided borrow areas. NFS is responsible for borrow as part of LERRDS.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
CV2	Utility Relocations	Timeliness of utility relocations has proved troublesome in the past.	USACE has limited control of the process. **Utility relocations must be begun years in advance.** Road relocations are particularly problematic and each are unique. County/Parish versus State relocations are all unique. Typically the state or county/parish will relocate with USACE reimbursement. Utility relocations may impact individual contracts but flexibility in funding between projects allows overall MRL program schedule to continue. New Orleans has identified all known utilities and accounted for relocations cost as best practical. Overall Cost Risk is Moderate (say +5% cost increase for all other costs). Schedules could be delayed cummulatively 12months waiting for relocations.	Possible	Moderate	Medium	Possible	Moderate	Medium	Triangular	Triangular			$0	$0	$5,790,900	0 Months	0 Months	12 Months				100%	100%	$0	100%	0 Mo	Assume WC 5% increase to all Non-Floodwall construction costs and 12months schedule delay.	
CV3	Unknown Utilities	Most construction will in be in existing alignments. Unknown utilities are fairly uncommon.	If significant unknown utilities are located windows are typically left open and finished later after construction. Minor utilities are relocated during construction. PDT feels risk is LOW.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
CV4	Railroad	Railroad runs parallel with Floodwall for many reaches in New Orleans and Cairo.	Working with the Railroad can be difficult. Cost growth and schedule delays are frequent. USACE estimate attempts to include inefficacies due to interactions with the railroad.	Very Likely	Moderate	High	Very Likely	Moderate	High	Triangular	Triangular			$0	$0	$43,356,150	0 Months	0 Months	12 Months	$0	$0	$3,868,435	100%	100%	$0	100%	0 Mo	Assume WC 5% increase to Floodwall construction costs and 12months schedule delay with PED costs due to RR delays.	
CV5				Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
Structural (SD)																													
SD1	Floodwall Designs	General cross sections have been assumed, detailed foundation structural designs have not been incorporated.	Greatest cost uncertainty is with foundation changes. Cross sections are based on structural designs that have been utilized elsewhere on the MRL. Overall structural design is at a conceptual level, design refinements and development are likely to result in MODERATE cost risk. NOT MODELED. RISK MODELED IN TR2 - LEVEL OF DESIGN FLOODWALLS	Likely	Moderate	Medium	Possible	Significant	Medium														100%	100%	$0	100%	0 Mo		

				Project Cost			Project Schedule			Other Information				Cost Model: COST			Schedule Model: Schedule Model			Cost due to Schedule Risk: Cost From Schedule			TOTAL Cost			TOTAL Schedule			
CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Likelihood (C)	Impact (C)	Risk Level (C)	Likelihood (S)	Impact (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Responsibility/ POC	Affected Project Component	Low Variance (Min)	Likely (C)	High Variance (80%H)	Low Variance (S) (Min)	Likely (S)	High Variance (S) (80%H)	Low Variance (CS) (Min)	Likely Added Cost (CS)	High Variance (CS) (80%H)	Event Prob (PC)	Event Prob (PCS)	Simulated Cost (C) + (CS)	Event Prob (PS)	Simulated Sched (S)	Risk Quantification Discussions	Suggested Risk Reduction Measures
SD2				Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
Hydraulics and Hydrology																													
~~HH1~~	Flowline	Project is using authorized 1973 flow line for H&H purposes.	A draft flow line assessment was done but updated numbers have not been approved. This is a CRITICAL ASSUMPTION and is not modeled.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
HH2	Hurricane Conditions	MRL is only authorized for riverine protection.	Hurricane conditions are outside the bounds of the MRL study and not included here.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
HH3	Sea Level Rise	Sea Level Rise was not included in 1973 flow line.	MRL Study has focused only on original 1973 as authorized. Study raise due to sea level rise is outside the scope of this authorization and not considered. This is a CRITICAL ASSUMPTION and is not modeled.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
Lands and Damages (LD)																													
LD1	New Orleans	Some 76 sites have been identified for right of way and borrow site locations with 1,500 ownerships	Some variations in the footprint are to be expected. MVN opinion is current footprint is worst case. Increase in acreage is unlikely.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
LD2	Memphis	Real Estate includes property acquisitions for berms, borrow, relief wells and access.	Memphis has laid out the limits of potential right-of-ways. Some variations in footprint are expected (50 ft for levee raises and 100 ft for slope flattening) but MVM has thought extents are worst case. In spite of variations overall cost and schedule risks are LOW.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
LD3	Vicksburg	Real Estate includes property acquisitions for berms, borrow, relief wells and access.	Vicksburg has laid out the limits of potential right-of-ways. Some variations in footprint are expected but MVK has thought extents are worst case. In spite of variations overall cost risk is LOW.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
LD4	Property Acquisitions	Expanded footprint of existing right-of-way is not likely large concern, borrow areas and floodwall acres could be problematic.	Floodwall real estate acquisition in urban areas and with railroad proximity could be difficult. Local sponsors strengths and weaknesses are well understood. Sufficient time and assistance are available for less capable sponsors. MVN may have some schedule impacts, MVK sponsors are very capable, MVM sponsors are also very capable. Overall program schedule is MEDIUM risk.	Unlikely	Negligible	Low	Likely	Moderate	Medium		Triangular						0 Months	0 Months	24 Months	$0	$0	$2,788,920	100%	100%	$0	100%	0 Mo	Assume WC Schedule could be delayed 24months for Property Acquistion with 50% monthly PED during delay	
LD5				Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
Regulatory Environmental Risks (RG)																													
RG1	Programmatic Agreement	An overall literature search is being conducted for the entire areas. A programmatic agreement will lay out how surveys will be developed and what to do if resources are encountered during construction.	Coordination had been handled project by project. Programmatic agreement should allow for more efficient coordination between USACE, States and Tribes.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
RG2	Cultural Resources	Most of the construction will be in the existing footprint, borrow areas will be more likely to encounter resources.	Cultural surveys will be conducted once footprints and access / staging areas have been defined. Programmatic agreement with the SEIS will lay out the process if resources are discovered. Primarily risk would be to schedule to allow time for surveys and proper documentation (if required). Efforts will be made to avoid cultural impacts.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
RG3	Archeological Sites and Standing Structures	Most Standing Structures are known. Archeological sites are likely not known.	Historic sites previously "capped" by existing levee are likely to be encountered with this MRL. Overall Memphis and Vicksburg have been able avoid sites. In New Orleans it's likely archeological sites will be encountered. If eligible sites are encountered additional cost and schedule for site documentation and mitigation. Flexibility in MRL schedule would individual sites to be shuffled to allow time for individual site surveys to be completed. Highly likely for floodwalls in urban areas. Surveys could be minimal from $100k. Site Mitigation would range from $250k to $500k for site mitigations (full archeological survey and documentation). Cultural survey costs have been included in the baseline estimate. Site mitigation has not been included. Of the 143 sites some 15% to 20% may require some level of mitigation ranging from $250k to $500k. If encountered construction would work around that area until location is resolved.	Likely	Marginal	Medium	Unlikely	Negligible	Low	Uniform				$5,400,000	$0	$14,400,000							100%	100%	$0	100%	0 Mo	Assume BC 143sites, 15% require mitigation at $250k/EA WC 143sites, 20% require mitigation at $500k/EA	
RG4	Burial Locations	At least three known cemeteries will need to be relocated in New Orleans. Additional unknown burial sites are likely to be encountered.	Burial Sites (both historic and prehistoric) will need to be relocated. Every effort will be made to avoid burial sites. Assume 1% to 5% of sites will encounter burial locations with relocation costs of $500k to $700k per site. Given extensive surveys, it is not likely burial sites will be located during construction. If encountered construction would work around that area until location is resolved.	Very Likely	Marginal	Medium	Unlikely	Negligible	Low	Uniform				$720,000	$0	$5,040,000							100%	100%	$0	100%	0 Mo	Assume BC 1% of the sites @ 500k / EA WC 5% of sites will encounter burial locations at $700k per site.	

				Project Cost			Project Schedule			Other Information				Cost Model			Schedule Model			Cost due to Schedule Risk									
														COST			Schedule Model			Cost From Schedule			TOTAL Cost			TOTAL Schedule			
CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Likelihood ©	Impact ©	Risk Level ©	Likelihood (S)	Impact (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Responsibility/ POC	Affected Project Component	Low Variance (Min)	Likely (C)	High Variance (80%H)	Low Variance (S) (Min)	Likely (S)	High Variance (S) (80%H)	Low Variance (CS) (Min)	Likely Added Cost (CS)	High Variance (CS) (80%H)	Event Prob (PC)	Event Prob (PCS)	Simulated Cost (C) + (CS)	Event Prob (PS)	Simulated Sched (S)	Risk Quantification Discussions	Suggested Risk Reduction Measures
RG5	Threatened and Endangered Species	Minimal Endangered Species are in the area.	A bat in the Northern reaches has been accounted for. Few other species are present. Potential schedule impacts exist in Illinois, Missouri, Kentucky and Tennessee due to bats. Schedule could be impacted based upon when funds are recevied vs. contract award and available time for winter tree clearing.	Unlikely	Negligible	Low	Possible	Moderate	Medium								0 Months	0 Months	12 Months	$0	$0	$409,246	100%	100%	$0	100%	0 Mo	Assume WC 12month schedule delay to entire project with 50% additional monthly PED for delayed projects	
RG6	Clean Water Act Compliance and Mitigation Impacts	Mitigation has been developed based on projected Impacts.	Impacts requiring mitigation are likely to change over time due to detailed designs however, no net loss of mitigation land is anticipated.	Possible	Negligible	Low	Possible	Negligible	Low														100%	100%	$0	100%	0 Mo		
RG7	HTRW	Preliminary assessments (literature search and site surveys were possible) have begun.	All known sites will attempt to be avoided. In existing alignments encountering HTRW is very unlikely. For new borrow sources HTRW will be avoided.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
RG8	Environmental Justice	High or high adverse disproportionate impacts must be encountered before mitigation will be required per EO 12898.	Cost and Schedule impacts are not likely.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
RG9				Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
Construction Risks (CO)																													
CO1	Site Access and Site Constraints - Floodwalls	Floodwall construction is often in densely populated urban areas.	Floodwall construction in New Orleans will be in the French Quarter. Cost Estimates have attempted to address site constraints.	Likely	Moderate	Medium	Unlikely	Negligible	Low	Triangular				$0	$0	$43,356,150							100%	100%	$0	100%	0 Mo	Assume WC Floodwall costs could increase 5% for dense urban area (assuming equipment/labor are half the total cost and could be extended an additional 10% for reduced productivity).	
CO2	Weather	Contracts will include weather days.	Memphis District typically does not see time growth for weather. New Orleans historically experiences significant time growth due to weather delays, especially for large clay construction contracts and moisture control. Schedule Growth is very likely and could be significant (assume 25% time growth due to weather).	Unlikely	Negligible	Low	Very Likely	Moderate	High	Triangular	Triangular						0 Months	0 Months	168 Months	$0	$0	$31,341,906	100%	100%	$0	100%	0 Mo	Assume WC 25% schedule increase due to weather with 25% of monthly PED burn rate during delay.	
CO3	Cultural Resources	Most of the construction will be in the existing footprint, borrow areas will be more likely to encounter resources.	Cultural surveys will be conducted once footprints have been defined. Programmatic agreement with the SEIS will lay out the process if resources are discovered. Primarily risk would be to schedule to allow time for surveys and proper documentation (if required). Efforts will be made to avoid cultural impacts.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
CO4	Mods and Claims	Every project experiences cost growth after award.	MRL projects have typically tracked best case 5%, most likely 8% and 12% worst case after award cost growth. Schedule growth on individual contracts is likely, but overall program is unlikely to be affected.	Likely	Significant	High	Unlikely	Negligible	Low	Triangular				$50,147,050	$80,235,280	$120,352,920							100%	100%	$80,235,280	100%	0 Mo	Assume BC 5% cost growth, Most Likely (ML) 8% and WC 12%	
CO5	Relocations	Poor performing utility subcontractors have proved troublesome to relocate in a timely manner.	USACE has no control of the utility relocations. Best practice would be to move the utility prior to solicitation of USACE contract. Through floodwalls have to be concurrent. Utility relocations have in the past lead to cost and schedule growth and are likely to continue. Schedule delays for relocations will result in USACE extended contractor overhead. Assume worst case 2% cost growth for extended contractor overhead delays.	Unlikely	Negligible	Low	Likely	Moderate	Medium		Triangular						0 Months	0 Months	12 Months	$0	$0	$20,058,820	100%	100%	$0	100%	0 Mo	Assume WC 12month total program delay due to relocation delays with 2% construction growth due to extended contractor OH.	
CO6	Poor Performing Contractor	Poor performing contractors can significantly delay individual contracts.	Individual contracts will be impacted by poor performing contractors. Vicksburg alone has experienced 2 contracts in default due to performance in last five year. Overall program schedule is not likely to be impacted. Contracts are independent. Program Risk is low and not modeled.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
CO7	Remote Site Locations	Many sites could be fairly remote impacting ability to find labor and deliver material.	Remote sites could result in higher awarded costs. Overall risk is low. Labor risk is captured in EX2 - Market Conditions.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
CO8	Work Windows	USFW may require winter tree clearing to avoid endangered species.	As plan sets advance winter tree clearing may continue in Northern States. Work windows with requirements must be defined in construction contracts. Very small areas compared to overall scope of the program.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
CO9				Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
Estimate and Schedule Risks (ES)																													

														Cost Model			Schedule Model			Cost due to Schedule Risk									
				Project Cost			Project Schedule			Other Information				COST			Schedule Model			Cost From Schedule			TOTAL Cost			TOTAL Schedule			
CREF	Risk/Opportunity Event	Risk Event Description	PDT Discussions on Impact and Likelihood	Likelihood (C)	Impact (C)	Risk Level (C)	Likelihood (S)	Impact (S)	Risk Level (S)	Cost Variance Distribution	Schedule Variance Distribution	Responsibility/ POC	Affected Project Component	Low Variance (Min)	Likely (C)	High Variance (80%H)	Low Variance (S) (Min)	Likely (S)	High Variance (S) (80%H)	Low Variance (CS) (Min)	Likely Added Cost (CS)	High Variance (CS) (80%H)	Event Prob (PC)	Event Prob (PCS)	Simulated Cost (C) + (CS)	Event Prob (PS)	Simulated Sched (S)	Risk Quantification Discussions	Suggested Risk Reduction Measures
ES1	Vicksburg Estimates	Earthwork based on crews with production rates and haul distances. Wells based on crews. Stainless Steel Screen is the largest cost driver.	Earthwork is highly dependent on weather and contractors mositure control. Earthwork crews sized around excavation/production rates with assumed off road haul trucks. Estimates include multiple mobs/demobs around seasonal windows. Potential cost uncertianty in haul distances and production rates. Cost Engineer judgement is estimate is cost neutral to cost conservative.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
ES2	Memphis Estimates	Floodwall costs based on parametric costs for floodwall based on historic pricing. Relief Wells historic pricing (Price/well) with an average spacing of wells. Earthwork based on crews with most likely haul distances.	Overall, based on recent MVM historical data Cost Engineer feels costs to be neutral to conservative. Relief wells are likely conservative, floodwall is likely reasonable given design data and earthwork is neutral based on standard MVM practice. Overall LOW estimate uncertainty assuming quantities and scope remain unchanged. Design refinement risks modeled elsewhere.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
ES3	New Orleans Estimates	~~I-Wall to T-Wall replacement based on recent Floodwall cross section with crews and adjusted localized production rates.~~ Floodwall estimate includes designer provided quantities with site specific crews and production rates. Relief Wells with crews and verified with recent historical pricing. Overall minimal program cost. Earthwork based on government furnished material and assumed 10mile haul.	Levee estimates are likley cost neutral. Floodwalls are highly complicated, cost risk is Moderate.	Likely	Marginal	Medium	Unlikely	Negligible	Low					-$5,286,700	$0	$5,286,700							100%	100%	$0	100%	0 Mo	Assume -/+5% for all other MVN construction estimates.	
ES4	New Orleans Estimates I-Wall to T-Wall Replacement	I-Wall to T-Wall replacement based on recent Floodwall cross section with crews and adjusted localized production rates.	I-Wall construction is likely conservative.	Likely	Moderate	Medium	Likely	Moderate	Medium					-$31,257,300	$0	$0							100%	100%	$0	100%	0 Mo	Assume -5 to +0% for all other MVN flloodwall estimates.	
ES5	New Orleans Utilities	USACE Cost Engineer has developed utility relocations.	USACE utility relocation costs may not reflect sponsor and utility owner relocation costs.	Very Likely	Moderate	High	Unlikely	Negligible	Low					$0	$0	$12,573,400							100%	100%	$0	100%	0 Mo	Assume 0% to +10% cost for MVN Relocations	
ES6	New Orleans Borrow Source	Confirm with Legal and Planning the source of New Orleans Borrow material.	TO BE DETERMINED	Possible	Moderate	Medium	Possible	Moderate	Medium														100%	100%	$0	100%	0 Mo		
ES7	Material Pricing Uncertainty	Floodwall and Relief Well Material Pricing could fluctuation over the project life (50 to 100years)	Assume moderate cost risk with ENR commodity computations.	Possible	Moderate	Medium	Unlikely	Negligible	Low					-$5,017,646	$0	$5,017,646							100%	100%	$0	100%	0 Mo	Assume Material is 20% of the total construction cost and could vary +/-3%	
ES8	Fuel Fluctuations	Fuel will fluctuate over life of project.	Fuel is at historic lows. Assume fuel could increase 25% over life of project.	Possible	Moderate	Medium	Unlikely	Negligible	Low					$0	$0	$20,058,820							100%	100%	$0	100%	0 Mo	25% increase in fuel costs results in 2% total construction cost increase.	
External Risks (EX)																													
EX1	High Water	Mississippi in recent years has remained at above average stages for significant portions of the year impacting project access, design and construction.	Continued high water events would result in schedule delays and associated cost impacts. Normal construction on MRL is 4 July to 25 November for moisture control of borrow material. January to June is an exclusion time. Survey work could normally occur in spring but the last two years high water prevented survey and borrow work. Emergency response work has continued. Vicksburg has a current relief well contract awarded in December 2018 and has had only some 52 working days spread across the last year. Essentially one construction season has been lost. Contract remains unfinished. At a program level resources can be reallocated as necessary between the three districts. If high water events continue indefinitely reallocations become ever more difficult. RISK MODELED IN CO2 - WEATHER	Unlikely	Negligible	Low	Very Likely	Critical	High														100%	100%	$0	100%	0 Mo		
EX2	Market Conditions	Construction Market is highly saturated.	Districts have experienced significant cost growth due to limited bidder competition and the pool of qualified contractors (see Contracting Risk CA1 - MATOC). To project market conditions 50years into the future is difficult but market conditions and bidding climate is likely to continue to be a concern.	Likely	Marginal	Medium	Unlikely	Negligible	Low					-$20,058,820	$0	$50,147,050							100%	100%	$0	100%	0 Mo	Assume BC 2% Cost savings and WC 5% Cost Increase	
EX3	Federal Funding	Federal Funding profile assumes some $6.25M/yr for Vicksburg and Memphis and $22.5M/yr for New Orleans.	Historically MRL had received some $50M/year. That funding has decreased with time but the expectation is Federal Funding of $35M/year is likely. Given lack of funding for other projects, MRL funding is likley to continue. Funding risk of less than $35M/yr is unlikley.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
EX4	Escalation	Projected future escalation rates have significant impacts on fully funded costs.	Escalation projections are based on CWCCIS. It is possible local rates could vary from CWCCIS national rates. MRL region is likely to more closely track national averages than other urban projects. Assume CWCCIS average is sufficient, LOW Risk.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
EX5	Political and Sponsor Support	Political and Sponsor Support remains committed to the project and public safety.	Natural disasters could draw additional attention to the project potentially increasing funding (opportunity).	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
EX6	Threat of Lawsuits	Lawsuits have and continue to be brought forward litigating operations.	Changes in river system operations could have impacts on project design. Design impacts due to changes in system operations are outside the scope of the current MRL study and not modeled here.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
EX7	Sponsor Funding	Sponsor is responsible for LERRDS.	Sponsor funding should not be an issue. Project is not a typical cost sharing, sponsor is responsible only for LERRDS.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		
EX8	Environmental Community	Lawsuits have been filed previously over project impacts.	USACE has successfully defended lawsuits in the past through full disclosure of impacts in the EIS. Future litigation will likely also not result in changes to the project. Project work continued during previous litigation and would likely be able to continue during any future litigations. Overall Lawsuit Risk is considered Low.	Unlikely	Negligible	Low	Unlikely	Negligible	Low														100%	100%	$0	100%	0 Mo		

A4-5.9 Total Project Cost Summary (TPCS)
The first page of the TPCS is the project summary page – it shows the total of all 3 Corps Districts, for each feature, or account. The following 3 pages show a summary of costs, for each of the 3 Districts: MVM (Memphis), MVK (Vicksburg), and MVN (New Orleans).

The Total Project Cost form is developed and presented with three different estimates over time: Estimated Cost, Project First Cost (Constant Dollar), and Total Project Cost (Fully Funded).

Estimated Cost (TPCS columns C through F) is the current developed cost estimate which includes contingencies. The effective price level date for Estimated Cost is commonly reported as the previous 1 Oct 20XX to support economic study and escalation to Project First Cost.

Project First Cost (Constant Dollar Cost, TPCS columns G through J) is the Estimated Cost then escalated to the PROGRAM YEAR effective price level by applying the appropriate escalation from the CWCCIS tables. The Project First Cost is the cost estimate used in feasibility reports and Chief of Engineer's Report (Chief's Report) for Congressional funding requests.

Total Project Cost (Fully Funded with Inflation, TPCS columns L through O) is the total cost of the project. The inflation to midpoint of each activity is added to the Project First Cost column set. Total Project Cost is the cost estimate used in Project Partnership Agreements and Integral Determination Reports. Total Project Cost is the cost estimate provided to non-Federal sponsors for their use in financial planning as it provides information regarding the overall non-Federal cost sharing obligation.

Abbreviations:

WBS – Work Breakdown Structure. Each feature has an assigned WBS number.

CNTG – Contingency

ESC – Escalation

****** TOTAL PROJECT COST SUMMARY ******

PROJECT: **MRL SEIS#2**
PROJECT NO: P2 107060 (MVM)
LOCATION: Lower Mississippi River Valley

DISTRICT: MVM, MVK, MVN (LMVD)
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 3/31/2020

This Estimate reflects the scope and schedule in report; MRL SEIS#2, & Engineering Risk Assessment (Oct 2017) =

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2020 Effective Price Level Date: 1 OCT 19									
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	**TOTAL ($K) J**	Spent Thru: **1-Oct-19** ($K)	**TOTAL FIRST COST** ($K) K	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
02	RELOCATIONS	$135,808	$36,668	27.0%	$172,476	0.0%	$135,808	$36,668	$172,476	$0	$172,476	187.4%	$390,321	$105,387	$495,708
06	FISH & WILDLIFE FACILITIES	$11,425	$3,085	27.0%	$14,510	0.0%	$11,425	$3,085	$14,510	$0	$14,510	95.6%	$22,346	$6,033	$28,379
11	LEVEES & FLOODWALLS	$993,203	$268,165	27.0%	$1,261,367	0.0%	$993,203	$268,165	$1,261,367	$2,405,056	$3,666,423	185.2%	$2,832,344	$764,733	$6,002,132
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$1,140,436	$307,918		$1,448,353	0.0%	$1,140,436	$307,918	$1,448,353	$2,405,056	$3,853,409	184.5%	$3,245,010	$876,153	**$6,526,219**
01	LANDS AND DAMAGES	$104,507	$29,944	28.7%	$134,451	0.0%	$104,507	$29,944	$134,451	$0	$134,451	179.7%	$291,245	$84,871	$376,116
30	PLANNING, ENGINEERING & DESIGN	$285,109	$28,511	10.0%	$313,620	0.0%	$285,109	$28,511	$313,620	$0	$313,620	302.5%	$1,147,700	$114,770	$1,262,470
31	CONSTRUCTION MANAGEMENT	$171,065	$17,107	10.0%	$188,172	0.0%	$171,065	$17,107	$188,172	$0	$188,172	316.6%	$712,728	$71,273	$784,001
	PROJECT COST TOTALS:	$1,701,117	$383,479	22.5%	$2,084,596		$1,701,117	$383,479	**$2,084,596**	$2,405,056	**$4,489,652**	213.9%	$5,396,683	$1,147,067	$8,948,805

_______________________ **CHIEF, COST ENGINEERING, xxx**

_______________________ **PROJECT MANAGER, xxx**

_______________________ **CHIEF, REAL ESTATE, xxx**

_______________________ **CHIEF, PLANNING, xxx**

_______________________ **CHIEF, ENGINEERING, xxx**

_______________________ **CHIEF, OPERATIONS, xxx**

_______________________ **CHIEF, CONSTRUCTION, xxx**

_______________________ **CHIEF, CONTRACTING,xxx**

_______________________ **CHIEF, PM-PB, xxxx**

_______________________ **CHIEF, DPM, xxx**

ESTIMATED TOTAL PROJECT COST: $8,948,805

Filename: TPCS MVD MRL-SEIS#2 all three districts 2020 05 27 (002).xlsx
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: MRL SEIS#2
LOCATION: Lower Mississippi River Valley
This Estimate reflects the scope and schedule in report; MRL SEIS#2, & Engineering Risk Assessment (Oct 2017)

DISTRICT: MVM, MVK, MVN (LMVD)
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 3/31/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			31-Mar-20	Program Year (Budget EC):			2020					
		Effective Price Level:			1-Oct-19	Effective Price Level Date:			1 OCT 19					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	MVM (MEMPHIS DISTRICT)													
02	RELOCATIONS	$7,494	$2,023	27.0%	$9,517	0.0%	$7,494	$2,023	$9,517	2047Q1	122.3%	$16,658	$4,498	$21,155
06	FISH & WILDLIFE FACILITIES	$5,501	$1,485	27.0%	$6,986	0.0%	$5,501	$1,485	$6,986	2047Q1	122.3%	$12,228	$3,301	$15,529
11	LEVEES & FLOODWALLS	$183,468	$49,536	27.0%	$233,004	0.0%	$183,468	$49,536	$233,004	2049Q3	139.4%	$439,214	$118,588	$557,801
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$196,463	$53,045	27.0%	**$249,508**		$196,463	$53,045	$249,508			$468,099	$126,387	$594,486
01	LANDS AND DAMAGES	$6,922	$1,384	20.0%	$8,306	0.0%	$6,922	$1,384	$8,306	2047Q1	122.3%	$15,386	$3,077	$18,464
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$3,929	$393	10.0%	$4,322	0.0%	$3,929	$393	$4,322	2048Q3	209.4%	$12,158	$1,216	$13,374
1.0%	Planning & Environmental Compliance	$1,965	$196	10.0%	$2,161	0.0%	$1,965	$196	$2,161	2048Q3	209.4%	$6,079	$608	$6,687
14.0%	Engineering & Design	$27,505	$2,750	10.0%	$30,255	0.0%	$27,505	$2,750	$30,255	2048Q3	209.4%	$85,108	$8,511	$93,619
1.0%	Reviews, ATRs, IEPRs, VE	$1,965	$196	10.0%	$2,161	0.0%	$1,965	$196	$2,161	2048Q3	209.4%	$6,079	$608	$6,687
1.0%	Life Cycle Updates (cost, schedule, risks)	$1,965	$196	10.0%	$2,161	0.0%	$1,965	$196	$2,161	2048Q3	209.4%	$6,079	$608	$6,687
1.0%	Contracting & Reprographics	$1,965	$196	10.0%	$2,161	0.0%	$1,965	$196	$2,161	2048Q3	209.4%	$6,079	$608	$6,687
2.0%	Engineering During Construction	$3,929	$393	10.0%	$4,322	0.0%	$3,929	$393	$4,322	2049Q3	222.4%	$12,669	$1,267	$13,936
2.0%	Planning During Construction	$3,929	$393	10.0%	$4,322	0.0%	$3,929	$393	$4,322	2049Q3	222.4%	$12,669	$1,267	$13,936
0.0%	Adaptive Management & Monitoring	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Project Operations	$1,965	$196	10.0%	$2,161	0.0%	$1,965	$196	$2,161	2048Q3	209.4%	$6,079	$608	$6,687
31	CONSTRUCTION MANAGEMENT													
12.5%	Construction Management	$24,558	$2,456	10.0%	$27,014	0.0%	$24,558	$2,456	$27,014	2049Q3	222.4%	$79,181	$7,918	$87,099
0.0%	Project Operation:	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$4,912	$491	10.0%	$5,403	0.0%	$4,912	$491	$5,403	2049Q3	222.4%	$15,836	$1,584	$17,420
	CONTRACT COST TOTALS:	$281,970	$62,288		$344,258		$281,970	$62,288	**$344,258**			$731,502	$154,266	**$885,768**

Filename: TPCS MVD MRL-SEIS#2 all three districts 2020 05 27 (002).xlsx
TPCS

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: **MRL SEIS#2**
LOCATION: Lower Mississippi River Valley
This Estimate reflects the scope and schedule in report; MRL SEIS#2, & Engineering Risk Assessment (Oct 2017)

DISTRICT: MVM, MVK, MVN (LMVD)
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 3/31/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			31-Mar-20	Program Year (Budget EC):			2020					
		Effective Price Level:			1-Oct-19	Effective Price Level Date:			1 OCT 19					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	MVK (VICKSBURG DISTRICT)													
02	RELOCATIONS	$2,580	$697	27.0%	$3,277	0.0%	$2,580	$697	$3,277	2030Q1	34.5%	$3,470	$937	$4,406
06	FISH & WILDLIFE FACILITIES	$4,579	$1,236	27.0%	$5,815	0.0%	$4,579	$1,236	$5,815	2030Q1	34.5%	$6,158	$1,663	$7,821
11	LEVEES & FLOODWALLS	$58,857	$15,891	27.0%	$74,748	0.0%	$58,857	$15,891	$74,748	2031Q3	40.6%	$82,764	$22,346	$105,111
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$66,016	$17,824	27.0%	**$83,840**		$66,016	$17,824	$83,840			$92,392	$24,946	$117,338
01	LANDS AND DAMAGES	$7,164	$1,433	20.0%	$8,597	0.0%	$7,164	$1,433	$8,597	2030Q1	34.5%	$9,634	$1,927	$11,561
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$1,320	$132	10.0%	$1,452	0.0%	$1,320	$132	$1,452	2030Q3	48.9%	$1,966	$197	$2,163
1.0%	Planning & Environmental Compliance	$660	$66	10.0%	$726	0.0%	$660	$66	$726	2030Q3	48.9%	$983	$98	$1,081
14.0%	Engineering & Design	$9,242	$924	10.0%	$10,166	0.0%	$9,242	$924	$10,166	2030Q3	48.9%	$13,762	$1,376	$15,138
1.0%	Reviews, ATRs, IEPRs, VE	$660	$66	10.0%	$726	0.0%	$660	$66	$726	2030Q3	48.9%	$983	$98	$1,081
1.0%	Life Cycle Updates (cost, schedule, risks)	$660	$66	10.0%	$726	0.0%	$660	$66	$726	2030Q3	48.9%	$983	$98	$1,081
1.0%	Contracting & Reprographics	$660	$66	10.0%	$726	0.0%	$660	$66	$726	2030Q3	48.9%	$983	$98	$1,081
2.0%	Engineering During Construction	$1,320	$132	10.0%	$1,452	0.0%	$1,320	$132	$1,452	2031Q3	54.9%	$2,045	$204	$2,249
2.0%	Planning During Construction	$1,320	$132	10.0%	$1,452	0.0%	$1,320	$132	$1,452	2031Q3	54.9%	$2,045	$204	$2,249
0.0%	Adaptive Management & Monitoring	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Project Operations	$660	$66	10.0%	$726	0.0%	$660	$66	$726	2030Q3	48.9%	$983	$98	$1,081
31	CONSTRUCTION MANAGEMENT													
12.5%	Construction Management	$8,252	$825	10.0%	$9,077	0.0%	$8,252	$825	$9,077	2031Q3	54.9%	$12,779	$1,278	$14,057
0.0%	Project Operation:	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$1,650	$165	10.0%	$1,815	0.0%	$1,650	$165	$1,815	2031Q3	54.9%	$2,556	$256	$2,811
	CONTRACT COST TOTALS:	$99,586	$21,898		$121,484		$99,586	$21,898	**$121,484**			$142,093	$30,879	**$172,972**

Filename: TPCS MVD MRL-SEIS#2 all three districts 2020 05 27 (002).xlsx

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: MRL SEIS#2
LOCATION: Lower Mississippi River Valley
This Estimate reflects the scope and schedule in report; MRL SEIS#2, & Engineering Risk Assessment (Oct 2017)

DISTRICT: MVM, MVK, MVN (LMVD)
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 3/31/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			31-Mar-20	Program Year (Budget EC):			2020					
		Effective Price Level:			1-Oct-19	Effective Price Level Date:			1 OCT 19					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	MVN (NEW ORLEANS DISTRICT)													
02	RELOCATIONS	$125,734	$33,948	27.0%	$159,682	0.0%	$125,734	$33,948	$159,682	2056Q3	194.4%	$370,194	$99,952	$470,146
06	FISH & WILDLIFE FACILITIES	$1,345	$363	27.0%	$1,708	0.0%	$1,345	$363	$1,708	2056Q3	194.4%	$3,960	$1,069	$5,029
11	LEVEES & FLOODWALLS	$750,878	$202,737	27.0%	$953,615	0.0%	$750,878	$202,737	$953,615	2058Q1	207.7%	$2,310,365	$623,799	$2,934,164
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$877,957	$237,048	27.0%	**$1,115,005**		$877,957	$237,048	$1,115,005			$2,684,519	$724,820	$3,409,339
01	LANDS AND DAMAGES	$90,421	$27,126	30.0%	$117,548	0.0%	$90,421	$27,126	$117,548	2056Q3	194.4%	$266,224	$79,867	$346,091
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$17,559	$1,756	10.0%	$19,315	0.0%	$17,559	$1,756	$19,315	2057Q1	339.0%	$77,080	$7,708	$84,787
1.0%	Planning & Environmental Compliance	$8,780	$878	10.0%	$9,658	0.0%	$8,780	$878	$9,658	2057Q1	339.0%	$38,540	$3,854	$42,394
14.0%	Engineering & Design	$122,914	$12,291	10.0%	$135,205	0.0%	$122,914	$12,291	$135,205	2057Q1	339.0%	$539,557	$53,956	$593,512
1.0%	Reviews, ATRs, IEPRs, VE	$8,780	$878	10.0%	$9,658	0.0%	$8,780	$878	$9,658	2057Q1	339.0%	$38,540	$3,854	$42,394
1.0%	Life Cycle Updates (cost, schedule, risks)	$8,780	$878	10.0%	$9,658	0.0%	$8,780	$878	$9,658	2057Q1	339.0%	$38,540	$3,854	$42,394
1.0%	Contracting & Reprographics	$8,780	$878	10.0%	$9,658	0.0%	$8,780	$878	$9,658	2057Q1	339.0%	$38,540	$3,854	$42,394
2.0%	Engineering During Construction	$17,559	$1,756	10.0%	$19,315	0.0%	$17,559	$1,756	$19,315	2058Q1	357.4%	$80,317	$8,032	$88,349
2.0%	Planning During Construction	$17,559	$1,756	10.0%	$19,315	0.0%	$17,559	$1,756	$19,315	2058Q1	357.4%	$80,317	$8,032	$88,349
0.0%	Adaptive Management & Monitoring	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Project Operations	$8,780	$878	10.0%	$9,658	0.0%	$8,780	$878	$9,658	2057Q1	339.0%	$38,540	$3,854	$42,394
31	CONSTRUCTION MANAGEMENT													
12.5%	Construction Management	$109,745	$10,974	10.0%	$120,719	0.0%	$109,745	$10,974	$120,719	2058Q1	357.4%	$501,980	$50,198	$552,178
0.0%	Project Operation:	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$21,949	$2,195	10.0%	$24,144	0.0%	$21,949	$2,195	$24,144	2058Q1	357.4%	$100,396	$10,040	$110,436
	CONTRACT COST TOTALS:	$1,319,561	$299,293		**$1,618,854**		$1,319,561	$299,293	**$1,618,854**			$4,523,088	$961,922	**$5,485,009**

Filename: TPCS MVD MRL-SEIS#2 all three districts 2020 05 27 (002).xlsx
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: MRL SEIS#2
LOCATION: Lower Mississippi River Valley
This Estimate reflects the scope and schedule in report; MRL SEIS#2, & Engineering Risk Assessment (Oct 2017)

DISTRICT: MVM, MVK, MVN (LMVD)
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 3/31/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			31-Mar-20	Program Year (Budget EC):			2020	FULLY FUNDED PROJECT ESTIMATE				
		Effective Price Level:			1-Oct-19	Effective Price Level Date:			1 OCT 19					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 4 or CONTRACT 4													
03	RESERVOIRS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
04	DAMS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
05	LOCKS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
06	FISH & WILDLIFE FACILITIES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
07	POWER PLANT	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
08	ROADS, RAILROADS & BRIDGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
09	CHANNELS & CANALS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
10	BREAKWATER & SEAWALLS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
	CONSTRUCTION ESTIMATE TOTALS:	$0	$0	0.0%	**$0**		$0	$0	$0			$0	**$0**	**$0**
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
1.0%	Planning & Environmental Compliance	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
14.0%	Engineering & Design	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
1.0%	Reviews, ATRs, IEPRs, VE	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
1.0%	Life Cycle Updates (cost, schedule, risks)	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
1.0%	Contracting & Reprographics	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
2.0%	Engineering During Construction	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
2.0%	Planning During Construction	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
0.0%	Adaptive Management & Monitoring	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
1.0%	Project Operations	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
31	CONSTRUCTION MANAGEMENT													
12.5%	Construction Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
0.0%	Project Operation:	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
2.5%	Project Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
	CONTRACT COST TOTALS:	$0	$0		**$0**		$0	$0	**$0**			$0	**$0**	**$0**

Filename: TPCS MVD MRL-SEIS#2 all three districts 2020 05 27 (002).xlsx
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: MRL SEIS#2
LOCATION: Lower Mississippi River Valley
This Estimate reflects the scope and schedule in report; MRL SEIS#2, & Engineering Risk Assessment (Oct 2017)

DISTRICT: MVM, MVK, MVN (LMVD)
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 3/31/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 31-Mar-20 Effective Price Level: 1-Oct-19				Program Year (Budget EC): 2020 Effective Price Level Date: 1 OCT 19				FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 5 or CONTRACT 5													
03	RESERVOIRS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
04	DAMS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
05	LOCKS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
06	FISH & WILDLIFE FACILITIES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
07	POWER PLANT	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
08	ROADS, RAILROADS & BRIDGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
09	CHANNELS & CANALS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
10	BREAKWATER & SEAWALLS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
	CONSTRUCTION ESTIMATE TOTALS:	$0	$0	0.0%	**$0**		$0	$0	$0			$0	**$0**	$0
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
1.0%	Planning & Environmental Compliance	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
14.0%	Engineering & Design	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
1.0%	Reviews, ATRs, IEPRs, VE	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
1.0%	Life Cycle Updates (cost, schedule, risks)	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
1.0%	Contracting & Reprographics	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
2.0%	Engineering During Construction	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
2.0%	Planning During Construction	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
0.0%	Adaptive Management & Monitoring	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
1.0%	Project Operations	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
31	CONSTRUCTION MANAGEMENT													
12.5%	Construction Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
0.0%	Project Operation:	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
2.5%	Project Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	$0
	CONTRACT COST TOTALS:	$0	$0		**$0**		$0	$0	**$0**			$0	**$0**	**$0**

Filename: TPCS MVD MRL-SEIS#2 all three districts 2020 05 27 (002).xlsx
TPCS

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: MRL SEIS#2
LOCATION: Lower Mississippi River Valley
This Estimate reflects the scope and schedule in report; MRL SEIS#2, & Engineering Risk Assessment (Oct 2017)

DISTRICT: MVM, MVK, MVN (LMVD)
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 3/31/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			31-Mar-20	Program Year (Budget EC):			2020	FULLY FUNDED PROJECT ESTIMATE				
		Effective Price Level:			1-Oct-19	Effective Price Level Date:			1 OCT 19					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 6 or CONTRACT 6													
03	RESERVOIRS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
04	DAMS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
05	LOCKS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
07	POWER PLANT	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
08	ROADS, RAILROADS & BRIDGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
10	BREAKWATER & SEAWALLS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$0	$0	0.0%	**$0**		$0	$0	$0			$0	$0	$0
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Planning & Environmental Compliance	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
14.0%	Engineering & Design	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Reviews, ATRs, IEPRs, VE	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Life Cycle Updates (cost, schedule, risks)	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Contracting & Reprographics	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.0%	Engineering During Construction	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.0%	Planning During Construction	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Adaptive Management & Monitoring	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Project Operations	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
12.5%	Construction Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Project Operation:	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:	$0	$0		**$0**		$0	$0	**$0**			$0	$0	**$0**

Filename: TPCS MVD MRL-SEIS#2 all three districts 2020 05 27 (002).xlsx
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: MRL SEIS#2
LOCATION: Lower Mississippi River Valley
This Estimate reflects the scope and schedule in report; MRL SEIS#2, & Engineering Risk Assessment (Oct 2017)

DISTRICT: MVM, MVK, MVN (LMVD)
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 3/31/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			31-Mar-20	Program Year (Budget EC):			2020					
		Effective Price Level:			1-Oct-19	Effective Price Level Date:			1 OCT 19	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 7 or CONTRACT 7													
03	RESERVOIRS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
04	DAMS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
05	LOCKS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
07	POWER PLANT	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
08	ROADS, RAILROADS & BRIDGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
10	BREAKWATER & SEAWALLS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$0	$0	0.0%	**$0**		$0	$0	$0			$0	$0	$0
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Planning & Environmental Compliance	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
14.0%	Engineering & Design	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Reviews, ATRs, IEPRs, VE	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Life Cycle Updates (cost, schedule, risks)	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Contracting & Reprographics	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.0%	Engineering During Construction	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.0%	Planning During Construction	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Adaptive Management & Monitoring	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Project Operations	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
12.5%	Construction Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Project Operation:	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:	$0	$0		**$0**		$0	$0	**$0**			$0	$0	**$0**

Filename: TPCS MVD MRL-SEIS#2 all three districts 2020 05 27 (002).xlsx
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: MRL SEIS#2
LOCATION: Lower Mississippi River Valley
This Estimate reflects the scope and schedule in report; MRL SEIS#2, & Engineering Risk Assessment (Oct 2017)

DISTRICT: MVM, MVK, MVN (LMVD)
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 3/31/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			31-Mar-20	Program Year (Budget EC):			2020					
		Effective Price Level:			1-Oct-19	Effective Price Level Date:			1 OCT 19	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 8 or CONTRACT 8													
03	RESERVOIRS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
04	DAMS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
05	LOCKS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
06	FISH & WILDLIFE FACILITIES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
07	POWER PLANT	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
08	ROADS, RAILROADS & BRIDGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
09	CHANNELS & CANALS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
10	BREAKWATER & SEAWALLS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
	CONSTRUCTION ESTIMATE TOTALS:	$0	$0	0.0%	**0**		$0	$0	$0			$0	**$0**	**$0**
01	LANDS AND DAMAGES	$0	$0	0.0%	$ -	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
1.0%	Planning & Environmental Compliance	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
14.0%	Engineering & Design	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
1.0%	Reviews, ATRs, IEPRs, VE	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
1.0%	Life Cycle Updates (cost, schedule, risks)	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
1.0%	Contracting & Reprographics	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
2.0%	Engineering During Construction	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
2.0%	Planning During Construction	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
0.0%	Adaptive Management & Monitoring	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
1.0%	Project Operations	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
31	CONSTRUCTION MANAGEMENT													
12.5%	Construction Management	$0	$0	10.0%	0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
0.0%	Project Operation:	$0	$0	10.0%	0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
2.5%	Project Management	$0	$0	10.0%	0	0.0%	$0	$0	$0	0	0.0%	$0	**$0**	**$0**
	CONTRACT COST TOTALS:	$0	$0		**0**		$0	$0	**$0**			$0	**$0**	**$0**

Filename: TPCS MVD MRL-SEIS#2 all three districts 2020 05 27 (002).xlsx
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: MRL SEIS#2
LOCATION: Lower Mississippi River Valley
This Estimate reflects the scope and schedule in report; MRL SEIS#2, & Engineering Risk Assessment (Oct 2017)

DISTRICT: MVM, MVK, MVN (LMVD)
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 3/31/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			31-Mar-20	Program Year (Budget EC):			2020					
		Effective Price Level:			1-Oct-19	Effective Price Level Date:			1 OCT 19	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 9 or CONTRACT 9													
03	RESERVOIRS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
04	DAMS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
05	LOCKS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
07	POWER PLANT	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
08	ROADS, RAILROADS & BRIDGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
10	BREAKWATER & SEAWALLS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$0	$0	0.0%	**$0**		$0	$0	$0			$0	$0	$0
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Planning & Environmental Compliance	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
14.0%	Engineering & Design	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Reviews, ATRs, IEPRs, VE	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Life Cycle Updates (cost, schedule, risks)	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Contracting & Reprographics	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.0%	Engineering During Construction	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.0%	Planning During Construction	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Adaptive Management & Monitoring	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Project Operations	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
12.5%	Construction Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Project Operation:	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:	$0	$0		**$0**		$0	$0	**$0**			$0	$0	**$0**

Filename: TPCS MVD MRL-SEIS#2 all three districts 2020 05 27 (002).xlsx
TPCS

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: MRL SEIS#2
LOCATION: Lower Mississippi River Valley
This Estimate reflects the scope and schedule in report; MRL SEIS#2, & Engineering Risk Assessment (Oct 2017)

DISTRICT: MVM, MVK, MVN (LMVD)
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 3/31/2020

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			31-Mar-20	Program Year (Budget EC):			2020					
		Effective Price Level:			1-Oct-19	Effective Price Level Date:			1 OCT 19	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 10 or CONTRACT 10													
03	RESERVOIRS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
04	DAMS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
05	LOCKS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
06	FISH & WILDLIFE FACILITIES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
07	POWER PLANT	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
08	ROADS, RAILROADS & BRIDGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
09	CHANNELS & CANALS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
10	BREAKWATER & SEAWALLS	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$0	$0	0.0%	**$0**		$0	$0	$0			$0	$0	$0
01	LANDS AND DAMAGES	$0	$0	0.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Planning & Environmental Compliance	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
14.0%	Engineering & Design	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Reviews, ATRs, IEPRs, VE	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Life Cycle Updates (cost, schedule, risks)	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Contracting & Reprographics	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.0%	Engineering During Construction	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.0%	Planning During Construction	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Adaptive Management & Monitoring	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
1.0%	Project Operations	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
31	CONSTRUCTION MANAGEMENT													
12.5%	Construction Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Project Operation:	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
2.5%	Project Management	$0	$0	10.0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:	$0	$0		**$0**		$0	$0	**$0**			$0	$0	**$0**

Filename: TPCS MVD MRL-SEIS#2 all three districts 2020 05 27 (002).xlsx
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