Technical Memorandum

GEI Consultants

To: Mr. David Kepler

CC: Mr. Ron Hansen, P.E., P.S.

From: Paul D. Drew, P.E.,CFM, Richard J. Anderson, P.E., William H. Walton, P.E.(MI), S.E.

Date: July 13, 2020

Re: Post Failure – Reconstruction Cost Analysis
Four Lakes Task Force (FLTF)
Midland, Michigan
GEI Project No. 2002879

Introduction and Project Background

This technical memorandum (TM) presents the results of a study by GEI Consultants of Michigan, P.C. (GEI) to develop "planning-level" opinions of probable construction cost to reconstruct and/or rehabilitate the four hydropower dams currently owned by Boyce Hydro, LLC (Boyce), Sanford, Edenville, Smallwood, and Secord (list from downstream to upstream), following the May 19, 2020 flood that resulted in severe damage to the Smallwood Dam and a catastrophic failure of both the Edenville and Sanford Dams. No obvious visual damage has been reported by Spicer Group Inc. (SGI) at Secord Dam. In response to the failures, the Federal Energy Regulatory Commission (FERC) ordered that the current owner (Boyce Hydro) to:

1) Safely draw down the impoundment of each of the four dams,
2) Have an independent engineer inspect each of the four dams,
3) Develop an interim plan to safely pass flows until a safe reservoir elevation can be established and implemented, and
4) Engage an independent panel of experts to perform a root cause forensic evaluation of the dam failures.

Furthermore, we understand that Gladwin and Midland Counties have signed a resolution in June 2020 to have the four projects condemned in accordance with Part 307 of the Michigan Natural Resources and Environmental Protection Act (NREPA).

GEI has not yet received permission to access the sites to perform a visual assessment of the dams, and inspection reports by an independent engineer have not yet been provided to us. Therefore, the opinions of probable construction cost presented in this TM are solely based on engineering judgement and expert opinion based on our experience with the design and construction of similar dams. We understand these planning level costs will be used by the County's assessors to estimate the current value of the assets and liabilities associated with acquiring the properties from Boyce. Since we have not had an opportunity to inspect the dams following the failures and because FERC has ordered Sanford, Smallwood, and Secord Dams to be fully drawn down, we assume that none are currently safe to retain and pass ½ probable maximum flood (PMF) water flows and will either need complete reconstruction (Sanford and Edenville Dams) or major rehabilitation (Smallwood and Secord Dams). Prior to the May 2020 flood event, a number of significant dam safety deficiencies, including insufficient spillway capacity to pass the design flood event, were identified by the previous Part 12D Independent Consultant D. Purkeypile, P.E., the

FERC and the Michigan Department of Environment, Great Lakes and Energy (EGLE) that needed to be addressed to bring the dams into compliance with State and Federal guidelines.

Criteria for Developing Opinions of Probable Construction Cost

The engineers' opinions of probable construction cost presented in this TM assumes the following criteria for the complete reconstruction of the Sanford and Edenville Dams, and the rehabilitation of the Smallwood and Secord Dams:

- The reconstruction / rehabilitation of the four dams will provide 75+ year design service life.
- The reconstruction / rehabilitation of the four dams will be designed to meet the current industry standards of engineering practice and the design standards for high hazard dams in accordance with the Michigan Department of Environment, Great Lakes and Energy (EGLE).
- Restoring hydropower generation would not be part of the reconstruction and was not included in our costs.
- The spillways for all four dams will be required to safely pass ½ of the Probable Maximum Flood (PMF) in accordance with the current State of Michigan EGLE dam safety requirements. A separate set of cost estimates was developed presuming the dams would be reconstructed to pass the full PMF per FLTF's request.
- A means to substantially draw down each of the four impoundments (i.e., add or enhance low level outlets).
- The ability to safely pass base plus flood flows (assumed 100-year storm event) without failing during construction.

Data Review

The information collected and used to develop an engineer's opinion of probable construction costs includes the following:

- Sanford, Edenville, Smallwood and Secord Design Drawings, 1923 to1924.
- Sanford, Edenville, Smallwood and Secord Dam Improvement Drawings, SGI, 2020.
- Supporting Technical Information Document (STID), Sanford, Edenville, Smallwood and Secord.
- Probable Maximum Flood Upgrades, Secord Dam – FERC Project No. 10809, GEI Consultants, April 2020.
- DRAFT Discharge Rating Curves (Secord, Smallwood, Edenville and Sanford Projects), GEI Consultants, April 2020.
- DRAFT Probable Maximum Flood Determination, Ayers Associates, May 2020.
- Post Failure Drone Photographs provided by SGI, May 2020.
- Unit price cost data from various dam repair / reconstruction projects within the last five (5) years (ref. GEI project records from similar projects)

Hydrology and Hydraulics – Existing Conditions

Ayers Associates under contract to the SGI, performed an updated PMF study in May 2020 to re-evaluate the PMF at all four projects using improved precipitation, streamflow and watershed data in accordance with current FERC engineering guidelines. The Four Lakes Task Force (FLTF) requested that GEI review the available hydraulic information and develop new spillway discharge rating curves for each project. The updated spillway rating curves were provided in the GEI April 2020 Technical Memorandum and submitted to Ayers for their use in the PMF study update. As shown in **Table 1**, the results of the Ayers

PMF study indicate the each of the four projects lack the necessary spillway capacity to safely pass the PMF.

Table 1: PMF Flood Routing – Existing (Pre-May 2020 Flood) Conditions

Dam	Peak PMF Inflow (cfs)	Peak PMF Outflow (cfs)	Peak Reservoir El. (ft)	Min. Dam Crest El. (ft)	Overtopping (ft)
Secord Dam	29,400	28,100[1]	759.0	757.8	1.2
Smallwood Dam	41,200	41,000	716.8	715.7	1.1
Edenville Dam	80,900	80,100	686.0	682.1	3.9
Sanford Dam	80,600[2]	79,100	641.2	636.8	4.4

Notes:
1. Includes 13,000 cfs flowing over the east reservoir rim private home and properties and into the Tea Creek Drainage Area.
2. Sanford Dam Inflow Design Flood (IDF) = 37,000 cfs
3. Elevations (El.) listed herein are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

Description of Existing Project Facilities

The Sanford and Edenville Dams breached on May 19, 2020 after several days of intense rainfall. Smallwood Dam incurred significant damage due to high flows and resulting scour erosion of the embankments. The damage to Secord Dam is uncertain, but SGI reported no significant damage was visible from visual observations. FERC in their letter dated May 20, 2020 to Boyce Hydro, ordered Boyce to full drawdown the impoundments behind all four dams. We understand that several of the water retaining structures, including the Edenville embankment to the west of the Michigan highway M-30 causeway and the Tobacco River Spillway, are still impounding some amount of water since no low-level outlet is present to fully draw down the impoundments. The Sanford embankments and fuse plug spillway are completely breached but the spillway and powerhouse structures are still standing. The amount of damage to the remaining structures is uncertain since GEI has not yet received permission to access the sites to perform a visual assessment of the dams and post-failure inspection reports by others have not yet been provided. However, it is our assumption that given the damage to the adjacent structures, depth and quantity of flood flow and observations from drone footage, that existing powerhouse and spillways at both Edenville and Sanford Dams are assumed to have incurred significant damage to their abutments and potentially undermining and toe erosion downstream of the structures.

We developed a "high-level" list of reconstruction and rehabilitation activities anticipated for the water retaining structures at each dam. These repairs or reconstruction activities are based on available design drawings, previous condition reports, previous engineering studies, and post-flood condition assessment records provided by SGI including post-failure photos and drone videos. The following lists the general condition of the gated spillways, powerhouses and embankments observed at each of the four dams. **Table 2** provides a summary matrix of the major reconstruction and rehabilitation items likely needed at each of the four dams. Photographs of the condition of the four dam's post-failure condition are provided in **Attachment 1**.

Based on our review of the information provided to date, we have assumed the following for the purposes of estimating reconstruction and repair costs:

Existing Gated Spillways:

- None of the four dams meet FERC engineering standards for spillway discharge capacity (full PMF) or residual available freeboard (i.e., all embankments overtop). Only Smallwood Dam has sufficient spillway capacity to meet the Michigan EGLE's flood capacity requirements (1/2 PMF).

- The gated spillways are reinforced concrete hollow, buttress-type structures constructed on soil that were more common pre-1940s when materials were expensive and labor cheap. This style of dam does not currently meet industry standards of design practice in terms of long-term durability and ductility during an earthquake.
- The projects do not include sufficient downstream energy dissipation structures or armor stone or riprap to protect against high tailwater and velocities that can scour un-zoned earth dam toes and spillway abutments.
- Edenville and Sanford spillways may have been shifted or undermined during the May 2020 flood. Status of tailrace scour and undermining at the Smallwood and Secord Dams is uncertain.
- Existing concrete spillways at each of the four projects were constructed on non-air entrained concrete and exhibit extensive deteriorations.
- The existing Tainter gates are likely beyond end of their design life and exhibit signs of age and corrosion. The Tainter gate hoisting mechanisms are generally insufficiently sized for the range of design service loads including ice and do not meet current industry design standards for wire rope cable hoists and several automated gate operators.

Existing Powerhouses:

- The amount of potential downstream scour, undermining and damage to the Sanford and Edenville Powerhouses is uncertain. The Sanford and Edenville Dams will likely need to be demolished and excavations made to sound foundation soils within dry cofferdams.
- The projects will need to include low-level outlets at all of the dams as a means to partially drain or draw down the impoundment. The powerhouse draft tubes could be converted to low-level outlets at Smallwood and Secord Dams and filling the remaining passages with mass concrete. However, if the hollow areas under the rollway slabs and between the piers are filled in with lightweight grout or concrete (heavier than water), the powerhouses would likely require underpinning with grouted steel micro-piles founded in native soil to prevent settlement and cracking under the additional weight of concrete fill.
- The water passages at the Sanford and Edenville powerhouses are not large enough to serve as a low-level outlet without the risk of reservoir refilling for events up to the 100-year flood.

Existing Embankments:

- None of the embankment dams were constructed to modern standards since they are homogenous (un-zoned), contain no impervious core or seepage cutoff, no internal filter sand and gravel drainage system, insufficient upstream erosion protection and are all generally too steep. Only the Smallwood Dam embankment has a sheet pile seepage cutoff through the dam into the foundation.
- The embankment dams at Secord and Edenville will need to be completely reconstructed including installation of a fully penetrating dam into foundation seepage cutoff wall, downstream granular filter sand / drainage gravel zones to control dam and foundation seepage that bypasses the cutoff, downstream slopes flattened or stabilized to improve stability, and installation of armor stone riprap and bedding to prevent erosion along the upstream face of the dam during high flows.
- Extensive damage or complete failure observed at all embankments except at the Secord Dam.

Table 2: Matrix of Major Dam Reconstruction Items

Reconstruction Item	Sanford	Edenville[1]	Smallwood	Secord
Abutment Reconstruction / Laydown Area	☑	☑	☑	☑
Water Diversion During Construction	☑	☑☑	☑	☑
Powerhouse Decommissioning/Demo	☑	☑	☑	☑

Reconstruction Item	Sanford	Edenville[1]	Smallwood	Secord
Existing Gated Spillway Demolition	☑	☑☑	NA	NA
Repair Existing Gated Spillway	NA	NA	☑	☑
New Gated Spillway	☑	☑☑	NA	NA
New Auxiliary Spillway	☑	☑☑	☑	☑
Left Embankment Reconstruction	☑	☑☑	NA	NA
Right Embankment Reconstruction	☑	☑☑	NA	NA
Left Embankment Repair	NA	NA	☑	☑
Right Embankment Repair	NA	NA	☑	☑
U/S and D/S Cofferdams	☑	☑☑	☑	☑
U/S and D/S Channel Restoration	☑	☑☑	☑	☑
Regrading and Erosion Control	☑	☑☑	☑	☑
Temporary M-30 Diversion Structure	NA	☑	NA	NA
Grouted Micro-piles and Underpinning	NA	NA	☑	☑
Regrading and Erosion Control	☑	☑☑	☑	☑

Notes:
1. Two check boxes to denote required at both the Edenville and Tobacco spillways and flanking earthen embankments because the dams were constructed at the confluence of the Tobacco and Tittabawassee Rivers and need to manage flows past them independently.
2. NA – Not applicable

Description of Proposed Project Repairs

Based on the condition of the existing project facilities, GEI has developed new conceptual spillway and dam configurations for each of the four projects which would allow the four dams to safely pass the ½ PMF. The configurations consist of reconstruction or rehabilitation of earthen embankments, demolition and replacement of the primary gated spillways, low-level outlets, powerhouse demolition / abandonment, and construction of new passive auxiliary spillways. Conceptual-level proposed spillway rating curves (see **Attachment 2**) were developed using the methods prescribed in the United States Bureau of Reclamation Design of Small Dams (USBR) 1987) and Hydraulic Design of Labyrinth Weirs – Henry T, Falvey (Falvey 2003). The following list the general dam configurations and preliminary flood routing of each of the four projects.

Sanford Dam:
The Sanford Dam gated spillway and powerhouse will be demolished and replaced in the same location with a slightly wider and deeper spillway. The spillway ogee shaped crest will be constructed at El. 620.0 with six (6) 22-foot wide automated Obermeyer or hydraulic crest gates to increase spillway discharge capacity. One (1) of the gates will be a deep gate installed at a lower sill elevation to provide a means to draw down the impoundment. The automated gates would be designed to open and close with minimal human intervention during normal operation and flood events. Operation of the crest gates would remain the primary means for regulated releases through the impoundments under normal operations and flood conditions. The proposed spillway structure will discharge through a rectangular spillway chute and USBR type stilling basin.

A new 165-foot-wide, minimum 6-cycle auxiliary labyrinth spillway structure (**see Figure 1**) will be constructed at weir El. 632.5 within the right embankment near the footprint of the existing breach channel to provided additional spillway capacity during the ½ PMF. The labyrinth spillway will have an un-gated passive overflow crest that will control water surface elevations during extreme flood events without human intervention.

The Sanford Dam embankments will be reconstructed to minimum El. 638.0 feet to provide adequate freeboard for all inflows up to and including the ½ PMF. The downstream slopes will be constructed to 2.5H:1V to provide adequate stability in accordance with EGLE stability requirements under normal and flood pool loading criteria. A new permanent steel sheet pile cutoff (PZC-26 or equal hot rolled sheets with interlock sealants) will be constructed upstream of the dam crest and extend into the impermeable clay till foundation soil to provide a seepage barrier cutoff. Downstream granular filter drainage layers will be constructed to control seepage that bypasses the cutoff. The downstream slope will be buttressed and armored with new riprap and bedding material to protect against high tailwater flood conditions. The upstream slopes will be protected from beaching and wave erosion by the installation of bedding and riprap sized for fetch and wave runup. A minimum crest width of 20 ft will be provided to access the dam and spillways. Typical Sanford Dam embankment reconstruction is provided in **Figure 2**. Preliminary flood routing is provided in **Table 3**.

Table 3: Sanford Dam ½ PMF Flood Routing – Proposed Conditions

Peak ½ PMF Inflow (cfs)	Primary Spillway Discharge (cfs)	Auxiliary Spillway Discharge (cfs)	Total Spillway Discharge (cfs)	Peak Reservoir Stage (ft)	Design Dam Crest (ft)	Freeboard (ft)
40,300	33,235	7,835	40,945	636.0	638.0	2.0

Notes:
1. Construct new primary spillway with six (6) new 22-foot wide crest gates at El. 620.0 ft (lowered from El. 622.3)
2. Raise the Embankments from El. 636.8 to El. 638.0 ft
3. Construct new labyrinth spillway at El. 632.5 ft

Edenville Dam:

The Edenville and Tobacco gated spillways and powerhouse will be demolished and replaced in the same location with slightly wider and deeper spillways independent of each other in the long-term to allow the Tobacco and Tittabawassee Rivers to maintain their drainage and tailrace ecosystem upstream of their natural confluence. The improved Edenville and Tobacco ogee crests will be installed at El. 665.5 with three (3) 24-foot wide Obermeyer or hydraulic crest gates to increase spillway discharge capacity. One (1) of the gates will be a deep gate installed at a lower sill elevation to provide means to substantially draw down the impoundment. The automated crest gates would be designed to open and close with minimal human intervention during normal operation or during flood events.

New 125-foot-wide, 6-cycle auxiliary labyrinth spillway structures (**see Figure 1**) will be constructed within the Tobacco and Edenville embankments impounding the Tobacco and Tittabawassee Rivers respectively, at El. 677.8 to provided additional spillway capacity during the ½ PMF. The proposed spillway structure will discharge through a rectangular spillway chute and USBR type stilling basin.

Similar to the Sanford Dam, the Edenville and Tobacco earthen embankments will be fully reconstructed to provide adequate freeboard for all inflows up to and including the ½ PMF. The typical Edenville embankment reconstruction is provided in **Figure 2**. Preliminary flood routing is provided in **Table 4**.

Table 4: Edenville Dam ½ PMF Flood Routing – Proposed Conditions

Peak ½ PMF Inflow (cfs)	Primary Spillway Discharge (cfs)	Auxiliary Spillway Discharge (cfs)	Total Spillway Discharge (cfs)	Peak Reservoir Stage (ft)	Design Dam Crest (ft)	Freeboard (ft)
40,450	30,615	10,720	41,335	681.0	685.0	4.0

Notes:

1. Construct new Edenville primary spillway with three (3) new 24-foot wide crest gates at El. 665.5 (lowered from El. 667.8) for the Tittabawassee River.
2. Construct new Tobacco primary spillway with three (3) new 22-foot wide crest gates at El. 665.5 (lowered from El. 667.8) for the Tobacco River.
3. Raise the embankments from El. 682.0 to 685.0.
4. Construct new 125-foot wide Edenville labyrinth spillway at El. 677.8 for the Tittabawassee River.
5. Construct new 125-foot wide Tobacco labyrinth spillway at El. 677.8 for the Tobacco River.

Smallwood Dam:

The Smallwood Dam gated spillway will be repaired and the two (2) existing Tainter gates will be replaced with either automated Obermeyer or hydraulic crest gates. The powerhouse will be decommissioned, and the draft tubes converted to low-level outlets and the remaining passages filled with mass lightweight grout or concrete. The filled-in powerhouse will likely require underpinning with grouted steel micro-piles founded in hardpan clay to minimize excessive settlement and cracking under the additional weight in the voids of the powerhouse.

Currently the Smallwood Dam has sufficient capacity to pass the ½ PMF through the spillway gates and existing auxiliary spillway. However, an auxiliary spillway will likely be needed to pass base and flood flows during the rehabilitation of the existing gated spillway and powerhouse. A new passive, 125-foot-wide, minimum 6-cycle, reinforced concrete auxiliary labyrinth spillway structure will be constructed at El. 709.5 within the left embankment to pass base flows during construction and provide additional spillway capacity during the ½ PMF. The proposed spillway structure will discharge through a rectangular spillway chute and USBR Stilling basin (**see Figure 3**).

The Smallwood embankment slopes will be flattened to a minimum slope of 2.5H:1V to provide adequate stability in accordance with EGLE stability requirements under normal and flood pool loading criteria. The embankment toe and downstream slope was damaged and eroded during the May 2020 storm and will be repaired with new structural fill and buttressed with new riprap and bedding stone. A minimum crest width of 20 ft will be provided to access the spillways. The upstream slope will be protected with riprap over bedding stone. A typical Smallwood dam embankment repair section is provided in **Figure 4**. Preliminary flood routing is provided in **Table 5**.

Table 5: Smallwood Dam ½ PMF Flood Routing – Proposed Conditions

Peak ½ PMF Inflow (cfs)	Primary Spillway Discharge (cfs)	Auxiliary Spillway Discharge (cfs)	Total Spillway Discharge (cfs)	Peak Reservoir El. (ft)	Design Dam Crest El. (ft)	Freeboard (ft)
20,600	13,380	7,500	20,880	713.5	715.7	2.2

Notes:

1. Remove Tainter gates and replace with crest gates at invert El. 694.8
2. Construct new 125-foot wide labyrinth spillway at El. 709.5

Secord Dam:

The Secord Dam gated spillway will be repaired and the two (2) Tainter gates will be replaced with automated Obermeyer or hydraulic crest gates at El. 737.5 to increase spillway capacity. The powerhouse will be decommissioned, and the draft tubes converted to low-level outlets and the

remaining passages filled with lightweight grout or mass concrete. The powerhouse will likely require underpinning with grouted steel micro-piles founded in hardpan clay to reduce settlement.

As documented in the Preliminary Design Basis Report by GEI in April 2020, a significant portion of the inflow into Secord Lake discharges over the populated (e.g., with streets, homes and yards) Secord Lake Ridgeline and left abutment rim at El. 755.0 into Tea Creek before reaching the dam. This overflow presents a significant flood risk to the resident's homes and streets along the eastern shoreline of Secord Lake. The goal of this proposed configuration is to pass the ½ PMF without surcharging the reservoir above the Secord Lake Ridgeline at El. 755.0 and reduce flood impacts to the eastern shoreline residential properties including streets, utilities, homes and yards.

A new 200-foot-wide ungated, reinforced concrete overflow spillway will be constructed at El. 752.0 to provided additional spillway capacity during the ½ PMF. Conceptually, the spillway would consist of a passive concrete overflow weir, concrete chute, stilling basin and discharge channel to the Tittabawassee River (see **Figure 5**). The spillway will have an un-gated passive overflow crest that will control water surface elevations during extreme flood events without human intervention. Operation of the crest gates would remain the primary means for regulated releases through the impoundments under normal operations and flood conditions.

The Secord Dam embankment slopes will be flattened to provide adequate stability in accordance with EGLE stability requirements under normal and flood pool loading criteria. A new permanent steel sheet pile cutoff (PZC-26 hot rolled sheets with interlock sealants) will be constructed upstream of the Secord dam crest and extend into the clay till to provide a seepage cutoff. New drainage filter and drainage stone will be constructed along the interface of the existing downstream slope and new embankment fill. Lastly, the downstream slope will be buttressed with new riprap and bedding material to protect against high tailwater flood conditions. A typical Secord embankment repair section is provided in **Figure 6**. Preliminary flood routing is provided in **Table 6**.

Table 6: Secord Dam ½ PMF Flood Routing – Proposed Conditions

Peak ½ PMF Inflow (cfs)	Primary Spillway Discharge (cfs)	Auxiliary Spillway Discharge (cfs)	Total Spillway Discharge (cfs)	Peak Reservoir Stage (ft)	Design Dam Crest (ft)	Freeboard (ft)
14,700	11,470	3,430	14,900	755.0	758.0	3.0

Notes:
1. Lower existing spillway gate sill from El. 742.8 to El. 737.5 to increase spillway capacity
2. Replace Tainter gates with two (2) new crest gates
3. Construct 200-foot wide passive overflow spillway structure at crest El. 752.0

Construction Sequence and Considerations

The proposed project configurations will require the ability to route base river flow and storm flows through each dam and divert flows around the construction work areas throughout the duration of the construction projects. Because the construction duration will last multiple years, the project will require significant upstream and downstream cofferdams and flow diversion. Upstream and downstream temporary cofferdams will be required to allow demolition of the powerhouse and existing gated spillways, and construction of the new gated and auxiliary spillways. The proposed cofferdams will likely consist of 35- to 40-foot-diameter sheet piles comprised of PS-27.5 sheets filled with granular fill that are self-stable under the range of anticipated hydraulic and ice loads during construction. The upstream cofferdam will be constructed above 100-year flood elevation during construction to provide adequate freeboard during construction. Typical Cofferdam plans for Sanford and Edenville Dams are provided in **Figure 7** through **Figure 10**. The anticipated

construction sequence for the four projects starting at Sanford Dam and working upstream towards Secord Dam is as follows:

Sanford Dam

1. Fully draw down impoundment, stabilize existing project structures, remove debris and inspect spillway and powerhouse. (To be completed by Boyce)
2. Contractor mobilization, left and right abutment reconstruction and develop laydown and contractor work areas.
3. Stabilize right embankment breach channel and fully divert water from spillway and powerhouse area.
4. Construct Phase I upstream and downstream cofferdams at gated spillway and powerhouse.
5. Demolish existing gated spillway and powerhouse.
6. Construct new gated spillway.
7. Remove Phase I cofferdams and construct Phase II upstream and downstream cofferdams at new auxiliary labyrinth spillway located at breach channel area. Divert river flows through new gated spillway.
8. Construct new auxiliary labyrinth spillway and reconstruct flanking embankments.
9. Remove Phase II cofferdams.
10. Refill Sanford Lake and, monitor performance.
11. Final site restoration and contractor demobilizations.

Edenville Dam

1. Fully draw down impoundment, stabilize existing project structures, remove debris and inspect spillway and powerhouse. (To be completed by Boyce).
2. Contractor mobilization, left and right abutment reconstruction and develop laydown and contractor work areas.
3. Improve and stabilize diversion through left embankment breach channel.
4. **Construct temporary diversion control structure at M-30 bridge upstream of Tobacco Dam to allow partial flow of either river (Tittabawassee or Tobacco) to either watershed.**
5. Construct Phase I upstream and downstream cofferdams at Tobacco spillway.
6. Demolish Tobacco spillway.
7. Construct new auxiliary labyrinth spillway and gated spillway at Tobacco Dam.
8. Reconstruct Tobacco Dam flanking embankments from M-30 causeway to right abutment.
9. Restore Tobacco River channel.
10. Remove Phase I cofferdams and construct Phase II cofferdams at Edenville Spillway and Powerhouse.
11. **Divert water from Tittabawassee River through M-30 Diversion through Tobacco spillway into the Tobacco River Channel.**
12. Demolish Edenville spillway and powerhouse.
13. Construct new auxiliary spillway and gated spillway at Edenville Dam.
14. Reconstruct Edenville Dam flanking embankment from M-30 causeway to left abutment.
15. Restore Tittabawassee River channel.
16. Remove Phase II cofferdams.
17. Remove M-30 causeway control structure and restore M-30 bridge.
18. Refill Wixom Lake and, monitor performance.
19. Final site restoration and contractor demobilizations.

Special Consideration

- The County Highway M-30 bridge and causeway embankment that separates Wixom Lake at the Edenville Dam project failed during the May 2020 storm. Since the failure, the Tobacco River flow is conveyed to the Tittabawassee River through the M-30 and Edenville Dam breach channels. We understand the Michigan Department of Transportation is currently

working on plans to rebuild the M-30 bridge to restore the corridor across Wixom Lake. During construction, a temporary control structure will likely be needed at the M-30 corridor to divert a portion of the Tobacco and Tittabawassee River flows through either the Tobacco or Edenville gated spillways **(see Figure 11)**.

Smallwood Dam

1. Fully draw down impoundment, stabilize existing project structures, remove debris and inspect spillway and powerhouse. (To be completed by Boyce).
2. Contractor mobilization, left and right abutment reconstruction and develop laydown and contractor work areas.
3. Rehabilitate the left and right embankments and install downstream erosion protection.
4. Construct new auxiliary labyrinth spillway at left abutment and armor discharge channel.
5. Repair and stabilize the gated spillway, tailrace area and replace gate hoists and actuators as needed.
6. Decommission and remove the turbine-generator set. Convert water passage to gated low-level outlet and backfill with cellular concrete and stabilize structure.
7. Refill Smallwood Lake and monitor performance.
8. Final site restoration and contractor demobilizations.

Secord Dam

1. Fully draw down impoundment, stabilize existing project structures, remove debris and inspect spillway and powerhouse. (To be completed by Boyce).
2. Contractor mobilization, left and right abutment reconstruction and develop laydown and contractor work areas.
3. Decommission and remove Tainter gates. Convert water passage to gated low level outlet, backfill with cellular concrete and underpin structure.
4. Construct new auxiliary labyrinth spillway and increase flow capacity by cutting down the ogee crest, underpinning, backfilling with cellular concrete and installing larger crest gates. Modify training walls and stilling basin as needed.
5. Rehabilitate and stabilize left and right embankments.
6. Refill Secord Lake and monitor performance.
7. Final site restoration and contractor demobilizations.

The exact sequence of construction by dam could vary from the sequence presented above, for example, rehabilitate Secord and Smallwood prior to reconstruction of Edenville and Sanford Dams. However, in general, Sanford should be reconstructed prior to and ready to receive flows prior to reconstruction of Edenville Dam to mitigate the potential for damage at and downstream of Sanford Dam due to possible increased flow releases from Edenville Dam during or after construction.

Planning Level Cost Analysis

Opinions of probable construction cost (OPCC) were developed for the four project configurations to pass the ½ PMF based on the proposed project facilities and construction approaches presented in this report. The level of detail for this type of estimate is assumed to provide construction cost within the range of -30 to +50%, typically used for conceptual design studies. The OPCC includes 30% contingency for all construction items and includes an allowance of 8% to 15% of the total construction cost for site investigations, engineering design, permitting and construction engineering / management costs. The range of OPPC was approximately $14 million for the Secord Dam up to approximately $208 million for the Edenville Dam repairs. The total OPCC for each of the four dams to pass the ½ PMF was approximately $337 million. A summary of the ½ PMF OPPC for each of the four projects is summarized in **Table 7** through **Table 10** with the total project costs provided in **Table 11.** ½ PMF OPCC estimate worksheets are provided as **Attachment 3**.

The FLTF have also requested that GEI develop an OPCC to pass the full PMF in case the State of Michigan EGLE increases the required high hazard dam minimum spillway capacity requirement above the ½ PMF or if, at a future date, the probable maximum precipitation estimates for the region increase. The project configurations described in the sections above were expanded to include additional spillway capacity to accommodate the full PMF by providing additional primary spillway gates, longer auxiliary labyrinth spillways, and expanded upstream and downstream cellular cofferdams. For the purposes of this analysis, the primary gated spillway was sized to pass approximately 75% of the PMF, and the remaining 25% of the PMF was passed through the auxiliary labyrinth spillways. During preliminary design, this ratio will be optimized to an appropriate recurrence interval storm to be passed through the primary gated spillway, and the remainder above the selected the recurrence interval will be passed through the auxiliary labyrinth spillways. For example, the primary gated spillways could be sized to pass the 500- to 1,000-year storm event and the auxiliary spillway will be sized to pass the remaining flow up to the PMF. Without these recurrence interval statistics available at this time, the assumed gated to passive spillway ratio of 75% / 25% is considered appropriate for this level of OPCC.

A summary of the PMF OPCC for each of the four projects is summarized in **Table 7** through **Table 10** with the total project costs provided in **Table 11**. A bulleted summary precedes each project table highlighting the major additional construction activities needed to increase spillway capacity from the ½ PMF to the full PMF. PMF OPCC estimate worksheets are provided as **Attachment 4**.

Sanford Dam – Additional Construction Activities to Increase Spillway Capacity to the PMF

- Increase the size and footprint of the cellular cofferdam for the demolition of the existing powerhouse and primary gated spillway and the construction of a new wider primary gated spillway.
- Increase the number of 22-foot wide crest gates on the primary spillway from six (6) to twelve (12).
- Increase the footprint of the cellular cofferdam for the construction of a wider auxiliary labyrinth spillway on the right embankment.
- Increase the width of the auxiliary labyrinth spillway from 165-foot wide to 250-foot wide.
- Reduce the amount of right embankment reconstruction due to the increased width of the primary gated spillway and auxiliary labyrinth spillway.

Table 7: Summary of Opinion of Probable Construction Costs – Sanford Dam

Item	Description	½ PMF	Full PMF
0.00	General Conditions	$ 5,297,000	$ 7,356,000
1.00	Site Preparation and Cofferdams	$ 14,260,000	$ 21,775,000
2.00	Demolition / Abandonment	$ 5,250,000	$ 5,250,000
3.00	Left Abutment Reconstruction	$ 1,119,000	$ 1,110,000
4.00	Right Embankment Reconstruction	$ 16,421,000	$ 13,130,000
5.00	New Gated Spillway / Outlet Works	$ 15,326,000	$ 30,700,000
6.00	New Labyrinth Spillway Structure	$ 5,677,000	$ 8,960,000
7.00	Site Restoration	$ 250,000	$ 250,000
	Subtotal	$ 63,600,000	$ 88,531,000
	30% Contingency	$ 19,080,000	$ 26,559,000
	Construction Subtotal	$ 82,680,000	$ 115,090,000
	Site Investigations, Engineering, Permitting and Construction Management (10%)	$ 8,268,000	$ 11,509,000
	Total Estimated Cost	**$ 90,948,000**	**$ 126,599,000**

Edenville Dam – Additional Construction Activities to Increase Spillway Capacity to the PMF

- Increase the size and footprint of the cellular cofferdam for the demolition of the existing powerhouse and primary gated spillways, and the construction of new wider primary gated spillways at Edenville and Tobacco. Increase the number of 24-foot wide crest gates on the Edenville and Tobacco primary spillways from three (3) to six (6).
- Increase the width of the Edenville and Tobacco auxiliary labyrinth spillways from 125-foot wide to 200-foot wide.
- Reduce the amount of embankment reconstruction due to the increased width of the primary gated spillways and auxiliary labyrinth spillways.

Table 8: Summary of Opinion of Probable Construction Costs – Edenville Dam

Item	Description	½ PMF	Full PMF
0.00	General Conditions	$ 12,258,000	$ 14,678,000
1.00	Site Preparation and Cofferdams	$ 31,620,000	$ 39,730,000
2.00	M-30 Diversion	$ 4,000,000	$ 4,000,000
3.00	Demolition / Abandonment	$ 5,750,000	$ 5,750,000
4.00	Edenville Embankments - Breached Section	$ 13,406,000	$ 13,406,000
5.00	Edenville Embankments - Repaired and Stabilized	$ 31,370,000	$ 29,159,000
6.00	Tobacco Embankments - Repaired and Stabilized	$ 22,186,000	$ 20,360,000
7.00	New Gated Spillways and Outlet Works - Edenville	$ 7,865,000	$ 15,730,000
8.00	New Gated Spillways and Outlet Works - Tobacco	$ 7,865,000	$ 15,730,000
9.00	New Labyrinth Spillway Structure - Edenville	$ 5,542,000	$ 9,085,000
10.00	New Labyrinth Spillway Structure - Tobacco	$ 5,542,000	$ 9,085,000
11.00	Site Restoration	$ 500,000	$ 500,000
	Subtotal	$ 147,904,000	$ 177,213,000
	30% Contingency	$ 44,371,000	$ 53,164,000
	Construction Subtotal	$ 192,275,000	$ 230,377,000
	Site Investigations, Engineering, Permitting and Construction Management (8%)	$ 15,382,000	$ 18,430,000
	Total Estimated Cost	**$ 207,657,000**	**$ 248,807,000**

Smallwood Dam – Additional Construction Activities to Increase Spillway Capacity to the PMF

- Construct cellular cofferdam upstream and downstream of the existing powerhouse and gated spillway. Demolish the existing primary gated spillway and powerhouse.
- Construct new wider primary gated spillway with five (5) new 24-foot wide crest gates.
- Increase the width of the auxiliary labyrinth spillway from 125-foot wide to 180-foot wide.
- Reduce the amount of embankment rehabilitation due to the increased width of the primary gated spillways and auxiliary labyrinth spillways.

Table 9: Summary of Opinion of Probable Construction Costs – Smallwood Dam

Item	Description	½ PMF	Full PMF
0.00	General Conditions	$ 802,000	$ 2,704,000
1.00	Site Preparation and Cofferdams	$ 270,000	$ 7,137,000

2.00	Powerhouse Demolition	$ 500,000	$ 4,250,000
3.00	Left Embankment Repair and Stabilization	$ 794,000	$ 794,000
4.00	Right Embankment Repair and Stabilization	$ 371,000	$ 252,000
5.00	Gated Spillways	$ 1,880,000	$12,077,000
6.00	Powerhouse Rehabilitation	$ 960,000	$ -
7.00	Auxiliary Spillway Structure	$ 3,446,000	$ 4,846,000
8.00	Site Restoration	$ 130,000	$ 130,000
	Subtotal	$ 9,153,000	$32,190,000
	30% Contingency	$ 2,746,000	$ 9,657,000
	Construction Subtotal	$ 11,899,000	$41,847,000
	Site Investigations, Engineering, Permitting and Construction Management (15%)	$ 1,785,000	$ 6,277,000
	Total Estimated Cost	**$ 13,684,000**	**$48,124,000**

Secord Dam – Additional Construction Activities to Increase Spillway Capacity to the PMF

- Construct cellular cofferdam upstream and downstream of the existing powerhouse and gated spillway.
- Demolish the existing primary gated spillway and powerhouse.
- Construct new primary gated spillway with four (4) new 24-foot wide crest gates.
- Replace the 200-foot wide passive overflow weir structure with a new 200-foot wide auxiliary labyrinth spillway.

Table 10: Summary of Opinion of Probable Construction Costs – Secord Dam

Item	Description	½ PMF	Full PMF
0.00	General Conditions	$ 1,392,000	$ 3,088,000
1.00	Site Preparation and Cofferdams	$ 220,000	$ 7,087,000
2.00	Powerhouse Decommissioning and TG Abandonment	$ 500,000	$ 4,250,000
3.00	Left Embankment Repair and Stabilization	$ 3,341,000	$ 3,341,000
4.00	Right Embankment Repair and Stabilization	$ 2,555,000	$ 2,552,000
5.00	Gated Spillway Rehabilitation	$ 3,298,000	$10,887,000
6.00	Powerhouse Rehabilitation	$ 1,946,000	$ -
7.00	Auxiliary Spillway Structure	$ 2,928,000	$ 5,512,000
8.00	Site Restoration	$ 130,000	$ 130,000
	Subtotal	$16,310,000	$36,847,000
	Contingency	$ 4,893,000	$11,054,000
	Construction Subtotal	$21,203,000	$47,901,000
	Site Investigations, Engineering, Permitting and Construction Management (15%)	$ 3,180,000	$ 7,185,000
	Total Estimated Cost	**$24,383,000**	**$55,086,000**

The incremental cost needed to increase spillway capacity from the ½ PMF to the PMF is approximately 42% higher or $141,944,000. We consider the range of costs presented appropriate for the intended use of the County's assessors to estimate the current value of assets and liabilities associated with acquiring these from Boyce. The project configurations described in this TM will be further refined and optimized during the preliminary design phase to economically pass the selected design storm (1/2 PMF or Full PMF) safely.

Table 11: Summary of Opinion of Probable Construction Costs

Dam	½ PMF	Full PMF
Sanford Dam	$ 90,948,000	$ 126,599,000
Edenville Dam	$ 207,657,000	$ 248,807,000
Smallwood Dam	$ 13,684,000	$ 48,124,000
Secord Dam	$ 24,383,000	$ 55,086,000
Total	**$ 336,672,000**	**$ 478,616,000**

Closing

Our opinions of probable cost should be considered rough budgetary estimates based on conceptual level designs, costs for similar projects and engineering judgment. Detailed designs and quantities have not yet been prepared. Actual bids and total project costs may vary based on contractor's perceived risk, site access, season, market conditions, etc. No warranties concerning the accuracy of costs presented herein are expressed or implied.

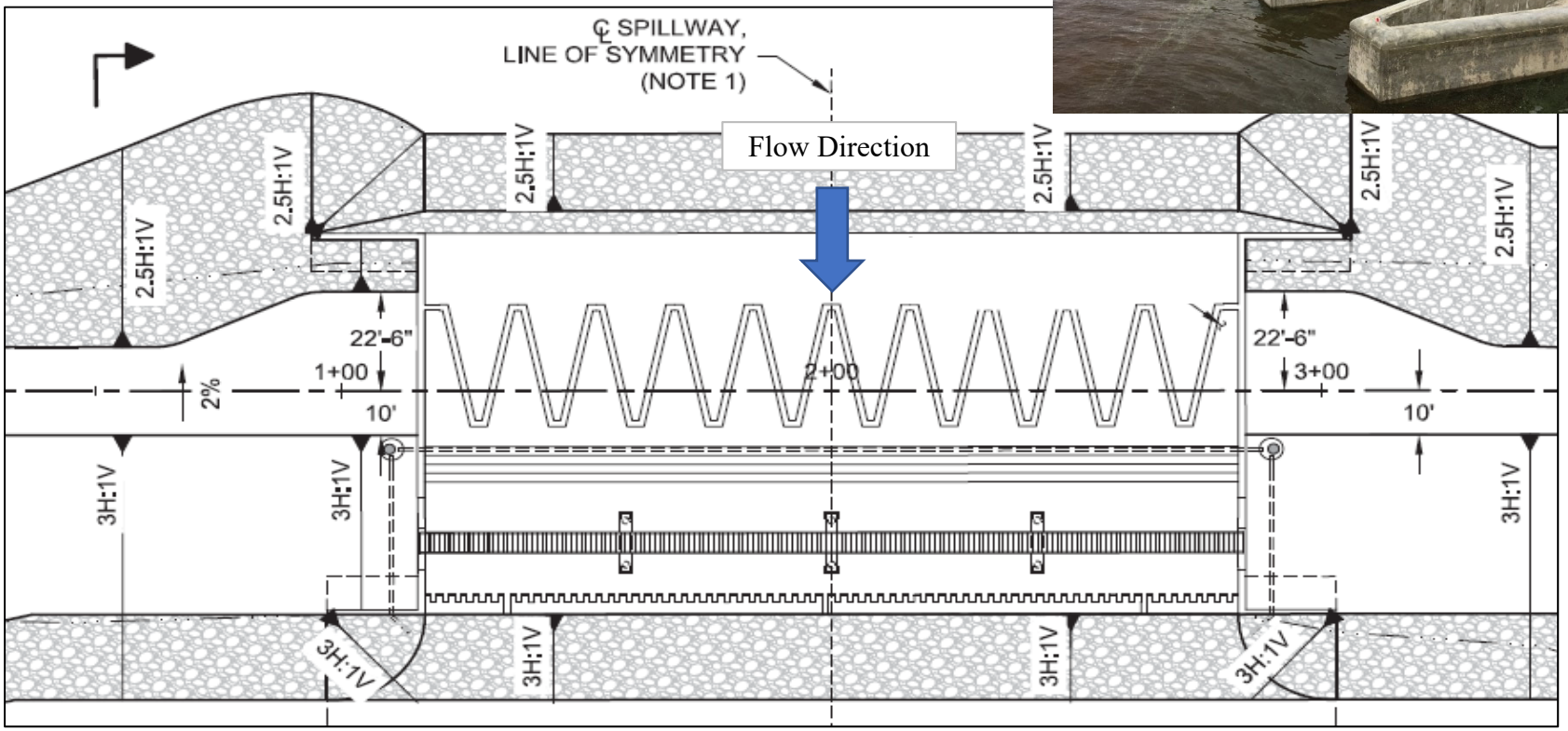
Enclosed

- Figure 1 – Typical Labyrinth Spillway Plan View (Sanford, Edenville and Smallwood Dams)
- Figure 2 – Typical Embankment Reconstruction Cross Section (Sanford and Edenville Dams)
- Figure 3 – Smallwood Dam Auxiliary Spillway Isometric View
- Figure 4 – Smallwood Dam Embankment Rehabilitation Cross Section View
- Figure 5 – Secord Dam Auxiliary Spillway Plan View
- Figure 6 – Secord Dam Embankment Rehabilitation Cross Section View
- Figure 7 – Sanford Dam Gated Spillway Cofferdam Plan
- Figure 8 – Sanford Dam Auxiliary Spillway and Breach Channel Cofferdam Plan
- Figure 9 – Edenville Dam - Tobacco Spillway Cofferdam Plan
- Figure 10 – Edenville Dam - Edenville Spillway and Breach Channel Cofferdam Plan
- Figure 11 – M-30 Control Structure Location Plan

Attachment 1 – Pre and Post Failure Project Photographs
Attachment 2 – Concept Level Spillway Rating Curves
Attachment 3 – OPCC Estimate Worksheets – ½ PMF
Attachment 4 – OPCC Estimate Worksheets – PMF

Figures

Reference: Typical 10-Cycle Labyrinth Spillway.

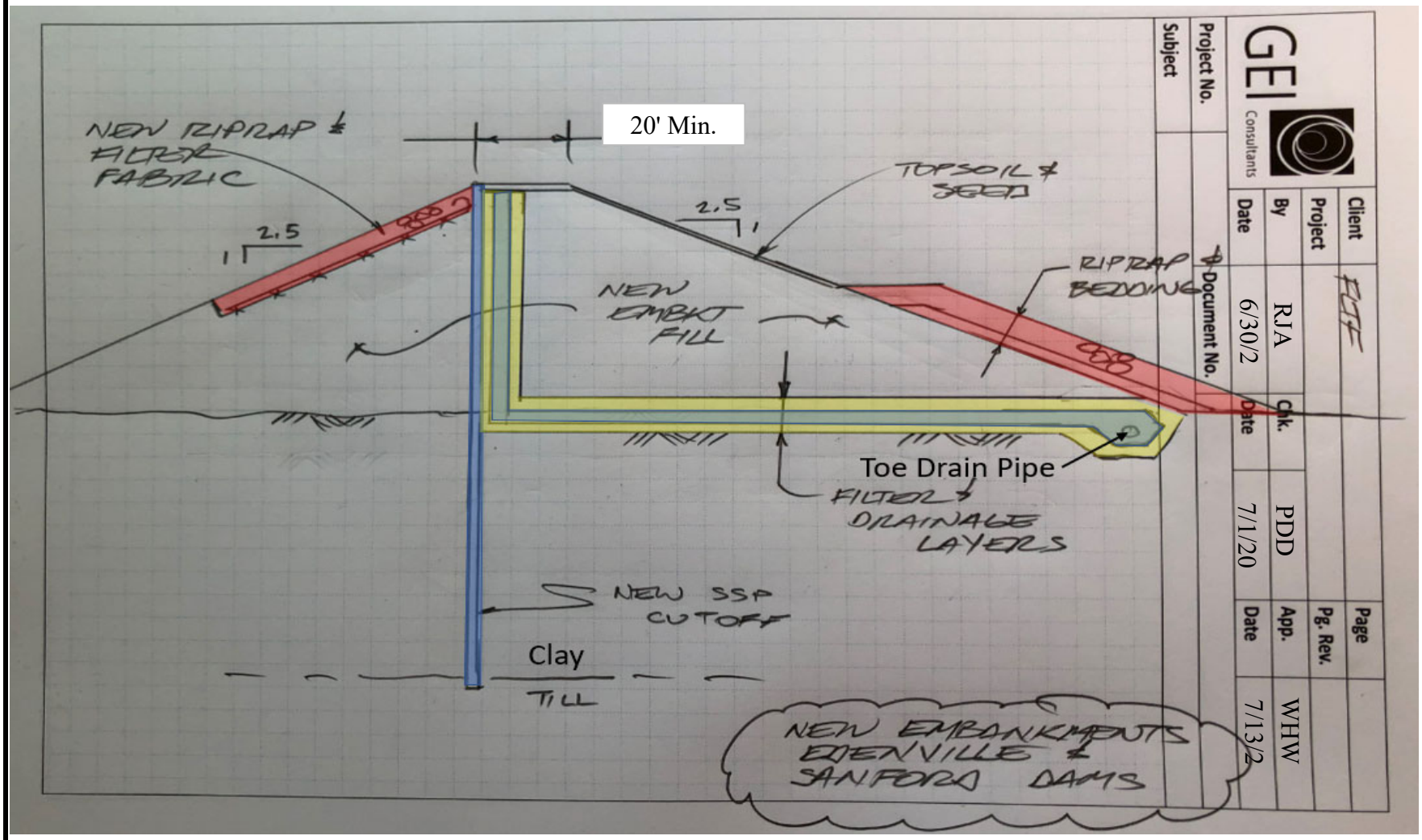


Post Failure Reconstruction Cost Analysis
Client: Four Lake Task Force (FLTF)
Location: Midland, Michigan

GEI Consultants

Typical Labyrinth Spillway Plan View (Sanford, Edenville, and Smallwood Dams)

Project 2002879	July 2020	Figure 1

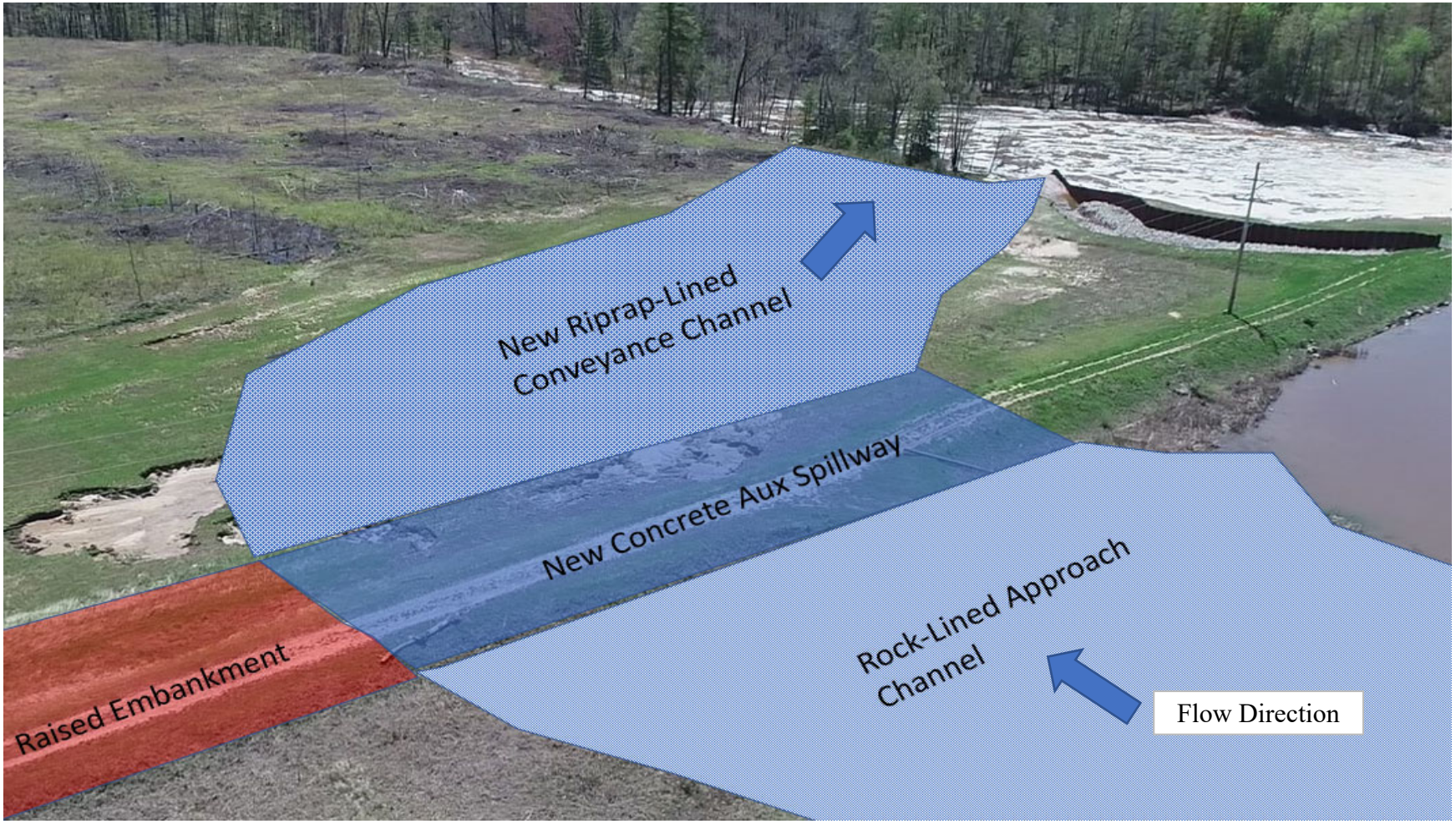


Post Failure Reconstruction Cost Analysis
Client: Four Lake Task Force (FLTF)
Location: Midland, Michigan

GEI Consultants

Typical Embankment Reconstruction Cross Section (Sanford and Edenville Dams)

Project 2002879	July 2020	Figure 2

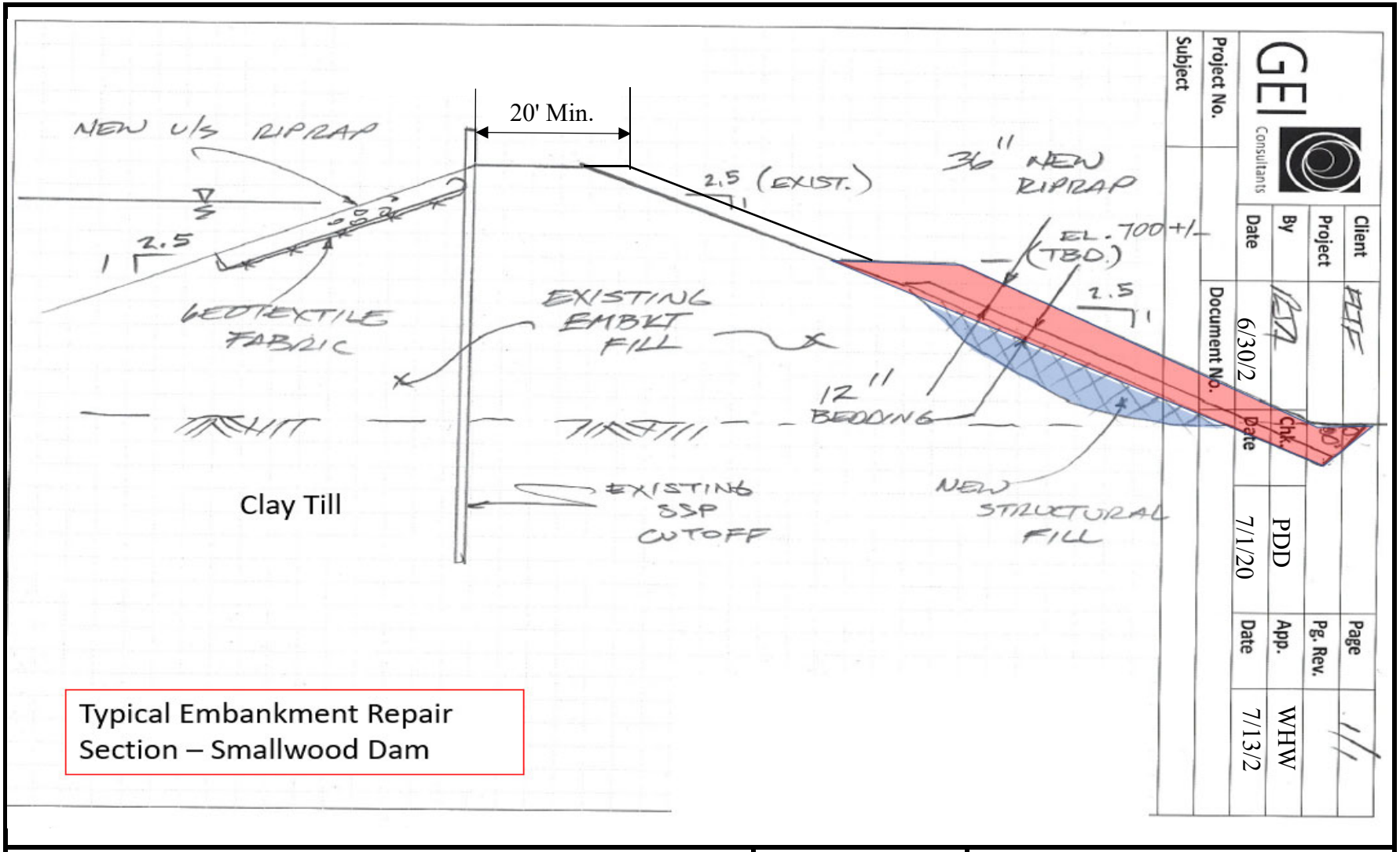


Post Failure Reconstruction Cost Analysis
Client: Four Lake Task Force (FLTF)
Location: Midland, Michigan

GEI Consultants

Smallwood Dam Auxiliary Spillway
Isometric View

Project 2002879	July 2020	Figure 3



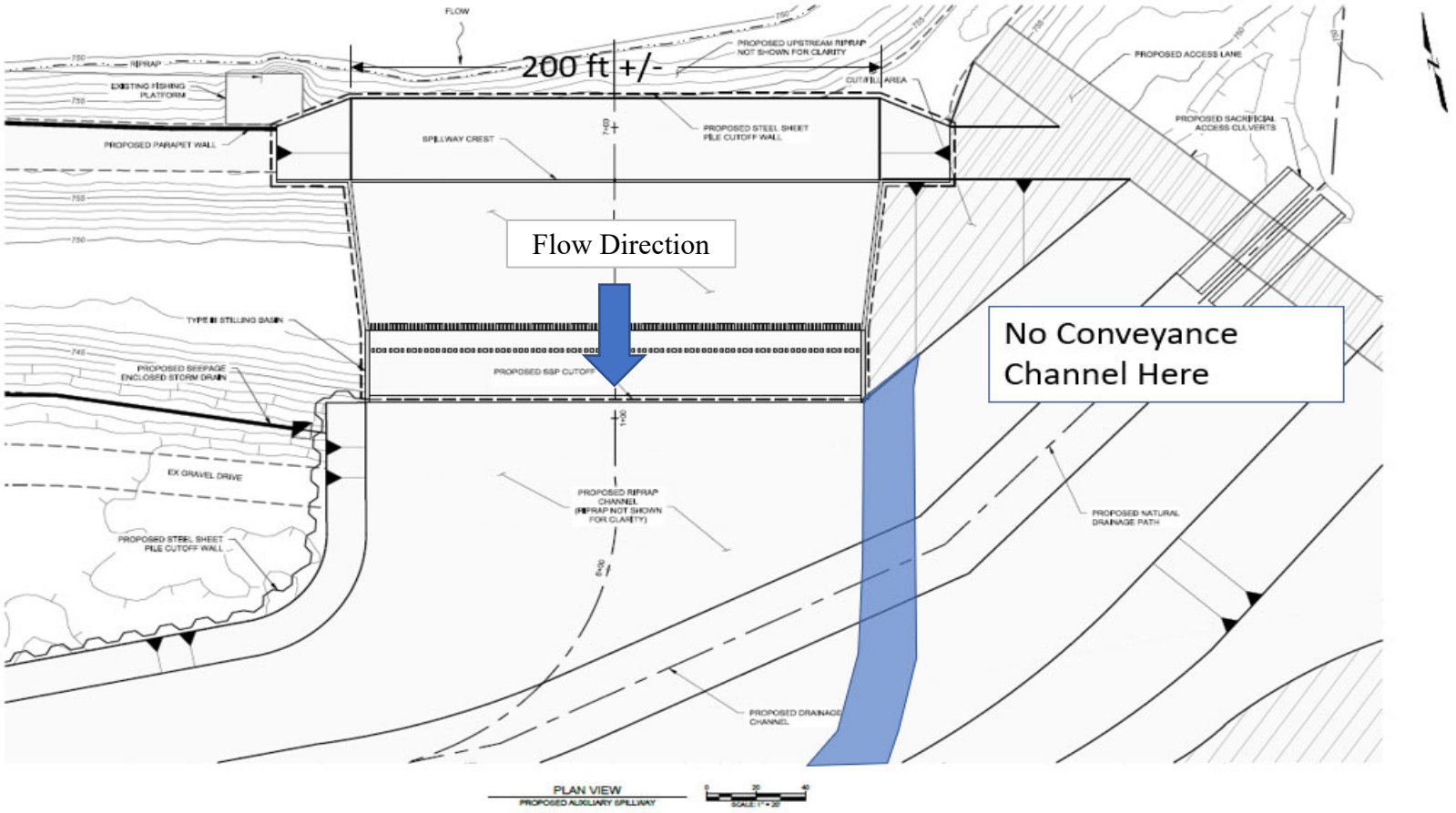
Typical Embankment Repair Section – Smallwood Dam

Post Failure Reconstruction Cost Analysis
Client: Four Lake Task Force (FLTF)
Location: Midland, Michigan

GEI Consultants

Smallwood Dam Embankment Rehabilitation Cross Section View

Project 2002879	July 2020	Figure 4

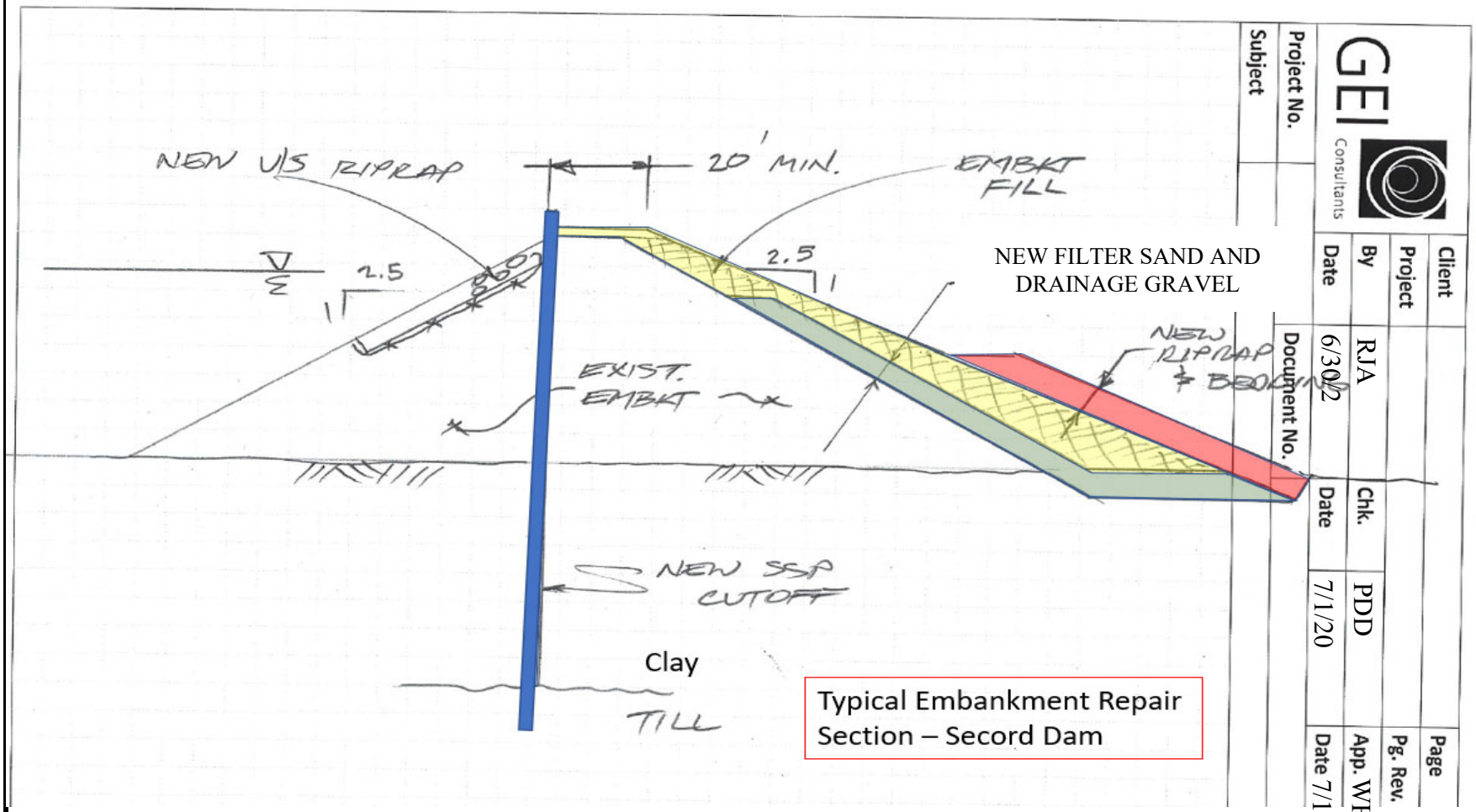


Post Failure Reconstruction Cost Analysis
Client: Four Lake Task Force (FLTF)
Location: Midland, Michigan

GEI Consultants

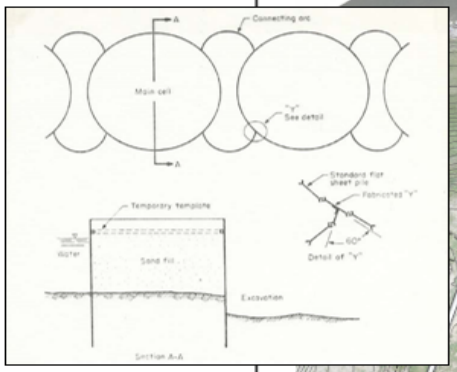
Secord Dam Auxiliary Spillway
Plan View

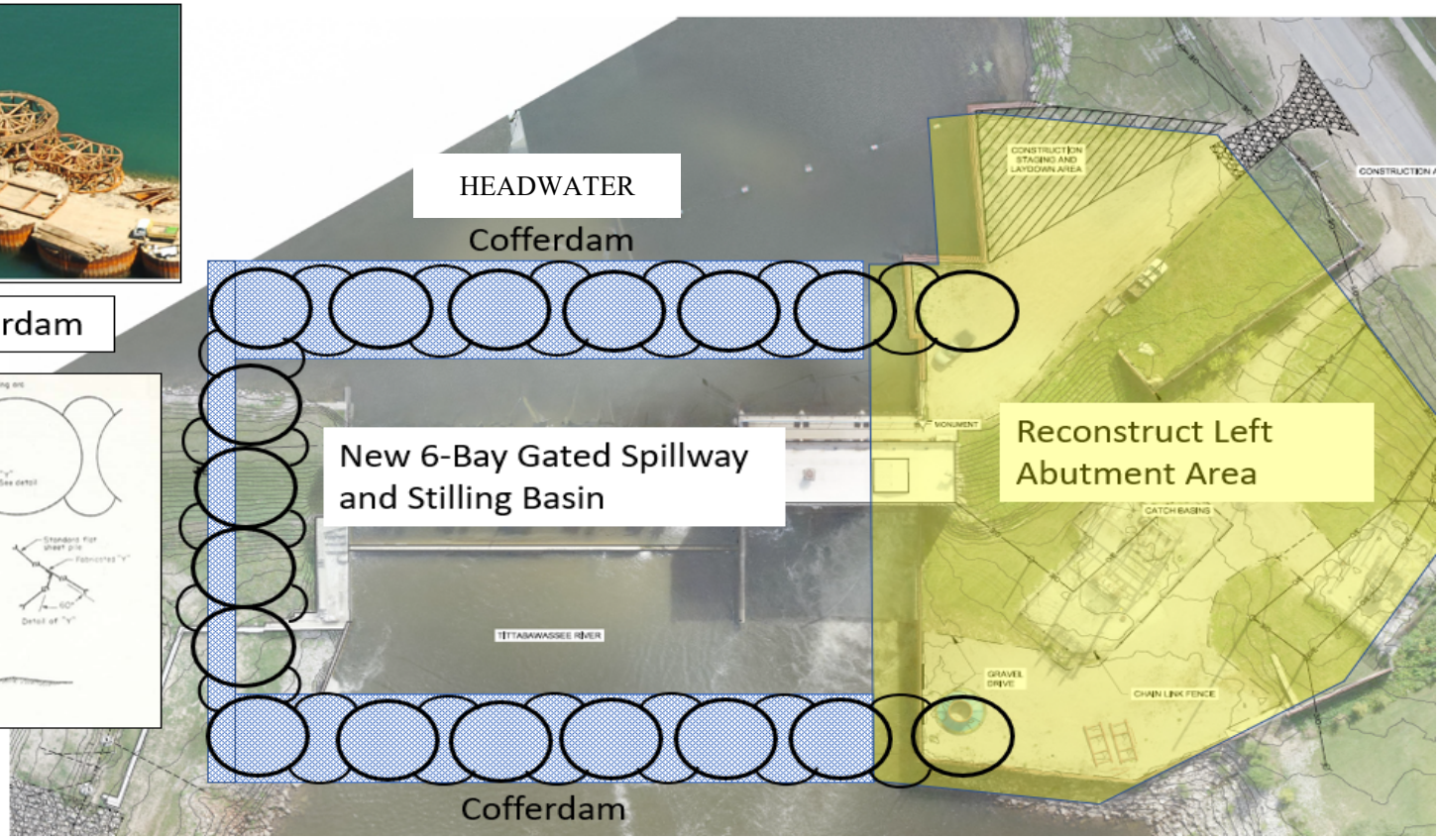
Project 2002879	July 2020	Figure 5



Post Failure Reconstruction Cost Analysis **Client: Four Lake Task Force (FLTF)** **Location: Midland, Michigan**	GEI Consultants	**Secord Dam Embankment Rehabilitation Cross Section View**
	Project 2002879	**July 2020**	**Figure 6**

Cellular Cofferdam

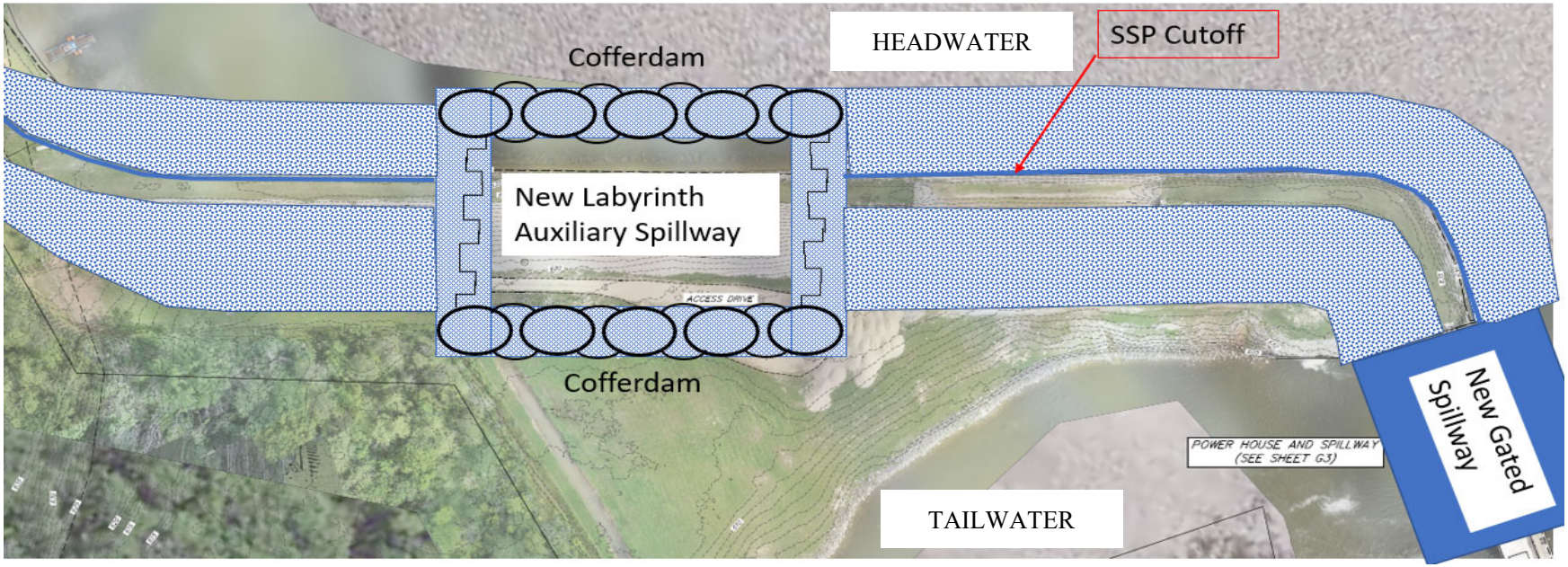




TAILWATER

Post Failure Reconstruction Cost Analysis **Client: Four Lake Task Force (FLTF)** **Location: Midland, Michigan**	GEI Consultants	**Sanford Dam Gated Spillway** **Cofferdam Plan**	
	Project 2002879	**July 2020**	**Figure 7**

Breach Area Cofferdam and Right Embankment Access

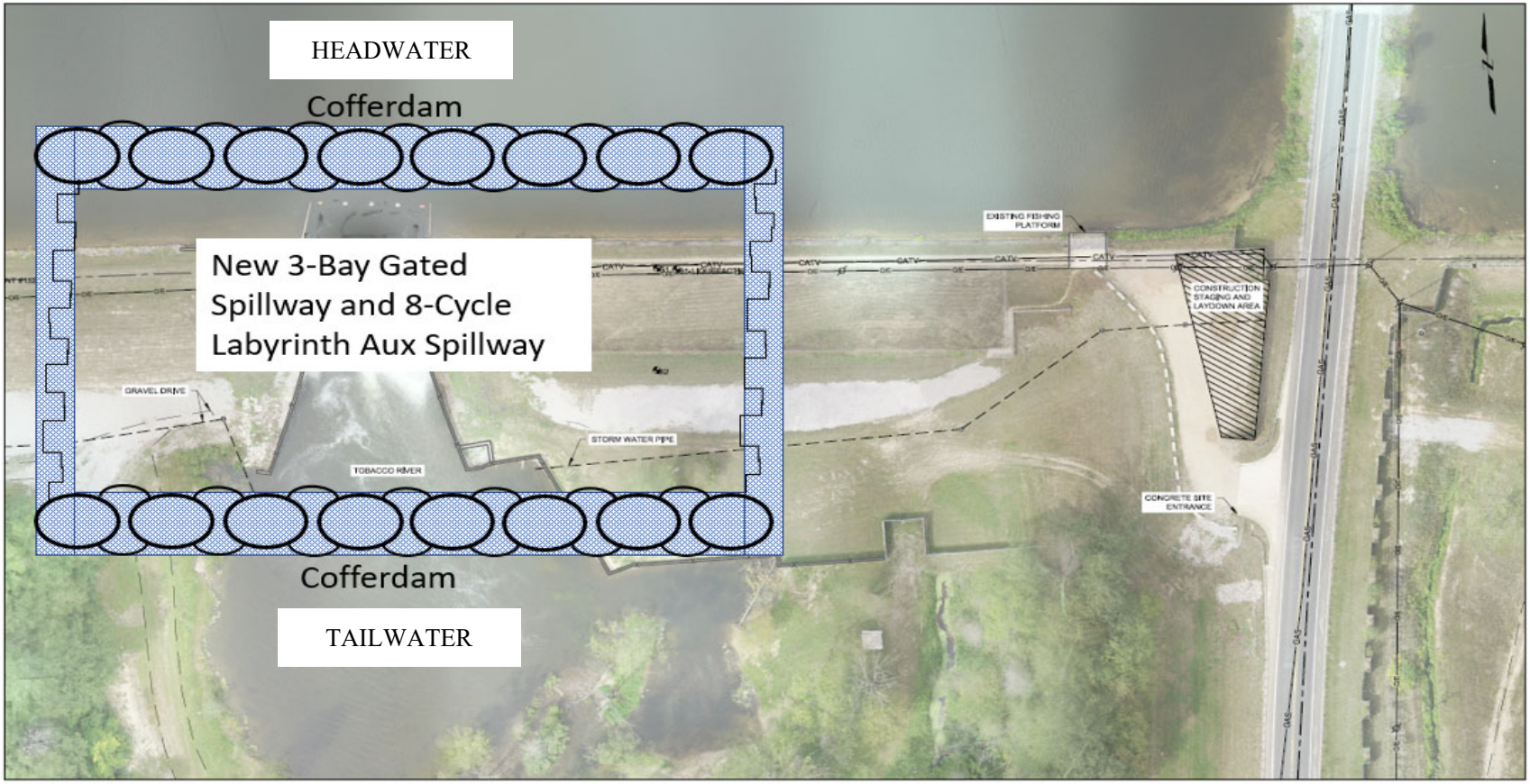


Post Failure Reconstruction Cost Analysis
Client: Four Lake Task Force (FLTF)
Location: Midland, Michigan

GEI Consultants

Sanford Dam Auxiliary Spillway and Breach Channel Cofferdam Plan

Project 2002879	July 2020	Figure 8

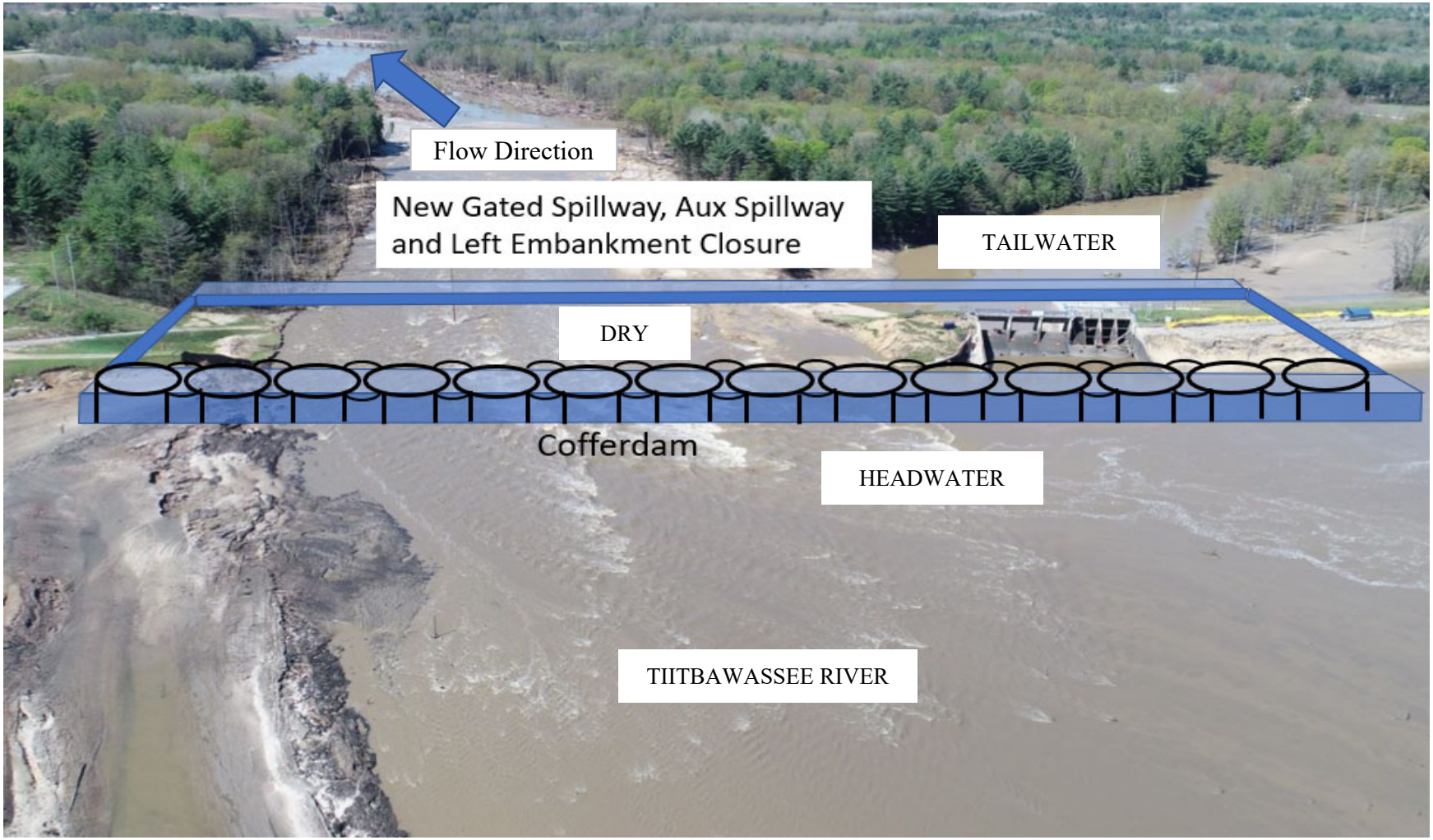


Post Failure Reconstruction Cost Analysis
Client: Four Lake Task Force (FLTF)
Location: Midland, Michigan

GEI Consultants

Edenville Dam - Tobacco Spillway Cofferdam Plan

Project 2002879	July 2020	Figure 9

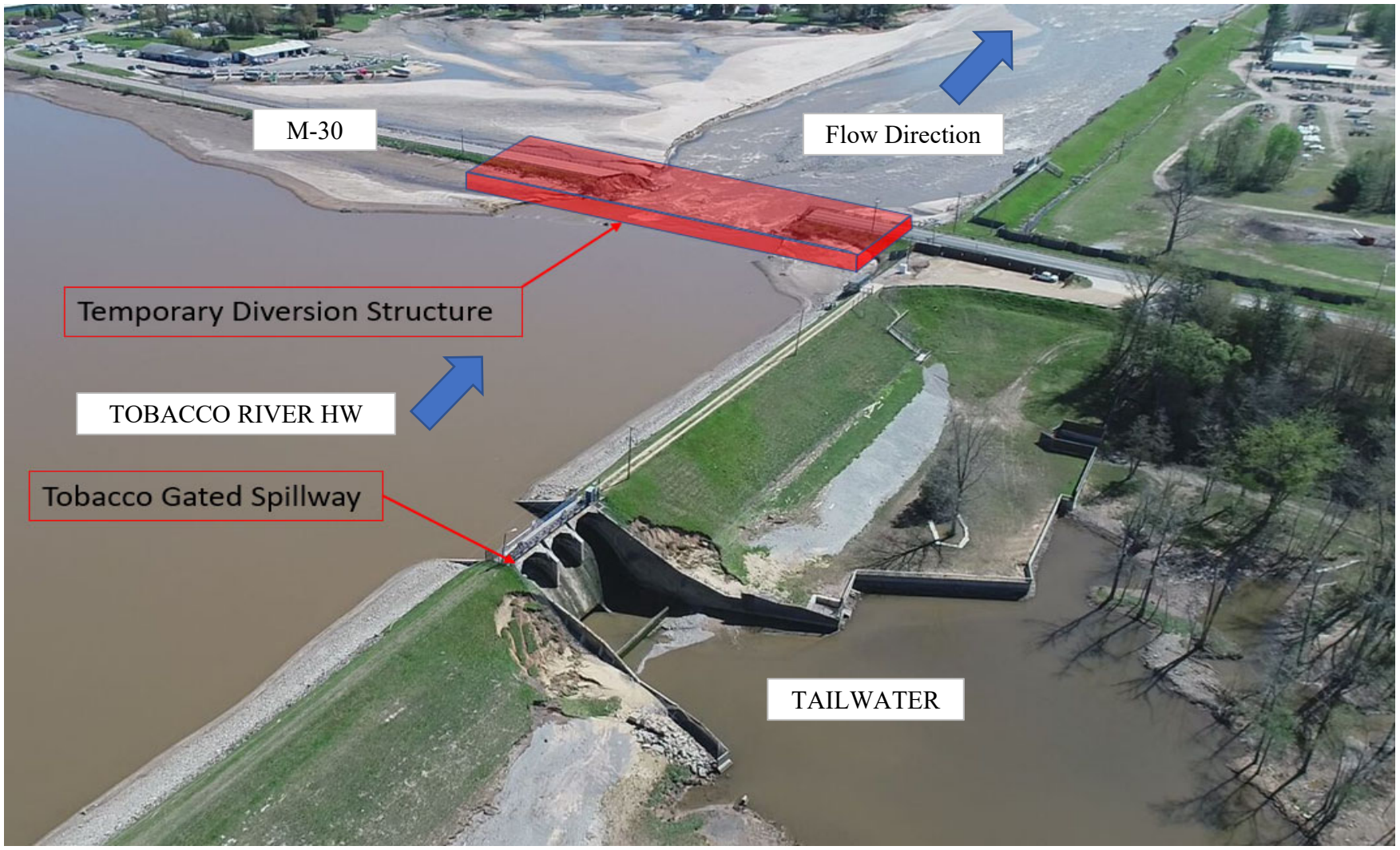


Post Failure Reconstruction Cost Analysis
Client: Four Lake Task Force (FLTF)
Location: Midland, Michigan

GEI Consultants

Edenville Dam - Edenville Spillway and Breach Channel Cofferdam Plan

Project 2002879	July 2020	Figure 10



Post Failure Reconstruction Cost Analysis
Client: Four Lake Task Force (FLTF)
Location: Midland, Michigan

GEI Consultants

M-30 Control Structure Location Plan

Project 2002879	July 2020	Figure 11

Attachment 1 – Pre and Post Failure Project Photographs

Sanford Dam

Sanford Dam

Sanford Dam

Edenville Dam - Tobacco Spillway

Edenville Dam - Tobacco Spillway

Edenville Dam - Tobacco Spillway

Edenville Dam - Tobacco Spillway

Edenville Dam - Edenville Spillway

Edenville Dam - Edenville Spillway

Edenville Dam - Edenville Spillway

Smallwood Dam

Smallwood Dam

Smallwood Dam

Smallwood Dam

Smallwood Dam

Attachment 2 – Concept Level Spillway Rating Curves

GEI Consultants

Client:	Four Lakes Task Force	**Project #:**	2002879	**Page:**	
Project:	Sanford Dam	**By:**	PDD	**Date:**	6/19/2020
Subject:	Rating Curve Calculations	**Checked:**	RJA	**Date:**	7/13/2020
		Approved:	WHW	**Date:**	7/13/2020

Ogee Spillway Discharge Rating Curve - Tainter Gates *(Fully Open)*

Input Parameter	Gate#1	Gate #2	Gate #3	Gate #4	Gate #5	Gate #6	Unit	Reference:
Crest Length	22	22	22	22	22	22	feet	STID
Crest El.	620	620	620	620	620	620	NGVD29 feet	STID
Ogee Design Head (Ho)	11	11	11	11	11	11	feet	*from Upper Nappe Profile Tab*
Approach El.	600.3	600.3	600.3	600.3	600.3	600.3		
Approach Depth (P)	19.7	19.7	19.7	19.7	19.7	19.7	feet	
Number of Piers	1	2	2	2	2	1	-	Discharge, $Q = Leff*C*H^{3/2}$
Abutment coeff (Ka)	0.1	0	0	0	0	0.1	-	
Pier coeff (Kp)	0	0	0	0	0	0		
Top of Non-Overflow El.	635.6	636.8	636.8	636.8	636.8	636.8	feet	L=L'- 2 (NKP +Ka) He
P/Ho	1.79	1.79	1.79	1.79	1.79	1.79		
Design Head Coeff.	3.92	3.92	3.92	3.92	3.92	3.92	Figure 9-23	USBR DOSD 1987

Weir Flow

Reservoir El.	Total Head, He	He / Ho	Ratio of Coeff. c/co	Adjusted Coeff., c	Eff. Length (Gate 1)	Eff. Length (Gate 2)	Eff. Length (Gate 3)	Eff. Length (Gate 4)	Eff. Length (Gate 5)	Eff. Length (Gate 6)	Discharge (Gate 1)	Discharge (Gate 2)	Discharge (Gate 3)	Discharge (Gate 4)	Discharge (Gate 5)	Discharge (Gate 6)	Discharge (All Gates)
ft	ft	-	-	-	ft	ft	ft	ft	ft	ft	cfs	cfs	cfs	cfs	cfs	cfs	cfs
620.0	0.0	0.0	0.78	3.06	22.0	22.0	22.0	22.0	22.0	22.0	0	0	0	0	0	0	0
622.5	2.5	0.2	0.86	3.36	21.5	22.0	22.0	22.0	22.0	21.5	285	292	292	292	292	285	1,738
623.0	3.0	0.3	0.87	3.40	21.4	22.0	22.0	22.0	22.0	21.4	379	389	389	389	389	379	2,314
623.5	3.5	0.3	0.88	3.45	21.3	22.0	22.0	22.0	22.0	21.3	481	497	497	497	497	481	2,950
624.0	4.0	0.4	0.89	3.49	21.2	22.0	22.0	22.0	22.0	21.2	592	615	615	615	615	592	3,643
624.5	4.5	0.4	0.90	3.53	21.1	22.0	22.0	22.0	22.0	21.1	711	742	742	742	742	711	4,390
625.0	5.0	0.5	0.91	3.57	21.0	22.0	22.0	22.0	22.0	21.0	838	878	878	878	878	838	5,189
625.5	5.5	0.5	0.92	3.61	20.9	22.0	22.0	22.0	22.0	20.9	972	1,023	1,023	1,023	1,023	972	6,037
626.0	6.0	0.5	0.93	3.64	20.8	22.0	22.0	22.0	22.0	20.8	1,113	1,177	1,177	1,177	1,177	1,113	6,933
626.5	6.5	0.6	0.94	3.67	20.7	22.0	22.0	22.0	22.0	20.7	1,260	1,339	1,339	1,339	1,339	1,260	7,876
627.0	7.0	0.6	0.95	3.70	20.6	22.0	22.0	22.0	22.0	20.6	1,413	1,509	1,509	1,509	1,509	1,413	8,864
627.5	7.5	0.7	0.95	3.73	20.5	22.0	22.0	22.0	22.0	20.5	1,572	1,687	1,687	1,687	1,687	1,572	9,895
628.0	8.0	0.7	0.96	3.76	20.4	22.0	22.0	22.0	22.0	20.4	1,737	1,874	1,874	1,874	1,874	1,737	10,969
628.5	8.5	0.8	0.97	3.79	20.3	22.0	22.0	22.0	22.0	20.3	1,908	2,067	2,067	2,067	2,067	1,908	12,084
629.0	9.0	0.8	0.98	3.82	20.2	22.0	22.0	22.0	22.0	20.2	2,083	2,269	2,269	2,269	2,269	2,083	13,240
629.5	9.5	0.9	0.98	3.85	20.1	22.0	22.0	22.0	22.0	20.1	2,263	2,477	2,477	2,477	2,477	2,263	14,436
630.0	10.0	0.9	0.99	3.87	20.0	22.0	22.0	22.0	22.0	20.0	2,449	2,694	2,694	2,694	2,694	2,449	15,672
630.5	10.5	1.0	1.00	3.90	19.9	22.0	22.0	22.0	22.0	19.9	2,639	2,917	2,917	2,917	2,917	2,639	16,945
631.0	11.0	1.0	1.00	3.92	19.8	22.0	22.0	22.0	22.0	19.8	2,833	3,148	3,148	3,148	3,148	2,833	18,257
631.5	11.5	1.0	1.01	3.95	19.7	22.0	22.0	22.0	22.0	19.7	3,032	3,386	3,386	3,386	3,386	3,032	19,605
632.0	12.0	1.1	1.01	3.97	19.6	22.0	22.0	22.0	22.0	19.6	3,234	3,630	3,630	3,630	3,630	3,234	20,990
632.5	12.5	1.1	1.02	3.99	19.5	22.0	22.0	22.0	22.0	19.5	3,441	3,882	3,882	3,882	3,882	3,441	22,410
633.0	13.0	1.2	1.03	4.02	19.4	22.0	22.0	22.0	22.0	19.4	3,651	4,140	4,140	4,140	4,140	3,651	23,864
633.5	13.5	1.2	1.03	4.04	19.3	22.0	22.0	22.0	22.0	19.3	3,865	4,406	4,406	4,406	4,406	3,865	25,352
634.0	14.0	1.3	1.04	4.06	19.2	22.0	22.0	22.0	22.0	19.2	4,082	4,677	4,677	4,677	4,677	4,082	26,871
634.5	14.5	1.3	1.04	4.08	19.1	22.0	22.0	22.0	22.0	19.1	4,301	4,954	4,954	4,954	4,954	4,301	28,421
634.8	14.8	1.3	1.04	4.09	19.0	22.0	22.0	22.0	22.0	19.0	4,434	5,124	5,124	5,124	5,124	4,434	29,365
635.0	15.0	1.4	1.05	4.10	19.0	22.0	22.0	22.0	22.0	19.0	4,524	5,238	5,238	5,238	5,238	4,524	29,999
635.5	15.5	1.4	1.05	4.12	18.9	22.0	22.0	22.0	22.0	18.9	4,748	5,527	5,527	5,527	5,527	4,748	31,604
636.0	**16.0**	**1.5**	**1.06**	**4.13**	**18.8**	**22.0**	**22.0**	**22.0**	**22.0**	**18.8**	**4,975**	**5,821**	**5,821**	**5,821**	**5,821**	**4,975**	**33,234**

LABYRINTH WEIR DESIGN
No Approach Velocity

PROJECT:	Sanford Labyrinth	**TIME:**	14:12:19
PROJECT NO.	2002879	**DATE:**	13-Jul-20
FLOOD CRITERIA:	1/2 PMF	**BY:**	PDD

USER INPUT

Max. Res	**Zr**	636.0	**ft**	**Thickness**			
Crest el.	**Zc**	632.5	**ft**	**Wall**	**Tw**	1.25	**ft**
Floor el.	**Zf**	628.0	**ft**	**Slab**	**Ts**	1.25	**ft**
Spillway width	**Ws**	165.0	**ft**	**Cutoff Depth**			
Apex Width	**2a**	2	**ft**	**Sheet Pile**	**Ds**	1	**ft**
No. of cycles	**n**	6		**Conc Wall**	**Dc**	1	**ft**
Magnification	**L/W**	3					

CHECK ON RATIOS

L_{de}/B = 0.22	**Ld/B RATIO IS OK**
H_o/P = 0.78	**Ho/P RATIO IS OK**
α = 17.42	**Angle IS OK**

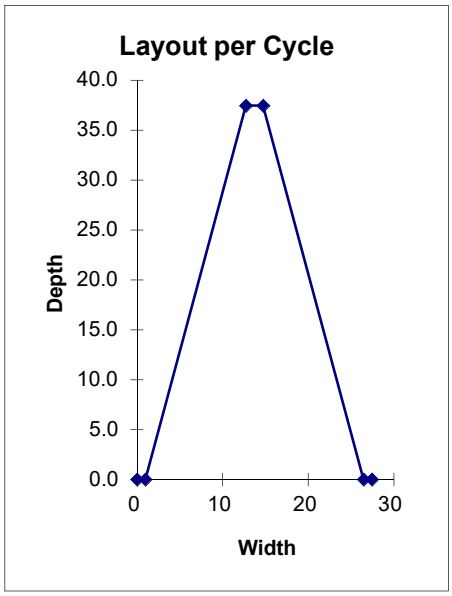
Note: L_{de}/B must be <= 0.35
Ho/P must be <= 0.9
α must be >= 6 deg

LABYRINTH DIMENSIONS (Per Cycle)

Wall Height	**P**	4.5	**ft**
Width	**W**	27.50	**ft**
Length	**L**	82.50	**ft**
Wall Length	**B**	39.25	**ft**
Depth	**D**	37.45	**ft**
Head max	**H**	3.50	**ft**
Wall Angle	**α**	17.42	**deg**
Length of Interference	**L_{de}**	8.66	**ft**

CREST LAYOUT
(One Cycle)

X	Y
0	0
1.00	0
12.75	37.45
14.75	37.45
26.50	0
27.50	0



DISCHARGE

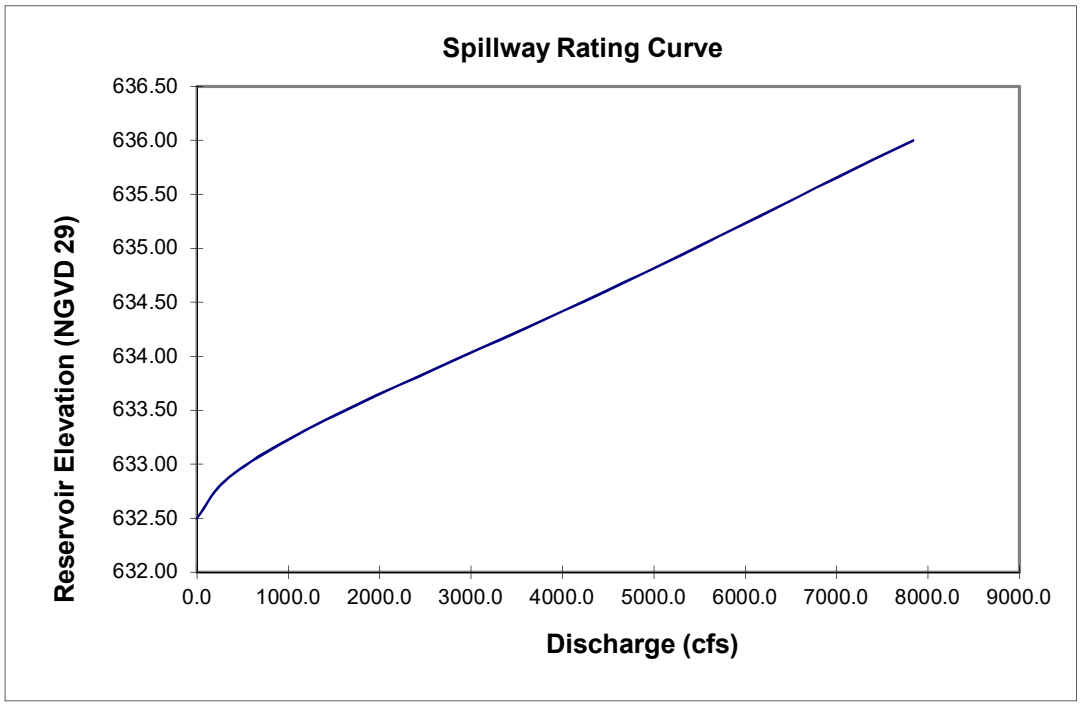
Qmax	7,837	**cfs**

COEFFICIENTS

Column	4.00
Cd lower	0.40
Cd Upper	0.46
Cd	0.45
Efficacy	1.80

RATING CURVE

HEAD	H_o/P	C_{lower}	C_{upper}	C_d	Q	RES
3.50	0.78	0.40	0.46	0.45	7837	636.00 1/2 PMF El.
3.15	0.70	0.42	0.48	0.47	6987	635.65
2.80	0.62	0.44	0.51	0.50	6157	635.30
2.45	0.54	0.47	0.54	0.52	5324	634.95
2.10	0.47	0.50	0.57	0.55	4464	634.60
1.75	0.39	0.53	0.59	0.58	3567	634.25
1.40	0.31	0.56	0.61	0.60	2648	633.90
1.05	0.23	0.57	0.62	0.61	1747	633.55
0.70	0.16	0.57	0.61	0.60	936	633.20
0.35	0.08	0.55	0.57	0.57	310	632.85
0.00	0.00	0.49	0.49	0.49	0	632.50



Discharge Coefficient Table Tullis et al. (1995)

Angle wall makes with centerline α

	6	8	12	15	18	25	35	90
A0	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
A1	-0.24	1.08	1.06	1.00	1.32	1.51	1.69	1.46
A2	-1.20	-5.27	-4.43	-3.57	-4.13	-3.83	-4.05	-2.56
A3	2.17	6.79	5.18	3.82	4.24	3.40	3.62	1.44
A4	-1.03	-2.83	-1.97	-1.38	-1.50	-1.05	-1.10	

GEI Consultants

Client:	Four Lakes Task Force	**Project #:**	2002879	**Page:**	
Project:	Edenville Dam	**By:**	PDD	**Date:**	6/19/2020
Subject:	Rating Curve Calculations	**Checked:**	RJA	**Date:**	7/13/2020
		Approved:	WHW	**Date:**	7/13/2020

Ogee Spillway Discharge Rating Curve - Tainter Gates *(Fully Open)*

	Edenville			Tobacco				
Input Parameter	**Gate#1**	**Gate #2**	**Gate #3**	**Gate #1**	**Gate #2**	**Gate #3**	**Unit**	**Reference:**
Crest Length	24	24	24	24	24	24	feet	STID
Crest El.	665.5	665.5	665.5	665.5	665.5	665.5	NGVD29 feet	STID
Ogee Design Head (Ho)	12	12	12	12	12	12	feet	*from Upper Nappe Profile Tab*
Approach El.	628.3	628.3	628.3	628.3	628.3	628.3		
Approach Depth (P)	37.2	37.2	37.2	37.2	37.2	37.2	feet	
Number of Piers	1	2	1	1	2	1	-	Discharge, $Q = Leff*C*H^{3/2}$
Abutment coeff (Ka)	0.15	0	0.15	0.15	0	0.15	-	
Pier coeff (Kp)	0.01	0.01	0.01	0.01	0.01	0.01		
Top of Non-Overflow El.	636.8	636.8	636.8	636.8	636.8	636.8	feet	L=L'- 2 (NKP +Ka) He
P/Ho	3.10	3.10	3.10	3.10	3.10	3.10		
Design Head Coeff.	3.93	3.93	3.93	3.93	3.93	3.93	Figure 9-23	USBR DOSD 1987
Max Opening Height							feet	From Gate Test Notes

Weir Flow

Reservoir El.	Total Head, He	He / Ho	Ratio of Coeff. c/co	Adjusted Coeff., c	Eff. Length (Edenville Gate 1)	Eff. Length (Edenville Gate 2)	Eff. Length (Edenville Gate 3)	Eff. Length (Tobacco Gate 1)	Eff. Length (Tobacco Gate 2)	Eff. Length (Tobacco Gate 3)	Discharge (Edenville Gate 1)	Discharge (Edenville Gate 2)	Discharge (Edenville Gate 3)	Discharge (Tobacco Gate 1)	Discharge (Tobacco Gate 2)	Discharge (Tobacco Gate 3)	Edenville Gates	Tobacco Gates
ft	ft	-	-	-	ft	ft	ft	ft	ft	ft	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs
665.5	0.0	0.0	0.78	3.08	24.0	24.0	24.0	24.0	24.0	24.0	0	0	0	0	0	0	0	0
668.0	2.5	0.2	0.85	3.35	23.2	23.9	23.2	23.2	23.9	23.2	307	316	307	307	316	307	930	930
668.5	3.0	0.3	0.86	3.39	23.0	23.9	23.0	23.0	23.9	23.0	406	421	406	406	421	406	1,234	1,234
669.0	3.5	0.3	0.87	3.44	22.9	23.9	22.9	22.9	23.9	22.9	515	537	515	515	537	515	1,566	1,566
669.5	4.0	0.3	0.88	3.48	22.7	23.8	22.7	22.7	23.8	22.7	632	663	632	632	663	632	1,927	1,927
670.0	4.5	0.4	0.89	3.51	22.6	23.8	22.6	22.6	23.8	22.6	757	799	757	757	799	757	2,313	2,313
670.5	5.0	0.4	0.90	3.55	22.4	23.8	22.4	22.4	23.8	22.4	889	945	889	889	945	889	2,724	2,724
671.0	5.5	0.5	0.91	3.59	22.2	23.8	22.2	22.2	23.8	22.2	1,029	1,100	1,029	1,029	1,100	1,029	3,157	3,157
671.5	6.0	0.5	0.92	3.62	22.1	23.8	22.1	22.1	23.8	22.1	1,174	1,264	1,174	1,174	1,264	1,174	3,612	3,612
672.0	6.5	0.5	0.93	3.65	21.9	23.7	21.9	21.9	23.7	21.9	1,326	1,436	1,326	1,326	1,436	1,326	4,088	4,088
672.5	7.0	0.6	0.94	3.68	21.8	23.7	21.8	21.8	23.7	21.8	1,483	1,617	1,483	1,483	1,617	1,483	4,583	4,583
673.0	7.5	0.6	0.94	3.71	21.6	23.7	21.6	21.6	23.7	21.6	1,646	1,806	1,646	1,646	1,806	1,646	5,097	5,097
673.5	8.0	0.7	0.95	3.74	21.4	23.7	21.4	21.4	23.7	21.4	1,813	2,003	1,813	1,813	2,003	1,813	5,629	5,629
674.0	8.5	0.7	0.96	3.76	21.3	23.7	21.3	21.3	23.7	21.3	1,985	2,207	1,985	1,985	2,207	1,985	6,178	6,178
674.5	9.0	0.8	0.96	3.79	21.1	23.6	21.1	21.1	23.6	21.1	2,162	2,420	2,162	2,162	2,420	2,162	6,744	6,744
675.0	9.5	0.8	0.97	3.82	21.0	23.6	21.0	21.0	23.6	21.0	2,342	2,640	2,342	2,342	2,640	2,342	7,325	7,325
675.5	10.0	0.8	0.98	3.84	20.8	23.6	20.8	20.8	23.6	20.8	2,527	2,867	2,527	2,527	2,867	2,527	7,921	7,921
676.0	10.5	0.9	0.98	3.87	20.6	23.6	20.6	20.6	23.6	20.6	2,715	3,102	2,715	2,715	3,102	2,715	8,531	8,531
676.5	11.0	0.9	0.99	3.89	20.5	23.6	20.5	20.5	23.6	20.5	2,906	3,343	2,906	2,906	3,343	2,906	9,156	9,156
677.0	11.5	1.0	1.00	3.91	20.3	23.5	20.3	20.3	23.5	20.3	3,101	3,592	3,101	3,101	3,592	3,101	9,794	9,794
677.5	12.0	1.0	1.00	3.94	20.2	23.5	20.2	20.2	23.5	20.2	3,298	3,848	3,298	3,298	3,848	3,298	10,445	10,445
678.0	12.5	1.0	1.01	3.96	20.0	23.5	20.0	20.0	23.5	20.0	3,498	4,111	3,498	3,498	4,111	3,498	11,108	11,108
678.5	13.0	1.1	1.01	3.98	19.8	23.5	19.8	19.8	23.5	19.8	3,701	4,380	3,701	3,701	4,380	3,701	11,782	11,782
679.0	13.5	1.1	1.02	4.00	19.7	23.5	19.7	19.7	23.5	19.7	3,906	4,656	3,906	3,906	4,656	3,906	12,468	12,468
679.5	14.0	1.2	1.02	4.02	19.5	23.4	19.5	19.5	23.4	19.5	4,113	4,939	4,113	4,113	4,939	4,113	13,164	13,164
680.0	14.5	1.2	1.03	4.04	19.4	23.4	19.4	19.4	23.4	19.4	4,321	5,227	4,321	4,321	5,227	4,321	13,870	13,870
680.5	15.0	1.3	1.03	4.06	19.2	23.4	19.2	19.2	23.4	19.2	4,531	5,522	4,531	4,531	5,522	4,531	14,584	14,584
680.8	15.3	1.3	1.04	4.07	19.1	23.4	19.1	19.1	23.4	19.1	4,658	5,702	4,658	4,658	5,702	4,658	15,017	15,017
681.0	**15.5**	**1.3**	**1.04**	**4.08**	**19.0**	**23.4**	**19.0**	**19.0**	**23.4**	**19.0**	**4,742**	**5,823**	**4,742**	**4,742**	**5,823**	**4,742**	**15,307**	**15,307**

LABYRINTH WEIR DESIGN
No Approach Velocity

PROJECT:	Edenville Labyrinth	**TIME:**	14:12:19
PROJECT NO.	2002879	**DATE:**	13-Jul-20
FLOOD CRITERIA:	1/2 PMF	**BY:**	PDD

USER INPUT

Max. Res	**Zr**	681.0	**ft**	**Thickness**			
Crest el.	**Zc**	677.8	**ft**	**Wall**	**Tw**	1.25	**ft**
Floor el.	**Zf**	673.0	**ft**	**Slab**	**Ts**	1.25	**ft**
Spillway width	**Ws**	125.0	**ft**	**Cutoff Depth**			
Apex Width	**2a**	2	**ft**	**Sheet Pile**	**Ds**	1	**ft**
No. of cycles	**n**	6		**Conc Wall**	**Dc**	1	**ft**
Magnification	**L/W**	3					

CHECK ON RATIOS

L_{de}/B =	0.28	**Ld/B RATIO IS OK**
H_o/P =	0.67	**Ho/P RATIO IS OK**
α =	16.72	**Angle IS OK**

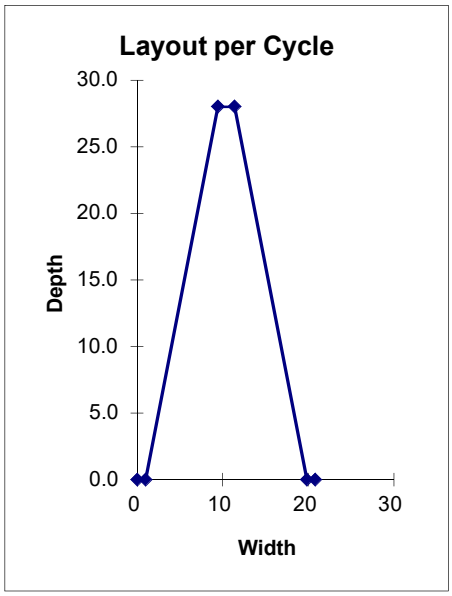
Note: L_{de}/B must be <= 0.35
Ho/P must be <= 0.9
α must be >= 6 deg

LABYRINTH DIMENSIONS (Per Cycle)

Wall Height	**P**	4.8	**ft**
Width	**W**	20.83	**ft**
Length	**L**	62.50	**ft**
Wall Length	**B**	29.25	**ft**
Depth	**D**	28.01	**ft**
Head max	**H**	3.20	**ft**
Wall Angle	**α**	16.72	**deg**
Length of Interference	**L_{de}**	8.21	**ft**

CREST LAYOUT
(One Cycle)

X	Y
0	0
1.00	0
9.42	28.01
11.42	28.01
19.83	0
20.83	0



DISCHARGE

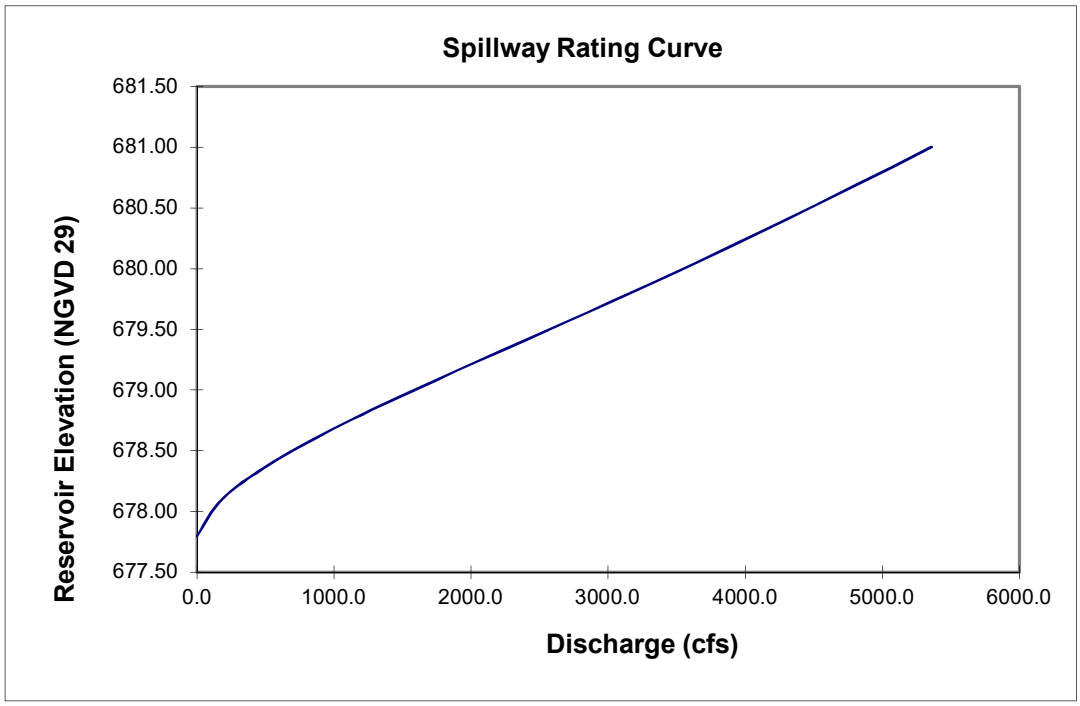
Qmax	5,360	**cfs**

COEFFICIENTS

Column	4.00
Cd lower	0.43
Cd Upper	0.49
Cd	0.47
Efficacy	1.86

RATING CURVE

HEAD	H_o/P	C_{lower}	C_{upper}	C_d	Q	RES
3.20	0.67	0.43	0.49	0.47	5360	681.00 1/2 PMF El.
2.88	0.60	0.45	0.52	0.49	4792	680.68
2.56	0.53	0.48	0.54	0.51	4218	680.36
2.24	0.47	0.50	0.57	0.54	3625	680.04
1.92	0.40	0.53	0.59	0.56	3009	679.72
1.60	0.33	0.55	0.61	0.58	2374	679.40
1.28	0.27	0.57	0.62	0.60	1739	679.08
0.96	0.20	0.58	0.62	0.60	1135	678.76
0.64	0.13	0.57	0.60	0.59	604	678.44
0.32	0.07	0.54	0.56	0.55	201	678.12
0.00	0.00	0.49	0.49	0.49	0	677.80



Discharge Coefficient Table Tullis et al. (1995)

Angle wall makes with centerline α

	6	8	12	15	18	25	35	90
A0	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
A1	-0.24	1.08	1.06	1.00	1.32	1.51	1.69	1.46
A2	-1.20	-5.27	-4.43	-3.57	-4.13	-3.83	-4.05	-2.56
A3	2.17	6.79	5.18	3.82	4.24	3.40	3.62	1.44
A4	-1.03	-2.83	-1.97	-1.38	-1.50	-1.05	-1.10	

LABYRINTH WEIR DESIGN
No Approach Velocity

PROJECT:	Tobacco Labyrinth	**TIME:**	14:12:19
PROJECT NO.	2002879	**DATE:**	13-Jul-20
FLOOD CRITERIA:	1/2 PMF	**BY:**	PDD

USER INPUT

Max. Res	**Zr**	681.0	**ft**	**Thickness**			
Crest el.	**Zc**	677.8	**ft**	**Wall**	**Tw**	1.25	**ft**
Floor el.	**Zf**	673.0	**ft**	**Slab**	**Ts**	1.25	**ft**
Spillway width	**Ws**	125.0	**ft**	**Cutoff Depth**			
Apex Width	**2a**	2	**ft**	**Sheet Pile**	**Ds**	1	**ft**
No. of cycles	**n**	6		**Conc Wall**	**Dc**	1	**ft**
Magnification	**L/W**	3					

CHECK ON RATIOS

L_{de}/B =	0.28	**Ld/B RATIO IS OK**
H_o/P =	0.67	**Ho/P RATIO IS OK**
α =	16.72	**Angle IS OK**

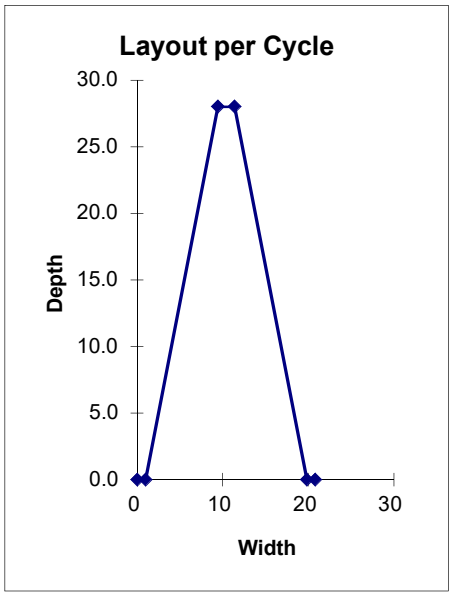
Note: L_{de}/B must be <= 0.35
Ho/P must be <= 0.9
α must be >= 6 deg

LABYRINTH DIMENSIONS (Per Cycle)

Wall Height	**P**	4.8	**ft**
Width	**W**	20.83	**ft**
Length	**L**	62.50	**ft**
Wall Length	**B**	29.25	**ft**
Depth	**D**	28.01	**ft**
Head max	**H**	3.20	**ft**
Wall Angle	**α**	16.72	**deg**
Length of Interference	**L_{de}**	8.21	**ft**

CREST LAYOUT
(One Cycle)

X	Y
0	0
1.00	0
9.42	28.01
11.42	28.01
19.83	0
20.83	0



DISCHARGE

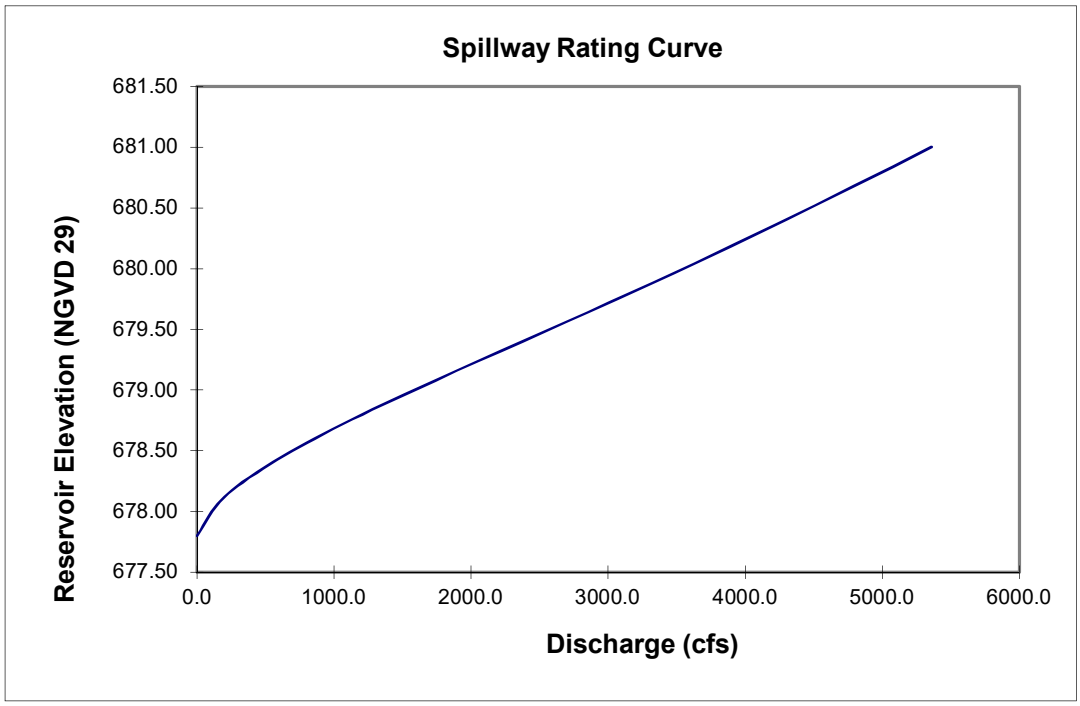
Qmax	5,360	**cfs**

COEFFICIENTS

Column	4.00
Cd lower	0.43
Cd Upper	0.49
Cd	0.47
Efficacy	1.86

RATING CURVE

HEAD	H_o/P	C_{lower}	C_{upper}	C_d	Q	RES
3.20	0.67	0.43	0.49	0.47	5360	681.00 1/2 PMF El.
2.88	0.60	0.45	0.52	0.49	4792	680.68
2.56	0.53	0.48	0.54	0.51	4218	680.36
2.24	0.47	0.50	0.57	0.54	3625	680.04
1.92	0.40	0.53	0.59	0.56	3009	679.72
1.60	0.33	0.55	0.61	0.58	2374	679.40
1.28	0.27	0.57	0.62	0.60	1739	679.08
0.96	0.20	0.58	0.62	0.60	1135	678.76
0.64	0.13	0.57	0.60	0.59	604	678.44
0.32	0.07	0.54	0.56	0.55	201	678.12
0.00	0.00	0.49	0.49	0.49	0	677.80



Discharge Coefficient Table Tullis et al. (1995)

Angle wall makes with centerline α

	6	8	12	15	18	25	35	90
A0	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
A1	-0.24	1.08	1.06	1.00	1.32	1.51	1.69	1.46
A2	-1.20	-5.27	-4.43	-3.57	-4.13	-3.83	-4.05	-2.56
A3	2.17	6.79	5.18	3.82	4.24	3.40	3.62	1.44
A4	-1.03	-2.83	-1.97	-1.38	-1.50	-1.05	-1.10	

GEI Consultants

Client:	Four Lakes Task Force	**Project #:**	2002879	**Page:**	
Project:	Smallwood Dam	**By:**	PDD	**Date:**	6/19/2020
Subject:	Rating Curve Calculations	**Checked:**	RJA	**Date:**	7/13/2020
		Approved:	WHW	**Date:**	7/13/2020

Ogee Spillway Discharge Rating Curve - Tainter Gates *(Fully Open)*

2 Gates

Input Parameter	Gate 1	Gate 2	Unit	Reference:
Crest Length	23.4	23.4	feet	STID, rev 2018
Crest El.	694.8	694.8	NGVD29 feet	STID, rev 2018
Ogee Design Head (Ho)	11	11	feet	*from Upper Nappe Profile Tab*
Apron Elevation	672.6	672.6		Original Drawings, Drw 10418
Approach Depth (P)	22.2	22.2	feet	
Number of Piers	1	1	-	Discharge, $Q = Leff*C*H^{3/2}$
Abutment coeff (Ka)	0.1	0.1	-	
Pier coeff (Kp)	0	0		
Top of Non-Overflow El.	715.7	715.7	feet	L=L'- 2 (NKP +Ka) He
P/Ho	2.02	2.02		
Design Head Coeff.	3.92	3.92	Figure 9-23	USBR DOSD 1987

Weir Flow

Reservoir El.	Total Head, He	He / Ho	Ratio of Coeff. c/co	Adjusted Coeff., c	Eff. Length (Gate 1)	Eff. Length (Gate 2)	Discharge (Gate 1)	Discharge (Gate 2)	Discharge (Both Gates)
ft	ft	-	-	-	ft	ft	cfs	cfs	cfs
694.8	0.0	0.00	0.78	3.07	23.4	23.4	0	0	0
695.0	0.2	0.02	0.79	3.09	23.4	23.4	6	6	13
695.5	0.7	0.06	0.81	3.16	23.3	23.3	43	43	86
696.0	1.2	0.11	0.82	3.22	23.2	23.2	98	98	196
696.5	1.7	0.15	0.84	3.28	23.1	23.1	167	167	335
697.0	2.2	0.20	0.85	3.33	23.0	23.0	249	249	499
697.5	2.7	0.25	0.86	3.38	22.9	22.9	343	343	686
698.0	3.2	0.29	0.87	3.43	22.8	22.8	446	446	893
698.5	3.7	0.34	0.89	3.47	22.7	22.7	560	560	1,119
699.0	4.2	0.38	0.90	3.51	22.6	22.6	682	682	1,364
699.5	4.7	0.43	0.91	3.55	22.5	22.5	813	813	1,625
700.0	5.2	0.47	0.92	3.59	22.4	22.4	951	951	1,903
700.5	5.7	0.52	0.92	3.62	22.3	22.3	1,098	1,098	2,195
701.0	6.2	0.56	0.93	3.66	22.2	22.2	1,251	1,251	2,502
701.5	6.7	0.61	0.94	3.69	22.1	22.1	1,411	1,411	2,823
702.0	7.2	0.65	0.95	3.72	22.0	22.0	1,578	1,578	3,157
702.5	7.7	0.70	0.96	3.75	21.9	21.9	1,752	1,752	3,503
703.0	8.2	0.75	0.96	3.78	21.8	21.8	1,931	1,931	3,862
703.5	8.7	0.79	0.97	3.81	21.7	21.7	2,116	2,116	4,232
704.0	9.2	0.84	0.98	3.83	21.6	21.6	2,307	2,307	4,613
704.5	9.7	0.88	0.98	3.86	21.5	21.5	2,503	2,503	5,005
705.0	10.2	0.93	0.99	3.89	21.4	21.4	2,704	2,704	5,408
705.5	10.7	0.97	1.00	3.91	21.3	21.3	2,910	2,910	5,820
706.0	11.2	1.02	1.00	3.94	21.2	21.2	3,121	3,121	6,243
706.5	11.7	1.06	1.01	3.96	21.1	21.1	3,337	3,337	6,674
707.0	12.2	1.11	1.02	3.98	21.0	21.0	3,557	3,557	7,115
707.5	12.7	1.15	1.02	4.01	20.9	20.9	3,782	3,782	7,564
708.0	13.2	1.20	1.03	4.03	20.8	20.8	4,010	4,010	8,021
708.5	13.7	1.25	1.03	4.05	20.7	20.7	4,243	4,243	8,485
709.0	14.2	1.29	1.04	4.07	20.6	20.6	4,478	4,478	8,957
709.5	14.7	1.34	1.04	4.09	20.5	20.5	4,717	4,717	9,435
710.0	15.2	1.38	1.05	4.11	20.4	20.4	4,959	4,959	9,918
710.5	15.7	1.43	1.05	4.13	20.3	20.3	5,203	5,203	10,406
711.0	16.2	1.47	1.06	4.15	20.2	20.2	5,449	5,449	10,898
711.5	16.7	1.52	1.06	4.16	20.1	20.1	5,697	5,697	11,393
712.0	17.2	1.56	1.07	4.18	20.0	20.0	5,945	5,945	11,890
712.5	17.7	1.61	1.07	4.19	19.9	19.9	6,194	6,194	12,387
713.0	18.2	1.65	1.07	4.20	19.8	19.8	6,442	6,442	12,884
713.5	**18.7**	**1.70**	**1.07**	**4.21**	**19.7**	**19.7**	**6,689**	**6,689**	**13,379**

LABYRINTH WEIR DESIGN
No Approach Velocity

PROJECT:	Smallwood Labyrinth	**TIME:**	14:12:19
PROJECT NO.	2002879	**DATE:**	13-Jul-20
FLOOD CRITERIA:	1/2 PMF	**BY:**	PDD

USER INPUT

Max. Res	**Zr**	713.5	**ft**	**Thickness**			
Crest el.	**Zc**	709.5	**ft**	**Wall**	**Tw**	1.25	**ft**
Floor el.	**Zf**	703.5	**ft**	**Slab**	**Ts**	1.25	**ft**
Spillway width	**Ws**	125.0	**ft**	**Cutoff Depth**			
Apex Width	**2a**	2	**ft**	**Sheet Pile**	**Ds**	1	**ft**
No. of cycles	**n**	6		**Conc Wall**	**Dc**	1	**ft**
Magnification	**L/W**	3					

CHECK ON RATIOS

L_{de}/B =	0.35	**USE FEWER CYCLES**
H_o/P =	0.67	**Ho/P RATIO IS OK**
α =	16.72	**Angle IS OK**

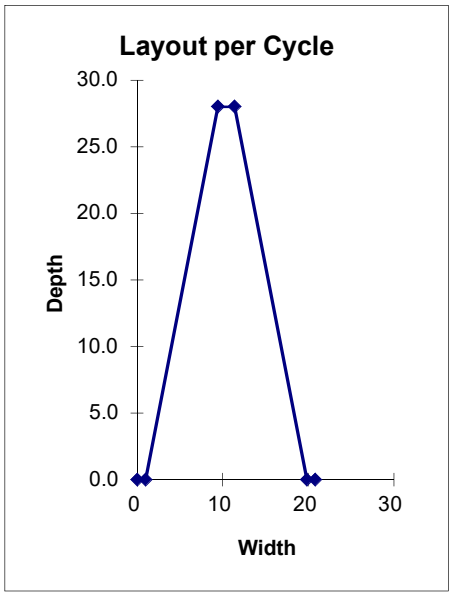
Note: L_{de}/B must be <= 0.35
Ho/P must be <= 0.9
α must be >= 6 deg

LABYRINTH DIMENSIONS (Per Cycle)

Wall Height	**P**	6	**ft**
Width	**W**	20.83	**ft**
Length	**L**	62.50	**ft**
Wall Length	**B**	29.25	**ft**
Depth	**D**	28.01	**ft**
Head max	**H**	4.00	**ft**
Wall Angle	**α**	16.72	**deg**
Length of Interference	**L_{de}**	10.26	**ft**

CREST LAYOUT
(One Cycle)

X	Y
0	0
1.00	0
9.42	28.01
11.42	28.01
19.83	0
20.83	0



DISCHARGE

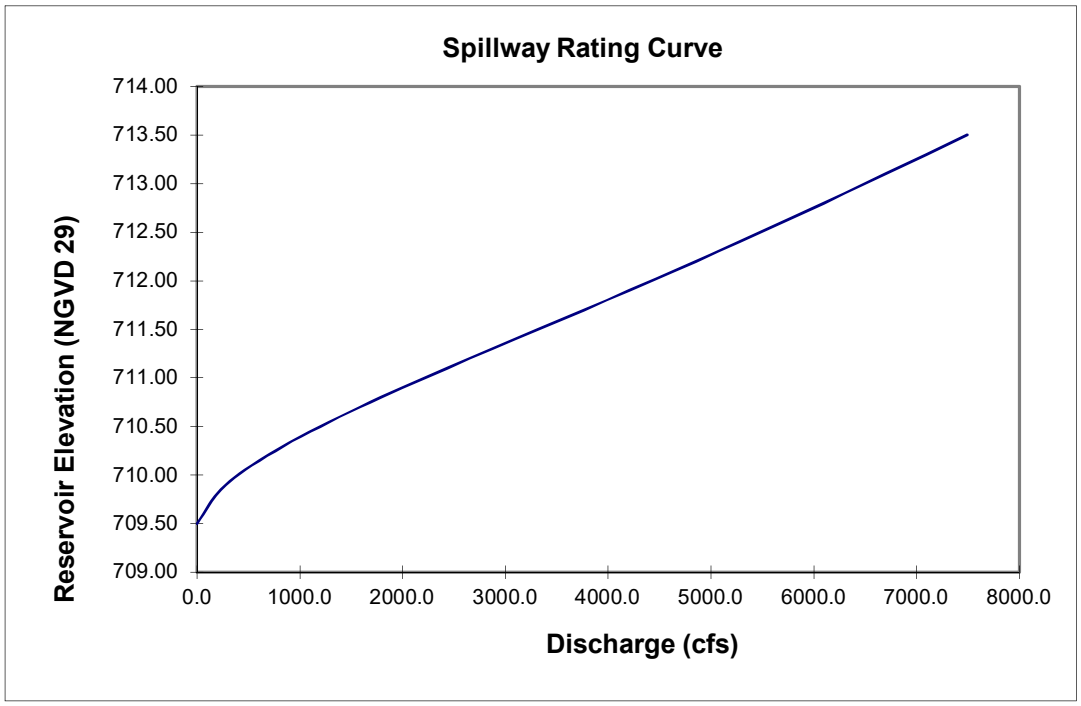
Qmax	7,491	**cfs**

COEFFICIENTS

Column	4.00
Cd lower	0.43
Cd Upper	0.49
Cd	0.47
Efficacy	1.86

RATING CURVE

HEAD	H_o/P	C_{lower}	C_{upper}	C_d	Q	RES
4.00	0.67	0.43	0.49	0.47	7491	713.50 1/2 PMF El.
3.60	0.60	0.45	0.52	0.49	6697	713.10
3.20	0.53	0.48	0.54	0.51	5895	712.70
2.80	0.47	0.50	0.57	0.54	5066	712.30
2.40	0.40	0.53	0.59	0.56	4205	711.90
2.00	0.33	0.55	0.61	0.58	3318	711.50
1.60	0.27	0.57	0.62	0.60	2431	711.10
1.20	0.20	0.58	0.62	0.60	1586	710.70
0.80	0.13	0.57	0.60	0.59	844	710.30
0.40	0.07	0.54	0.56	0.55	281	709.90
0.00	0.00	0.49	0.49	0.49	0	709.50



Discharge Coefficient Table Tullis et al. (1995)

Angle wall makes with centerline α

	6	8	12	15	18	25	35	90
A0	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
A1	-0.24	1.08	1.06	1.00	1.32	1.51	1.69	1.46
A2	-1.20	-5.27	-4.43	-3.57	-4.13	-3.83	-4.05	-2.56
A3	2.17	6.79	5.18	3.82	4.24	3.40	3.62	1.44
A4	-1.03	-2.83	-1.97	-1.38	-1.50	-1.05	-1.10	

GEI Consultants

Client:	Four Lakes Task Force	**Project #:**	2002879	**Page:**	
Project:	Secord Dam	**By:**	PDD	**Date:**	6/19/2020
Subject:	Rating Curve Calculations	**Checked:**	RJA	**Date:**	7/13/2020
		Approved:	WHW	**Date:**	7/13/2020

Ogee Spillway Discharge Rating Curve - Tainter Gates *(Fully Open)*

Input Parameter	Gate #1	Gate#2	Unit	Reference:
Crest Length	23	23	feet	Spicer Group Hydraulic Report
Crest El.	737.5	737.5	NGVD29 feet	Spicer Group Hydraulic Report
Ogee Design Head (Ho)	15	15	feet	*from Upper Nappe Profile Tab*
	702.8	702.8		
Approach Depth (P)	34.7	34.7	feet	
Number of Piers	1	1	-	Discharge, $Q = Leff*C*H^{3/2}$
Abutment coeff (Ka)	0.1	0.1	-	
Pier coeff (Kp)	0	0		
Top of Non-Overflow El.	757.8	757.8	feet	L=L'- 2 (NKP +Ka) He
P/Ho	2.31	2.31		
Design Head Coeff.	3.92	3.92	Figure 9-23	USBR DOSD 1987

Weir Flow

Reservoir El.	Total Head, He	He / Ho	Ratio of Coeff. c/co	Adjusted Coeff., c	Eff. Length (Gate 1)	Eff. Length (Gate 2)	Discharge (Gate 1)	Discharge (Gate 2)	Discharge (All Gates)
ft	ft	-	-	-	ft	ft	cfs	cfs	cfs
750.8	13.3	0.89	0.99	3.87	20.3	20.3	3,814	3,814	7,628
751.0	13.5	0.90	0.99	3.87	20.3	20.3	3,900	3,900	7,801
751.5	14.0	0.93	0.99	3.89	20.2	20.2	4,119	4,119	8,237
752.0	14.5	0.97	1.00	3.91	20.1	20.1	4,340	4,340	8,680
752.5	15.0	1.00	1.00	3.93	20.0	20.0	4,565	4,565	9,130
753.0	15.5	1.03	1.01	3.95	19.9	19.9	4,793	4,793	9,585
753.5	16.0	1.07	1.01	3.96	19.8	19.8	5,023	5,023	10,047
754.0	16.5	1.10	1.01	3.98	19.7	19.7	5,257	5,257	10,514
754.5	17.0	1.13	1.02	4.00	19.6	19.6	5,493	5,493	10,986
755.0	**17.5**	**1.17**	**1.02**	**4.01**	**19.5**	**19.5**	**5,732**	**5,732**	**11,463**

New Auxiliary Spillway

Pond El. (ft)	Invert El. (ft)	Spillway Length (ft)	C	Head (ft)	Discharge (cfs)
755	752	200	3.3	3	3,429

Attachment 3 – OPCC Estimate Worksheets – ½ PMF

OPINION OF PROBABLE COST - CONCEPTUAL

Project: Sanford Dam — **Project No.: 2002879**
Client: Four Lakes Task Force (FLTF) — **Date: 6/30/2020**
Design Discharge = 1/2 PMF — **Estimated by: P. Drew / R. Anderson**
Checked by: B. Walton

Item	Description	Quantity	Units	Unit Price	Total Cost	Notes
0.00	**General Conditions**					
0.01	Contractor Mobilization / Demobilization	1	LS	$ 4,081,000	$ 4,081,000	7% of Other Costs
0.02	Bonds and Insurance	1	LS	$ 1,166,000	$ 1,166,000	2% of Other Costs
0.03	Construction Permits	1	LS	$ 50,000	$ 50,000	
				Subtotal	**$ 5,297,000**	
1.00	**Site Preparation**					
1.01	Erosion and Sediment Control	1	LS	$ 50,000	$ 50,000	
1.02	Temporary Access Roads, Facilities and Laydown Areas	1	LS	$ 500,000	$ 500,000	
1.03	Stabilize Breach Channel and Right Embankment	1	LS	$ 300,000	$ 300,000	
1.04	Phase I Cofferdams - Spillway and PH Area (U/S and D/S)	1	LS	$ 4,120,000	$ 4,120,000	PS-27.5 SSP, circular cells, D=35', B=31.5', H=45'. Cofferdam L=500', $40/sf installed; ASTM C-33 fill at $20/cy
1.05	Phase II Cofferdams - Aux Spillway Area	1	LS	$ 6,590,000	$ 6,590,000	PS-27.5 SSP, circular cells, D=35', B=31.5', H=45'. Cofferdam L=800', $40/sf installed; ASTM C-33 fill at $20/cy
1.06	Construction Dewatering	1	LS	$ 2,000,000	$ 2,000,000	$1M / year x 2 years
1.07	Sediment Removal and Dredging	1	LS	$ 700,000	$ 700,000	
				Subtotal	**$ 14,260,000**	
2.00	**Demolition / Abandonment**					
2.01	Powerhouse Decommission, Demolition and Disposal	1	LS	$ 2,000,000	$ 2,000,000	
2.02	Gated Spillway Demolition and Disposal	1	LS	$ 2,000,000	$ 2,000,000	
2.03	Embankment Excavation and Disposal	50,000	CY	$ 20	$ 1,000,000	
2.04	Mechanical and Electrical Equipment Demolition and Disposal	1	LS	$ 250,000	$ 250,000	
				Subtotal	**$ 5,250,000**	
3.00	**Left Abutment Reconstruction**					
3.01	Left Abutment / Embankment Reconstruction	13,300	CY	$ 30	$ 399,000	
3.02	Sheet Pile Cutoff	8,000	SF	$ 70	$ 560,000	PZC-18 hot-rolled or equal with treated interlocks, L = 40' avg
3.03	Erosion Protection	2,000	CY	$ 80	$ 160,000	
				Subtotal	**$ 1,119,000**	
4.00	**Right Embankment Reconstruction**					
4.01	Sheet Pile Cutoffs	70,200	SF	$ 90	$ 6,318,000	PZC-26 hot-rolled or equal with treated interlocks, L = 60' avg
4.02	Embankment Fill	226,400	CY	$ 30	$ 6,792,000	20' wide crest, 2.5H:1V U/S and D/S slopes, crest EL. 638, L = 1170'
4.03	Structural Fill	0	CY	$ 35	$ -	under labyrinth spillway but not main body of flanking embankments
4.04	Filter Sand and Drainage Stone Layers	44,500	CY	$ 40	$ 1,780,000	C-33 Filter sand and minus 1/2" drainage stone
4.05	Upstream Rip-Rap Protection	9,100	CY	$ 80	$ 728,000	3' layer of Medium Riprap over 12" bedding stone down to El. 610
4.06	Downstream Rip-Rap Protection	7,000	CY	$ 80	$ 560,000	3' layer of Heavy Riprap over 12" bedding stone
4.07	Bedding Stone	5,400	CY	$ 45	$ 243,000	12" thick layer of bedding stone on U/S and D/S slopes
4.08	Crest Gravel	0	CY	$ 35	$ -	6" thick layer of MNDOT granular base course over 20' wide crest
4.09	Topsoil, Seed and Temp Erosion Protection	0	SY	$ 2	$ -	included under site restoration
				Subtotal	**$ 16,421,000**	
5.00	**New Gated Spillway / Outlet Works**					
5.01	Reinforced Concrete Ogee and Base Slab	1,500	CY	$ 900	$ 1,350,000	
5.02	Reinforced Concrete Structure Piers and Walls	830	CY	$ 1,200	$ 996,000	
5.03	Reinforced Concrete Stilling Basin Floor Slabs	2,200	CY	$ 800	$ 1,760,000	
5.04	Reinforced Concrete Stilling Basin Side Walls	1,100	CY	$ 1,200	$ 1,320,000	
5.05	Mass Concrete	5,900	CY	$ 600	$ 3,540,000	Foundation slab
5.06	Crest Gates (Shallow) - Installed with Hoists and Controls	4	EA	$ 300,000	$ 1,200,000	$850 / sf gate area --> 22' wide x 11' high --> 242 sf / gate x $850 = $205,700 / gate. Too low use $300k
5.07	Crest Gates (Deep) - Installed with Hoists and Controls	2	EA	$ 500,000	$ 1,000,000	$850 / sft gate area --> 22' wide x 20' high --> 440 sf /gate x $850 = $374,000 / gate. Too low, use $500k
5.08	Sheet Pile Cutoffs	24,000	SF	$ 90	$ 2,160,000	PZC-26 SSP, L = 30' under walls at all 4 sides
5.09	Steel Frame Operators Deck	1	LS	$ 2,000,000	$ 2,000,000	
				Subtotal	**$ 15,326,000**	
6.00	**New Labyrinth Spillway Structure**					
6.01	Reinforced Concrete Labyrinth Floor Slabs	670	CY	$ 900	$ 603,000	
6.02	Reinforced Concrete Chute Slabs	830	CY	$ 800	$ 664,000	
6.03	Reinforced Concrete Stilling Basin Floor Slabs	980	CY	$ 800	$ 784,000	
6.04	Reinforced Concrete End Sill	100	CY	$ 1,500	$ 150,000	
6.05	Reinforced Concrete Labyrinth Weir Walls	170	CY	$ 1,400	$ 238,000	
6.06	Reinforced Concrete Spillway and Stilling Basin Walls	250	CY	$ 1,200	$ 300,000	
6.07	Steel Sheet Pile Cutoffs	13,400	SF	$ 90	$ 1,206,000	L= 50' under upstream end of labyrinth floor slab; L = 25' under D/S under of stilling basin and wing walls; PZC-26 SSP
6.08	Upstream Riprap	1,000	CY	$ 80	$ 80,000	3' layer of medium riprap over 12" bedding stone down to EL. 610
6.09	Downstream Heavy Riprap Apron and Chute	3,700	CY	$ 80	$ 296,000	3' layer of heavy riprap over 12" bedding stone
6.10	Bedding	1,000	CY	$ 45	$ 45,000	12" thick layer of bedding stone on U/S slope and D/S apron and chute
6.11	Structural Fill	17,200	CY	$ 35	$ 602,000	
6.12	Filter Sand and Drainage Stone	4,600	CY	$ 40	$ 184,000	
6.13	Drain Pipe (Solid and Slotted)	1,000	LF	$ 25	$ 25,000	8" slotted schedule 80 drain pipe, 3 transverse slotted pipes plus 2 solid outlet pipes to D/S
6.14	Pre-Engineered Pedestrian Bridge and Piers (access over stilling basin)	1	LS	$ 500,000	$ 500,000	
				Subtotal	**$ 5,677,000**	
7.00	**Site Restoration**					
7.01	Place Overburden, Seed, Fertilize, and Mulch Slopes	1	LS	$ 100,000	$ 100,000	
7.02	Downstream River Restoration	1	LS	$ 100,000	$ 100,000	
7.03	Dam Safety Monitoring Instrumentation	1	LS	$ 50,000	$ 50,000	
				Subtotal	**$ 250,000**	
	Subtotal				$ 63,600,000	
	Contingency			30%	$ 19,080,000	
	Construction Subtotal				**$ 82,680,000**	
	Engineering Investigations, Design and Construction Engineering	-	-	10%	**$ 8,268,000**	
	Total Estimated Cost				**$ 90,948,000**	
				say	**$ 90,948,000**	

Information presented on this sheet represents our opinion of probable costs in 2020 dollars. Unit and lump-sum prices are based on costs for similar projects, engineering judgment, and/or published cost data. Client administrative/engineering costs and regulatory fees not included. Actual bids and total project costs may vary based on contractor's perceived risk, site access, season, market conditions, etc. No warranties concerning the accuracy of costs presented herein are expressed or implied.

OPINION OF PROBABLE COST - CONCEPTUAL

Project: Edenville Dam — **Project No.: 2002879**

Client: Four Lakes Task Force (FLTF) — **Date: 6/30/2020**

Design Discharge = 1/2 PMF — **Estimated by: P. Drew / R. Anderson**

Checked by: B. Walton

Item	Description	Quantity	Units	Unit Price	Total Cost	Notes
0.00	**General Conditions**					
0.01	Contractor Mobilization / Demobilization	1	LS	$ 9,495,000	$ 9,495,000	7% of Other Costs
0.02	Bonds and Insurance	1	LS	$ 2,713,000	$ 2,713,000	2% of Other Costs
0.03	Construction Permits	1	LS	$ 50,000	$ 50,000	
				Subtotal	**$ 12,258,000**	
1.00	**Site Preparation**					
1.01	Erosion and Sediment Control	1	LS	$ 50,000	$ 50,000	
1.02	Temporary Access Roads, Facilities and Laydown Areas	1	LS	$ 500,000	$ 500,000	
1.04	Stabilize Breach Channel and Edenville Dam Left Embankment	1	LS	$ 500,000	$ 500,000	
1.05	Phase I Cofferdams - Edenville Spillway, PH and Breach Area	1	LS	$ 19,950,000	$ 19,950,000	PS-27.5 SSP, circular cells, D=40', B=35', H=50'. Cofferdam L= 780' (L=2200' perim), $40/sf installed; ASTM C-33 fill at $20/cy
1.06	Phase II Cofferdam - Tobacco Spillway Area	1	LS	$ 4,120,000	$ 4,120,000	PS-27.5 SSP, circular cells, D=35', B=31.5', H=45'. Cofferdam L=250' (500' tot), $40/sf installed; ASTM C-33 fill at $20/cy
1.07	Construction Dewatering	1	LS	$ 3,000,000	$ 3,000,000	$1M / year x 3 years
1.08	Sediment Removal and Dredging	1	LS	$ 1,500,000	$ 1,500,000	
1.09	River Diversion	1	LS	$ 2,000,000	$ 2,000,000	Stream diversion during phase 1 and 2
				Subtotal	**$ 31,620,000**	
2.00	**M-30 Diversion**					
2.01	Temporary Diversion Control Structure Upstream of Tobacco Dam	1	LS	$ 2,000,000	$ 2,000,000	Multiple Bay Box Culvert Structure with Sufficient Capacity for both the Tittabawassee and Tobacco Rivers
2.02	Remove M-30 Control Structure and Restore Causeway Bridge	1	LS	$ 2,000,000	$ 2,000,000	Remove diversion structure and reconstruct causeway bridge
				Subtotal	**$ 4,000,000**	
3.00	**Demolition / Abandonment**					
3.01	Edenville Powerhouse Decommissioning, Demolition and Disposal	1	LS	$ 2,500,000	$ 2,500,000	
3.02	Edenville Gated Spillway Demolition and Disposal	1	LS	$ 1,500,000	$ 1,500,000	
3.03	Tobacco Gated Spillway Demolition and Disposal	1	LS	$ 1,500,000	$ 1,500,000	
3.04	Mechanical and Electrical Equipment Demolition and Disposal	1	LS	$ 250,000	$ 250,000	
				Subtotal	**$ 5,750,000**	
4.00	**Edenville Embankments - Reconstruct Breached Section**					
4.01	Sheet Pile Cutoffs	50,800	SF	$ 90	$ 4,572,000	PZC-26 hot-rolled or equal with treated interlocks, from left abutment to M-30, L ssp = 80' avg, L emb = 635'
4.02	Embankment Fill	216,900	CY	$ 30	$ 6,507,000	20' wide crest, 2.5H:1V U/S and D/S slopes, crest EL. 685, L emb = 635'
4.03	Structural Fill	0	CY	$ 35	$ -	under labyrinth spillway but not main body of flanking embankments
4.04	Filter Sand and Drainage Stone Layers	31,500	CY	$ 40	$ 1,260,000	C-33 Filter sand and minus 1/2" drainage stone
4.05	Upstream Riprap Protection	6,600	CY	$ 80	$ 528,000	3' layer of Medium Riprap over 12" bedding stone from EL. 685 down to 650
4.06	Downstream Riprap Protection	4,400	CY	$ 80	$ 352,000	3' layer of Heavy Riprap over 12" bedding stone from EL. 650 to 627
4.07	Bedding Stone	4,000	CY	$ 45	$ 180,000	12" thick layer of bedding stone on U/S and D/S slopes
4.08	Crest Gravel	200	CY	$ 35	$ 7,000	6" thick layer of MNDOT granular base course over 20' wide crest
4.09	Topsoil, Seed and Temporary Erosion Protection	0	SY	$ 2	$ -	included under site restoration
				Subtotal	**$ 13,406,000**	
5.00	**Edenville Embankments - Repaired and Stabilized Section**					
5.01	Sheet Pile Cutoffs	227,200	SF	$ 90	$ 20,448,000	PZC-26 hot-rolled or equal with treated interlocks, from left abutment to M-30, L = 80' avg
5.02	Embankment Fill	149,500	CY	$ 30	$ 4,485,000	20' wide crest, 2.5H:1V U/S and D/S slopes, crest EL. 685, L = 2840'
5.03	Structural Fill	0	CY	$ 35	$ -	under labyrinth spillway but not main body of flanking embankments
5.04	Filter Sand and Drainage Stone Layers	42,900	CY	$ 40	$ 1,716,000	C-33 Filter sand and minus 1/2" drainage stone
5.05	Upstream Riprap Protection	29,700	CY	$ 80	$ 2,376,000	3' layer of Medium Riprap over 12" bedding stone from EL. 685 to 650
5.06	Downstream Riprap Protection	19,600	CY	$ 80	$ 1,568,000	3' layer of Heavy Riprap over 12" bedding stone from EL. 650 to 627
5.07	Bedding Stone	16,400	CY	$ 45	$ 738,000	12" thick layer of bedding stone on U/S and D/S slopes under riprap
5.08	Crest Gravel	1,100	CY	$ 35	$ 39,000	6" thick layer of MNDOT granular base course over 20' wide crest
5.09	Topsoil, Seed and Temporary Erosion Protection	0	SY	$ 2	$ -	included under site restoration
				Subtotal	**$ 31,370,000**	
6.00	**Tobacco Embankments - Repaired and Stabilized Section**					
6.01	Sheet Pile Cutoffs	144,000	SF	$ 90	$ 12,960,000	PZC-26 hot-rolled or equal with treated interlocks, from right abutment to M-30, L = 60' avg
6.02	Embankment Fill	126,300	CY	$ 30	$ 3,789,000	20' wide crest, 2.5H:1V U/S and D/S slopes, crest EL. 685, L = 2400'
6.03	Structural Fill	0	CY	$ 35	$ -	under labyrinth spillway but not main body of flanking embankments
6.04	Filter Sand and Drainage Stone Layers	36,300	CY	$ 40	$ 1,452,000	C-33 Filter sand and minus 1/2" drainage stone
6.05	Upstream Riprap Protection	25,100	CY	$ 80	$ 2,008,000	3' layer of Medium Riprap over 12" bedding stone from EL. 685 to 650
6.06	Downstream Riprap Protection	16,500	CY	$ 80	$ 1,320,000	3' layer of Heavy Riprap over 12" bedding stone from EL. 650 to 627
6.07	Bedding Stone	13,900	CY	$ 45	$ 625,500	12" thick layer of bedding stone on U/S and D/S slopes under riprap
6.08	Crest Gravel	900	CY	$ 35	$ 31,500	6" thick layer of MNDOT granular base course over 20' wide crest
6.09	Topsoil, Seed and Temporary Erosion Protection	0	SY	$ 2	$ -	included under site restoration
				Subtotal	**$ 22,186,000**	
7.00	**New Gated Spillways and Outlet Works - Edenville**					
7.01	Edenville 3-Bay Spillway Structure	1	EA	$ 5,043,000	$ 5,043,000	Apportioned from Sanford quantities (L = 90')
7.02	Crest Gates (Shallow) - Installed with Hoists and Controls	2	EA	$ 300,000	$ 600,000	$850 / sf gate area --> 24' wide x 11' high --> 264 sf / gate x $850 = $224,400 / gate. Too low use $300k
7.03	Crest Gates (Deep) - Installed with Hoists and Controls	1	EA	$ 500,000	$ 500,000	$850 / sft gate area --> 24' wide x 20' high --> 480 sf /gate x $850 = $408,000 / gate. Too low, use $500k
7.04	Sheet Pile Cutoffs	10,800	SF	$ 90	$ 972,000	PZC-26 SSP, L = 30' under walls at all 4 sides
7.05	Steel Frame Operators Deck	1	EA	$ 750,000	$ 750,000	Apportioned from Sanford (L = 100')
				Subtotal	**$ 7,865,000**	

OPINION OF PROBABLE COST - CONCEPTUAL

Project: Edenville Dam — **Project No.: 2002879**

Client: Four Lakes Task Force (FLTF) — **Date: 6/30/2020**

Design Discharge = 1/2 PMF — **Estimated by: P. Drew / R. Anderson**

Checked by: B. Walton

Item	Description	Quantity	Units	Unit Price	Total Cost	Notes
8.00	**New Gated Spillways and Outlet Works - Tobacco**					
8.01	Tobacco 3-Bay Spillway Structure	1	EA	$ 5,043,000	$ 5,043,000	Apportioned from Sanford quantities (L = 90')
8.02	Crest Gates (Shallow) - Installed with Hoists and Controls	2	EA	$ 300,000	$ 600,000	$850 / sf gate area --> 24' wide x 11' high --> 264 sf / gate x $850 = $224,400 / gate. Too low use $300k
8.03	Crest Gates (Deep) - Installed with Hoists and Controls	1	EA	$ 500,000	$ 500,000	$850 / sft gate area --> 24' wide x 20' high --> 480 sf /gate x $850 = $408,000 / gate. Too low, use $500k
8.04	Sheet Pile Cutoffs	10,800	SF	$ 90	$ 972,000	PZC-26 SSP, L = 30' under walls at all 4 sides
8.05	Steel Frame Operators Deck	1	EA	$ 750,000	$ 750,000	Apportioned from Sanford (L = 100')
				Subtotal	**$ 7,865,000**	
9.00	**New Labyrinth Spillway Structure - Edenville**					
9.01	Reinforced Concrete Labyrinth Floor Slabs	510	CY	$ 900	$ 459,000	
9.02	Reinforced Concrete Chute Slabs	930	CY	$ 800	$ 744,000	
9.03	Reinforced Concrete Stilling Basin Floor Slabs	740	CY	$ 800	$ 592,000	
9.04	Reinforced Concrete End Sill	70	CY	$ 1,500	$ 105,000	
9.05	Reinforced Concrete Labyrinth Weir Walls	180	CY	$ 1,400	$ 252,000	
9.06	Reinforced Concrete Spillway and Stilling Basin Walls	250	CY	$ 1,200	$ 300,000	
9.07	Steel Sheet Pile Cutoffs	12,400	SF	$ 90	$ 1,116,000	PZC-26 SSP w/ Wadit; L= 50' under upstream end of labyrinth floor slab; L = 25' under D/S under of stilling basin and wing walls
9.08	Upstream Riprap	900	CY	$ 80	$ 72,000	3' layer of medium riprap over 12" bedding stone down to EL. 650
9.09	Downstream Heavy Riprap Apron and Chute	3,100	CY	$ 80	$ 248,000	5' layer of heavy riprap over 12" bedding stone
9.10	Bedding	900	CY	$ 45	$ 40,500	12" thick layer of bedding stone on U/S and D/S apron and chute
9.11	Structural Fill	25,100	CY	$ 35	$ 878,500	
9.12	Filter Sand and Drainage Stone	5,500	CY	$ 40	$ 220,000	
9.13	Drain Pipe (Solid and Slotted)	600	LF	$ 25	$ 15,000	8" slotted schedule 80 drain pipe, 3 transverse slotted pipes plus 2 solid outlet pipes to D/S
9.14	Pre-Engineered Pedestrian Bridge and Piers (access over stilling basin	1	LS	$ 500,000	$ 500,000	
				Subtotal	**$ 5,542,000**	
10.00	**New Labyrinth Spillway Structure - Tobacco**					
10.01	Reinforced Concrete Labyrinth Floor Slabs	510	CY	$ 900	$ 459,000	
10.02	Reinforced Concrete Chute Slabs	930	CY	$ 800	$ 744,000	
10.03	Reinforced Concrete Stilling Basin Floor Slabs	740	CY	$ 800	$ 592,000	
10.04	Reinforced Concrete End Sill	70	CY	$ 1,500	$ 105,000	
10.05	Reinforced Concrete Labyrinth Weir Walls	180	CY	$ 1,400	$ 252,000	
10.06	Reinforced Concrete Spillway and Stilling Basin Walls	250	CY	$ 1,200	$ 300,000	
10.07	Steel Sheet Pile Cutoffs	12,400	SF	$ 90	$ 1,116,000	PZC-26 SSP w/ Wadit; L= 50' under upstream end of labyrinth floor slab; L = 25' under D/S under of stilling basin and wing walls
10.08	Upstream Riprap	900	CY	$ 80	$ 72,000	3' layer of medium riprap over 12" bedding stone down to EL. 610
10.09	Downstream Heavy Riprap Apron and Chute	3,100	CY	$ 80	$ 248,000	5' layer of heavy riprap over 12" bedding stone
10.10	Bedding	900	CY	$ 45	$ 40,500	12" thick layer of bedding stone on U/S and D/S apron and chute
10.11	Structural Fill	25,100	CY	$ 35	$ 878,500	
10.12	Filter Sand and Drainage Stone	5,500	CY	$ 40	$ 220,000	
10.13	Drain Pipe (Solid and Slotted)	600	LF	$ 25	$ 15,000	8" slotted schedule 80 drain pipe, 3 transverse slotted pipes plus 2 solid outlet pipes to D/S
10.14	Pre-Engineered Pedestrian Bridge and Piers (access over stilling basin	1	LS	$ 500,000	$ 500,000	
				Subtotal	**$ 5,542,000**	
11.00	**Site Restoration**					
11.01	Place Overburden, Seed, Fertilize, and Mulch Slopes	1	LS	$ 300,000	$ 300,000	
11.02	Tobacco and Tittabawassee River D/S Restoration	1	LS	$ 200,000	$ 200,000	
11.03	Dam Safety Monitoring Instrumentation	1	LS	$ 100,000	$ 100,000	
				Subtotal	**$ 500,000**	
	Subtotal				$ 147,904,000	
	Contingency			30%	$ 44,371,000	
	Construction Subtotal				**$ 192,275,000**	
	Engineering Investigations, Design and Construction Engineering	-	-	8%	**$ 15,382,000**	
	Total Estimated Cost				**$ 207,657,000**	
				say	**$ 207,657,000**	

Information presented on this sheet represents our opinion of probable costs in 2020 dollars. Unit and lump-sum prices are based on costs for similar projects, engineering judgment, and/or published cost data. Client administrative/engineering costs and regulatory fees not included. Actual bids and total project costs may vary based on contractor's perceived risk, site access, season, market conditions, etc. No warranties concerning the accuracy of costs presented herein are expressed or implied.

OPINION OF PROBABLE COST - CONCEPTUAL

Project: Smallwood Dam — **Project No.: 2002879**
Client: Four Lakes Task Force (FLTF) — **Date: 6/30/2020**
Design Discharge = 1/2 PMF — **Estimated by: P. Drew / R. Anderson**
Checked by: B. Walton

Item	Description	Quantity	Units	Unit Price	Total Cost	Notes
0.00	**General Conditions**					
0.01	Contractor Mobilization / Demobilization	1	LS	$ 585,000	$ 585,000	7% of Other Costs
0.02	Bonds and Insurance	1	LS	$ 167,000	$ 167,000	2% of Other Costs
0.03	Construction Permits	1	LS	$ 50,000	$ 50,000	
				Subtotal	**$ 802,000**	
1.00	**Site Preparation**					
1.01	Erosion and Sediment Control	1	LS	$ 20,000	$ 20,000	
1.02	Temporary Access Roads, Facilities and Laydown Areas	1	LS	$ 100,000	$ 100,000	
1.05	Cofferdams - Aux Spillway	0	LS	$ -	$ -	Assume reservoir is drawn down - no cofferdam needed to construct the Auxiliary Spillway
1.07	Construction Dewatering	0	LS	$ -	$ -	Not required for Auxiliary Spillway construction since impounment is drawn down
1.08	Sediment Removal and Dredging	1	LS	$ 150,000	$ 150,000	Dredge material from tailrace
1.09	River Diversion	0	LS	$ -	$ -	Assume reservoir is drawn down
				Subtotal	**$ 270,000**	
2.00	**Powerhouse Decommissioning and TG Abandonment**					
2.01	Smallwood Powerhouse Decommissioning and TG Abandonment	1	LS	$ 500,000	$ 500,000	Remove turbine-generator set and all associated electrical and mechanical controls related to generation
				Subtotal	**$ 500,000**	
3.00	**Left Embankment Repair and Stabilization**					
3.01	Sheet Pile Cutoffs	0	SF	$ 90	$ -	Already has SSP cutoff
3.02	Embankment Fill	5,100	CY	$ 30	$ 153,000	widen crest from 15' to 20' wide, provide 2.5H:1V D/S slopes
3.03	Filter Sand and Drainage Stone Layers	3,100	CY	$ 40	$ 124,000	C-33 Filter sand and minus 1/2" drainage stone
3.04	Upstream Riprap Protection	2,500	CY	$ 80	$ 200,000	3' layer of Medium Riprap over 12" bedding stone from EL. 716 to 690
3.05	Downstream Riprap Protection	2,900	CY	$ 80	$ 232,000	3' layer of Heavy Riprap over 12" bedding stone from EL. 700 to 675
3.06	Bedding Stone	1,800	CY	$ 45	$ 81,000	12" thick layer of bedding stone on U/S and D/S slopes under riprap
3.07	Crest Gravel	120	CY	$ 35	$ 4,000	6" thick layer of MNDOT granular base course over 20' wide crest
3.08	Topsoil, Seed and Temporary Erosion Protection	0	SY	$ 2	$ -	included under site restoration
				Subtotal	**$ 794,000**	
4.00	**Right Embankment Repair and Stabilization**					
4.01	Sheet Pile Cutoffs	0	SF	$ 90	$ -	Already has SSP cutoff
4.02	Embankment Fill	2,400	CY	$ 30	$ 72,000	widen crest from 15' to 20' wide, provide 2.5H:1V D/S slopes
4.03	Filter Sand and Drainage Stone Layers	1,500	CY	$ 40	$ 60,000	C-33 Filter sand and minus 1/2" drainage stone
4.04	Upstream Riprap Protection	1,200	CY	$ 80	$ 96,000	3' layer of Medium Riprap over 12" bedding stone from EL. 716 to 690
4.05	Downstream Riprap Protection	1,300	CY	$ 80	$ 104,000	3' layer of Heavy Riprap over 12" bedding stone from EL. 700 to 675
4.06	Bedding Stone	830	CY	$ 45	$ 37,000	12" thick layer of bedding stone on U/S and D/S slopes under riprap
4.07	Crest Gravel	60	CY	$ 35	$ 2,000	6" thick layer of MNDOT granular base course over 20' wide crest
4.08	Topsoil, Seed and Temporary Erosion Protection	0	SY	$ 2	$ -	included under site restoration
				Subtotal	**$ 371,000**	
5.00	**Gated Spillway Rehabilitation**					
5.01	Misc. surface concrete repairs	1	EA	$ 250,000	$ 250,000	
5.02	New Crest Gates - Installed with Hoists and Controls	2	EA	$ 300,000	$ 600,000	same unit costs at Edenville and Sanford
5.03	Concrete Backfill	750	CY	$ 600	$ 450,000	cellular concrete - 1000 psi minimum
5.04	Foundation Micropiles and Structural Pile Caps	24	EA	$ 20,000	$ 480,000	foundation underpinning to support additional concrete weight; 150 kip design capacity / pile
5.05	Downstream Tailrace Armoring	1	LS	$ 100,000	$ 100,000	supplemental D/S riprap in the tailrace area
				Subtotal	**$ 1,880,000**	
6.00	**Powerhouse Rehabilitation**					
6.01	Misc surface concrete and masonry repairs	1	EA	$ 100,000	$ 100,000	
6.02	Convert water passages to low level outlet	1	EA	$ 500,000	$ 500,000	Includes wicket gate conversion and controls for low level outlet
6.03	Concrete Backfill	300	CY	$ 600	$ 180,000	cellular concrete - 1000 psi minimum
6.04	Foundation Micropiles and Structural Pile Caps	9	EA	$ 20,000	$ 180,000	foundation underpinning to support additional concrete weight; 150 kip design capacity / pile
				Subtotal	**$ 960,000**	
7.00	**New Labyrinth Spillway Structure**					
7.01	Reinforced Concrete Labyrinth Floor Slabs	510	CY	$ 900	$ 459,000	
7.02	Reinforced Concrete Chute Slabs	560	CY	$ 800	$ 448,000	
7.03	Reinforced Concrete Stilling Basin Floor Slabs	560	CY	$ 800	$ 448,000	
7.04	Reinforced Concrete End Sill	80	CY	$ 1,500	$ 120,000	
7.05	Reinforced Concrete Labyrinth Weir Walls	140	CY	$ 1,400	$ 196,000	
7.06	Reinforced Concrete Spillway and Stilling Basin Walls	230	CY	$ 1,200	$ 276,000	
7.07	Steel Sheet Pile Cutoffs	7,500	SF	$ 90	$ 675,000	PZC-26 SSP w/ Wadit; L= 40' under upstream end of labyrinth floor slab; L = 20' under D/S under of stilling basin and wing walls
7.08	Upstream Riprap	560	CY	$ 80	$ 44,800	3' layer of medium riprap over 12" bedding stone down to EL. 690
7.09	Downstream Heavy Riprap Apron and Chute	2,320	CY	$ 80	$ 185,600	5' layer of heavy riprpap over 12" bedding stone
7.10	Bedding	750	CY	$ 45	$ 33,750	12" thick layer of bedding sone on U/S and D/S apron and chute
7.11	Structural Fill	9,260	CY	$ 35	$ 324,100	
7.12	Filter Sand and Drainage Stone	5,600	CY	$ 40	$ 224,000	
7.13	Drain Pipe (Solid and Slotted)	470	LF	$ 25	$ 11,750	8" slotted schedule 80 drain pipe, 2 transverse slotted pipes and 3 solid outlet pipes
7.14	Pre-Engineered Pedestrian Bridge and Piers (access over stilling basin)	0	LS	$ 500,000	$ -	Not required since apron is above TW
				Subtotal	**$ 3,446,000**	
8.00	**Site Restoration**					
8.01	Place Overburden, Seed, Fertilize, and Mulch Slopes	1	LS	$ 100,000	$ 100,000	
8.02	Dam Safety Monitoring Instrumentation	1	LS	$ 30,000	$ 30,000	
				Subtotal	**$ 130,000**	
	Subtotal				$ 9,153,000	
	Contingency			30%	$ 2,746,000	
	Construction Subtotal				**$ 11,899,000**	
	Engineering Investigations, Design and Construction Engineering	-	-	15%	**$ 1,785,000**	
	Total Estimated Cost				**$ 13,684,000**	
				say	**$ 13,684,000**	

Information presented on this sheet represents our opinion of probable costs in 2020 dollars. Unit and lump-sum prices are based on costs for similar projects, engineering judgment, and/or published cost data. Client administrative/engineering costs and regulatory fees not included. Actual bids and total project costs may vary based on contractor's perceived risk, site access, season, market conditions, etc. No warranties concerning the accuracy of costs presented herein are expressed or implied.

OPINION OF PROBABLE COST - CONCEPTUAL

Project: Secord Dam — **Project No.: 2002879**
Client: Four Lakes Task Force (FLTF) — **Date: 6/30/2020**
Design Discharge = 1/2 PMF — **Estimated by: P. Drew / R. Anderson**
Checked by: B. Walton

Item	Description	Quantity	Units	Unit Price	Total Cost	Notes
0.00	**General Conditions**					
0.01	Contractor Mobilization / Demobilization	1	LS	$ 1,044,000	$ 1,044,000	7% of Other Costs
0.02	Bonds and Insurance	1	LS	$ 298,000	$ 298,000	2% of Other Costs
0.03	Construction Permits	1	LS	$ 50,000	$ 50,000	
				Subtotal	**$ 1,392,000**	
1.00	**Site Preparation**					
1.01	Erosion and Sediment Control	1	LS	$ 20,000	$ 20,000	
1.02	Temporary Access Roads, Facilities and Laydown Areas	1	LS	$ 200,000	$ 200,000	
1.05	Cofferdams	0	LS	$ -	$ -	Assume reservoir is drawn down - no cofferdam needed to construct the Auxiliary Spillway
1.07	Construction Dewatering	0	LS	$ -	$ -	Not required for Auxiliary Spillway construction since impoundment is drawn down
1.08	Sediment Removal and Dredging	0	LS	$ -	$ -	Dredge material from tailrace
1.09	River Diversion	0	LS	$ -	$ -	Assume reservoir is drawn down
				Subtotal	**$ 220,000**	
2.00	**Powerhouse Decommissioning and TG Abandonment**					
2.01	Secord Powerhouse Decommissioning and TG Abandonment	1	LS	$ 500,000	$ 500,000	Remove turbine-generator set and all associated electrical and mechanical controls related to generation
				Subtotal	**$ 500,000**	
3.00	**Left Embankment Repair and Stabilization**					
3.01	Sheet Pile Cutoffs	28,200	SF	$ 90	$ 2,538,000	PZC-26 hot-rolled or equal with treated interlocks, L = 60' avg
3.02	Embankment Fill	4,600	CY	$ 30	$ 138,000	widen crest from 15' to 20' wide, provide 2.5H:1V D/S slopes
3.03	Filter Sand and Drainage Stone Layers	2,600	CY	$ 40	$ 104,000	C-33 Filter sand and minus 1/2" drainage stone
3.04	Upstream Riprap Protection	3,700	CY	$ 80	$ 296,000	3' layer of Medium Riprap over 12" bedding stone
3.05	Downstream Riprap Protection	2,100	CY	$ 80	$ 168,000	3' layer of Heavy Riprap over 12" bedding stone
3.06	Bedding Stone	2,000	CY	$ 45	$ 90,000	12" thick layer of bedding stone on U/S and D/S slopes under riprap
3.07	Crest Gravel	200	CY	$ 35	$ 7,000	6" thick layer of MNDOT granular base course over 20' wide crest
3.08	Topsoil, Seed and Temporary Erosion Protection	0	SY	$ 2.00	$ -	included under site restoration
				Subtotal	**$ 3,341,000**	
4.00	**Right Embankment Repair and Stabilization**					
4.01	Sheet Pile Cutoffs	21,600	SF	$ 90	$ 1,944,000	PZC-26 hot-rolled or equal with treated interlocks, L = 60' avg
4.02	Embankment Fill	3,600	CY	$ 30	$ 108,000	widen crest from 15' to 20' wide, provide 2.5H:1V D/S slopes
4.03	Filter Sand and Drainage Stone Layers	2,000	CY	$ 40	$ 80,000	C-33 Filter sand and minus 1/2" drainage stone
4.04	Upstream Riprap Protection	2,800	CY	$ 80	$ 224,000	3' layer of Medium Riprap over 12" bedding stone
4.05	Downstream Riprap Protection	1,600	CY	$ 80	$ 128,000	3' layer of Heavy Riprap over 12" bedding stone
4.06	Bedding Stone	1,500	CY	$ 45	$ 67,500	12" thick layer of bedding stone on U/S and D/S slopes under riprap
4.07	Crest Gravel	100	CY	$ 35	$ 3,500	6" thick layer of MNDOT granular base course over 20' wide crest
4.08	Topsoil, Seed and Temporary Erosion Protection	0	SY	$ 2.00	$ -	included under site restoration
				Subtotal	**$ 2,555,000**	
5.00	**Gated Spillway Rehabilitation**					
5.01	Misc. surface concrete repairs and modifications	1	EA	$ 250,000	$ 250,000	
5.02	Structural Concrete - Ogee	140	CY	$ 1,200	$ 168,000	
5.03	Structural Concrete - Side Walls and Piers	300	CY	$ 1,200	$ 360,000	
5.04	New Hydraulic Crest Gates - Installed with Hoists and Controls	2	EA	$ 500,000	$ 1,000,000	
5.05	Concrete Backfill	1,200	CY	$ 600	$ 720,000	cellular concrete - 1000 psi minimum
5.06	Foundation Micropiles and Structural Pile Caps	30	EA	$ 20,000	$ 600,000	foundation underpinning to support additional concrete weight; 150 kip design capacity / pile
5.07	Downstream Tailrace Armoring	1	LS	$ 200,000	$ 200,000	supplemental D/S riprap in the tailrace area
				Subtotal	**$ 3,298,000**	
6.00	**Powerhouse Rehabilitation**					
6.01	Misc. surface concrete and masonry repairs	1	EA	$ 200,000	$ 200,000	
6.02	Convert water passages to low level outlet	2	EA	$ 500,000	$ 1,000,000	Includes wicket gate conversion and controls for low level outlet
6.03	Concrete Backfill	710	CY	$ 600	$ 426,000	cellular concrete - 1000 psi minimum
6.04	Foundation Micropiles and Structural Pile Caps	16	EA	$ 20,000	$ 320,000	foundation underpinning to support additional concrete weight; 150 kip design capacity / pile
				Subtotal	**$ 1,946,000**	
7.00	**New Overflow Auxiliary Spillway Structure**					
7.01	Reinforced Concrete Floor Slabs	300	CY	$ 900	$ 270,000	
7.02	Reinforced Concrete Chute Slabs	590	CY	$ 800	$ 472,000	
7.03	Reinforced Concrete Stilling Basin Floor Slabs	300	CY	$ 800	$ 240,000	
7.04	Reinforced Concrete Spillway and Stilling Basin Walls	92	CY	$ 1,200	$ 110,000	
7.05	Steel Sheet Pile Cutoffs	16,000	SF	$ 70	$ 1,120,000	PZC-18 SSP w/ Wadit; L= 30' under upstream end of labyrinth floor slab; L = 20' under D/S under of stilling basin and wing walls; L = 30' along D/S toe of left embankment
7.06	Upstream Riprap	700	CY	$ 80	$ 56,000	3' layer of medium riprap over 12" bedding stone
7.07	Downstream Heavy Riprap Apron	2,200	CY	$ 80	$ 176,000	3' layer of riprap over 12" bedding stone
7.08	Downstream Riprap Conveyance Channel	3,100	CY	$ 80	$ 248,000	
7.09	Bedding	1,800	CY	$ 45	$ 81,000	12" thick layer of bedding stone on U/S and D/S apron and chute
7.10	Structural Fill	0	CY	$ 35	$ -	
7.11	Filter Sand and Drainage Stone	1,000	CY	$ 40	$ 40,000	
7.12	Drain Pipe (Solid and Slotted)	600	LF	$ 25	$ 15,000	8" slotted schedule 80 drain pipe
7.13	Sacrificial Culvert Bridge to Parking Area	1	LS	$ 100,000	$ 100,000	
				Subtotal	**$ 2,928,000**	
8.00	**Site Restoration**					
8.01	Place Overburden, Seed, Fertilize, and Mulch Slopes	1	LS	$ 100,000	$ 100,000	
8.02	Dam Safety Monitoring Instrumentation	1	LS	$ 30,000	$ 30,000	
				Subtotal	**$ 130,000**	
	Subtotal				$ 16,310,000	
	Contingency			30%	$ 4,893,000	
	Construction Subtotal				**$ 21,203,000**	
	Engineering Investigations, Design and Construction Engineering	-	-	15%	**$ 3,180,000**	
	Total Estimated Cost				**$ 24,383,000**	
				say	**$ 24,383,000**	

Information presented on this sheet represents our opinion of probable costs in 2020 dollars. Unit and lump-sum prices are based on costs for similar projects, engineering judgment, and/or published cost data. Client administrative/engineering costs and regulatory fees not included. Actual bids and total project costs may vary based on contractor's perceived risk, site access, season, market conditions, etc. No warranties concerning the accuracy of costs presented herein are expressed or implied.

Attachment 4 – OPCC Estimate Worksheets – PMF

OPINION OF PROBABLE COST - CONCEPTUAL

Project: Sanford Dam
Client: Four Lakes Task Force (FLTF)
Design Discharge = PMF

Project No.: 2002879
Date: 6/30/2020
Estimated by: P. Drew / R. Anderson
Checked by: B. Walton

Item	Description	Quantity	Units	Unit Price	Total Cost	Notes
0.00	**General Conditions**					
0.01	Contractor Mobilization / Demobilization	1	LS	$ 5,682,000	$ 5,682,000	7% of Other Costs
0.02	Bonds and Insurance	1	LS	$ 1,624,000	$ 1,624,000	2% of Other Costs
0.03	Construction Permits	1	LS	$ 50,000	$ 50,000	
				Subtotal	**$ 7,356,000**	
1.00	**Site Preparation**					
1.01	Erosion and Sediment Control	1	LS	$ 50,000	$ 50,000	
1.02	Temporary Access Roads, Facilities and Laydown Areas	1	LS	$ 500,000	$ 500,000	
1.03	Stabilize Breach Channel and Right Embankment	1	LS	$ 300,000	$ 300,000	
1.04	Phase I Cofferdams - Spillway and PH Area (U/S and D/S)	1	LS	$ 8,240,000	$ 8,240,000	Double the size of the Phase I Cofferdam. Increase the Crest gates from 6 to 12.
1.05	Phase II Cofferdams - Aux Spillway Area	1	LS	$ 9,985,000	$ 9,985,000	Increase the size of the Phase II Cofferdam. Increase labyrinth spillway from 165 feet to 250 feet.
1.06	Construction Dewatering	1	LS	$ 2,000,000	$ 2,000,000	
1.07	Sediment Removal and Dredging	1	LS	$ 700,000	$ 700,000	
				Subtotal	**$ 21,775,000**	
2.00	**Demolition / Abandonment**					
2.01	Powerhouse Decommission, Demolition and Disposal	1	LS	$ 2,000,000	$ 2,000,000	
2.02	Gated Spillway Demolition and Disposal	1	LS	$ 2,000,000	$ 2,000,000	
2.03	Embankment Excavation and Disposal	50,000	CY	$ 20	$ 1,000,000	
2.04	Mechanical and Electrical Equipment Demolition and Disposal	1	LS	$ 250,000	$ 250,000	
				Subtotal	**$ 5,250,000**	
3.00	**Left Abutment Reconstruction (L = 200 feet)**					
3.01	Left Abutment / Embankment Reconstruction	13,000	CY	$ 30	$ 390,000	
3.02	Sheet Pile Cutoff	8,000	SF	$ 70	$ 560,000	
3.03	Erosion Protection	2,000	CY	$ 80	$ 160,000	
				Subtotal	**$ 1,110,000**	
4.00	**Right Embankment Reconstruction (L = 935 feet)**					
4.01	Sheet Pile Cutoffs	56,000	SF	$ 90	$ 5,040,000	Reduced the embankment reconstruction length from 1,170 to 935 feet
4.02	Embankment Fill	181,000	CY	$ 30	$ 5,430,000	
4.03	Structural Fill	0	CY	$ 35	$ -	
4.04	Filter Sand and Drainage Stone Layers	36,000	CY	$ 40	$ 1,440,000	
4.05	Upstream Rip-Rap Protection	7,000	CY	$ 80	$ 560,000	
4.06	Downstream Rip-Rap Protection	6,000	CY	$ 80	$ 480,000	
4.07	Bedding Stone	4,000	CY	$ 45	$ 180,000	
4.08	Crest Gravel	0	CY	$ 35	$ -	
4.09	Topsoil, Seed and Temp Erosion Protection	0	SY	$ 2	$ -	
				Subtotal	**$ 13,130,000**	
5.00	**New Gated Spillway / Outlet Works**					
5.01	Reinforced Concrete Ogee and Base Slab	3,000	CY	$ 900	$ 2,700,000	Double the size of the new gated spillway
5.02	Reinforced Concrete Structure Piers and Walls	1,700	CY	$ 1,200	$ 2,040,000	
5.03	Reinforced Concrete Stilling Basin Floor Slabs	4,400	CY	$ 800	$ 3,520,000	
5.04	Reinforced Concrete Stilling Basin Side Walls	2,200	CY	$ 1,200	$ 2,640,000	
5.05	Mass Concrete	11,800	CY	$ 600	$ 7,080,000	
5.06	Crest Gates (Shallow) - Installed with Hoists and Controls	8	EA	$ 300,000	$ 2,400,000	
5.07	Crest Gates (Deep) - Installed with Hoists and Controls	4	EA	$ 500,000	$ 2,000,000	
5.08	Sheet Pile Cutoffs	48,000	SF	$ 90	$ 4,320,000	
5.09	Steel Frame Operators Deck	1	LS	$ 4,000,000	$ 4,000,000	
				Subtotal	**$ 30,700,000**	
6.00	**New Labyrinth Spillway Structure**					
6.01	Reinforced Concrete Labyrinth Floor Slabs	1,000	CY	$ 900	$ 900,000	Increase the labyrinth spillway from 165 feet to 250 feet
6.02	Reinforced Concrete Chute Slabs	1,300	CY	$ 800	$ 1,040,000	
6.03	Reinforced Concrete Stilling Basin Floor Slabs	1,500	CY	$ 800	$ 1,200,000	
6.04	Reinforced Concrete End Sill	150	CY	$ 1,500	$ 225,000	
6.05	Reinforced Concrete Labyrinth Weir Walls	300	CY	$ 1,400	$ 420,000	
6.06	Reinforced Concrete Spillway and Stilling Basin Walls	400	CY	$ 1,200	$ 480,000	
6.07	Steel Sheet Pile Cutoffs	20,300	SF	$ 90	$ 1,827,000	
6.08	Upstream Riprap	1,500	CY	$ 80	$ 120,000	
6.09	Downstream Heavy Riprap Apron and Chute	5,600	CY	$ 80	$ 448,000	
6.10	Bedding	1,500	CY	$ 45	$ 68,000	
6.11	Structural Fill	26,100	CY	$ 35	$ 914,000	
6.12	Filter Sand and Drainage Stone	7,000	CY	$ 40	$ 280,000	
6.13	Drain Pipe (Solid and Slotted)	1,500	LF	$ 25	$ 38,000	
6.14	Pre-Engineered Pedestrian Bridge and Piers (access over stilling basin)	1	LS	$ 1,000,000	$ 1,000,000	
				Subtotal	**$ 8,960,000**	
7.00	**Site Restoration**					
7.01	Place Overburden, Seed, Fertilize, and Mulch Slopes	1	LS	$ 100,000	$ 100,000	
7.02	Downstream River Restoration	1	LS	$ 100,000	$ 100,000	
7.03	Dam Safety Monitoring Instrumentation	1	LS	$ 50,000	$ 50,000	
				Subtotal	**$ 250,000**	
	Subtotal				$ 88,531,000	
	Contingency			30%	$ 26,559,000	
	Construction Subtotal				**$ 115,090,000**	
	Engineering Investigations, Design and Construction Engineering	-	-	10%	**$ 11,509,000**	
	Total Estimated Cost				**$ 126,599,000**	
				say	**$ 126,599,000**	

Information presented on this sheet represents our opinion of probable costs in 2020 dollars. Unit and lump-sum prices are based on costs for similar projects, engineering judgment, and/or published cost data. Client administrative/engineering costs and regulatory fees not included. Actual bids and total project costs may vary based on contractor's perceived risk, site access, season, market conditions, etc. No warranties concerning the accuracy of costs presented herein are expressed or implied.

OPINION OF PROBABLE COST - CONCEPTUAL

Project: Edenville Dam — **Project No.: 2002879**

Client: Four Lakes Task Force (FLTF) — **Date: 6/30/2020**

Design Discharge = PMF — **Estimated by: P. Drew / R. Anderson**

Checked by: B. Walton

Item	Description	Quantity	Units	Unit Price	Total Cost	Notes
0.00	**General Conditions**					
0.01	Contractor Mobilization / Demobilization	1	LS	$ 11,377,000	$ 11,377,000	7% of Other Costs
0.02	Bonds and Insurance	1	LS	$ 3,251,000	$ 3,251,000	2% of Other Costs
0.03	Construction Permits	1	LS	$ 50,000	$ 50,000	
				Subtotal	**$ 14,678,000**	
1.00	**Site Preparation**					
1.01	Erosion and Sediment Control	1	LS	$ 50,000	$ 50,000	
1.02	Temporary Access Roads, Facilities and Laydown Areas	1	LS	$ 500,000	$ 500,000	
1.04	Stabilize Breach Channel and Edenville Dam Left Embankment	1	LS	$ 500,000	$ 500,000	
1.05	Phase I Cofferdams - Edenville Spillway, PH and Breach Area	1	LS	$ 23,940,000	$ 23,940,000	Increase the size of the Phase I Cofferdam by 20%
1.06	Phase II Cofferdam - Tobacco Spillway Area	1	LS	$ 8,240,000	$ 8,240,000	Double the size of the Phas II Cofferdam
1.07	Construction Dewatering	1	LS	$ 3,000,000	$ 3,000,000	
1.08	Sediment Removal and Dredging	1	LS	$ 1,500,000	$ 1,500,000	
1.09	River Diversion	1	LS	$ 2,000,000	$ 2,000,000	
				Subtotal	**$ 39,730,000**	
2.00	**M-30 Diversion**					
2.01	Temporary Diversion Control Structure Upstream of Tobacco Dam	1	LS	$ 2,000,000	$ 2,000,000	
2.02	Remove M-30 Control Structure and Restore Causeway Bridge	1	LS	$ 2,000,000	$ 2,000,000	
				Subtotal	**$ 4,000,000**	
3.00	**Demolition / Abandonment**					
3.01	Edenville Powerhouse Decommissioning, Demolition and Disposal	1	LS	$ 2,500,000	$ 2,500,000	
3.02	Edenville Gated Spillway Demolition and Disposal	1	LS	$ 1,500,000	$ 1,500,000	
3.03	Tobacco Gated Spillway Demolition and Disposal	1	LS	$ 1,500,000	$ 1,500,000	
3.04	Mechanical and Electrical Equipment Demolition and Disposal	1	LS	$ 250,000	$ 250,000	
				Subtotal	**$ 5,750,000**	
4.00	**Edenville Embankments - Reconstruct Breached Section (L = 635 feet)**					
4.01	Sheet Pile Cutoffs	50,800	SF	$ 90	$ 4,572,000	
4.02	Embankment Fill	216,900	CY	$ 30	$ 6,507,000	
4.03	Structural Fill	0	CY	$ 35	$ -	
4.04	Filter Sand and Drainage Stone Layers	31,500	CY	$ 40	$ 1,260,000	
4.05	Upstream Riprap Protection	6,600	CY	$ 80	$ 528,000	
4.06	Downstream Riprap Protection	4,400	CY	$ 80	$ 352,000	
4.07	Bedding Stone	4,000	CY	$ 45	$ 180,000	
4.08	Crest Gravel	200	CY	$ 35	$ 7,000	
4.09	Topsoil, Seed and Temporary Erosion Protection	0	SY	$ 2	$ -	
				Subtotal	**$ 13,406,000**	
5.00	**Edenville Embankments - Repaired and Stabilized Section (Unbreached - L = 2,640 feet)**					
5.01	Sheet Pile Cutoffs	211,200	SF	$ 90	$ 19,008,000	Reduced the embankment reconstruction length from 2,840 to 2,640 feet
5.02	Embankment Fill	138,900	CY	$ 30	$ 4,167,000	
5.03	Structural Fill	0	CY	$ 35	$ -	
5.04	Filter Sand and Drainage Stone Layers	39,900	CY	$ 40	$ 1,596,000	
5.05	Upstream Riprap Protection	27,600	CY	$ 80	$ 2,208,000	
5.06	Downstream Riprap Protection	18,200	CY	$ 80	$ 1,456,000	
5.07	Bedding Stone	15,300	CY	$ 45	$ 689,000	
5.08	Crest Gravel	1,000	CY	$ 35	$ 35,000	
5.09	Topsoil, Seed and Temporary Erosion Protection	0	SY	$ 2	$ -	
				Subtotal	**$ 29,159,000**	
6.00	**Tobacco Embankments - Repaired and Stabilized Section (L=2,200 feet)**					
6.01	Sheet Pile Cutoffs	132,000	SF	$ 90	$ 11,880,000	Reduced the embankment reconstruction length from 2,400 to 2,220 feet
6.02	Embankment Fill	115,800	CY	$ 30	$ 3,474,000	
6.03	Structural Fill	0	CY	$ 35	$ -	
6.04	Filter Sand and Drainage Stone Layers	33,200	CY	$ 40	$ 1,328,000	
6.05	Upstream Riprap Protection	23,000	CY	$ 80	$ 1,840,000	
6.06	Downstream Riprap Protection	15,200	CY	$ 80	$ 1,216,000	
6.07	Bedding Stone	13,200	CY	$ 45	$ 594,000	
6.08	Crest Gravel	800	CY	$ 35	$ 28,000	
6.09	Topsoil, Seed and Temporary Erosion Protection	0	SY	$ 2	$ -	
				Subtotal	**$ 20,360,000**	
7.00	**New Gated Spillways and Outlet Works - Edenville**					
7.01	Edenville 3-Bay Spillway Structure	2	EA	$ 5,043,000	$ 10,086,000	Doubled the size of the Gated Spillway
7.02	Crest Gates (Shallow) - Installed with Hoists and Controls	4	EA	$ 300,000	$ 1,200,000	
7.03	Crest Gates (Deep) - Installed with Hoists and Controls	2	EA	$ 500,000	$ 1,000,000	
7.04	Sheet Pile Cutoffs	21,600	SF	$ 90	$ 1,944,000	
7.05	Steel Frame Operators Deck	1	EA	$ 1,500,000	$ 1,500,000	
				Subtotal	**$ 15,730,000**	
8.00	**New Gated Spillways and Outlet Works - Tobacco**					
8.01	Tobacco 6-Bay Spillway Structure	2	EA	$ 5,043,000	$ 10,086,000	Doubled the size of the Gated Spillway
8.02	Crest Gates (Shallow) - Installed with Hoists and Controls	4	EA	$ 300,000	$ 1,200,000	
8.03	Crest Gates (Deep) - Installed with Hoists and Controls	2	EA	$ 500,000	$ 1,000,000	
8.04	Sheet Pile Cutoffs	21,600	SF	$ 90	$ 1,944,000	
8.05	Steel Frame Operators Deck	1	EA	$ 1,500,000	$ 1,500,000	
				Subtotal	**$ 15,730,000**	

OPINION OF PROBABLE COST - CONCEPTUAL

Project: Edenville Dam — **Project No.: 2002879**

Client: Four Lakes Task Force (FLTF) — **Date: 6/30/2020**

Design Discharge = PMF — **Estimated by: P. Drew / R. Anderson**

Checked by: B. Walton

Item	Description	Quantity	Units	Unit Price	Total Cost	Notes
9.00	**New Labyrinth Spillway Structure - Edenville**					
9.01	Reinforced Concrete Labyrinth Floor Slabs	800	CY	$ 900	$ 720,000	Increase spillway width from 125 feet to 200 feet
9.02	Reinforced Concrete Chute Slabs	1,500	CY	$ 800	$ 1,200,000	
9.03	Reinforced Concrete Stilling Basin Floor Slabs	1,200	CY	$ 800	$ 960,000	
9.04	Reinforced Concrete End Sill	110	CY	$ 1,500	$ 165,000	
9.05	Reinforced Concrete Labyrinth Weir Walls	300	CY	$ 1,400	$ 420,000	
9.06	Reinforced Concrete Spillway and Stilling Basin Walls	400	CY	$ 1,200	$ 480,000	
9.07	Steel Sheet Pile Cutoffs	19,800	SF	$ 90	$ 1,782,000	
9.08	Upstream Riprap	1,400	CY	$ 80	$ 112,000	
9.09	Downstream Heavy Riprap Apron and Chute	5,000	CY	$ 80	$ 400,000	
9.10	Bedding	1,400	CY	$ 45	$ 63,000	
9.11	Structural Fill	40,200	CY	$ 35	$ 1,407,000	
9.12	Filter Sand and Drainage Stone	8,800	CY	$ 40	$ 352,000	
9.13	Drain Pipe (Solid and Slotted)	960	LF	$ 25	$ 24,000	
9.14	Pre-Engineered Pedestrian Bridge and Piers (access over stilling basin	1	LS	$ 1,000,000	$ 1,000,000	
				Subtotal	**$ 9,085,000**	
10.00	**New Labyrinth Spillway Structure - Tobacco**					
10.01	Reinforced Concrete Labyrinth Floor Slabs	800	CY	$ 900	$ 720,000	Increase spillway width from 125 feet to 200 feet
10.02	Reinforced Concrete Chute Slabs	1,500	CY	$ 800	$ 1,200,000	
10.03	Reinforced Concrete Stilling Basin Floor Slabs	1,200	CY	$ 800	$ 960,000	
10.04	Reinforced Concrete End Sill	110	CY	$ 1,500	$ 165,000	
10.05	Reinforced Concrete Labyrinth Weir Walls	300	CY	$ 1,400	$ 420,000	
10.06	Reinforced Concrete Spillway and Stilling Basin Walls	400	CY	$ 1,200	$ 480,000	
10.07	Steel Sheet Pile Cutoffs	19,800	SF	$ 90	$ 1,782,000	
10.08	Upstream Riprap	1,400	CY	$ 80	$ 112,000	
10.09	Downstream Heavy Riprap Apron and Chute	5,000	CY	$ 80	$ 400,000	
10.10	Bedding	1,400	CY	$ 45	$ 63,000	
10.11	Structural Fill	40,200	CY	$ 35	$ 1,407,000	
10.12	Filter Sand and Drainage Stone	8,800	CY	$ 40	$ 352,000	
10.13	Drain Pipe (Solid and Slotted)	960	LF	$ 25	$ 24,000	
10.14	Pre-Engineered Pedestrian Bridge and Piers (access over stilling basin	1	LS	$ 1,000,000	$ 1,000,000	
				Subtotal	**$ 9,085,000**	
11.00	**Site Restoration**					
11.01	Place Overburden, Seed, Fertilize, and Mulch Slopes	1	LS	$ 300,000	$ 300,000	
11.02	Tobacco and Tittabawassee River D/S Restoration	1	LS	$ 200,000	$ 200,000	
11.03	Dam Safety Monitoring Instrumentation	1	LS	$ 100,000	$ 100,000	
				Subtotal	**$ 500,000**	
	Subtotal				$ 177,213,000	
	Contingency			30%	$ 53,164,000	
	Construction Subtotal				**$ 230,377,000**	
	Engineering Investigations, Design and Construction Engineering	-	-	8%	**$ 18,430,000**	
	Total Estimated Cost				**$ 248,807,000**	
				say	**$ 248,807,000**	

Information presented on this sheet represents our opinion of probable costs in 2020 dollars. Unit and lump-sum prices are based on costs for similar projects, engineering judgment, and/or published cost data. Client administrative/engineering costs and regulatory fees not included. Actual bids and total project costs may vary based on contractor's perceived risk, site access, season, market conditions, etc. No warranties concerning the accuracy of costs presented herein are expressed or implied.

OPINION OF PROBABLE COST - CONCEPTUAL

Project: Smallwood Dam — **Project No.: 2002879**

Client: Four Lakes Task Force (FLTF) — **Date: 6/30/2020**

Design Discharge = PMF — **Estimated by: P. Drew / R. Anderson**

Checked by: B. Walton

Item	Description	Quantity	Units	Unit Price	Total Cost	Notes
0.00	**General Conditions**					
0.01	Contractor Mobilization / Demobilization	1	LS	$ 2,064,000	$ 2,064,000	7% of Other Costs
0.02	Bonds and Insurance	1	LS	$ 590,000	$ 590,000	2% of Other Costs
0.03	Construction Permits	1	LS	$ 50,000	$ 50,000	
				Subtotal	**$ 2,704,000**	
1.00	**Site Preparation**					
1.01	Erosion and Sediment Control	1	LS	$ 20,000	$ 20,000	
1.02	Temporary Access Roads, Facilities and Laydown Areas	1	LS	$ 100,000	$ 100,000	
1.05	Phase I Cofferdams -Gated Spillway, PH	1	LS	$ 6,867,000	$ 6,867,000	Phase I Cofferdam selected apportioned from Tobacco Spillway
1.07	Construction Dewatering	0	LS	$ -	$ -	
1.08	Sediment Removal and Dredging	1	LS	$ 150,000	$ 150,000	
1.09	River Diversion	0	LS	$ -	$ -	
				Subtotal	**$ 7,137,000**	
2.00	**Powerhouse Decommissioning and TG Abandonment**					
2.01	Smallwood Powerhouse Decommissioning, Demolition and Dispos	1	LS	$ 2,500,000	$ 2,500,000	Costs from Edenville Dam Powerhouse Demolition
2.02	Smallwood Gated Spillway Demolition and Disposal	1	LS	$ 1,500,000	$ 1,500,000	
2.03	Mechanical and Electrical Equipment Demolition and Disposal	1	LS	$ 250,000	$ 250,000	
				Subtotal	**$ 4,250,000**	
3.00	**Left Embankment Repair and Stabilization (L = 325 feet)**					
3.01	Sheet Pile Cutoffs	0	SF	$ 90	$ -	
3.02	Embankment Fill	5,100	CY	$ 30	$ 153,000	
3.03	Filter Sand and Drainage Stone Layers	3,100	CY	$ 40	$ 124,000	
3.04	Upstream Riprap Protection	2,500	CY	$ 80	$ 200,000	
3.05	Downstream Riprap Protection	2,900	CY	$ 80	$ 232,000	
3.06	Bedding Stone	1,800	CY	$ 45	$ 81,000	
3.07	Crest Gravel	120	CY	$ 35	$ 4,000	
3.08	Topsoil, Seed and Temporary Erosion Protection	0	SY	$ 2	$ -	
				Subtotal	**$ 794,000**	
4.00	**Right Embankment Repair and Stabilization (L = 100 feet)**					
4.01	Sheet Pile Cutoffs	0	SF	$ 90	$ -	Reduced the embankment rehabilitation length from 150 to 100 feet
4.02	Embankment Fill	1,600	CY	$ 30	$ 48,000	
4.03	Filter Sand and Drainage Stone Layers	1,000	CY	$ 40	$ 40,000	
4.04	Upstream Riprap Protection	800	CY	$ 80	$ 64,000	
4.05	Downstream Riprap Protection	900	CY	$ 80	$ 72,000	
4.06	Bedding Stone	600	CY	$ 45	$ 27,000	
4.07	Crest Gravel	40	CY	$ 35	$ 1,000	
4.08	Topsoil, Seed and Temporary Erosion Protection	0	SY	$ 2	$ -	
				Subtotal	**$ 252,000**	
5.00	**New Gated Spillway and Outlet Works**					
5.01	Sanford 5-Bay Spillway Structure	1	EA	$ 8,405,000	$ 8,405,000	New Gated spillway. Cost apportioned from Edenville Dam
5.02	Crest Gates (Shallow) - Installed with Hoists and Controls	4	EA	$ 300,000	$ 1,200,000	
5.03	Crest Gates (Deep) - Installed with Hoists and Controls	1	EA	$ 500,000	$ 500,000	
5.04	Sheet Pile Cutoffs	10,800	SF	$ 90	$ 972,000	
5.05	Steel Frame Operators Deck	1	EA	$ 1,000,000	$ 1,000,000	
				Subtotal	**$ 12,077,000**	
6.00	**Powerhouse Rehabilitation**					
6.01	Misc surface concrete and masonry repairs		EA	$ 100,000	$ -	Powerhouse rehabilitation costs removed.
6.02	Convert water passages to low level outlet		EA	$ 500,000	$ -	
6.03	Concrete Backfill		CY	$ 600	$ -	
6.04	Foundation Micropiles and Structural Pile Caps		EA	$ 20,000	$ -	
				Subtotal	**$ -**	
7.00	**New Labyrinth Spillway Structure (L = 180 ft)**					
7.01	Reinforced Concrete Labyrinth Floor Slabs	700	CY	$ 900	$ 630,000	Increase spillway width from 125 feet to180 feet
7.02	Reinforced Concrete Chute Slabs	800	CY	$ 800	$ 640,000	
7.03	Reinforced Concrete Stilling Basin Floor Slabs	800	CY	$ 800	$ 640,000	
7.04	Reinforced Concrete End Sill	100	CY	$ 1,500	$ 150,000	
7.05	Reinforced Concrete Labyrinth Weir Walls	200	CY	$ 1,400	$ 280,000	
7.06	Reinforced Concrete Spillllway and Stilling Basin Walls	300	CY	$ 1,200	$ 360,000	
7.07	Steel Sheet Pile Cutoffs	10,800	SF	$ 90	$ 972,000	
7.08	Upstream Riprap	800	CY	$ 80	$ 64,000	
7.09	Downstream Heavy Riprap Apron and Chute	3,300	CY	$ 80	$ 264,000	
7.10	Bedding	1,100	CY	$ 45	$ 49,500	
7.11	Structural Fill	13,000	CY	$ 35	$ 455,000	
7.12	Filter Sand and Drainage Stone	8,100	CY	$ 40	$ 324,000	
7.13	Drain Pipe (Solid and Slotted)	700	LF	$ 25	$ 17,500	
7.14	Pre-Engineered Pedestrian Bridge and Piers (access over stilling basin)	0	LS	$ 500,000	$ -	
				Subtotal	**$ 4,846,000**	
8.00	**Site Restoration**					
8.01	Place Overburden, Seed, Fertilize, and Mulch Slopes	1	LS	$ 100,000	$ 100,000	
8.02	Dam Safety Monitoring Instrumentation	1	LS	$ 30,000	$ 30,000	
				Subtotal	**$ 130,000**	
	Subtotal				$ 32,190,000	
	Contingency			30%	$ 9,657,000	
	Construction Subtotal				**$ 41,847,000**	
	Engineering Investigations, Design and Construction Engineering	-	-	15%	**$ 6,277,000**	
	Total Estimated Cost				**$ 48,124,000**	
				say	**$ 48,124,000**	

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OPINION OF PROBABLE COST - CONCEPTUAL

Project: Secord Dam — **Project No.: 2002879**
Client: Four Lakes Task Force (FLTF) — **Date: 6/30/2020**
Design Discharge = PMF — **Estimated by: P. Drew / R. Anderson**
Checked by: B. Walton

Item	Description	Quantity	Units	Unit Price	Total Cost	Notes
0.00	**General Conditions**					
0.01	Contractor Mobilization / Demobilization	1	LS	$ 2,363,000	$ 2,363,000	7% of Other Costs
0.02	Bonds and Insurance	1	LS	$ 675,000	$ 675,000	2% of Other Costs
0.03	Construction Permits	1	LS	$ 50,000	$ 50,000	
				Subtotal	**$ 3,088,000**	
1.00	**Site Preparation**					
1.01	Erosion and Sediment Control	1	LS	$ 20,000	$ 20,000	
1.02	Temporary Access Roads, Facilities and Laydown Areas	1	LS	$ 200,000	$ 200,000	
1.05	Cofferdams	1	LS	$ 6,867,000	$ 6,867,000	
1.07	Construction Dewatering	0	LS	$ -	$ -	
1.08	Sediment Removal and Dredging	0	LS	$ -	$ -	
1.09	River Diversion	0	LS	$ -	$ -	
				Subtotal	**$ 7,087,000**	
2.00	**Powerhouse Decommissioning and TG Abandonment**					
2.01	Secord Powerhouse Decommissioning, Demolition and Disposal	1	LS	$ 2,500,000	$ 2,500,000	Costs from Edenville Dam Powerhouse Demolition
	Secord Gated Spillway Demolition and Disposal	1	LS	$ 1,500,000	$ 1,500,000	
	Mechanical and Electrical Equipment Demolition and Disposal	1	LS	$ 250,000	$ 250,000	
				Subtotal	**$ 4,250,000**	
3.00	**Left Embankment Repair and Stabilization (L = 470 feet)**					
3.01	Sheet Pile Cutoffs	28,200	SF	$ 90	$ 2,538,000	
3.02	Embankment Fill	4,600	CY	$ 30	$ 138,000	
3.03	Filter Sand and Drainage Stone Layers	2,600	CY	$ 40	$ 104,000	
3.04	Upstream Riprap Protection	3,700	CY	$ 80	$ 296,000	
3.05	Downstream Riprap Protection	2,100	CY	$ 80	$ 168,000	
3.06	Bedding Stone	2,000	CY	$ 45	$ 90,000	
3.07	Crest Gravel	200	CY	$ 35	$ 7,000	
3.08	Topsoil, Seed and Temporary Erosion Protection	0	SY	$ 2.00	$ -	
				Subtotal	**$ 3,341,000**	
4.00	**Right Embankment Repair and Stabilization (L = 360 feet)**					
4.01	Sheet Pile Cutoffs	21,600	SF	$ 90	$ 1,944,000	
4.02	Embankment Fill	3,500	CY	$ 30	$ 105,000	
4.03	Filter Sand and Drainage Stone Layers	2,000	CY	$ 40	$ 80,000	
4.04	Upstream Riprap Protection	2,800	CY	$ 80	$ 224,000	
4.05	Downstream Riprap Protection	1,600	CY	$ 80	$ 128,000	
4.06	Bedding Stone	1,500	CY	$ 45	$ 67,500	
4.07	Crest Gravel	100	CY	$ 35	$ 3,500	
4.08	Topsoil, Seed and Temporary Erosion Protection	0	SY	$ 2.00	$ -	
				Subtotal	**$ 2,552,000**	
5.00	**New Gated Spillway and Outlet Works**					
5.01	Secord 4-Bay Spillway Structure	1	EA	$ 6,724,000	$ 6,724,000	New Gated spillway. Cost apportioned from Edenville Dam
5.02	Crest Gates (Shallow) - Installed with Hoists and Controls	3	EA	$ 400,000	$ 1,200,000	
5.03	Crest Gates (Deep) - Installed with Hoists and Controls	1	EA	$ 667,000	$ 667,000	
5.04	Sheet Pile Cutoffs	10,800	SF	$ 120	$ 1,296,000	
5.05	Steel Frame Operators Deck	1	EA	$ 1,000,000	$ 1,000,000	
				Subtotal	**$ 10,887,000**	
6.00	**Powerhouse Rehabilitation**					
6.01	Misc. surface concrete and masonry repairs		EA	$ 200,000	$ -	Powerhouse rehabilitation costs removed.
6.02	Convert water passages to low level outlet		EA	$ 500,000	$ -	
6.03	Concrete Backfill		CY	$ 600	$ -	
6.04	Foundation Micropiles and Structural Pile Caps		EA	$ 20,000	$ -	
				Subtotal	**$ -**	
7.00	**New 200 foot Labyrinth Spillway**					
7.01	Reinforced Concrete Labyrinth Floor Slabs	800	CY	$ 900	$ 720,000	Increase spillway width from 125 feet to 200 feet
7.02	Reinforced Concrete Chute Slabs	900	CY	$ 800	$ 720,000	
7.03	Reinforced Concrete Stilling Basin Floor Slabs	900	CY	$ 800	$ 720,000	
7.04	Reinforced Concrete End Sill	128	CY	$ 1,500	$ 192,000	
7.05	Reinforced Concrete Labyrinth Weir Walls	200	CY	$ 1,400	$ 280,000	
7.06	Reinforced Concrete Spilllway and Stilling Basin Walls	400	CY	$ 1,200	$ 480,000	
7.07	Steel Sheet Pile Cutoffs	12,000	SF	$ 90	$ 1,080,000	
7.08	Upstream Riprap	900	CY	$ 80	$ 72,000	
7.09	Downstream Heavy Riprap Apron and Chute	3,700	CY	$ 80	$ 296,000	
7.10	Bedding	1,200	CY	$ 45	$ 54,000	
7.11	Structural Fill	14,800	CY	$ 35	$ 518,000	
7.12	Filter Sand and Drainage Stone	9,000	CY	$ 40	$ 360,000	
7.13	Drain Pipe (Solid and Slotted)	800	LF	$ 25	$ 20,000	
7.14	Pre-Engineered Pedestrian Bridge and Piers (access over stilling basin)	0	LS	$ 500,000	$ -	
				Subtotal	**$ 5,512,000**	
8.00	**Site Restoration**					
8.01	Place Overburden, Seed, Fertilize, and Mulch Slopes	1	LS	$ 100,000	$ 100,000	
8.02	Dam Safety Monitoring Instrumentation	1	LS	$ 30,000	$ 30,000	
				Subtotal	**$ 130,000**	
	Subtotal				$ 36,847,000	
	Contingency			30%	$ 11,054,000	
	Construction Subtotal				**$ 47,901,000**	
	Engineering Investigations, Design and Construction Engineering	-	-	15%	**$ 7,185,000**	
	Total Estimated Cost				**$ 55,086,000**	
				say	**$ 55,086,000**	

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