Rehabilitation Alternatives Analysis - DRAFT

Hesperia Dam

Oceana County, Michigan
Dam I.D. No. 678

Submitted to:
Village of Hesperia
33 E Michigan Avenue
Hesperia, Michigan 49421

Submitted by:
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Project No. 2403886

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1. Background and Purpose

1.1 Background

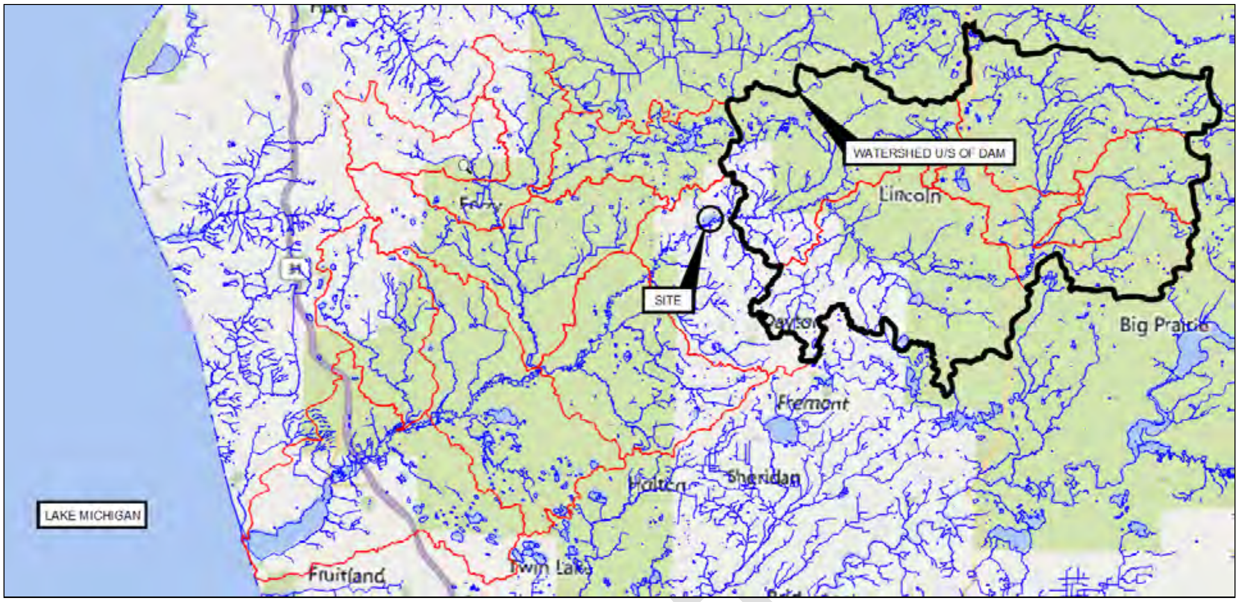
In recent years, numerous deficiencies have been identified during dam safety inspections by the Village's engineer and EGLE. These deficiencies range from uncertainty about spillway capacity, concrete deterioration, grouted riprap deterioration and seepage. These deficiencies have led to the dam receiving a fair condition rating. Given the fair condition rating and the challenges of maintenance and upkeep on the dam, the Village is seeking to develop a long-term plan for rehabilitation and maintenance of the dam. The EGLE condition assessment categories and their definitions are outlined in **Table 1-1**.

Table 1-1. Condition Assessment Category

Condition	Description
Satisfactory	No existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all loading conditions.
Fair	No existing dam safety deficiencies are recognized for normal loading conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency.
Poor	A dam safety deficiency is recognized for loading conditions that may realistically occur. Remedial action or further investigations and studies are necessary to determine risk.
Unsatisfactory	A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.
Not Rated	The dam has not been inspected, is not under State jurisdiction, or has been inspected but, for whatever reason, has not been rated.

In addition to the dam safety deficiencies, sea lamprey escapement has been documented in recent years, requiring lampricide treatment upstream. These escapements have been attributed to overtopping the auxiliary spillway and gaps in and around the stop logs of the primary spillway. Given the size of the upstream connected watershed, lampricide treatments are costly and carry their own ecological risks. For these reasons, USFWS and GLFC are partnering with the Village of Hesperia to rehabilitate the dam and improve sea lamprey barrier function. **Figure 1** below depicts the upstream watershed, the dam location, and the connectivity of the White River to Lake Michigan.

Figure 1. Hesperia Dam Watershed



1.2 Purpose

This Alternatives Analysis Report presents the design basis criteria and engineering evaluations for possible rehabilitation or removal alternatives of the Hesperia Dam located in Oceana and Newago Counties, Michigan on the White River. The report provides an understanding of the current condition of the Dam, a summary of risks, and an opinion of probable construction cost for the alternatives. In addition, fish passage options have also been evaluated with the rehabilitation alternatives. The dam impounds Hesperia Pond and currently serves as feature of the Village's River Front Park. The dam also serves as a lower-most barrier for sea lamprey control. In recent years, there have been recorded escapements of sea lamprey upstream. The current condition of the Hesperia Dam has been rated by Fleis & Vandenbrink (F&V) as Fair based on the 2021 inspection. However, additional deficiencies have been identified by EGLE and USFWS since the time of the report. The deficiencies are outlined in Section 2.2 below.

1.3 Vertical and Horizontal Datum

Elevations listed herein are references to the North American Vertical Datum of 1988 (NAVD88). The horizontal datum references are to the North American Datum of 1983 (NAD83), Michigan State Plane, South Zone, International Foot.

1.4 EGLE Dam Safety Design Criteria

Hesperia Dam is under the regulatory jurisdiction of the State of Michigan EGLE. The EGLE dam safety criteria are contained in Part 315, Dam Safety of the Natural Resources and Environmental Protection Act, 1994 PA 451 (NREPA). Dams are assigned a hazard classification and corresponding minimum flood flow requirements based on the potential downstream impacts caused by failure of the dam. There are three hazardous potential categories as outlined in **Table 1-2**.

Table 1-2. Hazardous Potential Category

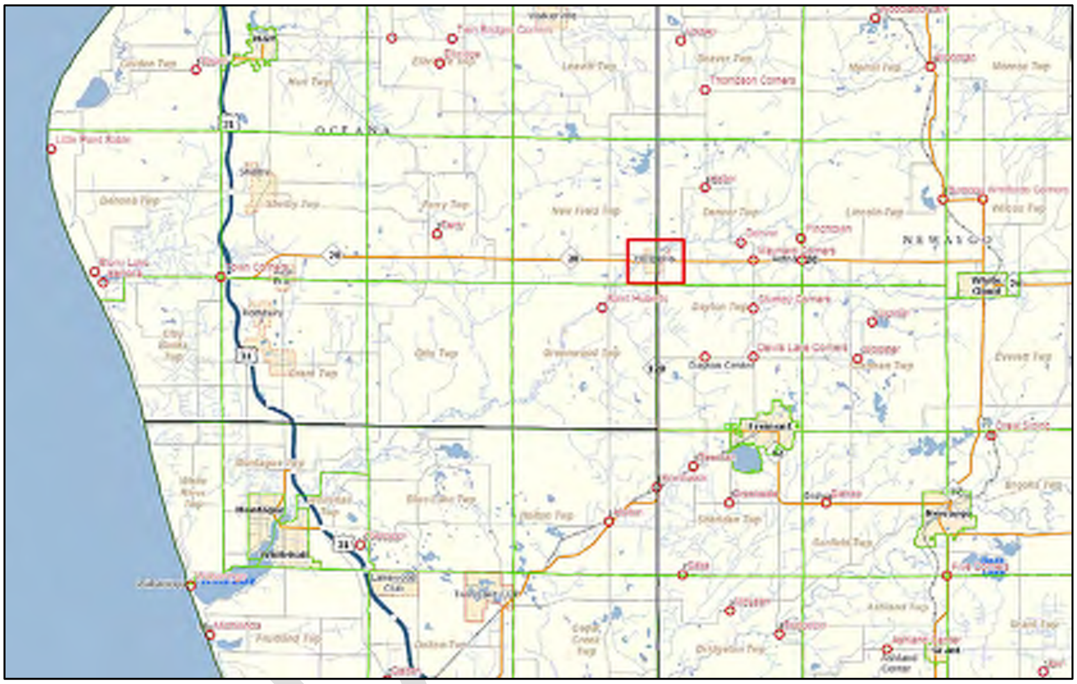
Classification	Loss of Human Life	Economic, Environmental, Lifeline Losses
Low	None Expected	Low and Generally Limited to Owner
Significant	None Expected	Yes
High	Probable (one or More Expected)	Yes

Hesperia Dam is currently classified as a Significant Hazard dam. Per EGLE, significant hazard potential dams shall be capable of passing the 200-year flood, or the flood of record, whichever is greater.

2. Description of Project Structures

Hesperia Dam is located in Hesperia, MI on the White River approximately 33 river miles upstream of White Lake and Lake Michigan. The Hesperia Dam also serves as a lower-most barrier to Lake Michigan for sea lamprey control, this project has implications for the Great Lakes fisheries and ecosystems. **Figure 2** below depicts the location of the site relative to White Lake, Lake Michigan, and surrounding communities.

Figure 2. Community Map



2.1 Existing Dam Features

The Hesperia Dam was originally constructed on the White River for power generation. Consumers Energy ceased hydroelectric power generation in the 1950s and relinquished ownership of the dam to the Village of Hesperia. Based on available photos the powerhouse that was originally constructed adjacent to the primary spillway left abutment was also removed. The remaining structure impounds approximately 50 acres, with a normal head of approximately 7 feet. This dam also serves as a lower-most barrier for sea lamprey on the White River.

The dam consists of a principal spillway structure, a grouted riprap auxiliary spillway and earthen embankments (See Figure 3). The principal spillway structure is approximately 70 feet wide and includes 6 bays with wooden stop logs, which are operated by manual lifting from the walkway above. The history of the construction of the principal spillway is unknown, but is assumed to be rock-filled timber crib and masonry which was typical for the era. At some unknown date, the dam was encased with a reinforced concrete cap. The left[1] earthen embankment extends 30 feet to the abutment. To the right of the primary spillway, the earthen embankment extends 240 feet to the abutment. Approximately 170 feet of the right embankment, immediately adjacent to the primary spillway, serves as the auxiliary spillway. The crest of the auxiliary spillway is stabilized with a concrete walkway and the downstream slope has armored grouted riprap. The key existing project elevations are outlined in **Table 2-1**.

Figure 3. Primary Spillway Layout

Downstream of the dam park spaces predominate both sides of the river. On the downstream left river bank, the amenities owned by the Village include a gazebo, pavilion, restrooms, and boardwalk. On the downstream right river bank, there is a privately owned campground. Upstream of the right embankment, there is a swimming pond with an artesian well owned by the Village, while on the left bank is a grocery store and parking lot.

Approximately 250 feet upstream of the dam is Division Street bridge (Maple Island Road) owned by the Village of Hesperia (structure number 8411). Based on the MDOT Bridge Condition GIS Database the current 2 lane bridge structure was constructed in 2003 and rated as good condition during the 2023 inspection. The Division Street bridge acts as an upstream hydraulic constriction according to the 2021 Dam Safety Inspection Report.

Historic records indicate that the dam has been overtopped along the right embankment in 1975, 1986, 2013, 2014, and 2018. In response to the threat of overtopping in 1986, the right embankment was mechanically breached at the spillway right abutment. As part of the repairs to the right embankment, a

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[1] References to left and right are based on orientation facing downstream.

formal auxiliary spillway, consisting of a lower crest and with grouted riprap to prevent erosion during spilling was constructed. However, the existing condition does not provide capacity to pass the required 200-year design flood. A stoplog failure occurred in July 2021, but no other dam safety concerns were reported with the incident.

Table 2-1. Key Existing Project Data

Parameters	Data
Zero Freeboard El. (feet)	722
Embankment Width (feet)	40
Normal Pool Headwater Surface El. (feet)	717.8
Normal Pool Tailwater Surface El. (feet)	710.7
Main Embankment Length (feet)	85
Dam Structural Height (feet)	11
Dam Hydraulic Height (feet)	11
Principal Spillway Type	Field Stone with Concrete Overlay and stoplog bays
Principal Spillway Invert El. (feet)	713.6
The number stoplog bays	6
Normal Stoplog El.	715.25
Auxiliary spillway Width	16
Auxiliary spillway Length (feet)	160
Auxiliary spillway Material	Concrete crest with downstream grouted riprap
Top of Auxiliary spillway Elevation(feet)	720
Top of Divider Berm El. (feet)	720 +/-

2.2 Documented Dam Deficiencies

The most recent dam inspection was performed in, 2021, by F&V. The following were the notable conclusions and recommendations from that inspection:

1. Monitor seepage/leakage and slope erosion at the downstream left berm at least monthly. Look for discolored water or other signs of material transport. Report any changed conditions immediately.
2. During the inspection, debris on the gates of the dam was very minor, limited to light wood debris and leaves/cattails. Debris should be removed routinely to prevent buildup, which can impede operation of the stop logs.
3. Minor brush growth was noted in various areas around the footprint of the structure. This should be removed routinely, as it prevents thorough inspection and provides habitat for burrowing animals.
4. The stop logs should be exercised at least annually to prevent them from locking up and inspect them for any wear or damage.

5. In conjunction with stop log operations, it is recommended that sections of the spillway be isolated to better inspect the lower spillway for deterioration and/or undermining. The normal flow of water over the spillway does not allow for visual inspection and makes probing somewhat impractical.
6. Several voids were detected in the grouted riprap between the principal and emergency spillways. It should be filled with loose grout or flowable fill as needed to fill the void and mitigate additional loss of material.
7. The toe of the grouted riprap on the downstream slope of the emergency spillway is settling. It should be monitored and replaced as needed.

In addition, to the noted deficiency in the dam safety inspection report the following deficiencies have also been identified EGLE and USFWS:

1. Continued seepage noted at the left abutment. Village to monitor weekly and provide update to GEI and EGLE.
2. Leakage through stoplogs allowing for sea lamprey escapement upstream.
3. Auxiliary spillway activation at 2-year event leading to sea lamprey escapement upstream.

The above listed deficiencies are attributed to an aging primary spillway structure that relies on stoplogs which may not be safe to remove during a flood event. These conditions result in overtopping of the right embankment due to inadequate primary spillway capacity during flood events. The frequent overtopping events and deteriorating controls create an ineffective sea lamprey barrier and leading to escapement and treatment of the White River upstream of the dam.

2.3 Summary of Existing Conditions

The following sections provide the topographic and bathymetric survey completed, existing hydrology and hydraulic data, subsurface (geotechnical and geologic) structural data review, and a review of property ownership.

2.3.1 Survey and Base Map

F&V performed topographic and bathymetric surveys of the project site, which were utilized by the team for engineering analyses and conceptual level design. The topographic survey encompassed the entire dam and Village-owned properties adjacent to the dam. Property corners were identified in the field and surveyed for inclusion in the base map. Additionally, a topographic survey was conducted about the parking area between Ed's Market and Division Street. Surveys were collected on known infrastructure within the vicinity of the dam, including the dam, storm sewers, bridges, hardscapes, and utilities, using survey-grade GPS equipment. F&V established permanent benchmarks on the project site to facilitate future construction work and monitoring.

A bathymetric survey was conducted in the impoundment from the dam to 100 feet upstream of the Division Street Bridge. The bathymetric survey also included the swimming pond upstream of the right embankment. Downstream of the dam, bathymetry was collected for the river from the dam to 200 feet downstream of Hawley Road. Each bridge crossing within that reach was surveyed, identifying low chord and high chord elevations and pier and abutment geometries.

Prior to performing the field survey, the MISS DIG Utility Notification (811) was contacted by F&V to perform subsurface utility locates in the vicinity of the dam. Topographic data were supplemented, as necessary, with publicly available LIDAR data or other as-built information provided by the Village.

2.3.2 Existing Hydrology and Hydraulic Information

Updated flood flows were requested from EGLE on October 16, 2024, to confirm the design storm event. Hesperia Dam has a total drainage area of 214 square miles. Since the dam is classified as significant hazard the design discharge is the 0.5% chance (200-year) flood. Flood flows are summarized in **Table 2- 2.** **(EGLE, 2024a)** Updated low flows were also requested from EGLE and are presented in **Table 2-3**. (**EGLE, 2024b**) In addition, EGLE provided flood hydrographs for the 50-, 100-, 200-, and 500-year flood events. The flood flow discharge request letter and hydrographs from EGLE are included in Appendix A.

Table 2-2. Summary of Flood Flows (EGLE, 2024a)

Return Period	Peak Inflow (cfs)
2-year	1,100
5-year	1,700
10-year	2,200
25-year	2,800
50-year	3,300
100-year	3,900
200-year	**4,400**
500-year	4,500

Table 2-3. EGLE Low Flows (EGLE, 2024b)

Month	50% Exceedance Flows (cfs)	95% Exceedance Flows (cfs)
January	220	160
February	230	150
March	290	180
April	310	200
May	250	170
June	200	130
July	150	110
August	150	110
September	150	110
October	180	120
November	220	140
December	220	150

GEI developed an existing conditions 1D model using the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS). That model geometry includes survey information for the dam, bridges, topography, and bathymetry from F&V and was supplemented with LiDAR in the upper impoundment to N Dickenson Ave. More details on the model development are discussed in **Section 4.1** including spillway rating curves.

2.3.3 Existing Subsurface Information

Due to the lack of historical subsurface information, a subsurface exploration and laboratory testing program were required to establish existing subsurface conditions and aid in the analysis of existing dam conditions. GEI prepared a Geotechnical Data Report (GDR) for the dam summarizing the results of field investigation and laboratory testing. The GDR is included in **Appendix B.1**.

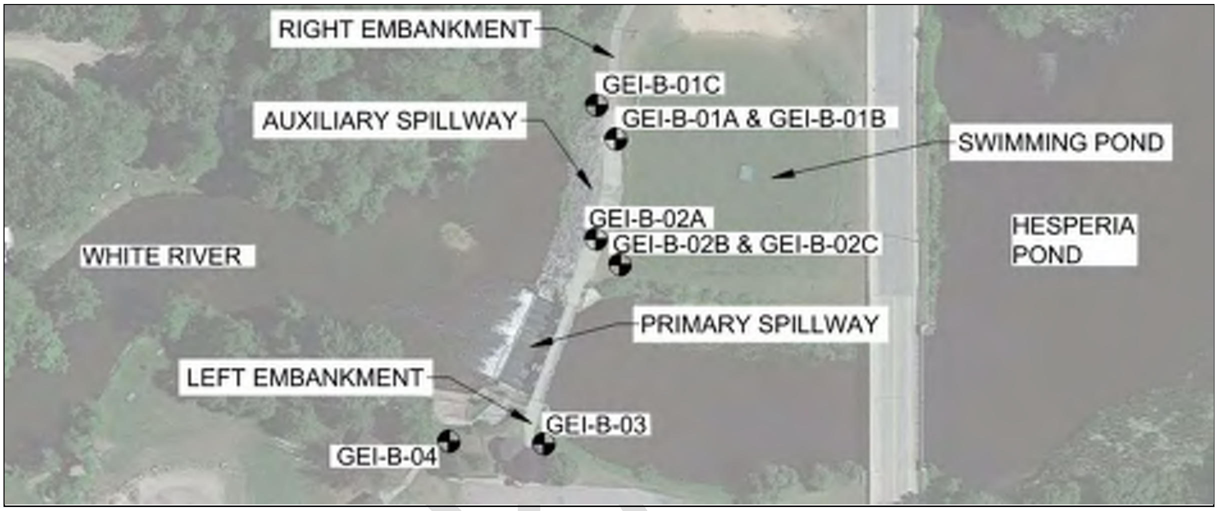
Soil boring locations were selected to sample and characterize the various embankment and foundation soil strata of geotechnical interest at each dam location. Subsurface explorations were performed at the dam in October 2024, under the oversight of a GEI field professional. Subsurface investigations included standard penetration (SPT) borings at the crest of the dam. Laboratory testing of representative disturbed SPT samples was completed at GEI's Marquette, Michigan, geotechnical laboratory.

The intent of the subsurface explorations was to:

- Define the depth of existing embankment fill and top of the foundation material.
- Collect Standard Penetration Test (SPT) samples to develop a characterization of the subsurface stratigraphy within the embankment and foundation soils layers.
- Classify and define the engineering properties of the constituent embankment fills and foundation soils.
- Install open standpipe piezometers at each boring location.

The subsurface investigation consisted of four borings to depths 30 feet. Several attempts were made at boring locations B-1 and B-2 due to obstructions not allowing for advancement of the augers. The foundation soils were encountered below elevations ranging from 712 to 704 feet and generally fine sands and silty fine to medium sands, with sandy clay and gravel also observed. The foundation soils were overlain by existing embankment fill consisting of a combination of fine to coarse sand, with gravel, cobbles, and silt. In addition, in the left embankment borings layers of saw dust were encountered. Groundwater was encountered during sampling between elevation (El.) 716.7 to 713.2 or 4.4 to 8.5 feet below the crest of the dam. The boring locations are shown in **Figure 4** and in the GDR provided in **Appendix B.1**.

Figure 4: Boring Location Diagram



2.3.4 *Existing Structural Information*

A desktop evaluation of the available as-built documentation of the structure was preformed. This desktop analysis included reviewing documents provided by EGLE and F&V, obtaining records from the Oceana County Historical Society and The Heritage Museum of Newaygo County and reaching out to Consumers Energy Company for historic archive documents. Original dam construction documents were not available for review. The following drawings were reviewed:

- Dam Repairs prepared by Norlund, Dunlap & Associates, Inc. date August 1986
- Dam Schematic prepared by F&V dates October 2021
- Dam Repair Permit prepared by F&V dated September 2023

2.3.5 Existing Property Ownership

F&V performed a desktop study on the potential impacted parcels upstream and downstream of the dam. A map depicting parcel ownership extents is provided in **Appendix C.1** and parcel ownership is included in the alternative drawings. The following process was used to evaluate real estate concerns that may impact a future project for Hesperia Dam:

- Parcel linework and ownership were obtained from Oceana and Newaygo County GIS mapping.
- Tax descriptions were reviewed using the respective county GIS data to evaluate bottomland ownership.
- For those parcels whose bottomland ownership was unclear from tax descriptions, title work was completed to obtain the latest deed.
- A summary map ("Real Estate Evaluation") was developed with color coding to identify those properties with ownership to the bank, ownership to the river centerline/thalweg, known ownership with unknown bottomland rights and unknown parcel ownership. The two parcels with unknown ownership are upstream impoundment and upstream channel, which is branched, and are assumed to be publicly owned.
- Most of the parcels adjacent to the White River upstream and downstream of Hesperia dam with known bottomland rights have ownership just to the bank. The Village of Hesperia owns the only two parcels with confirmed rights/ownership beyond the bank – a parcel at the south/left end of the dam and an island area within the impoundment east of Division Street/Maple Island Road.
- Ownership and bottomland rights will need to be determined/confirmed during the design phase.

3. Environmental and Cultural Resource Considerations

The following sections outline the information that was readily available during the desktop review for environmental cultural and historical resources for Hesperia Dam. Additional research and field investigations may be required during the design phase of the selected alternative.

3.1 Environmental Considerations

GEI performed a desktop analysis to help inform of potential wetland and threatened and endangered species impacts along with potential permitting requirements that need be considered during the feasibility assessment for dam rehabilitation at the Hesperia dam. The following sections outline the results of the existing information that was reviewed at this time.

3.1.1 Wetlands

Reviews of aerial imagery and state and federal agency databases indicate the presence of wetlands at the Hesperia Dam site. Based on data obtained from National Wetlands Inventory (NWI) and Natural Resource Conservation Service (NRCS) Web Soil Survey (WSS) databases, it is likely there are wetlands both upstream and downstream of the dam. The WSS map (**Figure 5**) shows Glendora mucky sand (hydric [wetland] 94% of the time) upstream of the dam and Glendora mucky loamy fine sand (hydric 96% of the time) downstream of the dam. Upstream of the dam, the NWI (**Figure 6**) map shows emergent wetlands and the Hesperia Dam impoundment; downstream of the dam, the map shows forested wetlands downstream of the dam along the White River.

Wetlands are considered contiguous and regulated by Part 303 of NREPA if they meet any of the following criteria:

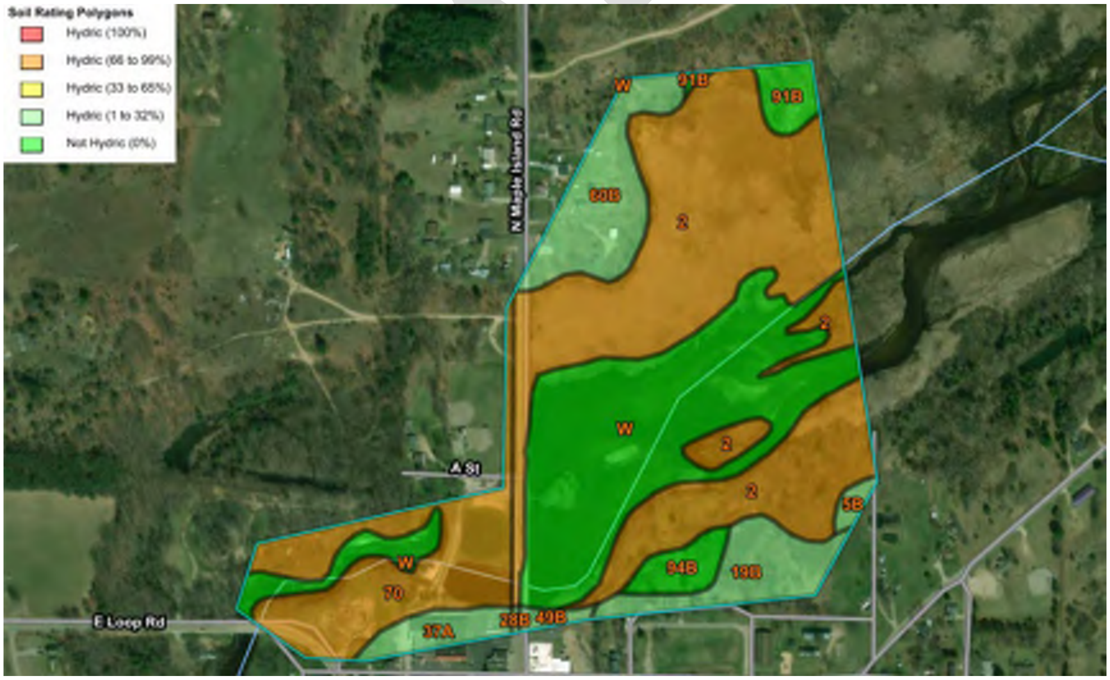
1. A permanent surface water connection or other direct physical contact with an inland lake or stream, a pond, a river, one of the Great Lakes, or the connecting waters of the Great Lakes.
2. A seasonal or intermittent direct surface water connection to an inland lake or stream, a pond, river, one of the Great Lakes, or the connecting waters of the Great Lakes.
3. Partially or entirely located within 500 feet of the ordinary high watermark of an inland lake or stream, a pond, or a river or is within 1,000 feet of the ordinary high watermark of one of the Great Lakes or the connecting waters of the Great Lakes, unless it is determined by EGLE that there is no surface water or groundwater connection to these waters; or
4. Two or more areas of wetland separated only by unnatural barriers, such as dikes, roads, berms, or other similar constructed features, but with any of the wetland areas contiguous under the criteria described in this definition. The connecting waters of the Great Lakes shall be considered part of the Great Lakes for purposes of this definition.

5. The wetland is not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, stream, or river, but is more than 5 acres in size.
6. The wetland is not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, stream, or river, and less than 5 acres in size, but EGLE has determined that these wetlands are essential to the preservation of the state's natural resources and has notified the property owner.

Due to the proximity to regulated streams and/or inland lakes at the site, all wetlands identified for this project are regulated by EGLE. Pursuant to Part 303 of NREPA, a permit would be required from EGLE for any proposed dredging, filling, draining, or maintained use or development within a regulated wetland. A permit from EGLE would not be required if regulated wetlands were avoided and none of the forementioned activities are proposed within them.

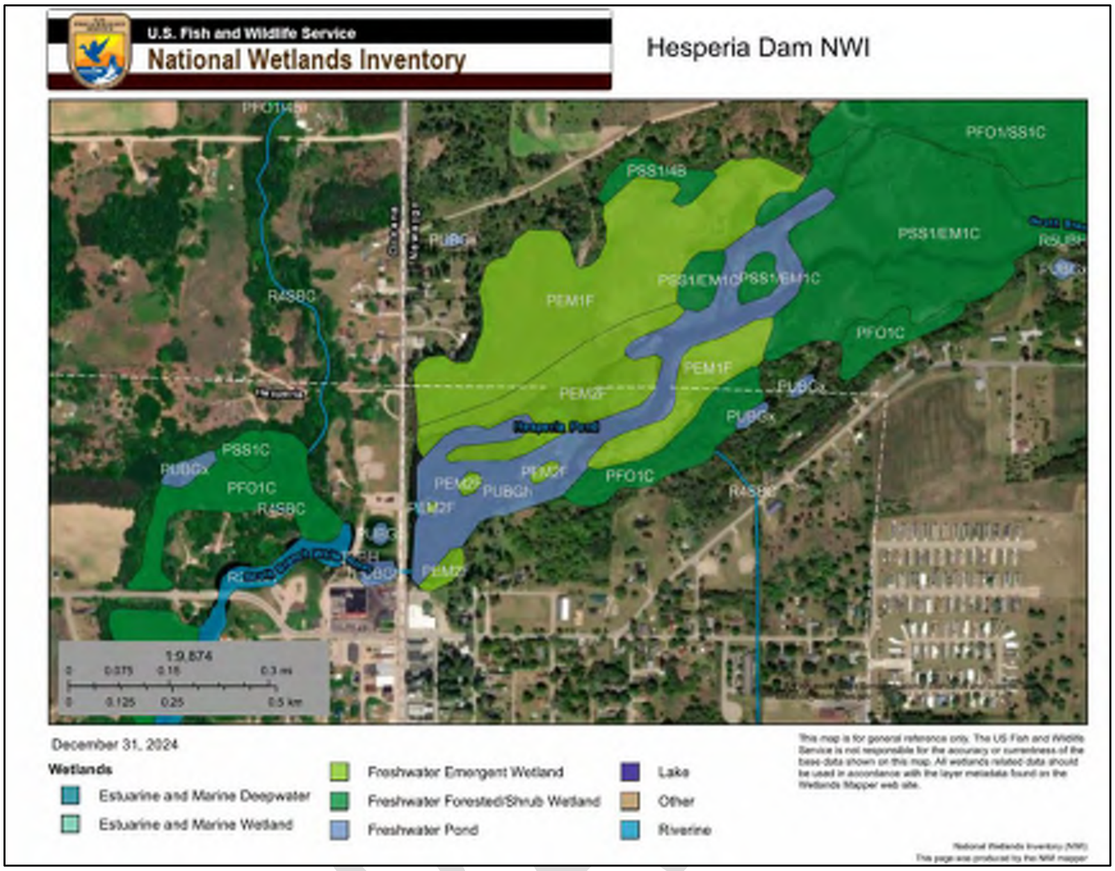
Due to the dynamic nature of wetland and water resources, this report reflects wetland and water body presence as they existed during the time the desktop review was completed. Please be advised this regulatory judgement represents our professional opinion based on desktop review alone and does not constitute a formal wetland delineation. EGLE is the state agency with regulatory authority and have final discretionary authority relative to wetland boundaries and jurisdictional determinations of "waters" of the United States.

Figure 5. Map of Hydric Soil Ratings at the Hesperia Dam Site



Source: USDA Natural Resources Conservation Service – Web Soil Survey

Figure 6. Map of NWI Wetland Designations at the Hesperia Dam Site



Source: U.S. Fish and Wildlife Service - National Wetland Inventory

3.1.2 Threatened and Endangered Species

Review of the Michigan Natural Features Inventory (MNFI) protected species database identified three state/federal threatened or endangered species with records at or within 1.5 miles of the site: American bumble bee (*Bombus pensylvanicus*; state endangered), wood turtle (*Glyptemis insculpta*; state threatened), and bigmouth shiner (*Notropis dorsalis*; state threatened). American bumblebee is a foraging generalist, but prefers grassland habitats, which are not currently present in the vicinity of the project. Wood turtles are likely to find suitable habitats for foraging (mid-size to large streams, wooded or shrubby wetlands) and nesting (sandy roadsides and agricultural settings) within and nearby the project area. Both the impoundment and downstream run of the White River may currently support this species. Wood turtles nest during the month of June, at which time they may be vulnerable to impacts resulting from construction activities. The single record of American bumblebee near the site is historic (1970), and more recent records from nearby Newaygo County are likely from the well-studied dry sand prairie ecosystems far to the east of Hesperia. Bigmouth shiner, a small (~3 inches long) minnow is typically found in small, fast-moving streams, but occasionally inhabits larger rivers as well. There is potential for this species to occupy the site, particularly downstream of the dam. The impounded area upstream of the dam is unlikely to provide suitable habitat fir this species.

One additional species listed as special concern was identified by the MNFI review, mudpuppy (*Necturus maculosus*). Mudpuppies are large aquatic salamanders which typically inhabit mid- to large-size rivers. There are recent records of this species within the White River both upstream and downstream of the Hesperia Dam.

Review of the United States Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) identified six federally protected species whose geographic range overlaps with the project site: Indiana bat (*Myotis sodalist*; endangered), northern long-eared bat (*Myotis septentrionalis*; endangered), rufa red knot (*Calidris canutus rufa*; threatened), eastern massasauga rattlesnake (*Sistrurus catenatus*; threatened), Karner blue butterfly (*Lycaeidus melissa samuelis*; endangered), and Pitcher's thistle (*Cirsium pitcheri*; threatened). Rufa red knot and Pitcher's thistle are both coastal species and are highly unlikely to be present at the site. Eastern massasauga rattlesnake (EMR) is not known to occur near the project site, and review by MNFI did not find any suitable habitat nearby. Karner blue butterfly occupies upland prairie and savanna habitats, which are not present at or near the site. The MNFI review did not indicate any known occurrences of protected bat species near or within the project area; however, the range of both Indiana bat and northern long-eared bat overlap the site. There may be suitable roost trees present near the site, and tree clearing activities may need to occur during the bats' inactive season (approximately November 1 through March 31) to avoid impacts to these species.

An additional federal candidate species, monarch butterfly (*Danaus Plexippus*; proposed threatened), was identified in the IPaC review. This species relies on milkweeds (*Asclepias spp.*) which are ubiquitous throughout the state of Michigan and likely occur in uplands and wetlands at the project site. As such, this species likely occurs at the site and may need to be considered if officially listed before or during the project.

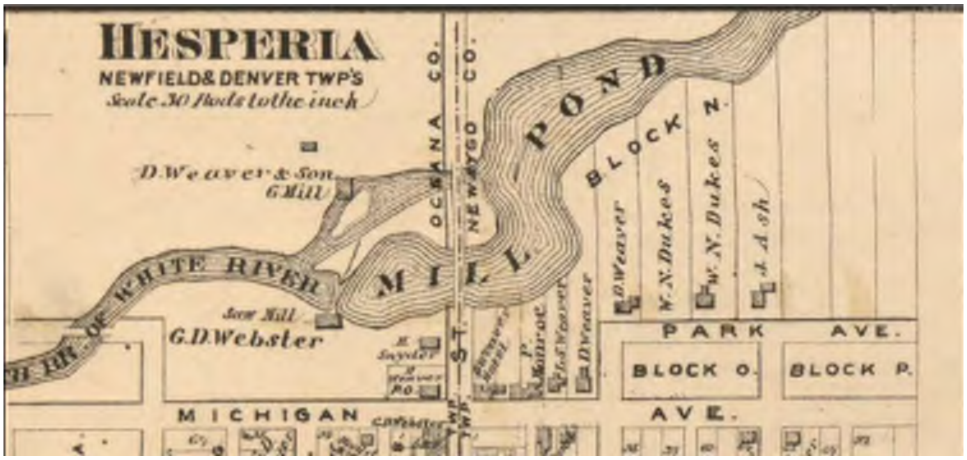
3.2 Historical Map Review

The course and shorelines of the White River and Hesperia Pond were somewhat different in the late 19th century (**Figure 7**). It appears that in 1876 a no-longer-extant dam situated approximately 150 feet downstream from the present-day dam formed a mill pond that extended west of North Maple Island Road (formerly Division Street). Other major differences included the presence of a no-longer-extant river that was formed by a no-longer-extant side channel (**Figure 8**).

Figure 7. White River and Hesperia Pond in the Late 19th Century

Source: U.S. Fish and Wildlife Service - National Wetland Inventory

Figure 8. Oceana County Historical Society



Although the alignment of North Maple Island Road appears to have maintained a straight north-south alignment as originally constructed, by 1931 the road alignment meandered westward north of White River (**Figure 9**). The existing alignment that presently forms the eastern boundary of Hesperia Dam Park (aka Hesperia Sports Park) was built sometime between 1931 and 1955 (**Figure 10**) (USGS 1931; Historic Aerials 1955).

Figure 9. Excerpt of 1931 USGA Showing the Original Alignment of North Maple Island Road

Figure 10. Excerpt of 2025 Aerial Image with Newer Alignment Shown in Dashed Yellow Line

After the new alignment of North Maple Island Road was built, the area that comprised Hesperia Dam Park was inundated while the A Street parking lot was a narrow causeway flanked by water on both sides (Historic Aerials 1955). The area north of that causeway was drained by 1958 to create the present-day park (Historic Aerials 1958). The berm south of the A Street parking lot was built sometime between 1976 and 1981, forming the extant pond (Figure 11) (USGS 1976 and 1981).

Figure 11. Excerpt of 2022 Aerial Image with the Berm Outlined in Red

It appears that a channel dredged into the south bank of White River, just downstream of Hesperia Dam, was present in 1955 but ultimately backfilled by 1958 (**Figure 12**) (Historic Aerials 1955 and 1958). Visibility in the 1955 aerial is poor, and its presence could not be verified in other aerial imagery or mapping.

Figure 12. Excerpt of 2022 aerial image with the approximate location of the no-longer-extant channel outlined in red

3.3 Cultural Considerations

GEI has completed a limited study to inform where the rehabilitation, repair, and/or removal alternatives may affect known cultural resources. Furthermore, and in consideration of the preliminary findings of this study, GEI has provided information about the next steps for future cultural resource compliance efforts based on applicable laws and regulations. Specifically, and in anticipation of the use of federal funds, this would necessitate National Historic Preservation Act (NHPA) Section 106 (Section 106) compliance review in the future and this study is intended to assist the project team in outlining the next steps for the compliance process relative to Section 106. The following sections summarize the results of the existing information that was reviewed at this time. Potential impacts for each alternative are discussed in the respective alternative sections.

Background research for this study focused on documenting known and previously recorded archaeological and architectural resources within the study area for Hesperia Dam and a one-mile radius.

Based on the knowledge that the project may be subject to a Section 106 review in the future due to a currently unspecified federal nexus, such as the use of federal funds, GEI has the following recommendations:

- An Area of Potential Effects (APE) should be delineated for the undertaking(s), once defined. The APE should include the horizontal and vertical extent of ground disturbance and any temporary use areas, such as access roads or equipment staging locations. Further, consideration should be given to the potential for the project to result in indirect effects to nearby lands and/or built-environment features, and as such, the APE may encompass lands beyond the direct impact area(s) associated with the project.

- The project would require a review by the Michigan State Historic Preservation Office (SHPO) to be initiated by the submittal of a Section 106 Application.
- The Section 106 review would require the examination of the Michigan SHPO database for the presence/absence of previously recorded cultural resources, including Historic Properties. Further, the review may require the completion of technical studies to determine the presence or absence of Historic Properties in the APE and the potential for the project to result in effects to Historic Properties pursuant to Section 106. While the scope and scale of these studies would be developed in coordination with the federal agency and SHPO, such studies may consist of a Phase I Archaeological Survey, a submerged resources assessment if portions of the APE are under water, and/or an Architectural Resources Survey, depending on the types of lands and potential resources in the APE, once defined.
    - Minimally, it is anticipated that an Architectural Resources Inventory and Evaluation Report will be needed at the dam location (if in the APE), because the examined dam is of historic age, and to determine if the resource is eligible for the National Register of Historic Places (NRHP). In addition, a corresponding Michigan SHPO Architectural Properties Identification Form will need to be completed to document the evaluated resource. If the architectural resource is recommended NRHP-eligible, a finding of effect analysis would also need to be prepared to assess the effects the proposed project may have on the significant resource. The inventory and evaluation report would need to meet Section 106 requirements and would require SHPO review and concurrence.

Finally, please note that any archaeological resources fieldwork on DNR-administered lands must be permitted by DNR, and that the DNR permitting process includes an approximate 45-day review window from the date an application is submitted until it may be granted. Survey on DNR lands cannot proceed until the permit is granted by the DNR and any resultant technical documents must be submitted to DNR for review. Further, any artifacts originating from DNR-administered lands remain the property of the state and would need to be returned to the DNR in accordance with permit conditions.

3.3.1 Cultural Resources Records Review

The purpose of the records review was to determine the presence or absence of previously recorded cultural resources in and near the dam locations, including archaeological sites and historic-era architectural resources. To identify these resources, GEI cultural resources specialists completed preliminary research, reviewed aerial photographs and site photographs of the dams and the adjacent environs, and examined publicly available databases for the presence/absence of previously documented cultural resources.

For the database review, the following resources were consulted to obtain information about the presence or absence of previously recorded cultural resources in and near the dam:

- National Historic Landmarks (NHL) List (2025a); and
- National Register of Historic Places (NRHP) GIS Public Database maintained by the National Park Service (NPS) (2025b).

Since GEI communicated with DNR for information on known cultural resources constraints, GEI has been contacted by SHPO to test the new digital database. As a result, GEI accessed the base maps that inform the Archaeological Site Files and the Above-Ground Geographic Information System (GIS) on April 28, 2025. SHPO notes that the digital databases will be updated throughout 2025 and are therefore, subject to change (SHPO 2025).

National Historic Landmarks List

There are no NHLs located in Oceana or Newaygo Counties; therefore, there are no NHLs located at any of the dam locations or within a one-mile radius of the dams (NPS 2025a).

National Register of Historic Places

There are no NRHP-listed resources located at any of the dam locations or within a one-mile radius of the dams. The closest resources are in Fremont, more than 8-miles southeast from the N Maple Island Rd Bridge. This resource consists of the Fremont High School at 204 East Main Street (Property ID 130000669) (NPS 2025b).

State Historic Preservation Office Archaeological Base Maps and Site Files

GEI reviewed the SHPO U.S. Geological Survey (USGS) topographic quadrangle maps for the dam location and a one-mile records search radius. This included a review of the Hesperia MI topographic quadrangle map, which is current as of 2019 (SHPO 2025). Overall, the map indicated that minimal prior surveys have occurred at the dam location or in the records search radius. In addition, two previously recorded sites are mapped in the records search radius. The closest resource is 20OA30, an unevaluated precontact site 0.1-mile west of the southwest corner of the project area. Site 20NE260, an unevaluated historic site 0.55-miles southeast from the southeast corner of the project area.

State Historic Preservation Office Above-Ground Geographic Information System

One resource is shown within the project location, and one additional resource is within a one-mile radius of the project area. The Stone Road Bridge over the South Branch of the White River (P60792) is a determined not eligible resource within the project area. The Weaver, Daniel House (P24323) is a demolished, determined eligible resource 0.3-mile southeast of the project area, located at 845 Cook Street, Hesperia.

3.3.2 Additional Research

Michigan Department of Environment, Great Lakes, and Energy (EGLE) and the National Inventory of Dams maintained by the Federal Emergency Management Agency (NID 2025). Further research was completed through online databases for historical monographs, newspapers, and aerial imagery.

Potential for Archaeological Resources

The potential for archaeological resources is currently unknown as the dam location and the majority of the one-mile records search radius have not been previously surveyed for the presence or absence of such resources. A Phase I survey may be needed to identify previously undocumented archaeological resources in the future, which could include a combination of pedestrian survey, subsurface exploration via Shovel Test Pits (STPs), or other methods, as appropriate for the existing conditions. Current Michigan SHPO standards would require pedestrian survey at 15-meter maximum intervals for areas exhibiting 25 percent or greater surface visibility and STPs at 15-meter intervals for areas exhibiting less than 25 percent surface visibility.

Identified Architectural Resources

One historic-era architectural resource was identified: Hesperia Dam.

Hesperia Dam is in the town of Hesperia in Oceana County. Built circa 1931, the dam features a crest height of 7.7 feet. The dam experienced some modifications in 1986 including a modified spillway that was added to the northside in 1986 to provide electrical energy to the nearby town (Cavanagh and Szegda 2004).

3.3.3 Cultural Context

A brief cultural context for Michigan's Lower Peninsula is discussed below. It provides a cultural background to contextualize the resources identified in the dam location areas and vicinity.

Precontact Period

Human presence in the Great Lakes region dates back between 10,000 and 12,000 years, shortly after the retreat of the Laurentide Ice Sheet. The earliest known inhabitants, evidenced by sites such as the Belson Clovis Site in St. Joseph County, lived in small, mobile groups and hunted local megafauna, including mastodon (Sherburne 2021; Talbot et al. 2021). Around 7,000 years ago, more semi-permanent settlements began to appear, and copper mining emerged in the region. Artifacts made from Michigan copper have been found as far away as the Gulf of Mexico, highlighting the early development of long-distance exchange networks.

By the Middle Woodland period (approximately 2,200 to 1,500 years ago), larger-scale, semi-agricultural settlements were established, particularly along waterways (Rosentreter 2013). Around this time, a vast trading network—often referred to as the Hopewell Interaction Sphere—formed across the central United States, allowing for the widespread distribution of goods and cultural practices. The Late Woodland period that followed was marked by short-term territorial forays for resource collection (Snyder 2017), an increased use of caching for food storage, and the adoption of the maize-squash-beans horticultural triad. During this period, communities began constructing large-scale earthworks. However, interregional trade declined, and ceremonial and mortuary practices became less elaborate. While overall subsistence and settlement systems remained similar to earlier Woodland phases, the introduction of the bow and arrow represented a significant technological advancement (Snyder 2017).

Contact Period

Late Woodland traditions in the Great Lakes region continued up until the time of European contact around 400 Before Present (BP). George Quimby (1966) identified this transitional era as the beginning of the Historic Period, which he further divided into three phases: an early phase (AD 1600–1700), a middle phase (AD 1700–1800), and a late phase (AD 1800–1850).

Initial European interactions with Indigenous groups in the western Great Lakes began with explorers and clergy, later followed by trappers and traders (Cleland 1976). The first permanent European presence was established by the French at Sault St. Marie in AD 1668. Prior to this, most written accounts come from Barthélemy Vimont (1917), who described Jean Nicolet's AD 1634 exploration of the northern Great Lakes and Wisconsin, and from Jérome Lalemant (1917), who documented the journey of Jesuit missionaries Charles Raymbault and Isaac Jogues to Sault St. Marie in AD 1641 (Snyder 2017). French documentation of early exploration also recorded contact with the Potawatomi, Huron, Chippewa, and Ottawa—groups who had been displaced from Michigan's Lower Peninsula as a result of the Iroquoian expansion and the Huron-Iroquois Fur Trade War (Snyder 2017).

Historic Setting

Oceana County

The territorial legislature of Michigan established Oceana County (County) circa 1831. The County originally consisted of portions of Newaygo, Muskegon, Montcalm, and Kent counties until it was reduced in size in 1855 to its current size (Oceana County 2025). The name is inspired by its long shoreline along Lake Michigan. The County originally participated heavily in the lumber industry until the 1890s when farming practices gained popularity. Around the same time, the County established lime quarries and clay factories throughout the region (Hartwick and Tuller 1890: 5). The City of Hart was nominated as the county seat in 1864. By 1890 the population reached 17,000. Today, the County focuses mostly on large-scale farming and tourism which includes orchards and exclusive resorts (Oceana County 2025).

The Village of Hesperia was established in 1866. Thaddens L. Waters and Fremont Clare surveyed the land for the village layout. The village is split by two counties: Oceana and Newaygo counties. The first building, constructed of logs, was located on the Newaygo side of the village. D. M. Maze & Co erected the first steam gristmill in the village in 1881. The mill boosted the village's economy and produced corn and animal feed (History of Manistee, Mason, and Oceana counties 1882: 143-148).

Dams

The County often constructed dams, such as the Hesperia Dam, during the first half of the 20th century for recreational purposes and for the purpose of generating electricity. The dam formed Hesperia Pond which tourists and County residents use for recreational purposes. The dams predominately consist of earthen embankments and concrete or corrugated metal pipe spillways (Moxey 2021:3).

4. Evaluation of Existing Conditions

This section provides a summary of the evaluation of existing conditions for the Hesperia Dam including hydrologic, hydraulic, geotechnical, and structural evaluation. In addition, current condition of the dam as a sea lamprey barrier.

4.1 Hydrologic and Hydraulic Analysis

4.1.1 Existing Conditions

GEI developed an existing conditions 1D model using the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS). That model geometry includes survey information for the dam, bridges, topography, and bathymetry from F&V and was supplemented with LiDAR in the upper impoundment to N Dickenson Ave. The available LiDAR captured the water surface in the impoundment upstream of the dam and is not representative of the actual channel geometry. In areas where only LiDAR data was used to generate the initial cross section geometry, a channel was interpolated and added to the model cross sections. The interpolated channel was developed using aerial imagery and channel geometry patterns downstream of the dam from the F&V survey as guides. This added channel is approximately 3.5-feet below the water surface captured by LiDAR and varies in width to match the channel extents visible in the aerial imagery.

The existing conditions model uses a downstream boundary condition of normal depth = 0.001 based on channel bottom elevations from the F&V survey. Manning's *n* values in the channel were set to 0.035 to represent a clean, winding channel with some pools and weeds (Chow, 1959). Manning's *n* values in the overbank regions range from 0.05 to 0.1, with grassy park areas and yards assigned a lower value and forested areas assigned a higher value.

To evaluate that the existing conditions model is a reasonable representation of existing site conditions, observed water surface elevations collected on 11/13/2024 during the F&V survey were compared to modeled water surface elevations. The flow at Hesperia for that date was estimated by taking the range of flows recorded on 11/13/2024 and 11/14/2024 at the USGS gage station located on the White River in Whitehall and applying a drainage area ratio of 0.53. The resulting flows ranged from 200 cfs to 220 cfs at Hesperia, and both of those flows were modeled and compared to observed water surface elevations. The comparison indicated agreement between modeled and observed water surface elevations, with most modeled elevations within +/- 0.2-feet of observed for both flow estimates.

To evaluate the existing spillway capacity, a steady-state run was performed to route flood flows provided by EGLE through the impoundment and spillway. Headwater and tailwater modeled water surface elevations are provided from the model runs without and with stoplogs in **Table 4-1** and **Table 4- 2**, respectively. The rating curves are graphically depicted in **Figure 13**.

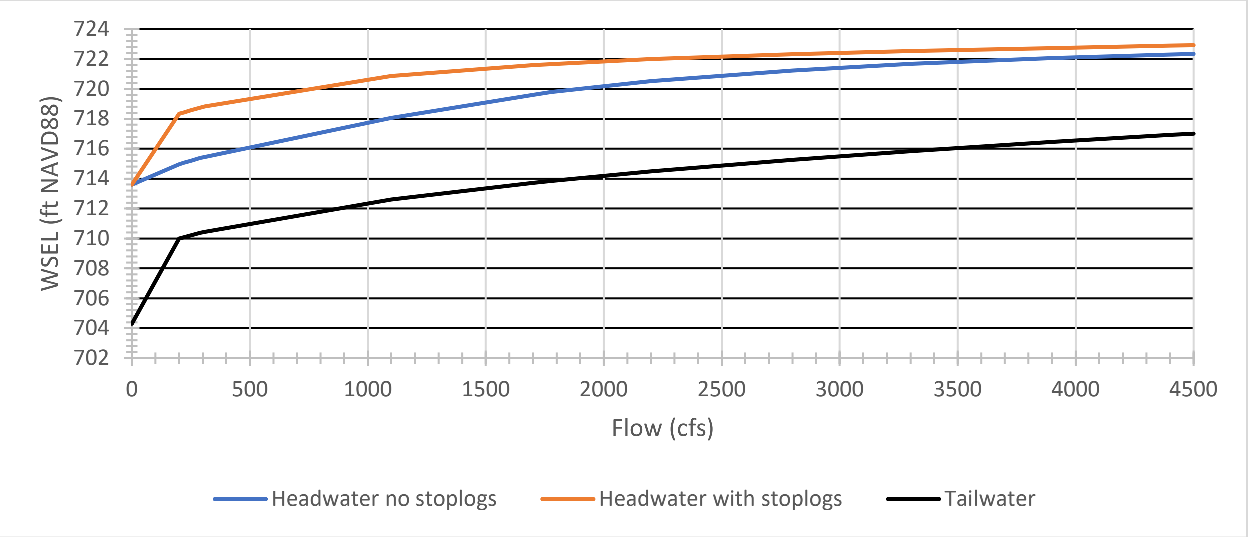
Table 4-1. Existing Conditions Headwater -Tailwater without Stoplogs

Return Interval	Peak Flow (cfs)	Headwater El. (ft)	Tailwater El. (ft)
2-year	1,100	718.1	712.6
5-year	1,700	719.6	713.7
10-year	2,200	720.5	714.5
100-year	3,900	722.1	716.4
200-year	4,400	722.3	716.9
500-year	4,500	722.3	717.0

Table 4-2. Existing Conditions Headwater -Tailwater with Stoplogs

Return Interval	Peak Flow (cfs)	Headwater El. (ft)	Tailwater El. (ft)
2-year	1,100	720.9	712.6
5-year	1,700	721.6	713.7
10-year	2,200	722.0	714.5
100-year	3,900	722.7	716.5
200-year	4,400	722.9	716.9
500-year	4,500	722.9	717.0

Figure 13. Existing Rating Curve



With the stoplogs removed and each bay open to the sill elevation of 713.6, the auxiliary spillway is engaged at the 10-year event, with approximately 0.5-feet of water flowing over the spillway. With stoplogs up to El. 716.9 (as recorded during the F&V survey), the auxiliary spillway is engaged at the 2-year event, with approximately 0.9-feet of water flowing over the spillway. With stoplogs removed, the 200-year event reaches a peak water surface elevation of 722.3 and overtops the bridge over the primary spillway by approximately 0.1-feet and the auxiliary spillway by approximately 2.3-feet. Based on this analysis, the existing dam is not able to safely pass the 200-year design event with or without the stoplogs in place.

The existing conditions model indicates that the auxiliary spillway is engaged between the 2-year and 10-year events, depending on if stoplogs are present or removed, respectively. The existing conditions model indicates that the N Division Street bridge, located upstream of the dam, impacts flow to the dam. The bridge acts as a flow restriction and depending on if stoplogs are present or removed, the 5-year and 25-year flows contact the bridge deck, respectively. During this condition there is substantial head loss through the bridge opening and the bridge and roadway act as the effective dam. Based on modeled water surface elevations and LiDAR elevations of the Division Street roadway north of the bridge, the Division Street roadway may be overtopped at the 200-year and 500-year flows, which indicates the roadway may no longer be the effective dam at those flows.

4.1.2 Sunny Day and Flood Event Breach Analysis

In response to an EGLE request from the last dam safety inspection, GEI performed a series of dam breach analyses using unsteady model runs to further assess the hazard potential of Hesperia Dam. These analyses included a sunny day failure with a reservoir elevation set to 718.7 and a constant base flow of 310 cfs, which corresponds to the normal pool elevation with stoplogs and the April 50% exceedance flow, respectively. A breach analysis was also conducted for the 200-year event using the hydrograph provided by EGLE. For this analysis, the breach was set to occur at the peak of the hydrograph.

GEI estimated breach parameters for Hesperia Dam using the FERC Engineering Guidelines for the Evaluation of Hydropower Projects. The breach location was assumed to be in the right embankment within the existing auxiliary spillway. The breach parameters were kept constant for each scenario and are summarized in **Table 4-3**.

Table 4-3. Breach Parameters Summary

Breach Parameter	**Value**
Height of Breach (ft)	6.8
Bottom Breach Width (ft)	20
Side Slopes, Z	1
Average Breach Width (ft)	28.4
Avg. Breach Width/Dam Height	4.2
Breach Formation Time (hrs)	0.2

Water surface elevations at select cross sections were compared with and without a breach occurring for each scenario to evaluate the relative magnitude of the flood wave. To evaluate the worst-case scenario, all breach analyses assumed the stoplogs were left in place and were unable to be removed before the breach occurred. Water surface elevations of the breach analyses are presented in **Table 4-4**.

Table 4-4. Breach Analyses Summary

Location Description	Model Cross Section Station (ft)[1]	Lowest El at Structure/ POI (ft)	200-yr WSE (ft)	200-yr WSE Breach (ft)	200-yr Incremental Difference (ft)	Sunny Day No Breach (ft)	Sunny Day Breach Pool 718.7 (ft)	Sunny Day Breach Incremental Difference (ft)
River Rock Campground	10419	714	716.38	716.72	0.34	710.63	711.34	0.71
Vida Weaver Park Boat Launch	9879	713.5	715.82	716.11	0.29	710.22	711.06	0.84
Houses (9046 M-20)	6762	715	713.15	713.46	0.31	706.24	707.12	0.88
Oxbow Park	3320	710	711.75	712.07	0.32	705.05	705.76	0.71
Houses on S Riverview Dr (River Right) & Newfield Dr (River Left)	1469	710	709.11	709.37	0.26	703.24	703.78	0.54

Notes: 1. Station 0 at downstream end of model.

The breach analysis indicates that the sunny day failure has the largest change in water surfaces with a maximum increase of approximately 0.9-feet between Vida Weaver Park and Oxbow Park. The 200-year breach scenario indicates a rise between 0.26-feet and 0.34-feet downstream of the dam. Based on depth and velocity model results, the River Rock Campground would have a medium flood severity category under the 200-year event and this breach scenario (FEMA, 2020). Based on these results, a change in hazard classification is not recommended at this time. Further evaluation may be required for the selected rehabilitation alternative.

4.1.3 Sea Lamprey Evaluation

Sea lampreys (*Petromyzon marinus*) have been observed in the White River system as early as Schultz (1953) and have a production potential estimated at 1.5-million larvae per year (O'Neal, 2012). The Hesperia Dam is the first physical barrier on the White River (Great Lakes Fishery Commission, (GLFC), 2012). Under the existing condition, overtopping of the right embankment of the structure occurs between the 2-year and 10-year flood, depending on the presence or absence of stoplogs, respectively. Overtopping flow is not considered an adequate barrier as it creates a way for lamprey to pass over the spillway. Additionally, there is concern that gaps in and around the stoplogs may provide escapement pathways for sea lamprey under a broader range of flow conditions.

4.2 Geotechnical Analysis

This section summarizes the geotechnical subsurface exploration and analyses for the earthen embankments. The right earthen embankment adjacent to the auxiliary spillway structure was selected for evaluation as it is the steepest unarmored earthen section. Key components of the geotechnical analysis include estimating material properties and completing embankment seepage and slope stability analysis and are discussed in depth in **Appendix D.2**.

4.2.1 Embankment Seepage and Stability Modeling

Downstream embankment stability analyses were performed on the right earthen embankment adjacent to the auxiliary spillway in accordance with the criteria provided in the USACE Engineering Manuals (EM 1110-2-1901, EM 1110-2-1902, and EM 1110-2-2300). The SLOPE/W module of the GeoStudio software package was used to model seepage and slope stability of existing conditions. Section geometry was based on the publicly available existing Lidar topographic information and survey performed by F&V.

A geotechnical investigation was completed including a total of four geotechnical soil borings were completed along the crest alignment of the dam on October 21 and October 22, 2024. The originally planned boring locations were offset multiple times due to auger refusal prior to the target drilling depth. Subsurface conditions for the embankment fill and foundation soils were characterized based on the geotechnical investigation results and laboratory data. Phreatic surface water levels in the Dam were assumed based on normal pool headwater, water surface elevations obtained while installing open standpipe piezometers, and the normal pool tailwater. No long-term phreatic surface data is available as monitoring wells were not present within the right embankment prior to the October 2024 subsurface exploration and piezometer installation.

The phreatic surface through the embankment and stability analysis was performed using the program SLOPE/W. The shape and location of critical slip surfaces considered were required to either:

- Breach the embankment crest, and/or
- Intercept the phreatic surface leading to loss of the impoundment.

Shallow (sloughing-type) failure surfaces, which do not meet these criteria, are considered routine maintenance issues that could be immediately addressed though the programmatic upkeep of the facility and are therefore not considered critical to dam stability. A minimum slip surface depth of 5 feet was set for failure surface searches.

4.2.2 Material Properties and Seepage Calibration

The subsurface conditions for the embankment and foundation soils are based on the results of the geotechnical investigation. The following parameters were assumed in the seepage and slope stability analysis:

Table 4-5. Material Properties

Soil	Unit Weight (pcf)	Friction Angle (deg)	USCA Classification
Embankment	129	34	SP-SM
Foundation	130	35	SP

Results of the geotechnical investigation indicated that the embankment consisted of similar material ranging from USCS classifications of SP – SM. The foundation soils consisted of primarily sand and sandy silt with approximately 0.5 feet of silty clay near the end of the boring. Soil index properties and strength parameters for the embankment fill and foundation materials were developed from the geotechnical investigation results, published correlations between SPT blow counts and vertical effective stress (Gibbs and Holtz, 1957), and published correlations between SPT blow counts and relative density (NAVFAC DM 7.1, 1986). The soils were assumed to have no effective cohesion due to the USCS classifications and laboratory testing performed. Material parameter development and selection is presented in more detail in **Appendix D.2**.

One representative section along the dam was chosen and developed to perform the seepage and stability analyses. The phreatic surface was calibrated to the exiting conditions based on the normal pool headwater elevation, water level elevation in the open standpipe piezometer, and the normal tailwater elevation. Following the calibration of the normal pool loading condition, the same parameters were used to model the flood pool loading condition with an increased headwater elevation. This assumes that the phreatic surface through the embankment soils would respond similarly to the normal pool loading condition.

4.2.3 Stability Analysis Results

Based on the available historical information, topographic data, visual observations, and subsurface information, a seepage and slope stability model was evaluated for both normal pool and flood leading conditions. These results were evaluated in comparison with USACE guidelines for the minimum required factor of safety values. The results of the slope stability analysis for both the normal pool and flood pool loading conditions are summarized below:

Table 4-6. Stability Analysis Results

Load Condition	Calculated FS	USACE Minimum Required SF
Normal Pool (718.6 feet)	1.9	1.5
Flood Pool (722.4 feet)	1.7	1.4

Based on the condition observed on-site, the assumptions, and analysis completed, the slope is considered to be stable in its current condition.

Based on the 2014 USGS seismic hazard map for Michigan and commonly accepted standards of practice as defined by the FERC Engineering Guidelines, it is not considered necessary to perform a site-specific seismic hazard analysis for the Hesperia Dam; therefore, the analysis did not account for seismic loading. **Appendix D.2** discusses this in more detail.

4.3 Structural Analysis

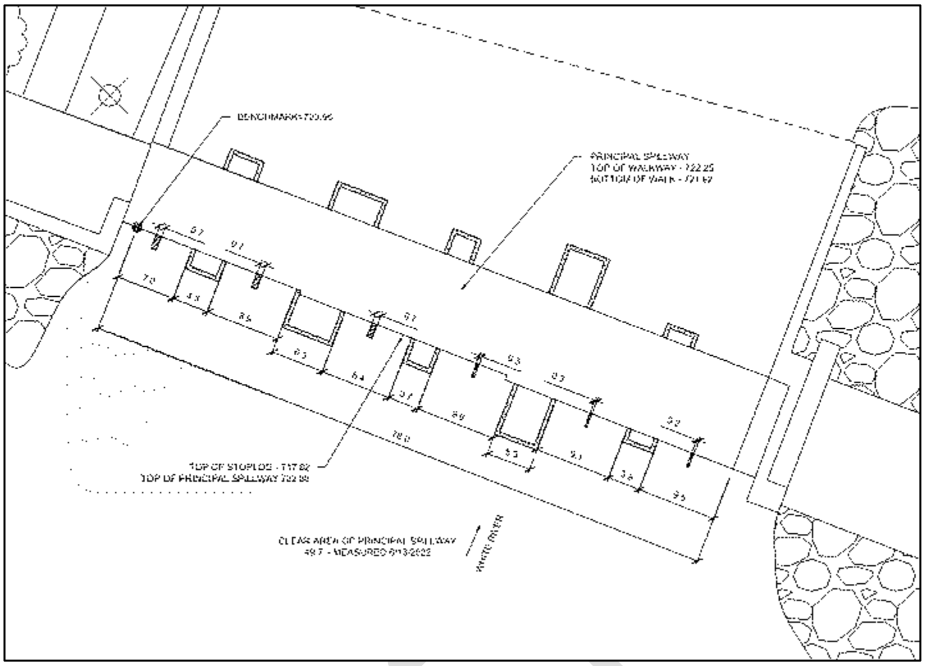
The existing spillway structure is believed to be a stone filled timber crib structure with a concrete cap overlay. The current structure materials do not meet industry standards and due to the lack of historical documents for the construction of the spillway structure, strength analysis of the walls, piers and slabs were not performed. The following sections describe the basis of the global stability analysis and a summary of the analysis results. The structural analysis criteria and evaluation are included in **Appendix D.3**.

4.3.1 Global Stability Model

The existing structure was evaluated in accordance with USACE – EM-1110-2-2100. The spillway is a rectangular structure which consists of six varying width stop log bays. It has an overall width of 76 feet wide at the upstream edge where it transitions to the principal spillway. The global stability for this structure was considered in two parts to resist hydrostatic forces, the first set of analysis assumes the structure will act monolithically and the second set of analysis assumes that the downstream apron is cracked at the piers and the structures acts as two independent structures. The structure is depicted in **Figure 14** and the analysis are outlined below:

- Overturning – Combined Piers & Apron Slab
- Sliding - Combined Piers & Apron Slab
- Overturning – Combined Piers & Cracked Apron Slab
- Sliding - Combined Piers & Cracked Apron Slab

Figure 14. Spillway Structure Plan View



The structural dimensions & material properties were taken from two existing drawing packages provided to GEI: Fleis & Vandenbrink Engineering, INC – "Hesperia Dam Principal Spillway Dimensions" Nordlund, Dunlap & Associates, INC. – "Dam Repairs North Branch White River." Due to a lack of confirmed geometry, some assumptions have been made to the details of foundation configurations, the structural self-weight has been calculated with this geometry and normal weight concrete. Passive earth pressure resistance has been assumed based on geotechnical data obtained at the site. The passive soil is assumed to be in good condition. Passive earth pressure utilized as resisting forces have been reduced in accordance with the load factors outlined in USACE_1110_2_2100 'Stability Analysis of Concrete Structures' due to the risk of voids/washout occurring during an overtopping event. The friction coefficient chosen for sliding factors of safety has been assumed as 0.7 for concrete sand, based on the typical soils found on site and compared to regional typical soils.

The structure was analyzed with details included in **Appendix D.3.** Uplift pressures are assumed to be equal to the headwater elevation with a linear distribution down to the tailwater elevation for the length of the inlet structure. A free body diagram showing the geometry and loads used in each analysis is shown in **Figure 15** and **Figure 16**.

Figure 15. Spillway Structure Free Body Diagram

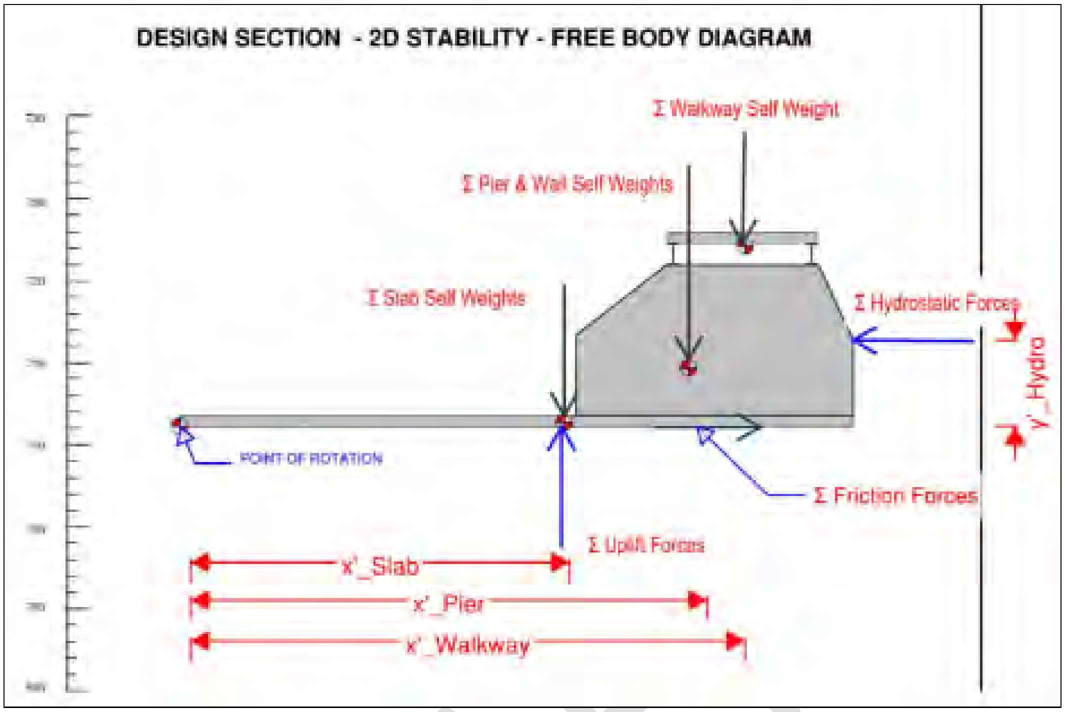
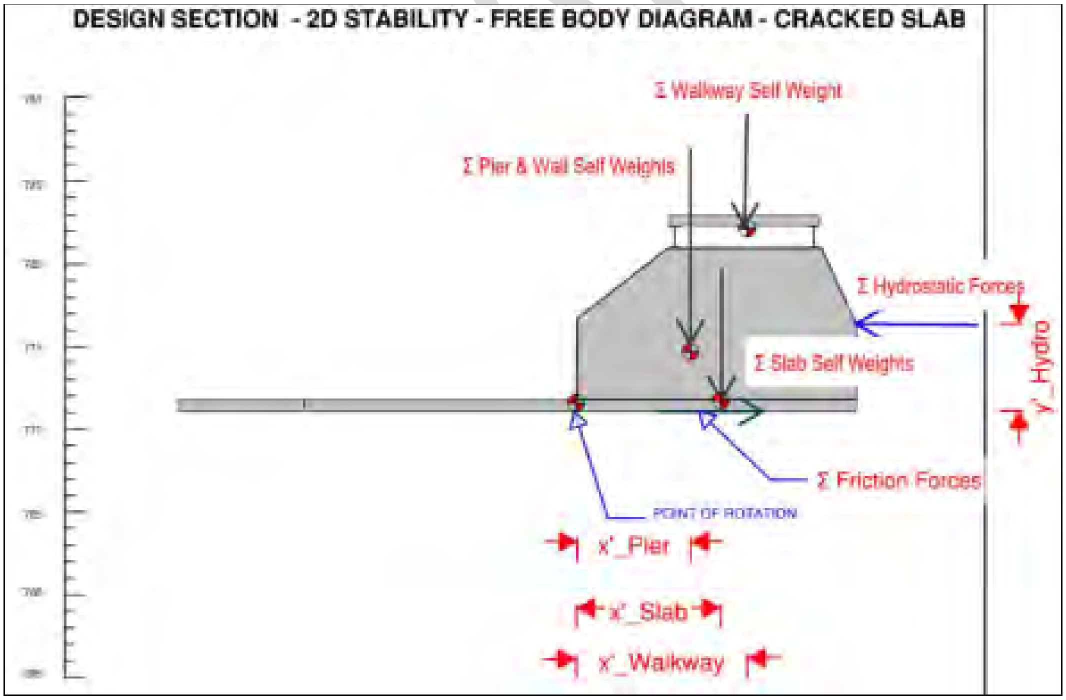


Figure 16. Spillway Structure Free Body Diagram – Cracked Slab



4.3.2 Stability Analysis Results

The results show the primary spillway inlet structure at normal pool conditions with stop logs does meet the minimum stability criteria based on current industry standard for sliding. However, the structure was found to be at risk of sliding during the condition of a cracked apron slab.

Table 4-7. Global Stability Analysis Results

Structure	Load Condition	Calculated FS	USACE Minimum Required FS
Principal Spillway	Overturning – Piers & Apron	Base 100% Compression	Base 100% Compression
Principal Spillway	Sliding – Piers & Apron	4.04	3
Principal Spillway	Overturning – Piers & Crack Apron	Resultant Outside Base	Base NOT 100% in Compression
Principal Spillway	Sliding – Piers & Cracked Apron	5.05	3

5. Assessment and Remedial Alternatives Evaluation

The following section outlines the design criteria used to develop the alternatives, the dam alternatives considered, sea lamprey barrier evaluation of the alternatives considered, and fish passage alternatives. In addition, a discussion on site amenities removal, replacement, and other options is included.

5.1 Design Criteria

The design criteria and assumptions adopted as part of the preliminary alternatives design include the following:

- Hydraulic Design
  - Minimum Discharge Capacity – 4,400 cfs
    - Peak inflow with 200-year recurrence.
  - Design Flood Elevation – El. 720.0 feet
    - Provides a minimum freeboard of 2.0 feet at the left and right embankment crest El. 722.0 feet.
    - The existing grade (natural high-ground) adjacent to the dam abutments does not allow for raising the crest elevation above 722.0 feet.
    - Existing spillway capacity is approximately 1,200 cfs at El. 720.0 feet.
    - Approximately 3,200 cfs of additional capacity is required to pass the peak design flood outflow at this impoundment elevation.
  - Unit Discharge – less than 100 cfs per foot
    - Design unit discharge target based on experience with similar structures.
  - Design Flood Tailwater Elevation – El. 716.8 +/- feet
    - Tailwater submergence of spillway crest is not allowed for floods up to 25-year recurrence to protect against Sea Lamprey migration.
    - Minimum 18 inches of drop from upstream to downstream water surface elevations at spillway crest and 6-inch overhanging lip are required to block passage of sea lamprey.
  - Normal Reservoir Elevation – El. 717.8 feet
    - Maintain current normal reservoir water surface elevation.

- Embankment Design
    - Left Embankment –
        - The left (west) property boundary is tight, thus preventing alternatives to the left of the existing spillway.
        - Improvements are proposed to address existing noted seepage.
    - Right Embankment –
        - Location availability is limited due to the need to keep the swimming area located just upstream.
        - Upstream berm separating swimming area and impoundment can be modified but to remain in final configuration.
    - All disturbed embankments will be restored post construction in accordance with industry standard design requirements for slope stability and seepage. This includes:
        - Removing the existing grouted riprap,
        - Improving the downstream slope by installing a graded filter and
        - Installing new riprap protection of the upstream slopes.
- Spillway Structure Design
    - Removal of the existing spillway and replacement with a modern spillway chute and apron design features such as:
        - Filtered and adequately sized underdrain system,
        - Transverse cutoff,
        - Reinforcement across transverse joints, and
        - Water stopped joints.
    - Pedestrian bridge over spillway structure will be provided.
- Fish Passage Design
    - Fish passage design options including a nature-like fish way, technical fishway and in-line fishway have been considered.
    - These options are designed to be add-on options to the selected rehabilitation alternative.

5.2 Spillway Alternatives Considered

The design team initially developed 11 alternatives; however, based on client preferences and site constraints, only three were developed further including conceptual plans and opinion of probable cost. **Table 5-1** provides a comprehensive overview of the alternatives considered, along with the rationale for their exclusion.

Table 5-1. Overview of Proposed Alternatives

Spillway Alternative	Exclusion Reason
A. Do Nothing	• Does not address dam safety or sea lamprey control concerns. • Likely results in non-compliance and enforcement measures and increased costs. • This alternative was advanced for further consideration as Alternative 5.
B. 300 Foot FIXED U-Shaped Weir	• This option has a significant concrete footprint. • Affecting the majority of swimming pond upstream of the right embankment. • Encroaches on upstream bridge.
C. 250 Foot Straight Drop with 2 Gated Weir	• This option has a significant concrete foodprint. • Affecting the majority of swimming pond upstream of the right embankment.
D. 220 Foot U-Shape Weir with 2 Gated Weir	• This option has a significant concrete foodprint. • Affecting the majority of swimming pond upstream of the right embankment. • Encroaches on upstream bridge
E. 300 Foot Fixed Straight Drop Weir	• This option has a significant concrete footprint. • Affecting the majority of swimming pond upstream of the right embankment.
F. 220 Foot U-Shape Weir with 4 Gated Weir	• This option has a significant concrete footprint. • Affecting the majority of swimming pond upstream of the right embankment. • Encroaches on the upstream bridge.
G. 200 Foot Straight Drop with 4 Gate Weir	• This alternative was advanced for further consideration as Alternative 2.
H. 75 Foot Labyrinth with 4 Gated Weir	• Requires more frequent operation of the gates to pass flood events.
I. 90 Foot Labyrinth with 2 Gated Weir	• This alternative was advanced for further consideration as Alternative 3.
J. 110 Foot Labyrinth	• This alternative was advanced for further consideration as Alternative 1.
K. Dam Removal	• This alternative was advanced for further consideration as Alternative 4.

The dam rehabilitation alternatives not selected (Alternatives B through F, and H) were not further evaluated due to the significant spillway footprint required, site constraints including impact to the existing swimming pond, encroachment to the upstream bridge, and aesthetics associated with the required footprint of the proposed spillway. In addition, alternatives that do not increase spillway capacity were ruled out.

The 5 alternatives that were selected for further consideration are as follows:

- Alternative 1 – Labyrinth Spillway
- Alternative 2 – Gated Straight Drop Spillway
- Alternative 3 – Gated Labyrinth Spillway
- Alternative 4 – Dam Removal
- Alternative 5 – Do Nothing

Regardless of the selected alternative, embankment improvements will be necessary to ensure the structural integrity and long-term performance of the dam. These upgrades are a fundamental requirement independent of the final design option chosen. The proposed embankments will include seepage control measures (cut off walls, graded filters, etc.) and slopes graded to meet current industry standard factors of safety. Additionally, the primary and auxiliary spillways will be replaced with the proposed spillway structures. The following sections summarize the design criteria, and the alternatives evaluated.

5.2.1 Alterative 1 – Labyrinth Spillway

Alternative 1 consists of a 110-foot Labyrinth spillway with a crest at El. 717.0, passes the spillway design flood with over 2-foot freeboard and allows the reservoir to remain at the current normal pool of El. 717.8 (feet). This alternative provides the advantage of a passive spillway system since the labyrinth spillway does not require a power supply and does not require the associated level of maintenance of an active system. A labyrinth spillway functions as a sharp-crested weir over the entire length of the concrete structure in a “zigzag” orientation as viewed in plan. That is, this compact spillway design, which includes a 110-foot spillway footprint with a magnification of 2.5, acts like a 325-foot wide, conventional weir design. Since the additional spillway capacity results in an increase to the base flood (200-year) elevations downstream, the impacts may need to be analyzed further as the design progresses.

The existing primary spillway would be demolished, and the adjacent embankment excavated and regraded, expanding the reservoir east toward swimming Pond Road to accommodate the proposed 110-foot footprint of the labyrinth spillway structure. The top of the labyrinth’s weir would be constructed at the El. 717 feet with a magnification of 2.5. The upstream wall face would be 8-feet in height with a bottom at El. 710 feet. The base of the spillway structure would be supported by driven piles. **Figure 17** and **Figure 18** below depict an example of a labyrinth spillway option.

Figure 17. Example Labyrinth Spillway – Upstream

Source: Ohio-Dam Rehabiliatons, 2025

Figure 18. Example Labyrinth Spillway – Side View

Source: Ohio Dam Rehabiliation, 2025

5.2.2 Alternative 2 – Gated Straight Drop Spillway

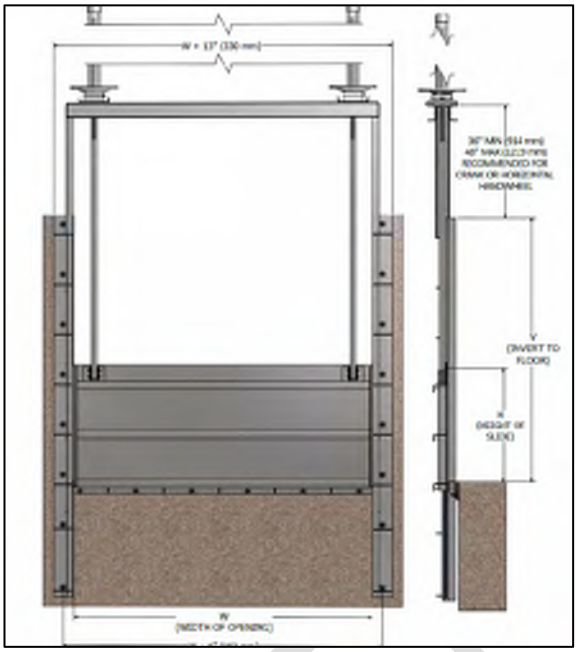
Alternative 2 consists of a 200-foot long straight drop spillway with a crest at El. 717.0 and 4 downward opening slide gates, passes the spillway design flood with over 2-foot freeboard, and allows the reservoir to remain at the current normal pool of El. 717.8 (feet). During flood events, the four gates would need to be operated to safely pass the design flood. This alternative requires modification and reduction of the pond.

The existing primary spillway would be demolished, and the adjacent embankment excavated and regraded, expanding the reservoir east toward swimming Pond Road to accommodate the proposed 200-foot footprint of the Straight Drop spillway structure. The top of the Straight Drop weir would be constructed at El.717 feet and gates will be constructed at EL. 714 feet. The base of the spillway structure would be supported by driven piles. **Figure 19** below depicts an example of a gated straight drop option. **Figure 20** depicts an example of the downward opening slide gate.

Figure 19. Example Straight Drop Weir – Side View

Source: Colin Merry, 2024

Figure 20. Example Downward Opening Slide Gate



Source: Whipps, inc., n.d.

5.2.3 *Alternative 3 – Gated Labyrinth Spillway*

Alternative 3 consists of a 90-foot Labyrinth spillway with a crest at El. 717.0, passes the spillway design flood with over 2-foot freeboard and allows the reservoir to remain at the current normal pool of El. 717.8 (feet). Since additional capacity becomes available in the basin by lowering the gates, this alternative reduces the spillway size, thereby reducing the construction quantities and channel sizing beneath the pedestrian bridge compared to Alternative 1 while still safely passing the design flood. During a design flood event, the gates would need to be lowered in order to maintain desirable freeboard on the dam. This structure includes a 90-foot spillway footprint with a magnification of 2.5, acts like a 175-foot wide, conventional weir design. Since the additional spillway capacity results in an increase to the base flood (200-year) elevations downstream, the impacts may need to be analyzed further as the design progresses.

The existing primary spillway would be demolished, and the adjacent embankment excavated and regraded, expanding the reservoir east toward swimming Pond Road to accommodate the proposed 90-foot footprint of the labyrinth spillway structure. The top of the labyrinth's weir would be constructed at El.717 feet with a magnification of 2.5 and the gates will be constructed at EL. 714 feet. The upstream wall face would be 10-feet in height with a bottom at El.709 feet. The base of the spillway structure would be supported by driven piles. **Figures 17** and **Figure 18** above depict an example of a labyrinth spillway option and **Figure 20.** depicts an example of a gated spillway option. A gated labyrinth spillway would consist of a hybrid of the two examples above.

5.2.4 Alternative 4 – Dam Removal

When considering the long-term disposition of the dam, EGLE requires dam removal to be considered as a feasible and prudent alternative. To evaluate this option, GEI anticipated that the primary factors for this alternative would be the volume of impounded sediment upstream of the dam and the new sea lamprey barrier that would be required at or near the current location of the dam. GEI utilized available LiDAR data and bathymetric data for the river to approximate the volume of sediment within the river. Additionally, a sea lamprey barrier with an effective height of 18-inches would be required to meet sea lamprey control requirements at the 25-year flood event.

The dam removal alternative was evaluated to be unfeasible based on the high cost of reintroducing a sea lamprey barrier, which could range from $4 million to $8 million depending on the type of barrier (i.e., adjustable structure or fixed-crest barrier). Additionally, the amount of impounded sediment behind Hesperia Dam was estimated to be between 160,000 and 240,000 cubic yards based on the limited bathymetric and depth of refusal data available. This sediment quantity would need to be further refined and subject to environmental testing before removal. A portion, if not all of that sediment volume would have to be managed following removal with estimated costs ranging from $5 million to greater than $40 million. Furthermore, it should be noted that dam removal is not currently supported by the dam owner due to the community's desire to maintain the prominent feature in their park and its historic significance.

5.2.5 Alternative 5 – Do Nothing

The "do nothing" alternative considers taking no action and leaving the dam in its current configuration. The Village of Hesperia is undertaking this evaluation because the existing dam deficiencies and inadequate spillway capacity do not meet state dam safety requirements or USACE, BoR and FEMA dam safety guidance. This means that the dam's risk of failure is greater than is typically accepted by dam safety regulators. Further, it does not address any of the identified deficiencies of the dam.

Taking no action will result in further degradation of the dam's physical condition and will not mitigate its inadequate spillway capacity. Maintenance activities to the spillway and embankment may improve their condition and lifespan; however, these activities will not modify the dam's inadequate spillway capacity which is the primary characteristic of the dam that is driving the design alternatives presented in this report.

Deferred replacement of the dam will result in greater time spent in its current condition which increases the risk of the dam experiencing a large discharge event and potential overtopping. This would increase the probability of a failure of the dam. Future costs for construction are typically greater. Thus, the "do nothing" alternative only delays the eventual cost to repair the dam while adding the maintenance cost of actively monitoring the dam and increasing the risk of dam failure.

Other potential impacts of the “do nothing” alternative include:

- Permitting/regulatory environment may change making it more difficult to replace the dam.
- Development downstream of the dam may increase and therefore increase the consequences to loss of life and property downstream of the dam in case of a dam failure.
- Funding options for the proposed alternatives may change, making it more costly for the Village.

5.3 Sea Lamprey Blockage Evaluation

Sea lamprey blockage is considered effective when migrating lamprey must overcome an 18-in free-overfall barrier with a 6-in overhanging lip. While velocity and behavioral barrier technologies exist, the jumping barrier criteria is considered a program standard for GLFC (Hrodey *et al.*, 2021) and is based on evaluations originally performed by Hunn and Youngs (1980). Hrodey *et al.* (2021) defines the season for blockage of spawning sea lampreys from March through June.

The tailwater in the White River is independent of spillway alternatives. Water-surface elevations from the project hydraulic model were extracted at the cross section downstream of the proposed alternatives. **Table 5-2** details free-overfall distance for various flow rates evaluated at target elevations in the proposed spillway alternatives. When compared to the proposed gate crest elevations of 717.0,’ an 18-in barrier is possible at 2,800 cfs (25-year flood event) which meets the design criteria. For the gate fully open for sill El. 714.0,’ barrier thresholds are achieved from normal flow up to approximately 1,050 cfs, or slightly less than the 2-year flood event. Therefore, gates can be fully open up to flows of 1,050 cfs and still maintain an 18-in barrier

Table 5-2. Free-Overfall Height for Key Elevations (bold denotes last discharge before barrier <18-inch)

Return Interval	Total Discharge (cfs)	Downstream WSEL (ft)	Crest 717 (ft)	Gate Sill 714[1] (ft)
Average Spring Flow[2]	260	710.3	6.7	**3.7**
2-year	1,100	712.6	4.4	1.4
5-year	1,700	713.7	3.3	0.3
10-year	2,200	714.5	2.5	- 0.5
25-year	2,800	715.3	**1.7**	-1.3
50-year	3,300	715.8	1.2	-1.8

Notes: 1. Applicable for gated Alternatives 2 and 3.
2. Sea Lamprey migration March through June averages.

5.4 Fish Passage Options

The White River supports a managed cold-water fishery that includes brook trout *Salvelinus fontinalis*, brown trout *Salmo trutta*, rainbow trout *Oncorhynchus mykiss*, winter-run steelhead *O. mykiss*, Chinook salmon *O. tshawytscha*, and Coho salmon *O. kisutch* in addition to a variety of other native jumping and non-jumping species (O’Neal, 2012).

Correspondence with MDNR and USFWS indicated that salmonid jumping passage during periods of sea lamprey blockage at the Hesperia Dam was desired as an additional component for the proposed dam options described in this report. Primary goals identified for the fish passage system include:

- Passage Efficacy – Ability to meet passage criteria during target seasons and flows.
- Blockage Efficacy – Ability to meet blockage criteria during sea lamprey migrations (March – June).

Passage efficacy is specific to a species and life stage. For the current application, passage of adult jumping species was desired, notably for steelhead. Guidelines for jumping passage were taken from Nordlund (NMFS) (2009), NOAA (2022), and USFWS (2019). These sources are summarized in **Table 5-3.**

Table 5-3. Jumping Fish Passage Guidelines

Criteria	USFWS (2109)	NOAA (2022)	NMFS (2009	Notes
Energy-Dissipation Factor (EDF) ft-lb/ft³/s)	4	4	16	Salmonids
Jumping Height (ft)	1	1	1	Salmonids
Width (ft)	4-10	8	4	Entrance & Pool/Weir
Depth (ft)	4	6	6	Pool/Weir

Sea lamprey blockage efficacy was defined in this study as the physical blockage of the species meeting the free-overfall targets previously defined. Spring runoff coincides with the highest flows in the White River and a target of a 25-year flood for blockage was used for blockage evaluations (MDNR, 2025; USFWS, 2025).

Design flows for the fishways considered values ranging from the low flow up to flood flows as provided by EGLE (2024). The 5% and 95% (low and high) monthly average exceedance flows are approximately 150 cfs and 600 cfs, respectively, which cover the ranges suggested by NMFS (2009). The 25-year flood event was 2,800 cfs. Attraction flows, or the quantity of flow passing the fishway compared to the total channel flow, are recommended by NMFS (2009) as 10% for flows greater than 1,000 cfs and higher for lower flow rates, up to 100%.

Secondary goals for fish passageways were developed in collaboration with agencies and the Village of Hesperia. These included the following qualitative criteria:

- Non-blockage Seasonal Passage – Ability for removal of structure components to facilitate non-jumping species migration.
- Aesthetics – Meet the community desires for the visual appearance of the facility.
- Recreation – Degree to which the facility improves or impairs recreation opportunities of the area.

- Cost/Constructability – Economic and resource feasibility of project.
- Maintenance – Ability and ease of accessible maintenance.

Three options were identified in collaboration with agencies and project partners. These included a nature-like fishway, an adjacent technical fishway, and an inline technical fishway. The development and specifics of these alternatives are described below. The drawings Sheet Series C-400 provided in **Appendix F** provide details conceptual layouts of the first two alternatives and associated cost estimates are also provided. The inline fishway was not considered a feasible alternative for development as described below. Options for the fishways are denoted as FW1, FW2 and FW3.

5.4.1 Option FW1 – Nature-like Fishway

Nature-like fishways are described by USFWS (2019) with the inclusion of Turek *et al.* (2016) guidelines. These facilities emulate natural stream conditions which are encountered within the local watershed. They are typically composed of naturalized elements such as coarse, stable alluvium with large roughness elements and grade-control structures where necessary. The governing parameters on nature-like fishways are primarily functions of the channel slope. Recommended slopes for the species of interest are 5% and below.

Option FW1 would be structured as a nature-like fishway with an entrance on the southern (river-left) bank upstream of the dam and then traveling downstream through the existing overbank area to confluence with the White River at the next downstream bend. The channel alignment was positioned in a way to encourage attracting flows and overbank recreation opportunities and may be refined during design progression. The channel was designed at a 2.6% slope with a roughened trapezoidal shape with 8-feet bottom width and 2H:1V side slopes. The entrance was submergence at low flow tailwater conditions (709.5 feet) and produced 25% attracting flows at the 5% discharge.

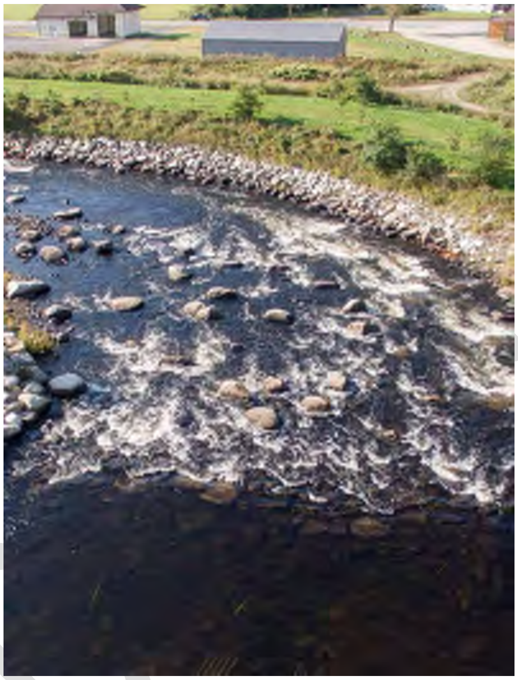
An upstream control on the entrance condition was envisioned as 8-feet steel stop logs with an installed crest invert of 717.0 feet. The stop logs would be slotted within a rectangular concrete channel and would be placed or removed depending on need for sea lamprey blockage. Access to the stop logs from the southern bank is available for hand or machine installation. Installed stop logs have been designed to provide an 18-in free-overfall barrier up to the 25-year flood event. Below the 25-year flood, free-overfall heights will increase above 18-in due to lower tailwater conditions, up to a maximum of 2.7 feet at the 95% flow. Migrating jumping species would be required to overcome the sea lamprey obstacle. The jumping pool below the free-overfall barrier was set at 4 feet at the 25-year flood event and may be deepened.

Removed stop logs would promote passage of non-jumping species, with only a velocity obstacle to overcome. The invert of the concrete channel was set at 713.8 feet. Velocities were estimated within the entry at approximately 4.5 feet/s during periods of non-blockage operations, which may be optimized and possibly reduced during design refinements.

The nature-like fishway would be constructed from coarse cobbles and small boulders (d_{50} of 1.0 feet) sized to resist mobilization while facilitating passage of baseline sediment transport. Imported and placed substrates should be void-filled and sealed to prevent through-flow. Depths and velocities were estimated using normal-depth assumptions with a Limerinos (1970) Manning's *n* approach. Velocities may be considered conservatively high due to non-inclusion of large-roughness elements and ignored reductions near the channel boundaries. Pertinent hydraulics for both the blockage and non-blockage configurations are provided in **Table 5-4** and **Table 5-5**, respectively.

Construction of Option FW1 could phase with the main dam structure alternatives or be performed independently. Access from the south bank would provide the ability for construction in the dry before activating the fishway. A cofferdam would be required at the upstream entrance. **Figure 21** below depicts an example of a naturalized fish passage option.

Figure 21. Example of Nature-Like Fish Passage



Source: Issuu – Holland Dam Fish Bypass

Table 5-4. Fish Passage and Barrier Hydraulics – Option FW1 – Blockage Configuration

Total Discharge (cfs)	Est. Fishway Discharge (cfs)	Free-overfall (ft)	Head Loss (ft)	Ramp *n*	Ramp Vel. (ft/s)	Ramp Depth (ft)
100	1.64	2.81	3.78	0.27	0.46	0.40
150	3.02	2.74	3.93	0.19	0.71	0.48
200	4.64	2.67	4.08	0.16	0.94	0.54
250	6.47	2.60	4.22	0.14	1.115	0.61
300	8.49	2.54	4.37	0.12	1.35	0.37
350	9.85	2.50	4.46	0.12	1.47	0.71
400	11.08	2.47	4.54	0.11	1.57	0.74
450	12.37	2.43	4.64	0.11	1.67	0.78
500	13.39	2.40	4.69	0.10	1.76	0.81

Total Discharge (cfs)	Est. Fishway Discharge (cfs)	Free-overfall (ft)	Head Loss (ft)	Ramp *n*	Ramp Vel. (ft/s)	Ramp Depth (ft)
550	15.06	2.37	4.76	01.10	1.85	0.84
600	16.47	2.3	4.84	0.10	1.94	0.87
650	17.92	2.31	4.92	0.10	2.02	0.90
1100	30.76	2.08	5.50	0.08	2.64	1.13
1700	47.70	1.83	6.14	0.08	3.22	1.38
2200	61.26	1.67	6.59	0.07	3.60	1.54
2800	77.60	1.50	7.09	0.07	3.97	1.71
3300	91.22	1.37	7.47	0.07	4.25	1.84

Table 5-5. Fish passage hydraulics – Option FW1 – Non-Blockage Configuration

Total Discharge (cfs)	Est. Fishway Discharge (cfs)	Free-overfall (ft)	Head Loss (ft)	Ramp *n*	Ramp Vel. (ft/s)	Ramp Depth (ft)
100	100.00	3.71	0.07	4.40	1.92	100.00
150	121.95	4.41	0.07	4.77	2.10	81.30
200	125.99	4.46	0.07	4.82	2.13	62.99
250	130.05	4.50	0.06	4.88	2.16	52.02
300	134.15	4.54	0.06	4.94	2.19	44.72
350	136.73	4.56	0.06	4.98	2.21	39.06
400	138.99	4.58	0.06	5.01	2.22	34.75
450	141.26	4.60	0.06	5.04	2.24	31.39
500	143.54	4.62	0.06	5.07	2.26	28.74
550	145.82	4.65	0.06	5.10	2.27	26.51
600	148.12	4.67	0.06	5.14	2.29	24.69
650	150.42	4.69	0.06	5.17	2.31	23.14
1100	169.02	4.84	0.06	5.36	2.41	15.37
1700	190.64	5.00	0.06	5.59	2.54	11.21
2200	206.55	5.11	0.06	5.75	2.63	9.39
2800	224.64	5.22	0.06	5.94	2.74	8.02
3300	239.03	5.30	0.06	6.09	2.82	7.24

5.4.2 *Option FW2 – Adjacent Technical Fishway*

Technical fishways exist at many structures in Michigan, with an example of an adjacent technical fishway on the 6th Street Dam on the Grand River (MDNR, 2025). There are a variety of configurations of technical fishways. For the purposes of this feasibility analysis, a pool-weir configuration was selected due to its ability to incorporate the free-overfall necessary for sea lamprey blockage design. The Option FW2 structure was designed as a static crest facility meeting the design objectives of **Table 5-3**. The fishway was positioned with an entrance near the right abutment of the dam spillway and with an exit that combines flow with the central spillway jet to promote fish attraction. The structure would be formed from concrete walls and floors with heights designed to not overtop during the 500-year flood event (720.0 feet).

The upstream drop of the fishway would be a free-overfall barrier for the greatest duration possible to promote sea lamprey blockage conditions while balancing passage goals at other drops. Widths of the structure were held uniform at 10 feet and pool depths were set at 6 feet, measured below the downstream crest invert. Lengths of pools were specified at 60 feet to meet an EDF limit of 4 at the 5% flow rate. The resulting overall length of 200 feet was compressed into a smaller footprint using a sinuous alignment. The alignment of the structure can be optimized at future design phases and should consider energy dissipation and site layout needs. For example, changes to the design parameters could shorten the overall length and could facilitate a straight run adjacent to the main spillway with trade-offs of lowered EDF values.

The upstream drop invert was set at 716.25 feet. Subsequent downstream drops were placed at 712.05 feet and 710.25 feet, designed both for sea lamprey blockage and to limit jumping barriers to below 1 feet at non-barrier drops. Three total drops were required, comprising two intermediate pools. Pertinent hydraulics calculated for the design are provided in **Table 5-6**. Values of headwater reported are approximated for the non-gated labyrinth weir main structure alternative. Tailwater conditions are significant in the fishway and submerge the weirs under increasing flows. Sea lamprey blockage was achieved up to the 10-year flood, due to submergence from rising tailwater. Migrating jumping species would have to overcome the free-overfall barrier of up to 3.3 feet at the 95% flow. Attracting flows ranged from 19% to 9% at the 5% and 95% flows, respectively.

Construction of Option FW2 would include cofferdams at the entrance and exit condition and could largely be performed in dry conditions. Access would be from the north bank. **Figure 22** below depicts an example of a technical fish passage option.

Figure 22. Example of a Technical Fish Passage Option

Source: Queensland Government – Pool and Wier Fishway

Table 5-6. Fish Passage Hydraulics – Option FW2

Total Discharge (cfs)	Est. Fishway Discharge (cfs)	Upstream (ft)	Tailwater (ft)	Pool 1. (ft)	Pool 2 (ft)	Free Overfall (ft/s)	Max EDF (ft)
100	25.59	717.17	709.49	711.11	712.91	3.34	1.89
150	29.06	717.25	709.76	711.19	712.99	3.26	2.15
200	32.66	717.34	710.00	711.26	713.06	3.19	2.42
250	36.38	717.42	710.21	711.34	713.18	3.11	2.70
300	40.20	717.50	710.41	711.41	713.21	3.04	2.99
350	43.81	717.54	710.59	711.48	713.28	2.97	3.23
400	45.85	717.58	710.77	711.52	713.32	2.93	3.39
450	47.91	717.62	710.94	711.56	713.36	2.89	3.54
500	50.00	717.66	711.09	711.60	713.40	2.85	3.70
550	52.12	717.70	711.25	711.63	713.43	2.82	3.86
600	54.27	717.75	711.39	711.67	713.47	2.78	4.02
650	56.44	717.79	711.53	711.71	713.51	2.74	4.18
1100	75.19	718.11	712.61	712.61	713.82	2.43	5.60
1700	98.30	718.48	713.73	713.73	714.16	2.09	7.36
2200	116.47	718.75	714.48	714.48	714.48	1.77	8.75
2800	138.45	719.07	715.26	715.26	715.26	0.99	10.47
3300	156.93	719.32	715.84	715.84	715.84	0.41	11.92

5.4.3 Option FW3 – Inline Technical Fishway

Inline technical fishways are feasible under certain channel configurations. The Homestead Dam on the Betsie River is one example of an inline technical fishway installation which has been considered successful for sea lamprey blockage and fish passage (MDNR, 2025). The difference between an inline and adjacent fishway is the prorated quantity of flow passing through a designed facility. An inline fishway will receive the full channel discharge as opposed to a reduced discharge for an adjacent structure.

Options for the Hesperia Dam have a crest invert of 717.0 feet and a downstream floor elevation of 710.0 feet. These configurations will provide sea lamprey blockage up to the 25-year flood event when operating with the gates in a closed position if present. Adding a pool-weir configuration above invert 710.0 feet would improve fish passage but compromise the effective range of blockage. Therefore, the presented spillway options are suitable as-is for an inline fishway while meeting sea lamprey blockage goals. Jumping obstacles required for successful passage would include up to a 7-feet vertical jumping height with little to no pool. Adding a staging pool below the structure would require significant modifications to the spillway, large fills in the downstream existing pool, and evaluation of complex hydraulics. **Figure 23** below depicts an example of an inline technical fish passage option.

Figure 23. Example of an Inline Technical Fish Passage Option

Source: Colin Merry, 2024

5.5 Site Amenities Considerations

Each alternative for dam rehabilitation and removal and fish passage option discussed above will have associated impacts to the current site amenities. The current site amenities include the following:

- Swimming pond upstream of right embankment.
- Swimming platform located in center of pond.
- Walkway access over existing spillway connecting the swimming pond to the park amenities on the left embankment.
- Gazebo on the left embankment.
- Picnic pavilion on the left embankment.
- Restroom facilities on the left embankment.
- Wood staircase and boardwalk along the left river bank.
- Overhead lighting on left and right embankments.

Regardless of the Alternative selected site amenities will be affected. The conceptual level plans provided in **Appendix F** provide a demolition sheet with coding based on required demolition vs possible demolition. The intent for any demolition of structural site amenities would be to temporarily remove the amenity during construction and store it for future use or replace the amenity. **Table 5-7** below provides a matrix of potential amenity options.

Table 5-7. Site Amenity Matrix

Amenities	Demolition/Removal	Salvageable
Swimming Pond	● Requires modifications for dam rehabilitation and removal for dam removal.	N/A
Swimming Platform	● May require modifications or relocation for dam rehabilitation. ● Will require removal for dam removal.	Yes
Walkway over Spillway	● Requires removal for dam rehabilitation and removal options. ● Will require replacement for dam rehabilitation to allow for park connectivity and dam maintenance.	No
Gazebo	● Requires removal for dam rehabilitation and dam removal to protect structure during construction. ● May require relocation depending on selected alternative and fish passage option.	Yes
Picnic Pavillion	● May require removal during construction of FW1 option to protect structure and possible relocation.	Yes
Restroom Facilities	● May require removal during construction of FW1 option to protect structure and possible relocation.	Yes
Wood Staircase and Boardwalk	● Will require removal for dam rehabilitation and removal alternatives. ● New staircase, platform, and boardwalk will be constructed for all dam rehabilitation options. ● Extension of the boardwalk will be considered for option FW1.	No
Overhead Lighting	● Requires removal for dam rehabilitation and removal options. ● New lighting will be considered in final design.	No

To facilitate an opinion of probable cost for the dam rehabilitation alternatives and fish passage options it is assumed that the following amenities will be replaced with new structures of equal or better value. All other minor amenities for replacement or relocation have been included in contingency included in the cost.

- Walkway access over spillway.
- Gazebo on the left embankment.
- Picnic pavilion on the left embankment.
- Restroom facilities on the left embankment.
- Wood staircase and boardwalk along the left river bank.

The major driving factor of cost for the site amenities is the replacement of the walkway over the proposed spillway structures. Each proposed alternative for dam rehabilitation will require at a minimum a walkway to allow for spillway maintenance and possible gate operations. The larger width of proposed dam structure will increase the walkway spans in turn increasing the walkway access associated cost. Another major driving factor in the cost of the walkway is the aesthetic appearance, **Figure 24** below depicts examples of pedestrian bridges. The current walkway consists of steel stringers with a concrete deck and railing with chain-link fencing. The figures below provide visual depictions of the walkway of multiple walkway options. To allow for ease of construction and installation a pre-fabricated walkway solution should be considered, this allows for customization including railing system, decking system, and aesthetics such as painted vs galvanized vs wood finishes.

Figure 24. Example Pedestrian Bridges

6. Construction Considerations

The following sections briefly highlight the construction considerations including site access, control of water, sediment management and known unknowns based on the available existing documentation for proposed alternatives discussed in **Section 5**.

6.1 Site Access

Along the left embankment the Village has ownership of the parking area and park amenities. The Village owned parcel is surrounded by privately own parcels with a utility access road to the southwest corner of the parcel. The utility access road can be accessed from West Michigan Avenue. While this access road may be suitable for small construction equipment, larger equipment will require crossing through the privately owned parcel on the southeast corner of the Village owned parcel.

Along the right embankment the Village has ownership of the road, baseball fields and parking area and can directly access this parcel from North Maple Island Road.

Figure 25 below depicts proposed site access locations, the routes highlighted in red are through publicly owned properties and the route in blue is through privately owned property.

Figure 25. Proposed Site Access

Source: GoogleEarth

6.2 Control of Water

Control of water and construction sequencing is crucial during dam rehabilitation and removal projects. Each project presents unique challenges based on site characteristic and existing infrastructure.

6.2.1 Dam Rehabilitation

The conceptual level sequencing and control of water for the dam rehabilitation Alternatives 1 through 3 are provided on the conceptual plans provided in **Appendix F**. Given the proposed scope associated with the dam rehabilitation it is anticipated that the construction duration would last one construction season. In addition, the use of the existing structure to pass the 95% exceedance flow of 150 cfs or greater. Flow events exceeding 200 cfs would results in overtopping of the proposed cofferdams and would need to be managed on a case by case basis.

6.2.2 Dam Removal

Managing water flow during dam removal is crucial for safety and sediment control. This process, known as dewatering, involves draining the impoundment behind the Dam. Various methods exist for dewatering and controlling water flow, including installing temporary cofferdams to divert flow around the Dam. Once flow is diverted, the Dam can be demolished in a controlled manner. Other methods, such as bypass pumping or siphon systems, or incremental demolition within active flow for dewatering can also be considered.

For the Hesperia Dam, utilizing the existing spillway gates to dewater and demolish the remaining concrete structure incrementally may be a feasible method of dewatering the impoundment. However, thorough hydraulic and structural assessments are necessary during the design phase to ensure appropriate methods are employed.

6.3 Sediment Management

The approach for sediment management for each proposed alternative varies based on anticipated scope. High level considerations for dam rehabilitation vs dam removal are discussed below.

6.3.1 Dam Rehabilitation

The approach to sediment management and dam rehabilitation is evaluated by the specific volume and characteristics of sediment at the site. The amount of sediment required to be removed for the dam rehabilitation options are assumed to be significantly less than required for dam removal. The sediment within the new footprint and a limited distance upstream of the spillway will need to be manipulated to allow for construction of the proposed spillway structure. Any sediment that will be removed will be subject to contamination testing to evaluate proper disposal procedures.

6.3.2 Dam Removal

The approach to sediment management and removal is evaluated by the specific volume and characteristics of sediment at the site. As discussed in Section 5, there is a large amount of sediment likely contained within the impoundment prevented from moving downstream by the Hesperia Dam. If Alternative 4 – Dam Removal was to be selected an investigation program to collect sediment data would be necessary to help quantity and test for potential contamination concerns associated with the impounded sediment. If the sediment was deemed contaminated from the investigation the dam removal cost could increase exponentially due to the disposal requirements.

Given the presumed amount of sediment within the impoundment and important fisheries present in the White River downstream of Hesperia Dam, sediment management throughout the duration of dam removal should be considered by use of engineered controls (such as turbidity curtains), incremental dewatering/demolition, and construction methods (such as sediment dredging). The use of all three approaches will result in the greatest capture of sediment and prevent the material from moving downstream.

6.4 Known Unknowns

Based on the available existing documentation the following items have been identified as known unknowns:

1. Existing spillway foundation thickness.
2. Presence of a cut off wall within the foundation of the existing spillway.
3. Extent of sawdust backfill on left embankment.
4. Remnants below grade remaining from the removed fish ladder on the right abutment of existing spillway.
5. Remnants below grade from original timber flume on the right embankment.
6. Extent of cobbles within the existing right embankment and divider berm.
7. Extent of erosion under the existing grouted riprap.
8. Depth and characteristics of impounded sediment on the upstream face of the existing spillway.

The above listed items are not all inclusive of unknowns that may be encountered on the site. This list will continue to evolve as a dam rehabilitation alternative and fish passage option are selected, design is progressed, and additional site investigation is performed.

7. Evaluation of Options

GEI compared various criteria of each of the identified options. No action option was also included for comparison against various criteria. Discussed in this section are the criteria used to rank each option, opinion of probable construction cost, and estimated operating and maintenance costs.

7.1 Evaluation Criteria

The three dam rehabilitation alternatives and two fish passage options that are discussed in **Section 5** above have been reviewed for pros and cons associated with the feasibility, and construction considerations and cost. **Tables 7-1** and **Table 7-2**. below outlines the pros, cons and potential constructability concerns for each dam alternative and fish passage option, respectively.

The Village should consider the following criteria to evaluate each option:

- Relative Estimated Construction Costs
- Constructability
- Operations and Maintenance Costs
- Environmental Impacts (including Sea Lamprey barrier efficacy)
- Recreation Impacts
- Aesthetics

Table 7-1. Dam Alternatives Evaluation Summary

Alternative	Pro	Con	Construction Considerations[1]	Risk Considerations
1 – Labyrinth	● Flows can pass through existing spillway structures during construction of new spillway structure. ● Requires smaller footprint than Alternative 2. ● Passive structure requires no operations to pass flows when reservoir level is above normal elevation or to stop passing flows when reservoir level returns to normal elevation. ● New upstream cutoff wall addresses some right embankment deficiencies (connection to existing spillway and embankment seepage). ● The impoundment is maintained for recreation. ● Less impact to existing swimming area geometry than Alternative 2.	● Ice loading can be problematic for labyrinth structures. ● Requires modification of existing divider berm for upstream swimming area.	● Upstream and downstream cofferdams and dewatering required to construct new spillway structures in the dry. ● Control of water through existing structures to construct new spillway ● Removal of remainder of structure and construction of new left embankment	● Stability of spillway structure will be improved. ● Long-term maintenance of spillway structure is less than gated Alternatives 1 and 3. ● Will required signage and boom to warn recreationists of hazard.
2 – Gated Straight Drop	● Flows can pass through existing spillway structure during construction of new weir gate spillway structure. ● Flows can pass through new gated spillway structure during construction of new straight drop spillway. ● Provides operational flexibility for flows less than the Design Flood. ● New upstream cutoff wall addresses some right embankment deficiencies (connection to existing spillway and embankment seepage). ● The Impoundment is maintained for recreation.	● Requires gate operations for larger floods. ● Requires modification of existing divider berm for upstream swimming area. ● Greatest impact to existing swimming area. ● Requires staged construction of spillway structure.	● Upstream and downstream cofferdams and dewatering required to construct new spillway structures in the dry. ● Control of water through existing structure to construct stage 1 of new spillway ● Control of water through stage 1 new partial spillway to construct stage 2 of new spillway	● Stability of spillway structure will be improved. ● Long-term maintenance of spillway structure is more than passive Alternative 1. ● Will require signage on boom to warn recreationists of hazard.
3 – Gated Labyrinth	● Flows can pass through existing spillway structure during construction of new spillway structure. ● Requires smaller footprint than Alternatives 1 and 2. ● New upstream cutoff wall addresses some right embankment deficiencies (connection to existing spillway and embankment seepage). ● The impoundment is maintained for recreation. ● Less impact to existing swimming area than Alternative 1 and 2.	● Ice loading can be problematic for labyrinth structures. ● Requires gate operations for larger floods. ● Requires modification of existing divider berm for upstream swimming area.	● Upstream and downstream cofferdams and dewatering required to construct new spillway structures in the dry. ● Control of water through existing structure to construct new spillway ● Removal of remainder of structure and construction of new left embankment ● More available working space and more available existing spillway to pass more flow during construction.	● Stability of spillway structure will be improved. ● Long-term maintenance of spillway structure is more than passive Alternative 1. ● Will require signage on boom to warn recreationists of hazard.
4 – Removal	● Capable of passing large debris. ● No operations required to pass flood flows. ● Eliminates all PFMs. ● Eliminates future dam safety inspections and maintenance.	● Requires substantial removal of dam materials, including earth embankments, stoplog concrete spillway structure, concrete-lined discharge channel, concrete aprons, retaining walls, and all appurtenant structures. ● Unknowns related to sediment contamination and environmental restoration requirements	● Staged demolition required to lower reservoir and remove dam and appurtenant structures. ● Upstream cofferdams required to demolish existing spillway. ● Upstream sediments need to be stabilized and re-vegetated during reservoir drawdown.	● Removes dam safety risks. ● Public opposition to loss of reservoir. ● Potential discharge of reservoir sediments.

Alternative	Pro	Con	Construction Considerations[1]	Risk Considerations
		could result in significantly higher construction costs. - The impoundment is not maintained for recreation. - Swimming area is lost. - Highest estimated construction costs compared to the other alternatives. - River levels will be impacted for upstream and downstream residents. - Requires new sea lamprey control barrier.		
5 – Do Nothing	- No short-term cost.	- Does not address note deficiencies. - Does not address sea lamprey encampment. - Exponentially increasing long term maintenance cost to maintain deteriorating structure. - Will likely result in compliance and enforcement from EGLE.	- No immediate construction required.	- Leaves dam in unsafe conditions. - Does not address dam safety noted deficiencies. - Does not pass design flood with stop logs in. - Unsafe conditions for stop logs removal during flooding events. - Spillway does not meet current industry standards.

Notes:
1. For additional construction considerations refer to **Section 6**.

Table 7-2. Fish Passage Options Evaluation Summary

Option	Pro	Con	Construction Considerations[1]
1 – Nature-Like Fishway	● Typically composed of naturalized elements. ● Aims to allow the passage of jumping species all year. ● Aims to allow passage of non-jumping species during periods when sea lamprey are not spawning. ● New park space amenity with observable fish passage.	● Crosses privately owned parcel. ● Existing Park amenities such as pavilion, gazebo and restrooms would need to be relocated. ● Required operation of stop log or gate system during sea lamprey spawning season.	● Will require obtaining waterfront property of privately owned parcel. ● Left embankment has been noted to have sawdust and mill debris within the limits of excavation. ● Additional cofferdam may be required during construction depending on sequencing.
2 – Adjacent Technical Fishway	● Entire structure on village owned parcel. ● Existing Park amenities such as pavilion, gazebo and restrooms may be able to remain in place pending selection of dam alternative. ● Aims to allow the passage of jumping species all year. ● Does not require operation.	● Typically composed of concrete structures. ● Structure may not be considered aesthetically pleasing. ● Does not allow passage of non-jumping species. ● Jumping species may be limited as larger drops are required to meet sea lamprey protection. ● Increase concrete cost due to difficult construction. ● Increased pedestrian bridge access would be required.	● Would aim to utilize cofferdams in place for dam rehabilitation construction.
3 – Inline Technical Fishway	● Entire structure on village owned parcel. ● Existing Park amenities such as pavilion, gazebo and restrooms may be able to remain in place pending selection of dam alternative. ● Aims to allow the passage of jumping species all year. ● Does not require operation.	● Structure may be difficult to incorporate into Alternatives 1 and 3. ● Does not allow passage of non-jumping species. ● Jumping species may be limited as larger drops are required to meet sea lamprey protection and weir efficiency.	● Would aim to utilize cofferdams in place for dam rehabilitation construction.

Notes:
1. For additional construction considerations refer to **Section 6**.

7.2 Opinion of Probable Construction Cost

GEI had developed opinions of the probable construction costs for three for dam rehabilitation alternatives (Alternative 1 through 3) and two for fish passage options (Options FW1 and FW2). The fish passage cost should be considered as an add-on cost to the selected dam rehabilitation alternative cost. The estimated costs were developed in accordance with the Association for the Advancement of Cost Engineering (AACE) 69R-12 – Class 5 which allows for an accuracy range of 30% to 100% on the high end, and a 20% to 50% on the low end, after the application of contingency. Our estimated cost includes an assumed 50% contingency to account for unknown risk.

After initial repairs are completed, ongoing financial commitments will be necessary for the dam. If not initially addressed, in the coming years the current list of repairs may continue to grow, and the cost associated with the repairs could increase exponentially. Additional ongoing costs involve the operation and maintenance of the dam. Village personnel will need to continue regularly assessing the dam's condition. They will also be responsible for keeping the spillway clear of debris and conducting regular checks of the functionality of all components.

Given the lifespan of a dam and the requirement for ongoing repairs, it is likely that maintenance similar to what is recommended above will be needed approximately every 50 years. Additionally, over the next 50 years, the Dam will necessitate annual maintenance, operations, periodic inspections, and insurance, incurring additional costs within the evaluated timeframe.

Summary worksheets for the detailed cost estimates are presented in **Appendix G**. **Table 7-3** provides a summary of estimated rehabilitation alternative and fish passage options cost.

Table 7-3. Opinion of Probable Construction Costs for each Alternative

Alternative/Option[1]	Estimate Initial Construction
Alt. 1: Labyrinth	$ 16,500,000
Alt. 2: Gated Straight Drop	$ 17,500,000
Alt. 3: Gated Labyrinth	$ 14,800,000
Option FW1: Naturalized Fish Passage	$ 1,700,000
Option FW2: Technical Fish Passage	$ 1,600,000

Notes: 1. Options FW1 and FW2 should be considered add-on cost to the selected dam rehabilitation alternative.

The OPCCs presented in this report are based on our professional opinion of the cost to construct the project as described in this report. The estimated costs are based on the sources of information described above, and our knowledge of current construction cost conditions in the locality of the project. Actual project construction costs are affected by several factors beyond our control, such as supply and demand for the types of construction required at the time of bidding and in the project vicinity; changes in material supplier costs; fuel costs; changes in labor rates; the competitiveness of contractors and suppliers; changes in applicable regulatory requirements; and changes in design standards. Therefore, conditions and factors that arise as project development proceeds through construction may result in construction costs that differ from the estimates documented in this report.

The following is a list of assumptions that were considered when developing the OPCCs presented in the table above:

- No removal or disposal of contaminated soils included.
- Steel sheet pile cutoffs, cofferdams and foundation piles can be effectively driven through the embankment soils, alluvial foundation soils, and toed into the natural hard glacial till foundation soils to provide an effective dam and foundation cutoff.
- Demolition quantities of the existing spillway are based on an assumption of members to be removed are approximately 2 feet thick.
- All site amenities will be replaced regardless of if they are listed as salvageable in **Table 5-7** above.
- Proposed concrete spillway structural concrete members are 2 feet thick.

7.3 Conclusions

Each alternative (1 through 3) and the accompanying fish passage options can meet the desired goals of achieving dam safety, sea lamprey control, and fish passage to varying degrees. Prior to selecting a preferred alternative, it is recommended that the project partners facilitate public outreach with the community to present the alternatives and solicit feedback. Following the public engagement, GEI can work with the partners to assess the alternatives based on desired criteria to select a preferred alternative.

1. Alternative 1 – Labyrinth Spillway
2. Alternative 2 – Gated Straight Drop Spillway
3. Alternative 3 – Gated Labyrinth Spillway
4. Option FW1 – Nature-Like Fishway
5. Option FW2 –Adjacent Technical Fishway

8. Future Funding Investigation

The following information comprises potential grant funding sources to conduct the final design, permitting, and rehabilitation of the Hesperia Dam. The following information considers grant opportunities at a high-level to allow for the greatest breadth of information and eligibility will have to be further vetted. This information provided here is subject to change and will be confirmed upon the release of the annual Notice of Funding Opportunity (NOFO).

The information provided herein regarding grant funding opportunities is intended solely for informational purposes. While we strive to present viable funding options, no grant funding is promised or guaranteed. The options discussed are proposals subject to further evaluation and approval by the relevant funding bodies. The Town of Hesperia is encouraged to conduct their own due diligence and consult with appropriate advisors before making any decisions based on the proposed funding options.

8.1 National Coastal Resilience Fund

National Fish and Wildlife Foundation

- Program Objectives: NCRF invests in nature-based solutions that protect coastal communities while enhancing habitats for fish and wildlife. The National Coastal Resilience Fund invests in conservation projects that restore, increase, and strengthen natural infrastructure such as coastal marshes and wetlands, dune and beach systems, oyster and coral reefs, rivers and floodplains, coastal forest, and barrier islands that mitigate the impacts of storms and other coastal hazards to communities.
- Eligibility Requirements: Non-profit 501(c) organizations, state and territorial government agencies, local governments, municipal governments, Tribal governments and organizations, educational institutions, or commercial (for-profit) organizations.
  - ☒ Final Design
  - ☒ Permitting
  - ☒ Construction
- Award Amount: up to $1M for design and $10M for construction
- Match Requirement: No match requirement
- Due Date: Late April / Early May

8.2 Sustain Our Great Lakes Program

National Fish and Wildlife Foundation

- Program Objectives: Funding priorities for this program include: Habitat Restoration to Conserve Species and Improve Water Quality; Green Stormwater Infrastructure in Great Lakes Communities ; Invasive Species Control to Protect and Enhance Restored Habitat; Activating

Restored Habitats and Greenspace

- Eligibility Requirements: Local units of government eligible
    - ☐ Final Design
    - ☐ Permitting
    - ☒ Construction
- Award Amount: Up to $750,000
- Match Requirement: Unknown
- Due Date: Pre-Proposals Due Early February, Full Proposals Due Early April
- Additional Information: Can we draw a connection to brook trout?

8.3 National Fish Passage Program

US Fish and Wildlife Service

- Program Objectives: Projects that improve the ability of fish or other aquatic species to migrate by reconnecting habitat that has been fragmented by a barrier such as a dam or culvert
- Eligibility Requirements
    - ☒ Final Design
    - ☐ Permitting
    - ☒ Construction
- Award Amount: Award amounts depend on the annual allocation of funding from Congress and the number of applications received by the regional offices, but can range as high as $300,000 and for some high priority projects even higher.
- Match Requirement: Unknown
- Due Date: Early February

8.4 America the Beautiful Challenge

National Fish and Wildlife Foundation / Department of Interior

- Program Objectives: locally led ecosystem restoration projects that invest in watershed restoration, resilience, equitable access, workforce development, corridors and connectivity, and collaborative conservation consistent with the America the Beautiful Initiative. Projects must be consistent with the principles outlined in the Conserving and Restoring America the Beautiful report and that focus on at least one of the following core areas: Conserving and restoring rivers, coasts, wetlands, and watersheds; Conserving and restoring forests, grasslands, and other important ecosystems that serve as carbon sinks; Connecting and reconnecting wildlife corridors, large landscapes, watersheds, and seascapes; Improving ecosystem and community resilience to coastal flooding, drought, and other climate-related threats; Expanding access to the outdoors, particularly in underserved communities

- Eligibility Requirements: State government agencies, U.S. territories, and Tribal Nations are eligible to apply for all grant categories. Non-profit 501(c) organizations, local governments, municipal governments, and educational institutions are eligible to apply for grants in categories: (3) Sentinel Landscape, (4) National Forest ,and (5) Private Forests and Farmland.
  - Unknown if planning and permitting are eligible, must wait until RFP is published
- Award Amount: (1) Implementation Grants: awards range from $1-5 million, and landscape-scale restoration requests over $5 million will be considered on a case-by-case basis. (2) Planning Grants: awards range from $200,000 to $2 million and are contingent upon awards from DOI.
- Due Date: The deadline for full proposals is typically in July and awards are announced in November.
- Additional Information: More information here https://fundingnaturebasedsolutions.nwf.org/programs/nfwf-america-the-beautiful-challenge/

8.5 Natural Resources Trust Fund

<u>Michigan Department of Natural Resources</u>

- Program Objectives: 2025 PRIORITY PROJECT TYPES OF THE MNRTF BOARD The MNRTF Board will emphasize the following four areas for funding in 2025: 1. Trails (including water trails) 2. Regionally Significant Projects 3. Wildlife Habitat, and Hunting Access (acquisition only) 4. Lake and River Public Access (acquisition only)
- Eligibility Requirements: State/local units of government, a limited number of school districts or recreation authorities which are legally constituted to provide recreation. A DNR-approved 5-year recreation plan is required to be eligible.
  - ☒ Final Design
  - ☒ Permitting
  - ☒ Construction
- Award Amount: $400,000 and approximately $15-20 million will be available for grants each year.
- Match Requirement: 25%
- Due Date: April 1 of the year of application (community recreation plans must be uploaded by Feb 1).
- Additional Information: Final grant awards are dependent on the appropriation process, but in general they are made within 12 to 18 months after the application deadline.

8.6 Habitat Protection and Restoration

Great Lakes Fishery Trust

- Program Objectives: to preserve essential habitat; protect, restore, and stabilize important fish habitats; and increase habitat availability. 1. The GLFT prefers to support projects that offer an increase in long-term, sustainable, natural reproduction for species now supported by hatchery production. Project benefits should be targeted toward salmonids and non-salmonid predator game species. 2. Projects that offer secondary benefits—for example, improved sea lamprey management or protection of state-listed threatened or endangered species—may be supported at a greater funding level. 3. Applicants are strongly encouraged to use the Great Lakes Aquatic Habitat Framework (GLAHF), the Great Lakes Fishery Commission (GLFC) Barrier Removal Collaboration Suite, existing field inventories, or similar tools to identify appropriate projects or as part of their proposed scopes of work.
- Eligibility Requirements:
  - ☒ Final Design
  - ☒ Permitting
  - ☒ Construction
- Award Amount: $750,000 total funding available in 2025
- Match Requirement: Organizations that are eligible to apply for GLFT grants include nonprofit organizations with a 501(c)(3) designation from the IRS (or nongovernmental organizations that hold charitable status in their country), as well as educational and governmental (including tribal) organizations.
- Due Date: Late February
- Additional Information: "Land acquisition, dam removal, fish passage, and other capital projects are highly resource intensive and, as a leading strategy, would quickly exhaust the resources of the GLFT. Therefore, the GLFT limits its direct investment in these projects to situations where the habitat opportunity is prime, other funders are contributing, long-term management is assured, and the proposed acquisition or restoration project has the strongest community support and interest."

8.7 Great Lakes Fish Habitat Restoration Partnership Grant

NOAA

- Program Objectives: hydrologic restoration/modifications; fish passage projects; shoreline/nearshore restoration

- Eligibility Requirements: institutions of higher education, non-profits, commercial (for profit) organizations, U.S. territories, and state, local and Native American tribal governments
    - ☒ Final Design
    - ☒ Permitting
    - ☒ Construction
- Award Amount: $500,000 - $5M
- Due Date: Late October
- Additional Information

8.8 Michigan Invasive Species Grant Program

<u>Michigan DNR/EGLE/Agriculture and Rural Development</u>

- Program Objectives: This program is designed to address strategic issues of prevention, detection, eradication, and control for both terrestrial invasive species (TIS) and aquatic invasive species (AIS) in Michigan. Projects must support the overalls goals of the MISGP: 1) Prevent new invasive species introductions. 2) Strengthen statewide invasive species early detection and response network. 3) Limit the dispersal of recently confirmed invasive species. 4) Manage and control widespread, long-established invasive species.
- Eligibility Requirements: units of government, nonprofits, universities
    - ☒ Final Design
    - ☐ Permitting
    - ☐ Construction
- Award Amount: $25,000 - $400,000
- Match Requirement: Not Required
- Due Date: Early November
- Additional Information: metrics do not align directly with dam rehabilitation; however, they could be used for a match for monitoring activities and/or community outreach

8.9 Fisheries Habitat Grant Program

<u>Michigan Department of Natural Resources</u>

- Program Objectives: Competitive projects will address causes of habitat degradation as opposed to symptoms, provide long-lasting benefits, address needs on the priority habitat projects list, be cost-effective, use appropriate methods, monitor project outcomes, address health and human safety for dam management, and/or address research and assessment needs to inform future habitat conservation.

  - ☒ Final Design
  - ☒ Permitting
  - ☒ Construction
- Eligibility Requirements: Local, state, federal or tribal units of government, academic institutions, or non-profit groups.
- Award Amount: Up to $1.6M, average high of $350,000
- Match Requirement: 10%
- Due Date: Early October
- Additional Information: a consultation with DNR staff must be completed prior to pre-proposal submission

8.10 Recreation Passport Grants

<u>Michigan Department of Natural Resources</u>

- Program Objectives: to provide funding to local units for the development of public recreation facilities. This includes the development of new facilities and the renovation of old facilities.
  - ☐ Final Design
  - ☐ Permitting
  - ☒ Construction
- Eligibility Requirements: Local Units of Government
- Award Amount: $7,500 - $150,000
- Match Requirement: 25%
- Due Date: April 1 of Each Year

8.11 Rural Readiness Grant Program

<u>Michigan Department of Labor and Economic Opportunity</u>

- Program Objectives: to support collaborative planning and capacity initiatives. These competitive, reimbursement grants support and invest in underserved areas and populations by providing reimbursement grant funding for capacity building activities, development readiness initiatives, partnership and plan formation, and cross sector collaboration.
  - Development Readiness. Projects include activities that prepare communities or key properties for development or investment, including development of property inventories, site development studies, site material development, site implementation or land assembly activities, feasibility, or market studies, and more.

  - Partnerships and Planning. Activities include development of plans and implementation structures that build readiness for future projects, collaborative initiatives, development, and investment.
  - Cross-sector Collaboration. Activities include various forms of community and stakeholder engagement that foster planning and dialogue across sectors, governments, and agency types.
- Eligibility Requirements: local units of government
  - ☐ Final Design
  - ☐ Permitting
  - ☐ Construction
- Award Amount: $50,000
- Match Requirement: 20%
- Due Date: August/September

8.12 Hometown Grants

T-Mobile Foundation

- Program Objectives: We will help fund projects that foster local connections, like technology upgrades, outdoor spaces, the arts, and community centers.
  - ☐ Final Design
  - ☐ Permitting
  - ☒ Construction
- Eligibility Requirements: This grant program is specifically open to 501(c)(3) and 501(c)(6) nonprofit organizations and local government entities in towns with a population of less than 50,000 residents
- Award Amount: $50,000
- Match Requirement: not applicable
- Due Date: quarterly

8.13 Dam Risk Reduction Grant Program

MI Department of Environment, Great Lakes, and Energy

- Program Objectives: This grant program aims to provide private owners with the needed resources for proper management of existing dams and reduce the overall risk of dam failure in Michigan.

  - NOTE: This program was approved in 2021 for a three-year period. As of May 2025, there is no guaranteed funding for this program for FY26. Funding levels will be determined in the future state budget as this program has been previously funded by the Michigan State Legislature.
- Eligibility Requirements
  - ☒ Final Design
  - ☒ Permitting
  - ☒ Construction
- Award Amount: There is no minimum or maximum award amount.
- Match Requirement: 10%
- Due Date: Preproposal due in November, full proposal due in January

9. References

9.1 Project References

Cavanagh, John and John Szegda. 2004. “Heavy rains prompt officials to keep an eye on Hesperia dam.” Herald-Journal Writers. Np. On file with GEI Consultants, Inc.

Cleland, Charles E. 1976. The Prehistoric Animal Ecology and Ethnozoology of the Upper Great Lakes Region. Anthropological Papers No. 29. Museum of Anthropology, University of Michigan.

F.W. Beers & Company. 1876. “Topographical Map of Oceano County, Michigan.” F.W. Beers & Company, New York, NY. Available at: https://lccn.loc.gov/2012593168. Accessed March 18, 2025.

Hartwick, L.M., and W. H. Tuller. 1890. Oceana County: Pioneers and Business Men of Today History, Biography, Statistics, and Humorous Incidents. Pentwater News Steam Print. Pentwater, MI. Available at: https://dn720001.ca.archive.org/0/items/oceanacountypion00hart/oceanacountypion00hart.pdf. Accessed April 29, 2025.

Great Lakes Fishery Commission (2012). “Barrier Fact Sheet – Hesperia Dam.” https://www.glfc.org/pubs/factsheets/barrier_factsheets/259110006.pdf

Historic Aerials. 1955-1981. “Hesperia Dam.” Available at: https://www.historicaerials.com/viewer. Accessed March 14, 2025.

History of Manistee, Mason and Oceana counties. No author. 1882. Available at: https://genealogytrails.com/mich/oceana/cityhesperia.html. Accessed April 29, 2025.

Michigan Department of Environment, Great Lakes, and Energy (2024). “Discharge Data – White River at Hesperia Dam #678.” EGLE (P-18-SE). EGLE Hydrologic Studies and Floodplain Management Unit. October, 2024.

Moxey, Jonathan M.. 2021. Part 315 Dam Safety Inspection Report: Hesperia Dam Crossing the White Ricer Inventory ID No. 678 Village of Hesperia Oceana County, MI. November 13, 2021. On file with GEI Consultants, Inc.

Michigan Department of Natural Resources (2025). Email correspondence with GEI Consultants, Inc.

National Park Service of the U.S. Department of the Interior (NPS). 2025a. National Historic Landmarks List by State. Public Database Review. https://www.nps.gov/subjects/nationalhistoriclandmarks/list-of-nhls-by-state.htm. Accessed May 6, 2025.

_________. 2025b. National Register of Historic Places Spatial Data (GIS). Public Database Review via Address Search. https://www.nps.gov/maps/full.html?mapId=7ad17cc9-b808-4ff8-a2f9-a99909164466. Accessed May 6, 2025.

NETR. 1955. “Historic Aerials.” Hesperia, MI. Available at: historicaerials.com/viewer. Accessed April 29, 2025.

_________. 1958.

_________. 1993.

_________. 1999.

_________. 2005.

_________. 2016.

_________. 2022.

Oceana County. 2025. “A Brief History of Oceana County.” Available at: https://oceana.mi.us/community/history/#:~:text=A%20Brief%20History%20of%20Oceana%20County&text=The%20first%20settlement%20in%20Oceana,mouth%20of%20the%20Pentwater%20River. Accessed April 29, 2025.

O’Neal, R.P. (2012). “White River watershed status of the fishery resource report, Muskegon, Oceana, and Newago Counties.” Michigan Department of Natural Resources, Fishery Division Research Report 212-121, Ann Arbor.

Rosentreter, R. 2013. Michigan: “A History of Explorers, Entrepreneurs, and Everyday People.” University of Michigan Press.

Schultz E.E. (1953). “Results of a biological and physical survey of the White River drainage system in Newaygo, Oceana and Muskegon Counties.” Michigan Department of Natural Resources, Fisheries Division Research Report 1378, Ann Arbor.

Sherburne, M. 2021. “Rewriting Michigan’s Archaeological History.” Michigan Today. Available at: https://michigantoday.umich.edu/2021/08/27/rewriting-michigans-archaeological-history/. Website accessed August 24, 2022.

Snyder, D. J. 2017. An Examination of Social Transformations During the Archaic–Early Woodland Transition in Western New York Using Resilience Theory and Lithic Analysis, M.A. thesis, University at Buffalo, State University of New York.

Talbot, T., H. T. Wright, and B. Nash. 2021. “The Belson Site: A Paleoindian Campsite on the Outwash Plains of the Central Great Lakes.” PaleoAmerica 7(1):76-84.

United States Geological Survey (USGS). 1931. Walkerville, MI.

_________. 1958. Milwaukee, MI.

_________. 1976. Hesperia SE, MI.

_________. 2012. Hesperia, MI.

_________. 2023.

U.S. Fish and Wildlife Service (2025). Email correspondence with GEI Consultants, Inc.

U.S. Geological Survey. 1931. “Walkerville, MI.”

U.S. Geological Survey. 1976. “Hesperia, MI.”

9.2 Technical References

Colin Merry, S. W. (2024, May 6). The Benzie Count Record Patriot. Retrieved from Photos: Spring arrives at Homestead Dam in Benzie County: https://www.recordpatriot.com/news/article/photos-betsie-river-s-homestead-dam-draws-19442460.php

Federal Emergency Management Agency (2020). “Guidance for Flood Risk Analysis and Mapping: Flood Depth and Analysis Rasters” https://www.fema.gov/sites/default/files/documents/fema_flood-depth-and-analysis-guidance.pdf

Hrodey, P. J., Lewandoski, S.A., Sullivan, P.W., Barber, J.A., Mann, K.A., Paudel, B., and Symbal, M.J. (2021). “Evolution of the sea lamprey control barrier program: The importance of lowermost barriers.” J. Great Lakes Res. 47(1).

Hunn, J.B. and Youngs, W.D. (1980). “Role of physical barriers in the control of sea lamprey.” Can. J. Fish. Aquat. Sci. 37(11).

Limerinos., J.T. (1970). “Determination of the Manning coefficient from measured bed roughness in natural channels.” U.S. Geological Survey, with California Department of Water Resources. Report 1898-B.

Nordlund, B (2009). “Design of upstream fish passage systems.” National Marine Fisheries Service. NWR. Lacey, Washington.

Ohio Dam Rehabilitations. (2025, May 2). Retrieved from Michael Baker International: https://mbakerintl.com/en/project/ohio-dam-rehabilitations

Turek, J., A. Haro, and B. Towler. (2016). “Federal Interagency Naturelike Fishway Passage Design Guidelines for Atlantic Coast Diadromous Fishes.” Interagency Technical Memorandum.

U.S. Fish and Wildlife Service (2019). “Fish passage engineering design criteria.” Northeast Region R5, Hadley, Massachusetts.

Whipps, inc. (n.d.). Retrieved from Product Brochures, Industry Leading Water Control Equipment: https://whipps.com/product-brochures/#WHIPPSBROCHURE900

Appendix A Existing Documentation

A.1. Inspection Report

A.2. Historic Documents

A.3. EGLE Flood Flow Request

A.4. EGLE Low Flow Request

A.1. Inspection Report

PART 315 DAM SAFETY INSPECTION REPORT

HESPERIA DAM CROSSING THE WHITE RIVER
INVENTORY ID NO. 678
VILLAGE OF HESPERIA
OCEANA COUNTY, MICHIGAN

Dam Owner:	Village of Hesperia 33 E. Michigan Avenue / P.O. Box 366 Hesperia, MI 49421 (231) 854-6205
Dam Operator:	Village of Hesperia Department of Public Works
Hazard Potential Classification:	Significant
Inspected By:	Jonathan W. Moxey, P.E. Fleis & VandenBrink Engineering, Inc. 2960 Lucerne Drive SE Grand Rapids, MI 49546 (616) 977-1000
Inspection Date:	October 22, 2021
Report Prepared By:	Jonathan W. Moxey, P.E. License No. 51462
F&V Project No.:	34892

VILLAGE OF HESPERIA
DAM SAFETY INSPECTION REPORT

TABLE OF CONTENTS

I. INTRODUCTION

Part 315, Dam Safety, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, requires that dam owners submit an inspection report that evaluates the condition of the dam and is prepared by a licensed professional engineer. According to Part 315, an inspection report must include the following:

- An evaluation of the dam's condition, spillway capacity, operational adequacy, and structural integrity
- A determination of whether deficiencies exist that could lead to failure of the dam
- Recommendations for maintenance, repair and alterations of a dam that are necessary to eliminate any deficiencies

Being classified by the Michigan Department of Environment, Great Lakes and Energy (EGLE) as having "significant hazard potential", the inspection report for Hesperia Dam is required to be submitted on a 4-year cycle. Prior to this report, the Hesperia Dam was last inspected October 26, 2017. In preparation of this report, the Hesperia Dam was inspected on October 22, 2021 by Jonathan W. Moxey, P.E. of Fleis & VandenBrink Engineering, Inc. This report has been prepared to meet the requirements of Part 315, is formatted to correspond to the requirements identified in Rule 10 of the administrative rules for Part 315 and is based on visual investigation and review of previous inspection reports.

II. CONCLUSIONS AND RECOMMENDATIONS

Recommended Repairs

The Hesperia Dam is in fair condition. Concrete repairs on the piers show cracking and efflorescence but appear to be functioning as intended. There are a few areas that still show deterioration, consistent with its age. Field inspection identified several areas of progressing deterioration that should be addressed, either in conjunction with other maintenance activities or contracted out:

- Significant seepage/leakage was noted in the downstream left/south berm area. The concrete slope paving between the south abutment and adjacent timber stairs is severely undermined, and the slope is eroding under the stairs. Boiling was observed at the toe of the slope paving. In reviewing prior inspection reports, the concrete slope paving was installed between the 2009 and 2013 inspections. The 2013 and 2017 reports did not note the seepage/leakage or erosion, suggesting that the rate of deterioration has increased in recent years. The Village should work to identify the source of the seepage/leakage, restore berm integrity and replace the concrete slope paving. The leakage may be related to a significant area of spalling in the southeast abutment, which should be repaired.
- Scour and undermining of the abutments are suspected, based on differential settlement observed. If practical, an inspection of the abutments and piers with the stoplogs removed is recommended.
- Remaining areas of cracking and spalling should be repaired. Unsound concrete should be removed and replaced.

- There are also a number of small cracks in the grouted riprap and sidewalk at the emergency spillway. These should be sealed annually with an exterior grade caulk. A technical data sheet for a recommended product can be found in the appendix.

- Riprap should be placed over geotextile at the outlets for the swimming pond and parking lot north of the pond to mitigate erosion and protect the slope.

The concrete spalling/cracking and the differential settlement at the abutments may be caused by scour and undermining of the foundation. It is recommended that the abutments be isolated and dewatered for a professional engineer to inspect this area. If left unaddressed, this issue could lead to serious stability issues and could eventually lead to failure of the dam. It is also recommended that the spillway be isolated for inspection, as it was previously reported that this area has been undermined with a complete loss of foundation material.

Operation and Maintenance Recommendations

In addition to maintaining the vegetation on the earthen berm slopes and exercising the swimming pond outlet valve at least annually, the following operation and maintenance is recommended:

- Monitor seepage/leakage and slope erosion at the downstream left berm at least monthly. Look for discolored water or other signs of material transport. Report any changed conditions immediately.

- During the inspection, debris on the gates of the dam was very minor, limited to light woody debris and leaves/cattails. Debris should be removed routinely to prevent buildup, which can impede operation of the stop logs.

- Minor brush growth was noted in various areas around the footprint of the structure. This should be removed routinely, as it prevents a thorough inspection and provides habitat for burrowing animals.

- The stop logs should be exercised at least annually to prevent them from locking up and inspect them for any wear or damage.

- In conjunction with stop log operations, it is recommended that sections of the spillway be isolated to better inspect the lower spillway for deterioration and/or undermining. The normal flow of water over the spillway does not allow for visual inspection and makes probing somewhat impractical.

- Several voids were detected in the grouted riprap between the principal and emergency spillways. It should be filled with loose grout or flowable fill as needed to fill the void and mitigate additional loss of material.

- The toe of the grouted riprap on the downstream slope of the emergency spillway is settling. It should be monitored and replaced as needed.

Report Conclusions

- The patching on the pier structures has hairline cracking and appears to be in fair condition.

- The dam is in fair condition, and with the exception of abutment scour and left berm seepage/leakage and slope erosion, no deficiencies were identified that could lead to failure of the dam.

- Implementing the repairs identified will make the structure safer and help to extend its useful life.

- The spillway capacity is adequate for the structure to pass a 0.5% (200-year) flood event with the dam being slightly overtopped during the design event. Due to the configuration of the dam downstream of the Division Street Bridge, it is anticipated that a flood event larger than the 0.5% would be required for the dam to actually experience the 0.5% flow rate, as the bridge is anticipated to act as a restriction to the flow during events of a design-type magnitude.

III. PROJECT INFORMATION

Description

Hesperia Dam is located on the White River in the southeast quarter of Section 25, Township 14 North, Range 15 West, Oceana County, Michigan. The dam consists of a concrete principal spillway structure and earthen berms. The principal spillway structure is approximately 70 feet wide and includes a 6-span concrete spillway with 5 piers and 2 abutments constructed of field stone and concrete. Each of the 6 spans has stop logs in place on a steel rail system to maintain the minimum upstream water elevation at approximately 717.80. The spillway structure also includes a walkway/sidewalk constructed of steel decking and concrete surface, as well as chain link fencing on both sides.

The left earthen berm extends approximately 15 south of the spillway structure, and the right berm extends approximately 240 feet north. The upstream face of the left berm is protected by grouted riprap. There is a timber boardwalk structure in place on the downstream face. The area between the boardwalk and concrete structure dam structure is filled with concrete slope paving. It has been reported that this area was previously a fish ladder. The upstream face of the right berm is protected by grouted riprap near the structure and vegetation beyond. The downstream face of the berm is protected by grouted riprap throughout most of its length and vegetation at the north end. The sidewalk over the spillway structure extends left and right of the structure to protect the top of the berm.

Recreational amenities have been installed around the dam area. In addition to the boardwalk down the left berm and along the southern downstream shoreline, a gazebo structure is in place in the southwest area. A swimming pond was installed in the northeast area of the site. The swimming pond is separated from the White River by a vegetated earthen berm with some light riprap and brush. Under normal conditions, water flows from two artesian wells into the pond through piping and discharging into the pond through outlets attached to the dock structure in the middle of the pond. During high flow events, water can also flow over the berm. The swimming pond area was designed to function as the dam overflow. Water discharges from the pond to the river downstream of the dam through a concrete outlet pipe with control valve. Under high flow conditions, water also flows over the right berm of the dam at a depression in the concrete sidewalk, the emergency spillway. An asphalt parking lot was constructed north of the swimming pond. The parking lot is drained by two catch basins connected by storm sewer, which outlets through the right berm near the north end of the berm.

Purpose

The Hesperia Dam was originally constructed for power generation. However, in the 1950's, Consumers Energy ceased hydroelectric power generation, and ownership, operation and maintenance of the structure was turned over to the Village of Hesperia. The powerhouse was removed a number of years ago, and the dam currently serves to impound an area of approximately 50 acres, with a grade change of approximately 7 feet. The dam has a drainage area of approximately 214 square miles.

History of Design, Construction, Improvements and Operations

Construction plans and design calculations and other information related to the original dam construction are no longer available. Prior to the 2013 inspection, repairs were made to the concrete structure including concrete "skins" over the field stone structure in several locations. The powerhouse for the structure was demolished some time after the dam was taken out of service for hydroelectric power generation.

In 1975, 1986, 2013, 2014 and 2018, it was reported that flood events resulted in overtopping of the northern berm. In response to mechanical breaching of the north berm to prevent overtopping, in 1986 the earthen berm portion was rebuilt. Soon after, the swimming pond system with inlet/outlet piping and spillway were incorporated into the dam to provide emergency overflow capacity. Concrete sidewalk was constructed over the berm with a depression to function as an emergency spillway. Portions of the construction plans for these improvements were included in previous reports and were reviewed in preparation of this report.

It was reported that since the emergency spillway construction, several flood events have occurred causing the emergency spillway to be utilized. Articles from the 1975 flood and several more recent ones are included in the appendices. One of the articles indicates that repairs and improvements were made to the dam as recently as summer of 2001 and 2010, when concrete was patched and several stop log boards replaced in conjunction with the US Fish and Wildlife's efforts to stop the spread of lamprey eels in the White River. Another article indicates that a 2004 storm was an approximately 25-year to 50-year event. In January 2013 a significant storm caused the utilization of emergency spillway as seen in the attached photograph. The emergency spillway was also utilized in April 2014 and February 2018.

A stoplog failure occurred at the White Cloud Dam in July 2021. Village staff reported that event had a minimal impact on operations of Hesperia Dam, with the water level increasing 4 to 6 inches. The emergency spillway was not utilized during the event.

Currently, several operational and maintenance activities are taking place. The earthen berms are routinely mowed to control brush and trees from obscuring the slopes from visual inspection and potentially compromising the integrity of the berms. Also, the valve controlling the swimming pond outlet pipe is exercised routinely, most recently in conjunction with this inspection to allow for better visual inspection of the berms. Since the 2017 inspection, riprap was placed on the west bank of the swimming pond, which is also the upstream slope of the north berm. The stone was placed on chicken wire to discourage burrowing activity.

Past Inspection Reports

The 1997 and 2001 Dam Safety Inspection Reports prepared by James T. Nordlund, Sr., P.E. of Nordlund & Associates, Inc. as well as the 2005 Dam Safety Inspection Report prepared by Patrick Conroy, P.E. of Collins Engineers, Inc. and the 2009, 2013 and 2017 Dam Safety Inspection Reports prepared by Jon Moxey of Fleis & VandenBrink were provided as part of this project. The background information, hydraulic calculations and conclusions and recommendations included in these reports have been reviewed and used in preparation of this report.

IV. FIELD INSPECTION SUMMARY

Field inspection performed in conjunction with this report consisted of a visual inspection of the dam site, including the concrete spillway structure, earthen berms and swimming pond emergency overflow area. The inspection also included probing for voids and basic survey to establish elevations for specific points of interest.

The plan sheet dated December 1997 included with the 2001 Dam Safety Inspection Report indicates a benchmark of 721.76 for the southeast corner of the dam walkway. This elevation appears to have also been used for the 2005 Dam Safety Inspection Report (there appears to be a typographical error in the text identifying it as “721.6”). In 2009, the benchmark was transferred to a railroad spike on the east face of the power pole just south of the principal spillway with an elevation of 723.96. This benchmark was used in the preparation of this report, and the corresponding upstream water level was approximately 718.84 during the inspection.

Prior to the 2013 inspection, considerable concrete repairs were completed. All five piers had approximately 6-8 inches of concrete cover added to all but the upstream face. This concrete repair has been anchored to the existing concrete with a minimum of 2 anchors per pier. This repair patched the deteriorating concrete surface and prolonged its useful life. The additional concrete also reduced the weir length used to pass water and subsequently the calculated flow rates have decreased by approximately 15%. At this time, there is no apparent substantial impact to the safety of the dam due to this change in water passage.

The deterioration of the southeastern corner section of the south abutment is approximately 3 feet high by 2 feet long with a spall depth of about 8 to 12 inches. The foundation under this section is suspected to have some minor scour and undermining that should be inspected in the dry condition. The steel decking supporting the walkway shows moderate surface corrosion of approximately 75% of the bottom surface. There are a number of areas of concrete surface weathering, cracking and minor spalling throughout the principal spillway structure, which are felt to be consistent with a structure of this age and construction. The steel rails and stop log supports show surface corrosion and section loss was minor in several areas.

One other item related to the spillway structure is the condition of the chain link fencing. Several fence supports for the east fence are loose, and the flexible nature of the fence allows for a gap between the walkway and bottom of fence, which could be a hazard.

Minor scouring in the downstream berm slope was noted at the outlets from the swimming pond and parking lot storm sewer. The area of the upstream slope below the normal water level of the swimming pond has been reinforced with riprap.

V. STRUCTURAL STABILITY

Because the original construction plans for the structure are not available, evaluation of structural stability is based on a visual review of the surface conditions at the dam supplemented by probing of the earthen berms in suspect areas. The principal spillway structure has withstood a number of recorded flood events without mention of stability concerns, and spillway instability is unlikely. Over time, deterioration of the structure could pose local stability concerns, and the earthen berms have had several recorded failures prior to the 1986 improvements project. Additionally, it has been reported that the spillway has been undermined significantly, and additional inspection is warranted.

If left unaddressed, erosion of the downstream side of the left berm from berm seepage/leakage could cause instability of the structure. It is important for the Village to address this condition in a timely manner and monitor the condition until such time as repairs can be made.

Another stability concern for the structure is the suspected undermining and scour under the abutment and principal spillway. A “dry” (to the extent practical) inspection performed by a professional engineer is highly recommended to determine the severity and amount of loss of the foundation material.

VI. HYDROLOGY AND HYDRAULICS

In conjunction with this report, current design flow information was requested from the Michigan Department of Environment, Great Lakes and Energy (EGLE). A copy of the EGLE response is included in the appendices. The current estimate of contributory drainage area to the White River at Hesperia Dam is 214 square miles. The design discharge for the dam is the 0.5% chance of exceedance (200-year) flow, which is 4,400 cubic feet per second (cfs). The hydraulic evaluation in the 1997 report was based on 4,640cfs, the 2001 report was 3,900cfs, the 2005 report was 4,400cfs, the 2009 report was based on 3,976cfs, the 2013 report was based on 4,500cfs and the 2017 report was based on 4,400cfs. All of these reports concluded that the dam would be overtopped slightly during a 0.5% flood event. Based on current calculations (included in the appendices), these conclusions are supported.

Due to the slight overtopping during the design flood event, the Village should be prepared to sandbag the structure as indicated in the 2001 report to direct water from the berms to the emergency spillway. A copy of the sandbagging plan has been included in this report for reference.

In the article relating to the flood event in 2004 (estimated at 25- to 50-year occurrence), it indicated that water was within approximately 2 feet of the bottom chord of the Division Street Bridge. Because the bridge was constructed to pass the 100-year flood, the water level may be above the bottom of beam of the structure during the design event for the dam. This would limit the flow actually experienced by the dam until topping of the Division Street roadway, and the Village should plan accordingly for additional sandbags or other flood control measures.

VII. OPERATION AND MAINTENANCE

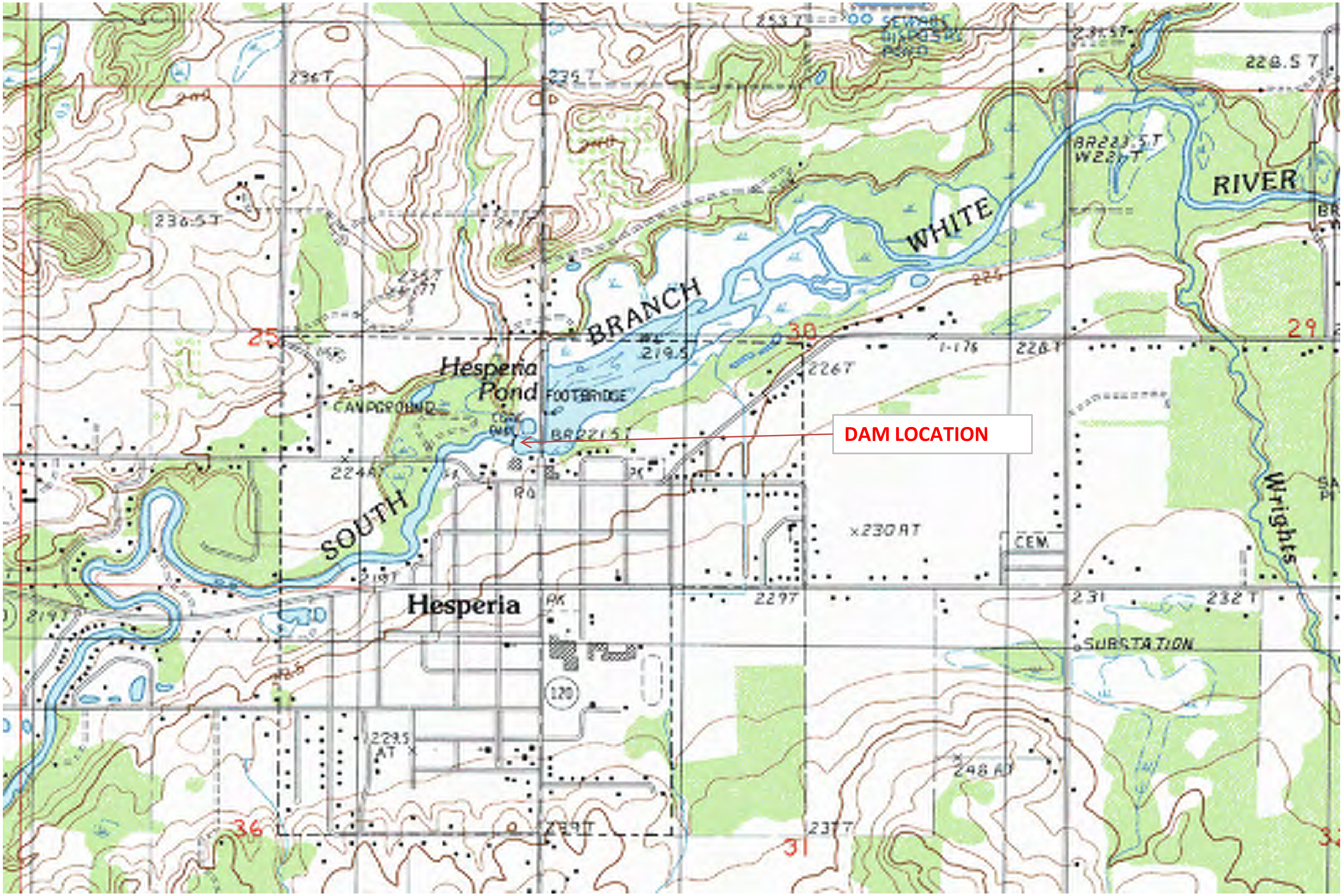
Hesperia Dam is operated by the Village of Hesperia’s Department of Public Works. Routine maintenance includes mowing of the vegetation on the earthen berms, removal of debris caught on the gates and exercising the outlet valve for the swimming pond.

In addition to the operation and maintenance activities recommended in Section II, Village personnel should inspect the dam on a 3-month cycle and after flooding events. The left berm should be inspected at least monthly and after flooding events. An inspection log should be kept documenting the inspections and record any significant findings, with photographs where applicable. The inspections should focus on areas and issues identified in this report as well as anything “out of the ordinary”.

IIX. APPENDICES

Please reference the Table of Contents for a list of materials included in the appendices.

HESPERIA DAM INSPECTION
DAM LOCATION MAP



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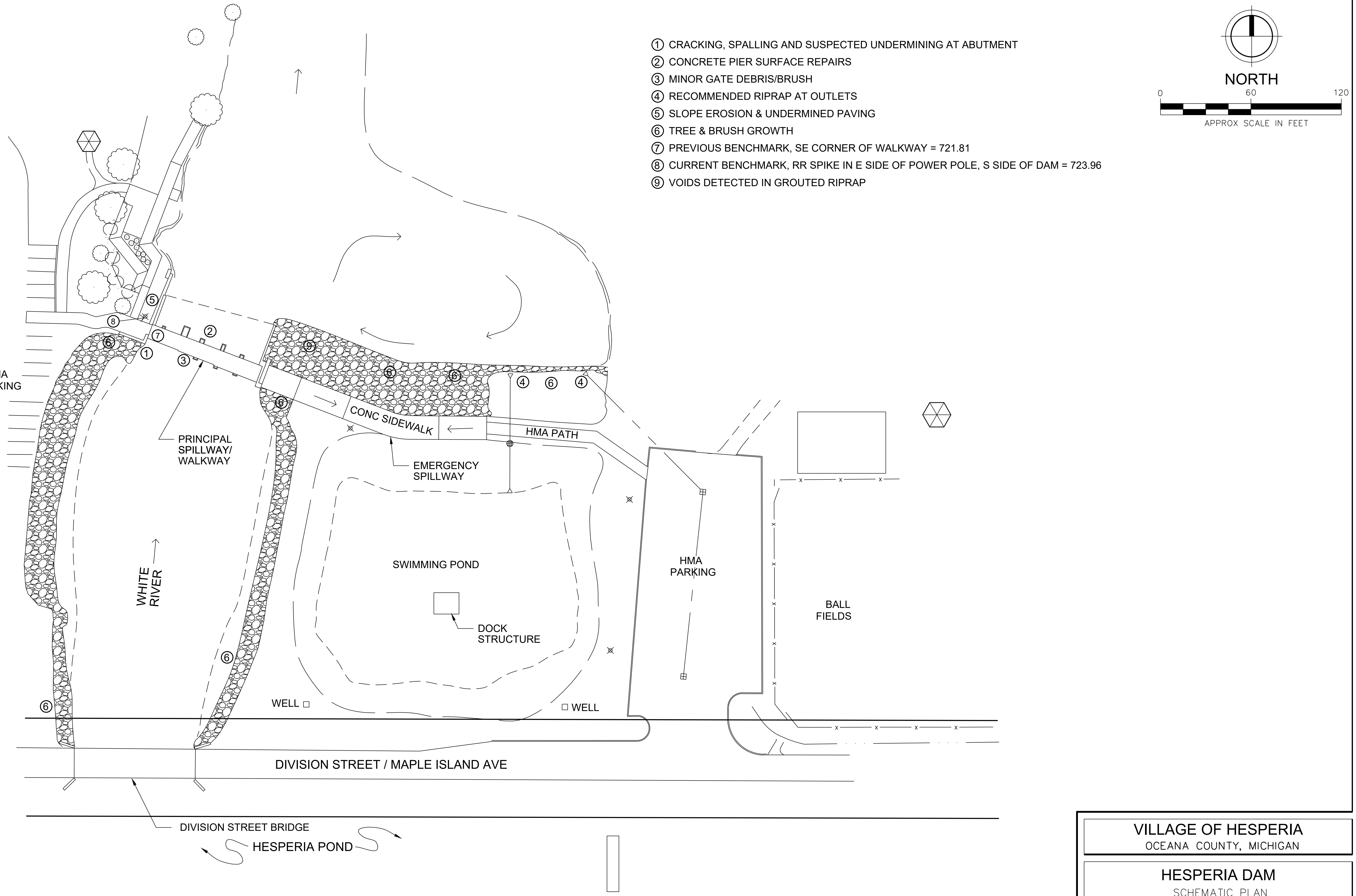
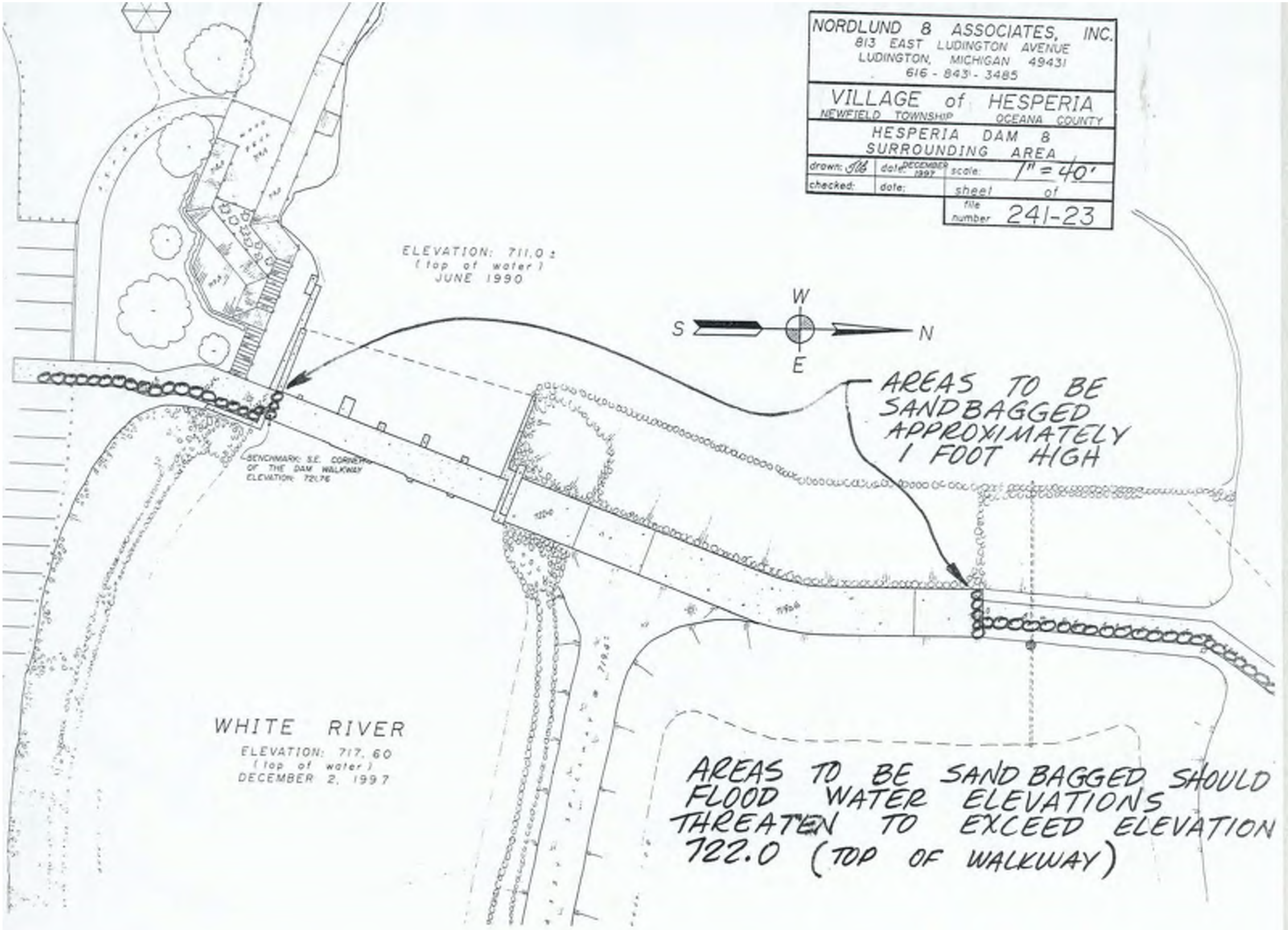


① CRACKING, SPALLING AND SUSPECTED UNDERMINING AT ABUTMENT
② CONCRETE PIER SURFACE REPAIRS
③ MINOR GATE DEBRIS/BRUSH
④ RECOMMENDED RIPRAP AT OUTLETS
⑤ SLOPE EROSION & UNDERMINED PAVING
⑥ TREE & BRUSH GROWTH
⑦ PREVIOUS BENCHMARK, SE CORNER OF WALKWAY = 721.81
⑧ CURRENT BENCHMARK, RR SPIKE IN E SIDE OF POWER POLE, S SIDE OF DAM = 723.96
⑨ VOIDS DETECTED IN GROUTED RIPRAP

VILLAGE OF HESPERIA
OCEANA COUNTY, MICHIGAN

HESPERIA DAM
SCHEMATIC PLAN
OCT 2021
34892

FLEIS & VANDENBRINK ENGINEERING, INC.



NORDLUND & ASSOCIATES, INC.
813 EAST LUDINGTON AVENUE
LUDINGTON, MICHIGAN 49431
616 - 843 - 3485

VILLAGE of HESPERIA
NEWFIELD TOWNSHIP OCEANA COUNTY

HESPERIA DAM &
SURROUNDING AREA

drawn: JLB	date: DECEMBER 1997	scale:	1" = 40'
checked:	date:	sheet	of
		file number	241-23

AREAS TO BE
SANDBAGGED
APPROXIMATELY
1 FOOT HIGH

AREAS TO BE SANDBAGGED SHOULD
FLOOD WATER ELEVATIONS
THREATEN TO EXCEED ELEVATION
722.0 (TOP OF WALKWAY)

View of structure looking west

View of principal spillway looking northeast

View of parking lot catch basin at end of right berm

View of swimming pond looking south

Outlet pipe in northwest corner of swimming pond

Riprap along west bank of swimming pond / upstream side of right berm

Outlet control structure for the swimming pond looking south

View of downstream right berm at swimming pond outlet pipe looking west

Erosion around end of catch basin outlet pipe

Erosion around end of catch basin outlet pipe

View of downstream side of right berm looking south

View of swimming pond outlet pipe

View of downstream side of right berm looking south

Cracking in grouted concrete on downstream slope of emergency spillway

Cracking in grouted concrete on downstream slope of emergency spillway

Patches in concrete sidewalk on emergency spillway from prior grouting of voids beneath

View of swimming pond looking east from emergency spillway

Riprap along west bank of swimming pond / upstream slope of right berm, looking south

Ponding on emergency spillway sidewalk, looking south

Settlement of grouted riprap on upstream side of emergency spillway sidewalk

View of upstream slope of emergency spillway / west bank of swimming pond, looking north

Minor bank erosion in southwest corner of swimming pond

View of south bank of swimming pond looking east

View of swimming pond looking northeast

View of berm between swimming pond and White River looking southeast

View of berm between swimming pond and White River looking west

Bank erosion at artesian well structure in northeast corner of swimming pond

Bank erosion at artesian well structure in northeast corner of swimming pond

Bank erosion at artesian well structure in northeast corner of swimming pond

View of artesian well structure in northeast corner of swimming pond looking southwest

View of artesian well structure in northeast corner of swimming pond looking southwest

View of east bank of swimming pond along Division Street looking south

Brush growth along upstream right bank of White River

Tree and brush growth along upstream left bank of White River

View of principal spillway structure looking west

View of upstream left bank looking west

Grouted riprap on upstream left slope

Gazebo structure south of principal spillway

View of left / south abutment and berm area looking northwest

Cracking and delamination on southeast abutment

Deterioration of southeast abutment area

View of stoplogs looking north

View of walkway over principal spillway looking north

Deterioration of southeast abutment area

Typical stoplog configuraton

View of stoplogs looking north

Vegetation growth in joint at end of walkway

Chain link fence post not connected to walkway

Chain link fence post not connected to walkway

Settlement of north approach sidewalk along north abutment

Settlement of north approach sidewalk along northeast abutment

Settlement of north approach sidewalk along northwest abutment

View of emergency spillway looking north

View of right bank of White River looking east

View of principal spillway structure looking southwest

View of grouted riprap on upstream right slope

Deterioration of northeast abutment area

Deterioration of northeast abutment area

Deterioration of northeast abutment area looking north

Minor channel debris on stoplog

View of primary spillway and downstream channel area looking west

View of Division Street bridge looking east from walkway

Concrete slope paving behind downstream south abutment

View of primary spillway structure looking northeast

Concrete slope paving behind south abutment looking northeast

View of timber boardwalk structure south of south abutment

View of timber boardwalk structure south of south abutment

Eroding slope and exposed roots beneath boardwalk structure along concrete slope paving

Section of concrete slope paving settled from erosion and flow of seepage/leakage water

Flow of seepage/leakage water through left berm re-entering downstream channel

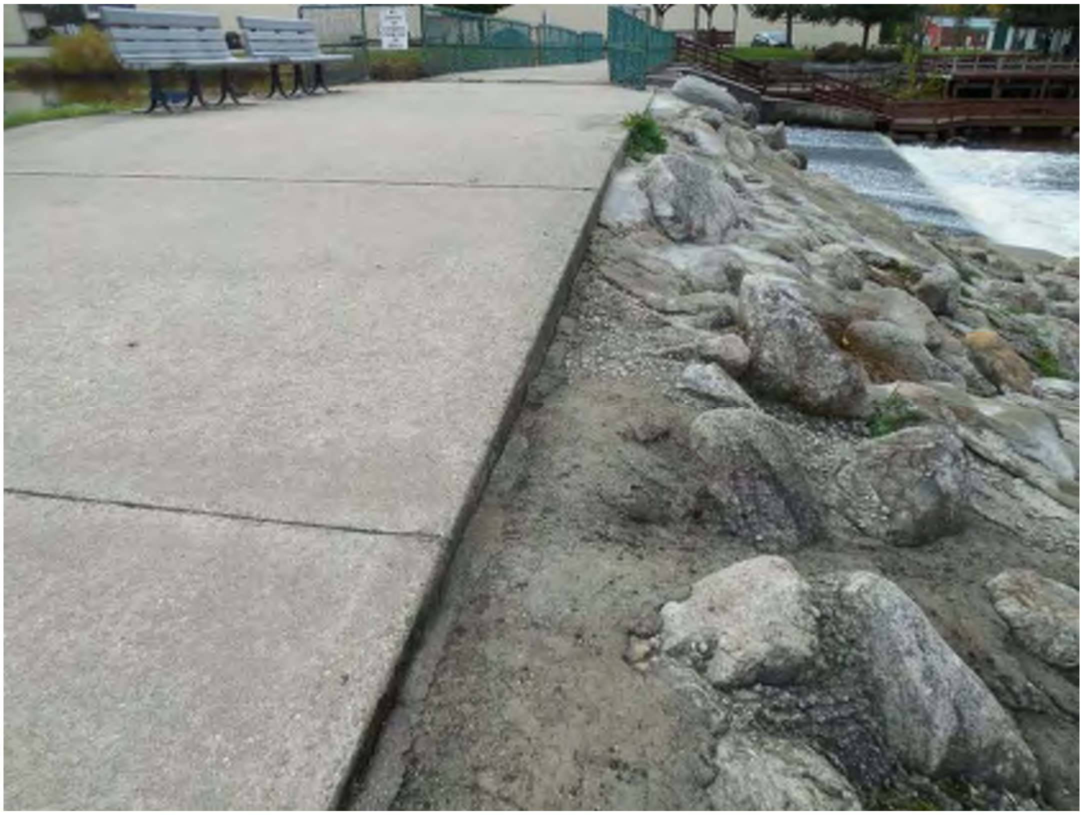
Sand bags placed to mitigate undermining of the boardwalk structure

View of principal spillway looking north

View of principal spillway looking northeast

View of left berm area looking south

View of grouted riprap on downstream slope of emergency spillway looking north



Settlement of grouted riprap looking south

Probe illustrating void in grouted riprap on downstream slope of emergency spillway

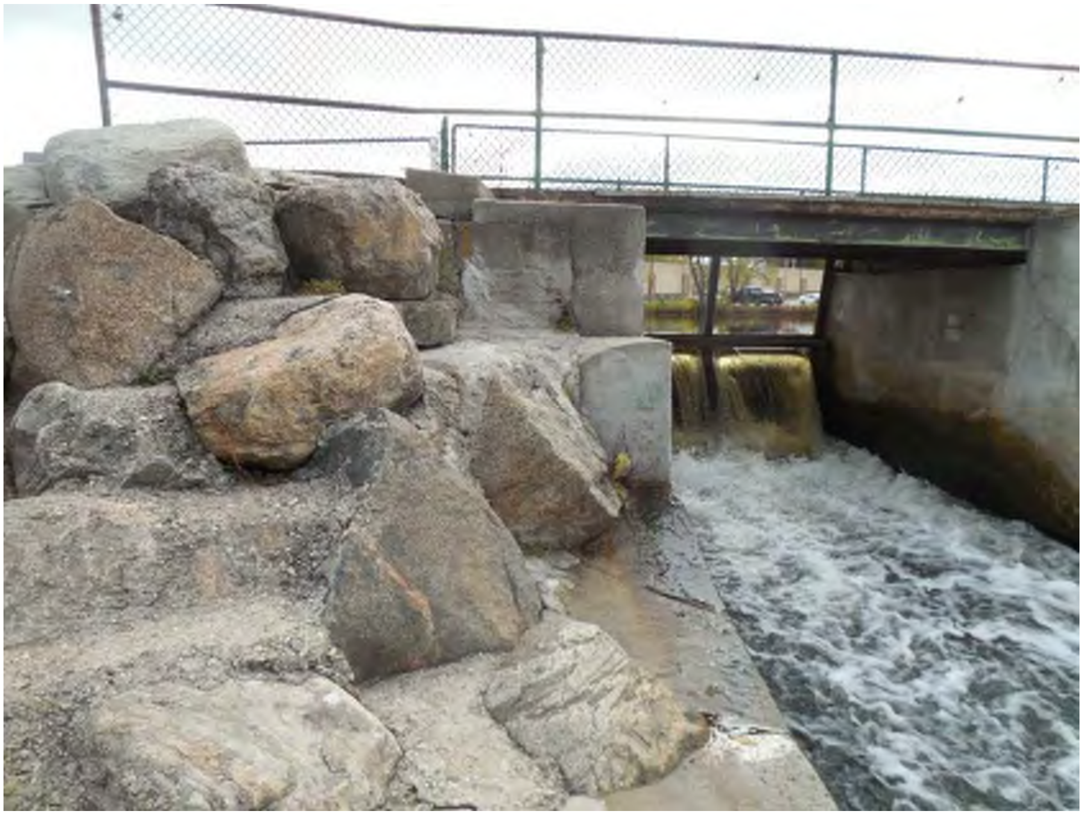
Probe illustrating void in grouted riprap on downstream slope of emergency spillway

Probe illustrating void in grouted riprap on downstream slope of emergency spillway

Prior patching of grouted riprap voids

Riprap at bottom of downstream emergency spillway slope settling into the channel

View of grouted riprap on downstream right berm looking south



View of northwest abutment looking east

Cracking in concrete repairs on piers

Boiling and sand deposition at bottom of concrete slope paving behind south abutment

Undermining of concrete slope paving behind south abutment

Undermining of concrete slope paving behind south abutment

From: EGLE-wrd-qreq <EGLE-wrd-qreq@michigan.gov>
Sent: Wednesday, November 10, 2021 11:03 AM
To: Jon Moxey
Subject: RE: flood or low flow discharge request (ContentID - 168812)

Importance: Low

We have processed the discharge request submitted by email on October 21, 2021 (Process No. 20210547), as follows:

South Branch White River at Hesperia Dam, Dam ID 678, Section 25, T14N, R15W, Village of Hesperia, Oceana County, has a total drainage area of 214 square miles and a contributing drainage area of 196 square miles. The design discharge for this dam is the 0.5% chance (200-year) flood. The 1%, 0.5%, and 0.2% chance peak flows are estimated to be 3900 cubic feet per second (cfs), 4400 cfs, and 4500 cfs, respectively. (Watershed Basin No. 37 White).

Please include a copy of this letter with your inspection report or any subsequent application for permit. These estimates should be confirmed by our office if an application is not submitted within one year. If you have any questions concerning the discharge estimates, please contact Ms. Susan Greiner, Hydrologic Studies and Floodplain Management Unit, at 517-927-3838, or by email at: GreinerS@michigan.gov. If you have any questions concerning the hydraulics or the requirements for the dam safety inspection report, please contact Mr. Thomas Horak of our Dam Safety Unit at 517-231-8594, or by email at: HorakT@michigan.gov.

-----Original Message-----
From: DoNotReply@michigan.gov <DoNotReply@michigan.gov>
Sent: Thursday, October 21, 2021 1:24 PM
To: EGLE-wrd-qreq <EGLE-wrd-qreq@michigan.gov>
Subject: flood or low flow discharge request (ContentID - 168812)

Requestor: Jon Moxey
Company: Fleis & VandenBrink
Address: 2960 Lucerne Drive SE
City: Grand Rapids
Zip: 49546
Phone: 6169771000
Date: 2021-10-21
F1percent: Yes
F0.5percent: Yes
F0.2percent: Yes
ContactAgency: None Selected
ContactPerson:
Watercourse: White River
LocalName:
CountyLocation: Oceana
CityorTownship: Village of Hesperia
Section: 25
Town: 14N
Range: 15W

Location: Dam No. 678 is owned by the Village of Hesperia. It is located just west of Division Street (aka N Maple Island Rd) at the White River in the north central area of the Village.
FFR1: Dam
fpReqEmailAddr: jmoxey@fveng.com

Hesperia Dam – Hydraulic Calculations

Dam Configuration Information

- Elevation of top of walkway = 722.25 (average, varies 721.84 to 722.59 as measured)
- Elevation of bottom of walkway = 721.92 (average, based on 4" thickness from previous report)
- Elevation at base of stop logs = 714.66 (as measured)
- Elevation of top of stop logs = 717.80 (as measured)
- Elevation of steel channel support = 717.46 (as measured)
- Clear length of principle spillway = 70 feet
- Length of principle spillway for overtopping flow = 110 feet (includes level concrete area between principle spillway and emergency spillway)
- Length of overflow spillway (top) = 130 feet
- Length of overflow spillway (bottom) = 90 feet

Develop State-Discharge Curve

Point 1 – Water Surface Elevation at 718.7 (current level)

Model flow through principle spillway as sharp crested weir with multiple contractions:

$Q = (2/3) * Cd * (2g)^{1/2} * (L - 0.1 * n * H) * H^{1.5}$

Where Cd = weir coefficient = 0.62
g = gravitational constant = 32.2 ft/sec^2
L = length of weir = 70 feet
n = number of contractions = 12 (2 per bay * 6 bays)
H = head on weir = 718.84 – 717.46 = 1.38 feet

$Q = (2/3) * (0.62) *(2 * 32.2)^{1/2} * (70 - 0.1 * 12 * 1.38) * (1.38)^{1.5} = 368$ CFS

Note: This model assumes the area between the top of stop logs and steel support channel is plugged with debris during a large storm event. Actual current flow likely exceeds 368 CFS.

With no flow over the overflow spillway, the total flow through the principal spillway is 368 CFS (neglecting flow through pond outlet pipe, which was minimal at time of inspection).

Point 2 – Water Surface Elevation at 721.3 (bottom chord of Division Street Bridge)

Flow through principle spillway (sharp crested weir with contractions):

$Q = (2/3) * (0.62) *(2 * 32.2)^{1/2} * (70 - 0.1 * 12 * 3.84) * (3.84)^{1.5} = 1{,}632$ CFS

At this elevation, water will also be flowing over the emergency spillway. Because of its high length to height ratio, treat it as a broad crested weir without contractions as opposed to triangular or trapezoidal and use average length and height values. The broad crested weir equation is as follows:

$Q = 0.385 * Cd * (2g)^{1/2} * L * H^{1.5}$

Where Cd = weir coefficient = 1.0 (varies 0.85 to 1.1)

g = gravitational constant = 32.2 ft/sec^2

L = length of weir

H = head on weir

Total length (from graph) is 110 feet and total height is 1.7 feet. Total area (from graph) is approximately 150 square feet. Therefore use an average height of 1.5 feet and an average length of 100 feet.

$Q = 0.385 * (1.0) * (2 * 32.2)^{1/2} * (100) * (1.5)^{1.5} = 568$ CFS

Total flow at elevation 721.3 = 1,632 + 568 = 2,200 CFS

Point 3 – Water Surface Elevation at 722.0 (top of principle spillway walkway):

Note: As the water surface elevation rises above 721.3, the Division Street Bridge will constrict the flow, making the following analysis slightly conservative. The following analysis assumes sand bagging is in place for flood events for flows above the bottom of beam of the Division Street Bridge.

Flow through the principle spillway become rectangular as opposed to sharp crested. Use the rectangular formula modified for contractions:

$Q = (2/3) * Cd * (2g)^{1/2} * (L – 0.1 * n * H) * (H_1^{1.5} – H_2^{1.5})$

Where Cd = weir coefficient = 0.62

g = gravitational constant = 32.2 ft/sec^2

L = length of weir = 70 feet

n = number of contractions = 12 (2 per bay * 6 bays)

H_1 = total head on weir = 722.0 – 717.46 = 4.54 feet

H_2 = head above top of flow area = 722.0 – 721.67 = 0.33 feet

$Q = (2/3) * (0.62) * (2 * 32.2)^{1/2} * (70 – 0.1 * 12 * 4.54) * [(4.54)^{1.5} – (0.33)^{1.5}] = 2,030$ CFS

Flow over the overflow spillway will still be governed by the broad crested weir equation. However, now the total length is 122 feet, the total flow height is 2.4 feet and the total area is 230 square feet. Use a length of 100 feet and a height of 2.3 feet:

$Q = 0.385 * (1.0) * (2 * 32.2)^{1/2} * (100) * (2.3)^{1.5} = 1,078$ CFS

Total flow at elevation 722.0 = 2,030 + 1, 078 = 3,108 CFS

Point 4 – Water Surface Elevation at 722.5 (top of emergency spillway)

Flow through the principle spillway from the rectangular formula:

$Q = (2/3) * (0.62) * (2 * 32.2)^{1/2} * (70 – 0.1 * 12 * 5.04) * [(5.04)^{1.5} – (0.83)^{1.5}] = 2,240$ CFS

Flow over the principal spillway walkway is also modeled as a broad crested weir with no contraction:

$Q = 0.385 * (1.0) * (2 * 32.2)^{1/2} * (110) * (722.5 – 722.0)^{1.5} = 120$ CFS

Flow over the overflow spillway will still be governed by the broad crested weir equation. However, now the total length is 130 feet, the total flow height is 2.9 feet and the total area is 293 square feet. Use a length of 105 feet and a height of 2.7 feet:

$Q = 0.385 * (1.0) * (2 * 32.2)^{1/2} * (105) * (2.7)^{1.5} = 1,439$ CFS

Total flow at elevation 722.5 = 2,240 + 120 + 1,439 = 3,799 CFS

Point 5 – Water Surface Elevation at 723.0 (just prior to backwater topping Division Street)

Flow through the principle spillway from the rectangular formula:

$Q = (2/3) * (0.62) * (2 * 32.2)^{1/2} * (70 – 0.1 * 12 * 5.54) * [(5.54)^{1.5} – (1.33)^{1.5}] = 2,418$ CFS

Flow over the principal spillway walkway:

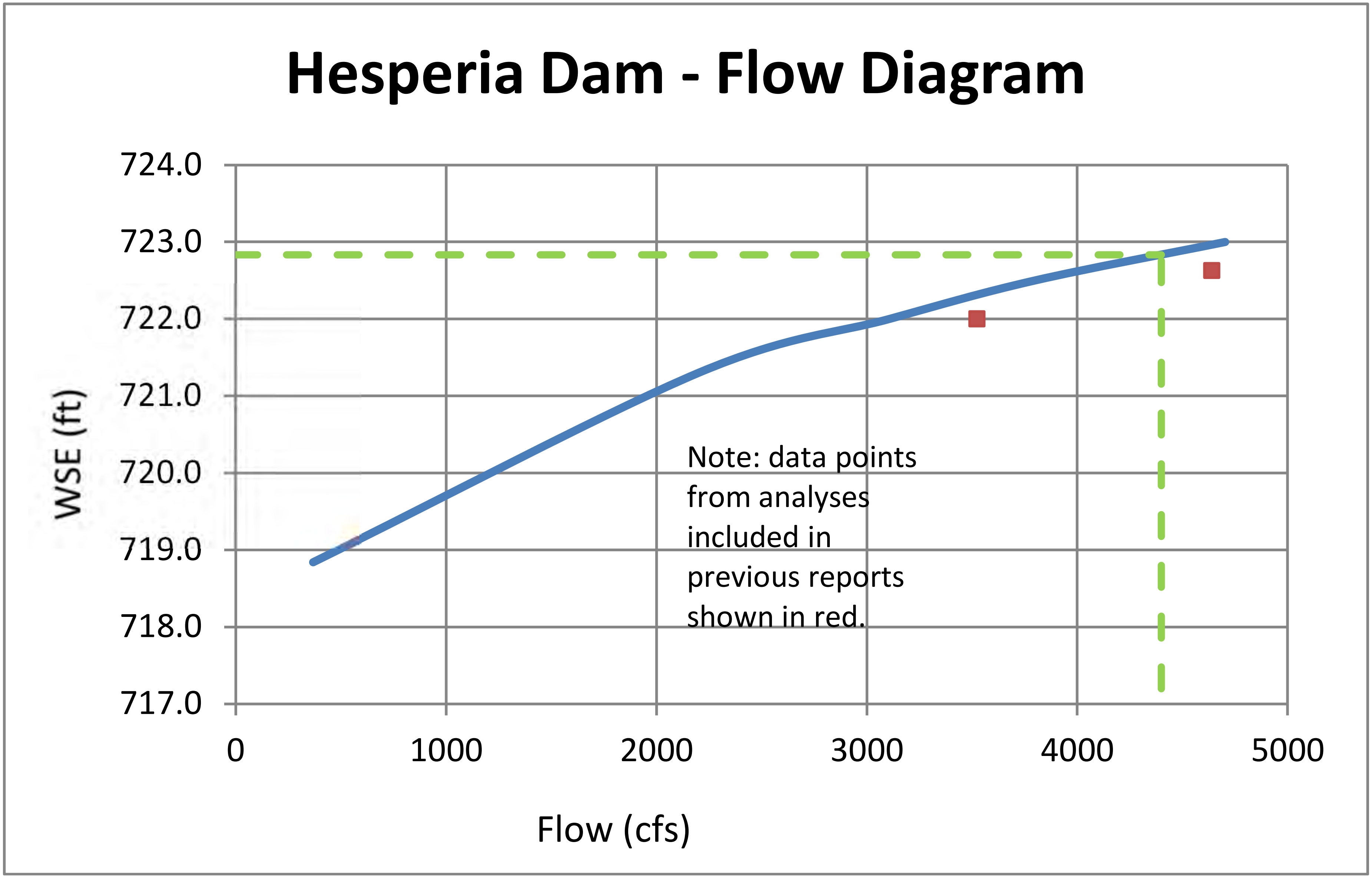
$Q = 0.385 * (1.0) * (2 * 32.2)^{1/2} * (110) * (723.0 – 722.0)^{1.5} = 340$ CFS

Flow over the overflow spillway will still be governed by the broad crested weir equation. However, now the total length is 130 feet, the total flow height is 3.4 feet and the total area is 358 square feet. Use a length of 110 feet and a height of 3.2 feet:

$Q = 0.385 * (1.0) * (2 * 32.2)^{1/2} * (110) * (3.2)^{1.5} = 1,945$ CFS

Total flow at elevation 723.0 = 2,418 + 340 + 1,945 = 4,703 CFS

Note: The stoplog elevation appears to have increased between 2017 and 2021. The analysis above assumes that stoplogs are not removed during a major flood event. Removing stoplogs is recommended to maintain additional freeboard.


Hesperia Dam - Flow Diagram
724.0
723.0
722.0
721.0
720.0
719.0
718.0
717.0
WSE (ft)
0
1000
2000
3000
4000
5000
Flow (cfs)
Note: data points from analyses included in previous reports shown in red.

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Hesperia Flood Threat Passes

By United Press International

The record-setting Labor Day weekend rains are over — too late for thousands of dispirited vactioners, but just in time for dozens of families along the swollen White River in Hesperia.

At least 50 homes in the Oceana County community were threatened after more than six inches of rain fell in a 24-hour period. The downpour cracked and weakened the 100-foot-wide concrete Hesperia dam as volunteers worked feverishly with 10,000 sandbags to prevent the dam from bursting.

At one point as many as 500 persons were evacuated from their homes along the river during the weekend as it pushed five feet above its normal 10-foot depth.

The water level dropped about two feet Monday and authorities said late Monday the danger finally appeared to be over.

"The roads are open and everything seems to be going just fine," a spokesman for the Oceana County Sheriff's Department said.

The threat against the dam was renewed early Monday when a smaller dam about 10 miles upstream broke, sending more water down to the already soaked Hesperia area.

Authorities estimated total flood damage to roads, bridges, homes and crops so far at about $500,000.

One Oceana County deputy sheriff said the ground at Hesperia felt "just like a wet sponge" — a description that was nearly as appropriate for just about everywhere else in lower Michigan.

The rain began Thursday and didn't let up until late Sunday. Monday was a bit drier, but skies remained forbidding and thousands of vacationers in the northland packed up and went home early.

In Detroit, the National Weather Service said the weekend rainfall boosted the city's accumulation for the month to 7.83 inches — the most for any August since records were first kept in 1872.

Labor Day. . .Whose Working?

Most Seem To Be On Strike

By United Press International

Perhaps it was an appropriate way to finish off Labor Day — to honor the workers of America.

— Firemen were on strike in Berkeley, Calif., and Pipe Bluff, Ark.

— Flight attendants had shut down National Airlines.

— Coal miners were in their fourth week of a crippling walkout.

— Teachers in the nation's three largest cities, New York, Chicago and Los Angeles, were threatening to stay off the job.

— Dockworkers in Louisiana were refusing to load grain on ships bound for Russia.

— Striking drivers had halted bus service in Louisville, Ky.

Union officials in Berkeley predicted its week-old strike could turn into an extended walkout. "Negotiations have completely broken down," said Jack Rinne, president of Fire Fighters Association Local 1227. "We're gearing for a long strike."

Firemen walked off the job in Pine Bluff, Ark., Aug. 13. The strikers were fired, and Gov. David W. Pryor mobilized 30 National Guardsmen to staff the fire stations.

About 1,200 flight attendants grounded National Airlines Monday with its second major strike in less than 10 months. But contract talks resumed a few hours later in Washington, the union announced.

In Charleston, W. Va., the United Mine Workers international union was hit with a $500,000 fine for contempt of court today for failing to get striking members back to work.

Recent Articles from Oceana's Herald Journal

Posted: 7-5-2001

Water Low For Dam, Road Repairs

Repairs to the Hesperia dam and adjacent roadways have caused the water level in the White River above the dam to be extremely low. According to Cherokee Thompson, supervisor of the Hesperia Department of Public Works, the work on the dam and roadway was planned in advance and is proceeding as scheduled.

The dam reconstruction is intended to stop lamprey eels from continuing upstream beyond the dam. According to Denny Lavis, station supervisor for the U.S. Fish and Wildlife Service in Ludington, some repair work was done on the dam as recently as three years ago, but the dam had begun to deteriorate again.

'When we heard that they (the Village of Hesperia) were going to draw down the river anyway for the road repair project, we decided that it would be a good time to fix the dam,' Lavis said. 'We have just completed an expensive lampricide (killing lampreys with chemicals) program on the upper portion of the White, between White Cloud and Hesperia. It is a lot cheaper to control the lampreys with a barrier than with lampricides,' Lavis added.

The lampreys were getting through the dam because some of the boards at water level were not sealed tightly. The repair work consists of patching concrete and replacing some boards. The Fish and Wildlife Service is reimbursing the Village of Hesperia for all of the dam repair.

In addition to the dam repair, the village has contracted with Adams Trucking and Excavating of Pentwater to repair sections of Division Street and the bridge off Division Street to a small island in the river. 'The water above the dam has changed course in recent years and has been wearing away at the roadbed,' Thompson said.

The work on the dam was started last Friday, and Thompson anticipates that the entire project will be completed within about two weeks.

Posted: 5-12-2004

Dam holds

Heavy weekend rains had officials keeping a watchful eye on the White River dam at Hesperia Sunday as water levels reached the "critical" stage.

"I think the most danger was the sight seekers taking a look at it. If someone would have fallen in we would have had a real problem on our hands," Hesperia Police Chief Dale Gibbs said.

According to Oceana County Emergency Preparedness Director Ken Mendenhall, water behind the dam rose to approximately 11 feet, prompting him to issue a "river watch" for people down stream. No one was evacuated. Water rose to approximately 2 feet below the new Division Street bridge.

"Normally, I think there's about 9 feet of water behind the dam," Mendenhall said.
Mendenhall contacted central dispatch at 5:20 p.m. Sunday, and the National Weather Service issued the watch at 5:35 p.m.

"All we could really do is get the word out that there could be a big rush of water, but thankfully that didn't come close to happening," Gibbs said. "We had officers there all night monitoring the system because of the high levels."

Gibbs estimated 4-6 inches of rain fell in the Hesperia area. The Michigan State Police Post in Hart recorded 4.2 inches of rain over the weekend.

"It's the highest level I've seen in five years," Gibbs said. "It could have put a real strain on things downstream."

"All we issued was a river watch so people would become aware what was happening," Mendenhall said.

A spillway built to the dam's north in 1986 was credited for functioning properly and keeping water moving around the dam.

"Rather than it breaking again they developed this system," Gibbs said. "This was the first real test, and it passed pretty good."

"That rebuild on the dam in '86, that spillway they put on it, it worked just fine," Mendenhall said. "I guess this is the first time since they put it in it was truly tested and it seemed to function quite well."
Because of flooded roads, Mendenhall went into his office at 4 a.m. Saturday. He said M-120 between Wilke and Roosevelt was closed because of flooding, and 200th and 192nd avenues between McKinley and Roosevelt roads were temporarily closed.

The heavy rains took their toll on other Oceana County roads. According to road commission Manager John Foss, the county's southeast quadrant was the hardest hit. Foss said the road commission didn't lose any roads, but had water running over roads in some areas and had some road edge washouts.
"Huge problems," Foss said. "Actually more than we've had in the past. We had a lot of washouts. We probably won't get things back in square until the end of the week. We didn't have that much culvert damage like I understand they did over in Newaygo."

While crews make repairs, regular road construction projects will be put on hold.

"We can handle some rain, but if there's no more damage we should get it cleaned up by the end of the week," Foss said.

"Fortunately, everything turned out OK and it's (the dam) still stable," Mendenhall said. "I just hope Mother Nature behaves herself the next couple days."

Scattered and isolated thunderstorms were forecast through Friday.

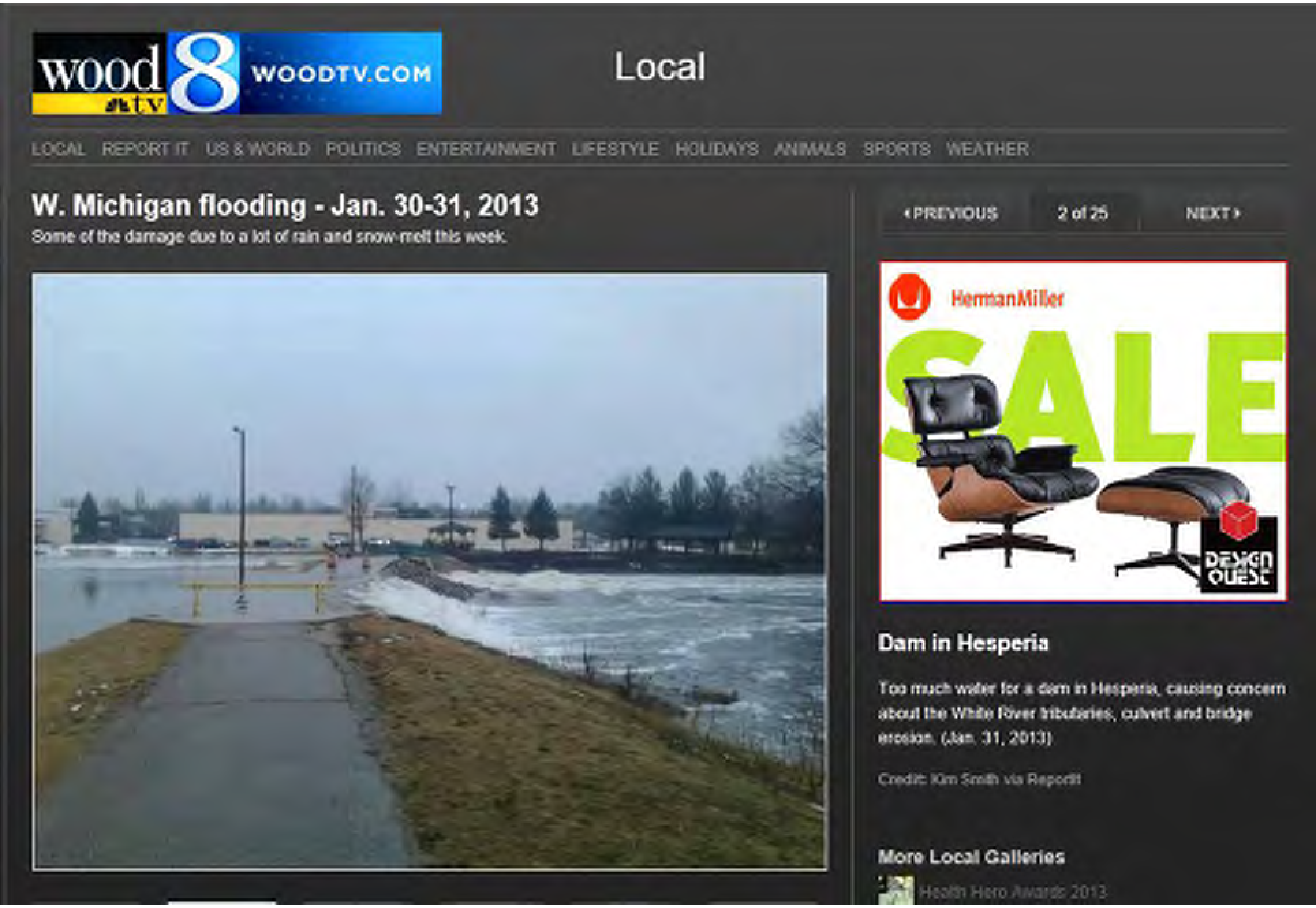
Hesperia Police, Michigan State Police, Hesperia Area Fire Department, Hesperia Department of Public Works, and Oceana County Undersheriff Robert Farber were at the scene.

Posted: 3-4-2009

Hesperia crews break up dam jam

A potential washout at the White River dam in Hesperia was averted last Saturday morning after Hesperia Department of Public Works personnel broke up a slush jam.

Oceana County Sheriff’s Department Lt. Craig Mast said he was contacted at approximately 6 a.m. about rising water possibly going over the embankment, creating a washout, but work crews broke up the jam with a backhoe and shovels. He said the water was a couple of inches from the top.



W. Michigan flooding - Jan. 30-31, 2013

Some of the damage due to a lot of rain and snow-melt this week.

Dam in Hesperia

Too much water for a dam in Hesperia, causing concern about the White River tributaries, culvert and bridge erosion. (Jan. 31, 2013)

Credit: Kim Smith via ReportIt

More Local Galleries

Health Hero Awards 2013

Dam closed Flooding update on White River in Hesperia Michigan

769 views • Feb 20, 2018

BASF
The Chemical Company

Technical Data Guide

3 | 03 64 23
Epoxy
Injection Grouting

Masterflow® 647R Repair Grout

Liquid epoxy grout for pressure or gravity application

PACKAGING
Masterflow 647R is available as a 2.5 gallon (9.43 liter) unit:

Part A 1.5 gallons (5.66 liters) in a 3.5 gallon steel pail.
Part B 1.0 gallon (3.77 liters) in a 1 gallon steel can.

YIELD
2.5 gallons yields 575 in^3 (0.33ft^3 or 0.009m^3) of mixed product

When estimating project requirements, be sure to account for application variables.

STORAGE
Store in unopened containers at temperatures at or below 80º F (27º C). Freezing temperatures during storage will not harm the product. However, the components should be conditioned to temperatures between 70º and 80º F (21º – 27º C) prior to use.

SHELF LIFE
2 years (for both part A and part B) when properly stored

RELATED DOCUMENTS
- Masterflow 647R Installation Guide
- Masterflow 647R MSDS

DESCRIPTION
Masterflow 647R grout is a two component, modified epoxy resin-based grout. It is specially formulated for grouting cracks in structures and machinery foundations. It may be applied using either pressure injection or gravity feed. The material will penetrate and fill voids cracks, and fissures. Masterflow 647R exhibits excellent adhesion to concrete or steel that is properly prepared whether wet, dry or oil-contaminated concrete. It can be used to repair cracks in concrete that contain water. (Not for use in underwater repair)

PRODUCT HIGHLIGHTS
- Structural grade epoxy and can be used under sustained loads
- Moisture tolerant helping it bond to damp concrete
- Oil tolerant allows bonding to oil-contaminated concrete
- Chemical resistant for use in a wide range of application environments
- Liquid resin can be stored at low temperature (20 °F) making it easy to transport and store
- Low viscosity helps to penetrate fine cracks
- Solvent-free; VOC compliant
- Fast cure rate for rapid return to service
- Simple mix ratio for ease of use in the field
- Can be extended for wide range of options for crack repair and void filling
- Accelerator available for increased usage capabilities at low temperatures

APPLICATIONS
- Pressure injection of grouted baseplates beneath compressors, cement mills and other vibrating and rotating machinery
- Thin bed repair grout applications
- Concrete wall repair
- Repair of cracked concrete
- Precast pile bonding
- Bonding post-tensioned beams

BASF Corporation
Building Systems
buildingsystems.basf.com

Technical Data

Composition

Masterflow 647R is a two-component, modified epoxy resin-based grout.

Compliances

- ASTM C881, Type I, II and IV, Grade 1 and 2.

Test Data

Time (hrs)	**55°F** psi	**(13°C)** Mpa	**75°F** psi	**(24°)** Mpa	**90°F** psi	**32 °C** Mpa
Compressive Strength Cure Rate						
8	-	-	800	6	1,100	8
16	-	-	3000	23	7100	49
24	500	3	4900	34	7800	54
48	5300	37	7800	54	9800	68
72	6400	44	9700	67		
96	8800	61				
120	9800	68				
144	10500	72				

Physical Properties

PROPERTY	RESULTS	TEST METHOD
Compressive Strength	10,000 psi (70 MPa)	ASTM C 579
Flexural Properties		ASTM D 790
Strength	9,800 psi (68 MPa)	
Elongation	4.7%	
Coefficient of Thermal Expansion		ASTM C 531
33° to 74°F in/in °F (0.6 to 23 °C cm/cm °C)	46 x 10^{-6} (83 x 10^{-6})	
74° to 110 °F (23 ° to 43 °C)	47 x 10^{-6} (85 x 10^{-6})	
Density	68.7lbs./ft^3 (1100kg/m^3)	ASTM C 905
Water Absorption	+0.4%	ASTM C 413
Flash Point (Pensky-Martens Closed Cup)		
Resin	230 ˚F (110 ˚C)	
Hardener	230 ˚F (110 ˚C)	

HOW TO APPLY

Consult the MasterFlow 647R Repair Grout Installation Guide. BASF recommends that the user request the services of the local representative for a pre-job conference to plan the installation.

FOR BEST PERFORMANCE

- Application temperature range is from 50 to 105˚ F (10 to 41˚ C). Please note that above 90º F (32º C), working time will be significantly reduced.
- Neat epoxy binder should not be applied greater than 1/4" (6 mm) in thickness. If greater thickness is required, contact BASF Technical Service.
- Bonding to a damp or oily surface is possible but less desirable than bonding to a dry, oil-free surface. When applying this product to a damp surface, remove free water by oil-free airblast. Excess oils should be removed using absorbent materials or solvent cleaning.
- Precondition all components to 70 to 80ºF (21 to 27ºC) for 24 hours before using.
- Proper application is the best responsibility of the user. Field visits by BASF personnel are for the purpose of making technical recommendations only and not supervising or providing quality control on the jobsite
- Do not add solvents, thinners or water to epoxy components.

HEALTH, SAFETY AND ENVIRONMENTAL

Read, understand and follow all Material Safety Data Sheets and product label information for this product prior to use. The MSDS can be obtained by visiting buildingsystems.basf.com, e-mailing your request to basfbscst@basf.com or calling 1(800)433-9517. Use only as directed. **For medical emergencies only, call ChemTrec® at 1(800) 424-9300.**

BASF Corporation
Building Systems

889 Valley Park Drive
Shakopee, Minnesota 55379
www.BuildingSystems.BASF.com

Customer Service 1(800) 433-9517
Technical Service 1(800) 243-6739

BASF Construction Chemicals, LLC
Registered to ISO 9001:2000
Certificate No. A14263

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Product Data Sheet
Edition 4.2005
Identification no.
Sikaflex Concrete Fix

Construction

Sikaflex® Concrete Fix

One-component, polyurethane sealant

Description

Sikaflex Concrete Fix is a moisture-cured, 1-component, polyurethane-based, non-sag elastomeric sealant. Meets Federal specification TT-S-00230C, Type II. Meets ASTM C-920, Type S, Grade NS.

Where to Use

- Designed for all types of joints and cracks where maximum depth of sealant will not exceed ½ in.
- Suitable for vertical and horizontal joints; readily placeable at 40°F (4°C).
- Has many applications as an elastic sealant between materials with dissimilar coefficients of expansion.
- Ideal for:
  - Weatherproofing of joints,cracks and gaps in concrete, brickwork, blockwork, masonry, stucco and metal frames.
  - Joints in walls, floors, balconies, around window or door frames.
  - Expansion joints.
  - Roofing.

Advantages

- High elasticity – cures to a tough, durable, flexible consistency with exceptional cut and tear-resistance.
- Stress relaxation.
- Excellent adhesion – bonds to most construction materials without a primer.
- Excellent resistance to aging, weathering.
- Non-staining.
- Urethane-based; suggested by EPA for radon reduction.
- Paintable with water-, oil- and rubber-based paints.
- Capable of ±25% joint movement.

Coverage

10.1 fl. oz. cartridge seals 12.2 lineal ft. of ½ x ¼ in. joint.

Packaging

Disposable 10.1 fl. oz., moisture-proof composite cartridges, 12/case.

Typical Data *(Material and curing conditions @ 73°F (23°C) and 50% R.H.)*

Shelf Life	12 months
Storage Conditions	Store at 40°-95°F (4°-35°C). **Condition material to 65°-75°F (18°-24°C) before using.**
Colors	Limestone
Application Temperature	40° to 100°F (4°-38°C) . Sealant should be installed when joint is at midrange of its anticipated movement.
Service Range	-40° to 170°F (-40°-77°C)
Curing Rate	Tack-free time: Meets ASTM C-920 Final cure: 7 days
Shore A Hardness	Meets ASTM C-920
Adhesion in Peel (ASTM C 794)	Concrete: Meets ASTM C-920 Aluminum: Meets ASTM C-920 Glass: Meets ASTM C-920
Weathering Resistance	Excellent
Chemical Resistance	Good resistance to water, diluted acids, and diluted alkalines. Consult Technical Service for specific data.

How to Use

Surface Preparation

Clean all surfaces. Joint walls must be sound, clean, dry, frost-free, and free of oil and grease and any other contaminants. Install bond breaker tape or backer rod to prevent bond at base of joint.

Priming

Priming is not usually necessary. Most substrates only require priming if testing indicates a need or where sealant will be subjected to water immersion after cure.

Consult Sikaflex Primer Technical Data Sheet or Technical Service for additional information on priming.

Application

Recommended application temperatures: 40°-100°F (4°-38°C). For cold weather application, condition units at approximately 70°F (21°C); remove prior to using.

For best performance, Sikaflex Concrete Fix should be gunned into joint when joint slot is at mid-point of its designed expansion and contraction.

Place nozzle of gun into bottom of the joint and fill entire joint. Keep the nozzle in the sealant, continue on with a steady flow of sealant preceding the nozzle to avoid air entrapment.

Avoid overlapping of sealant to eliminate entrapment of air. Tool as required. Joint dimension should allow for ¼ inch minimum and ½ inch maximum thickness for sealant. Proper design is 2:1 width to depth ratio.

For use in horizontal joints in traffic areas, the absolute minimum depth of the sealant is ½ in. and closed cell backer rod is recommended. Tool as necessary, dry or with clean water.

Limitations

- Allow 1-week cure at standard conditions when using Sikaflex Construction Sealant in total water immersion situations and prior to painting.
- When over-coating with water, oil and rubber based paints, compatibility and adhesion testing is essential.
- Avoid exposure to high levels of chlorine. (Maximum continuous level is 5ppm of chlorine.)
- Maximum depth of sealant must not exceed ½ in.; minimum depth is ¼ in.
- Maximum expansion and contraction should not exceed 25% of average joint width.
- Do not cure in the presence of curing silicone sealants.
- Avoid contact with alcohol and other solvent cleaners during cure.
- Do not apply when moisture-vapor-transmission condition exists from the substrate as this can cause bubbling within the sealant.
- Use opened cartridges the same day.
- When applying sealant, avoid air-entrapment.
- Since system is moisture-cured, permit sufficient exposure to air.
- The ultimate performance of Sikaflex Concrete Fix depends on good joint design and proper application with joint surfaces properly prepared.
- The depth of sealant in horizontal joints subject to traffic is ½ in.
- Do not tool with detergent or soap solutions.

Caution

Irritant

Contains xylene; avoid breathing vapors. Use with adequate ventilation.

Avoid skin and eye contact. Use of NIOSH/MSHA approved organic vapor respirator, safety goggles, and chemical-resistant gloves recommended. Remove contaminated clothing and shoes.

First Aid

In case of skin contact, wash thoroughly with soap and water. For eye contact, flush immediately with plenty of water for at least 15 minutes; contact physician. Wash clothing before re-use. Discard contaminated shoes.

Clean Up

Uncured material can be removed with approved solvent. Cured material can only be removed mechanically. For spillage, collect, absorb, and dispose of in accordance with current, applicable local, state, and federal regulations.

KEEP CONTAINER TIGHTLY CLOSED • KEEP OUT OF REACH OF CHILDREN • NOT FOR INTERNAL CONSUMPTION • FOR INDUSTRIAL USE ONLY

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Fax: 514-694-2792

Sika Mexicana S.A. de C.V.
Carretera Libre Celaya Km. 8.5
Fracc. Industrial Balvanera
Corregidora, Queretaro
C.P. 76920
Phone: 52 442 2385800
Fax: 52 442 2250537

ISO 9001:2000

Responsible Care
Good Chemistry at Work

A.2. Historic Documents

Repair Notes:

All rubble walls shall be tuck pointed with cement mortar mix.

Loose mortar shall be removed before tuck pointing.

Areas of the structure that have been undercut, such as the base of the walls of Bay 6, shall have all loose concrete removed before being repaired.

Patching material shall comply with M.D.O.T. Specification 7:03b. TYPE S-F OR S-FHE

Remove fish ladder and transport rubble to a location to be specified by the Village.

After removal of structure, place a 10 inch concrete wall against rubble and concrete wall the full length of the NORTH abutment.

Reinforce with #3 bars 18 inches O.C.

After construction of wall, rebuild dam as shown in the Dam Repair section.

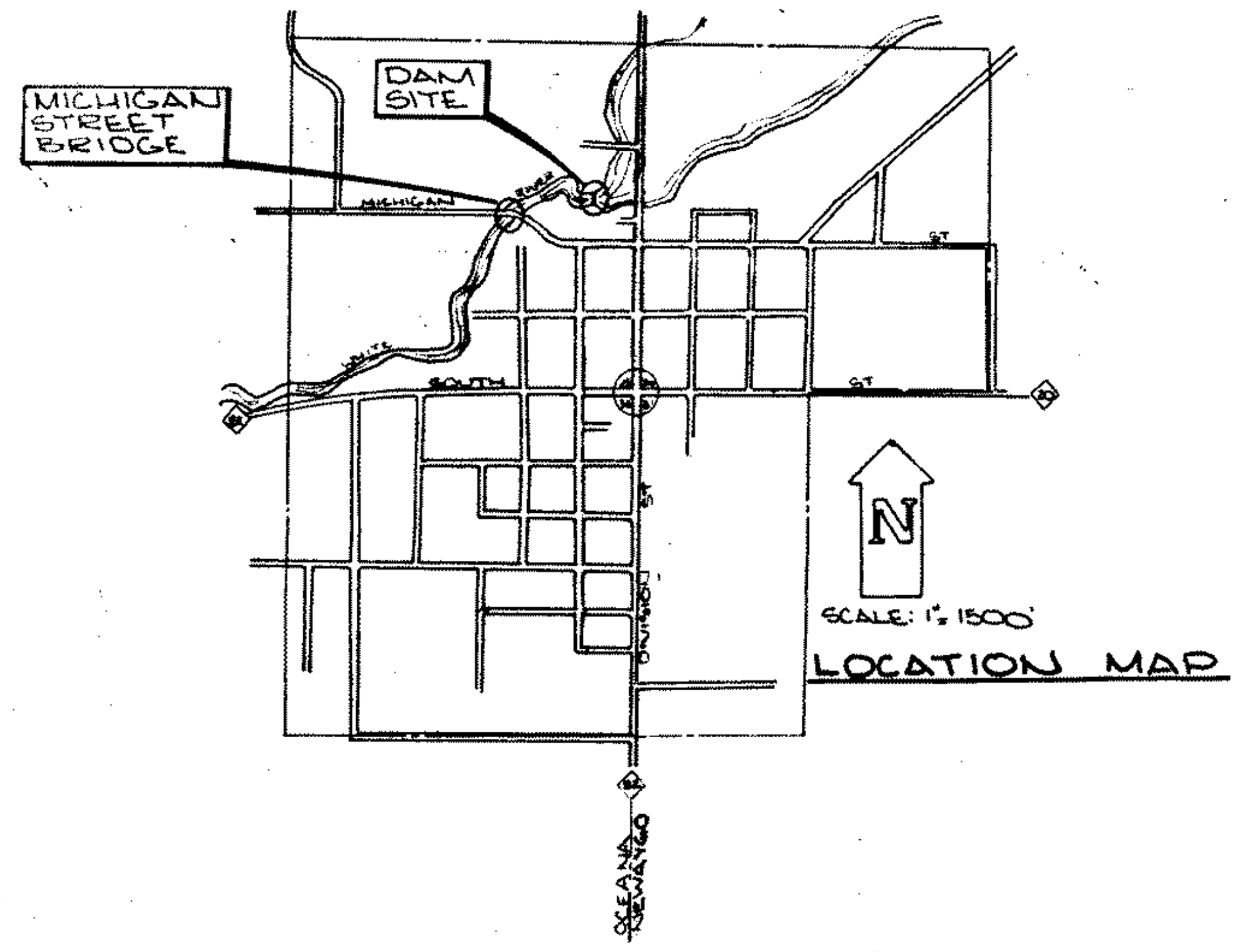
During removal of the stop logs, care shall be taken so that sediment is not released downstream.

The Village will be responsible for lowering the reservoir.

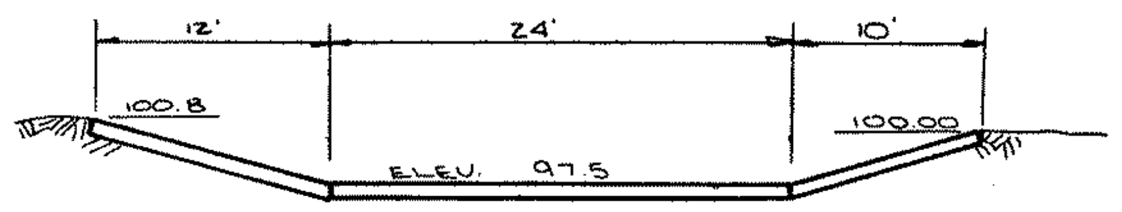
APPROXIMATE QUANTITIES: 22 Cubic Yards Concrete, 190 Cubic Yards Fill, 245 Cubic Yards Excavation and 195 Square Yards Grouted Rip-Rap.

VILLAGE OF HESPERIA

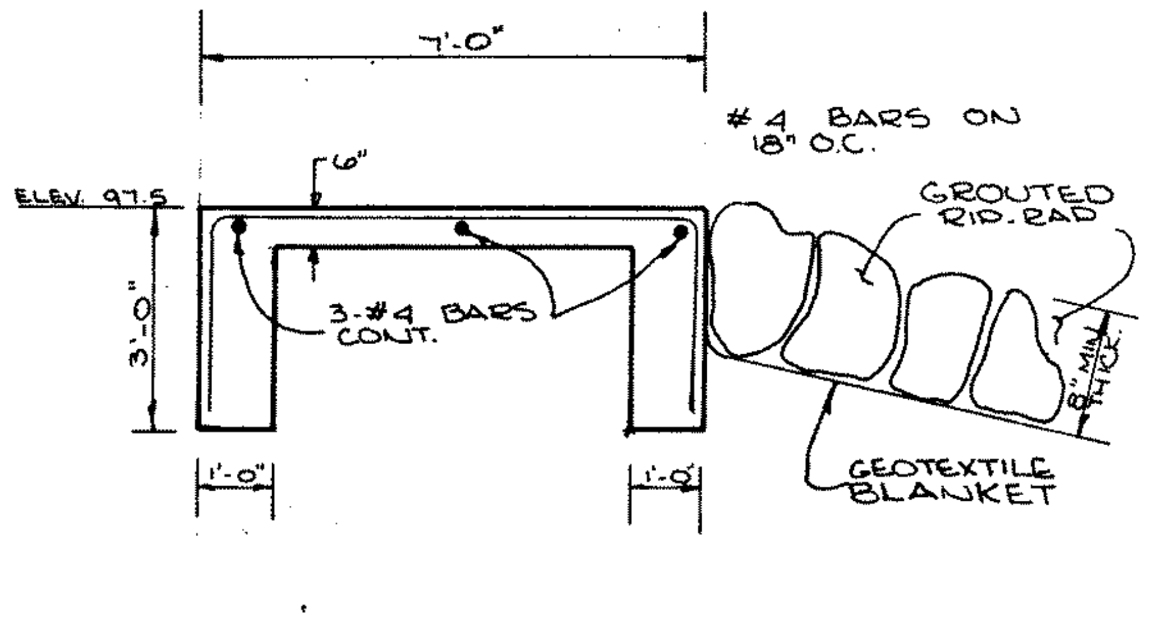
REPAIRS TO DAM ON WHITE RIVER



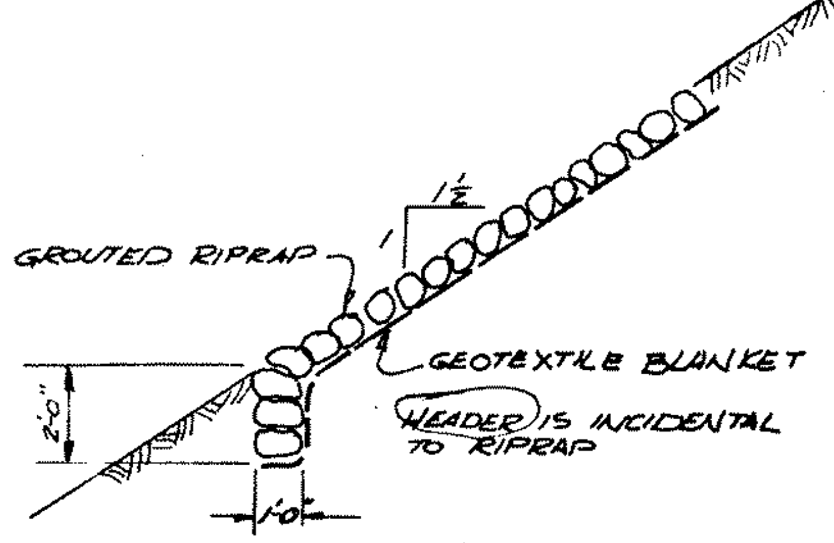
LOCATION MAP



DETAIL B-B



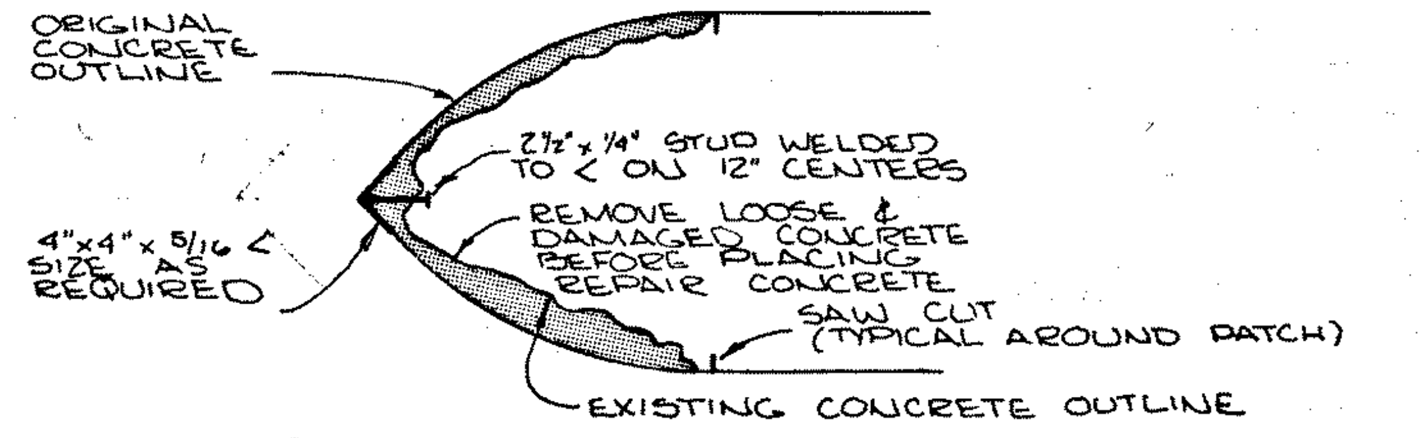
DETAIL C-C



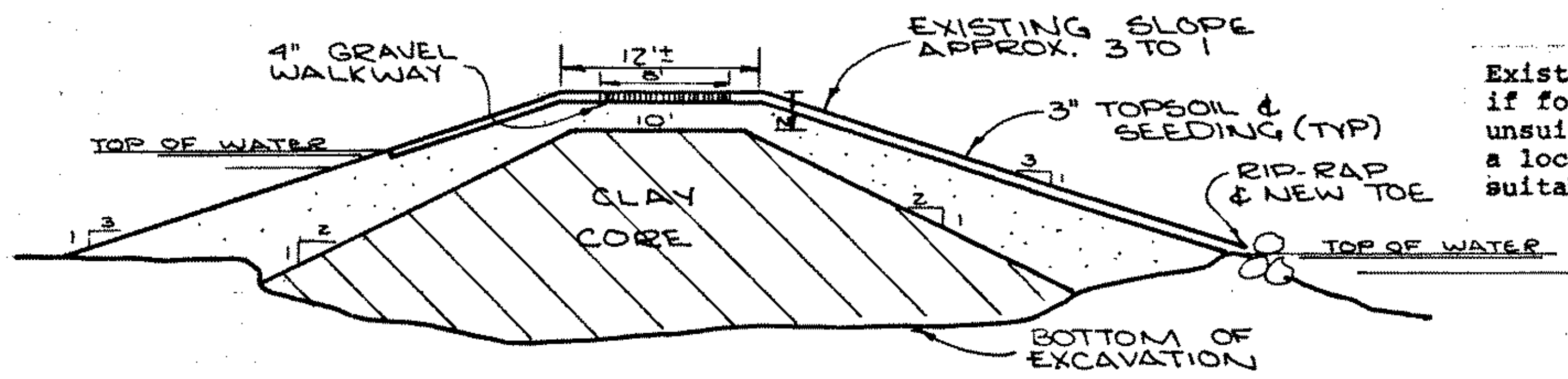
RIPRAP DETAIL

The Contractor shall repair the upstream and downstream corners of the Michigan Street Bridge center pier.

The length of the angle will extend from the soffit of the pier cap to the point where the concrete is no longer damaged. The pier cap will be repaired at the downstream abutment.

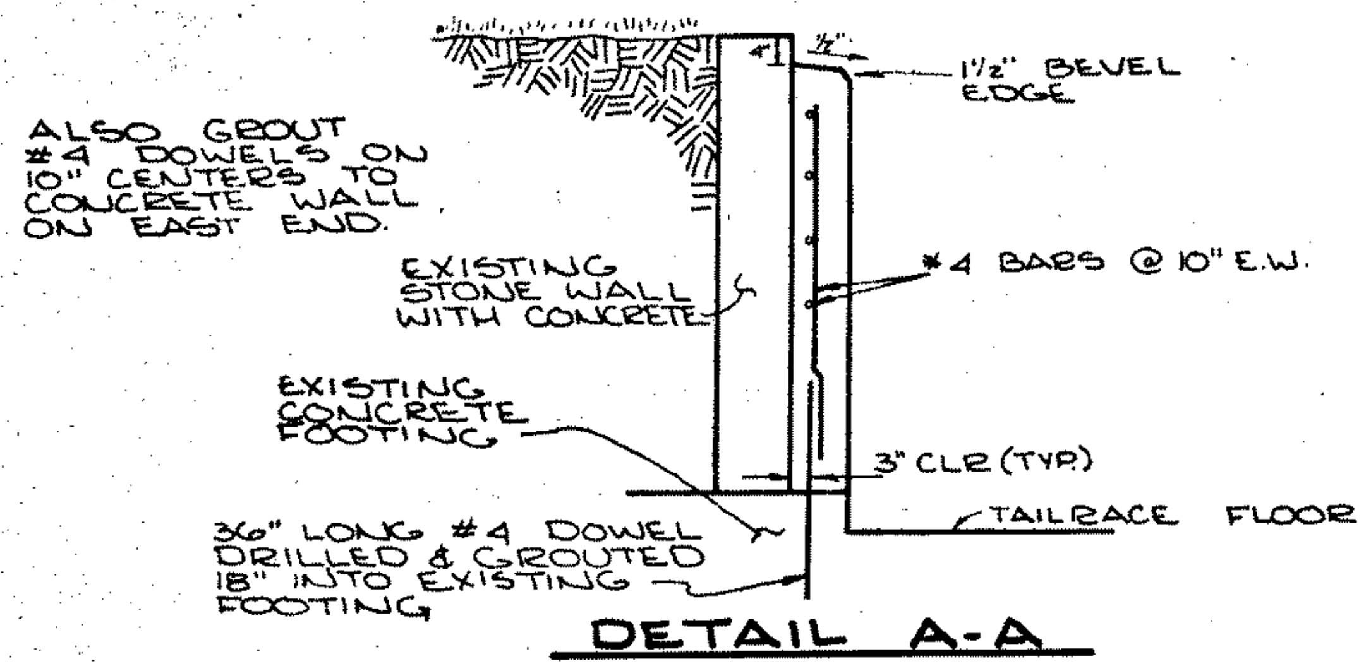


BRIDGE ABUTMENT REPAIR DETAIL

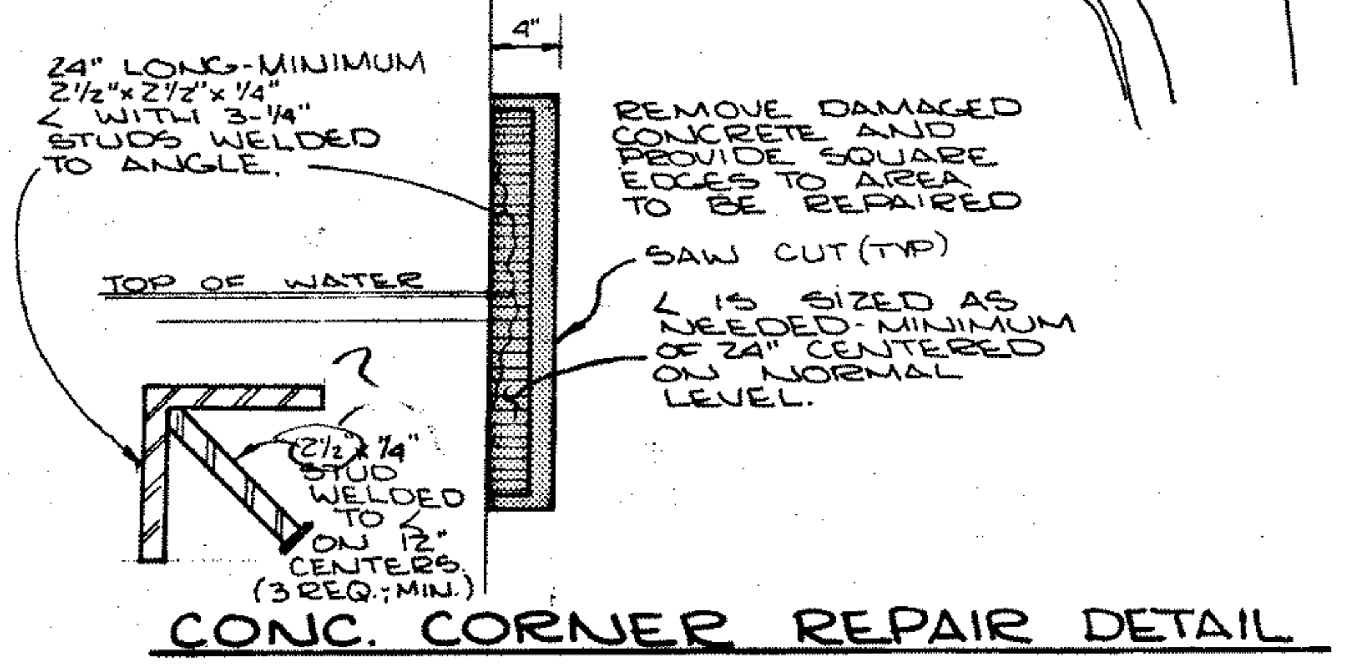


DAM REPAIR SECTION @ NORTH ABUTMENT

Existing excavated materials shall be reused, if found suitable by the Engineer. If found unsuitable, the materials will be moved to a location designated by the Village and suitable material furnished.



DETAIL A-A



CONC. CORNER REPAIR DETAIL

REMOVED TREE STUMPS SHOULD BE CUT FLUSH AND TREATED WITH AN EPA APPROVED HERBICIDE

THE EXISTING DIKE BETWEEN THE RIVER & SWIMMING POND SHALL BE LOWERED TO ELEVATION 98.0 FOR A DISTANCE OF 40' & BROUGHT BACK TO GRADE ON A 1 TO 6 SLOPE. CENTER THE 40' ON THE EXISTING CROSS-OVER PIPE. EXISTING ELEVATION AT PIPE 99.3±

BENCHMARK- 100.00 ON SOUTHEAST CORNER OF BRIDGE.

86-6-341

NO.	DESCRIPTION	DATE	BY

REVISIONS

DAM REPAIRS
NORTH BRANCH WHITE RIVER

NORDLUND, DUNLAP & ASSOCIATES, INC.
LUDINGTON, MICHIGAN

VILLAGE OF HESPERIA

DWN. TG	DATE 6/86	SCALE: 1"= 10'
CKD. JTN	DATE 8/86	SHEET 1 OF 1 REV.

FILE: 241-Z

Notes:

All trees, brush and stumps to be removed from existing embankments.

Two power poles to be relocated to the east side of the concrete spillway.

All material removed from the site will be deposited at an upland site. The village sewage treatment site has land available for this purpose.

LEGEND

000×0 EXISTING ELEVATIONS
- - - - EXISTING
——— PROPOSED

VILLAGE OF HESPERIA
OCEANA COUNTY

NO.	DESCRIPTION	DATE	BY
1	AS-BUILTS	12-88	TG

REVISIONS

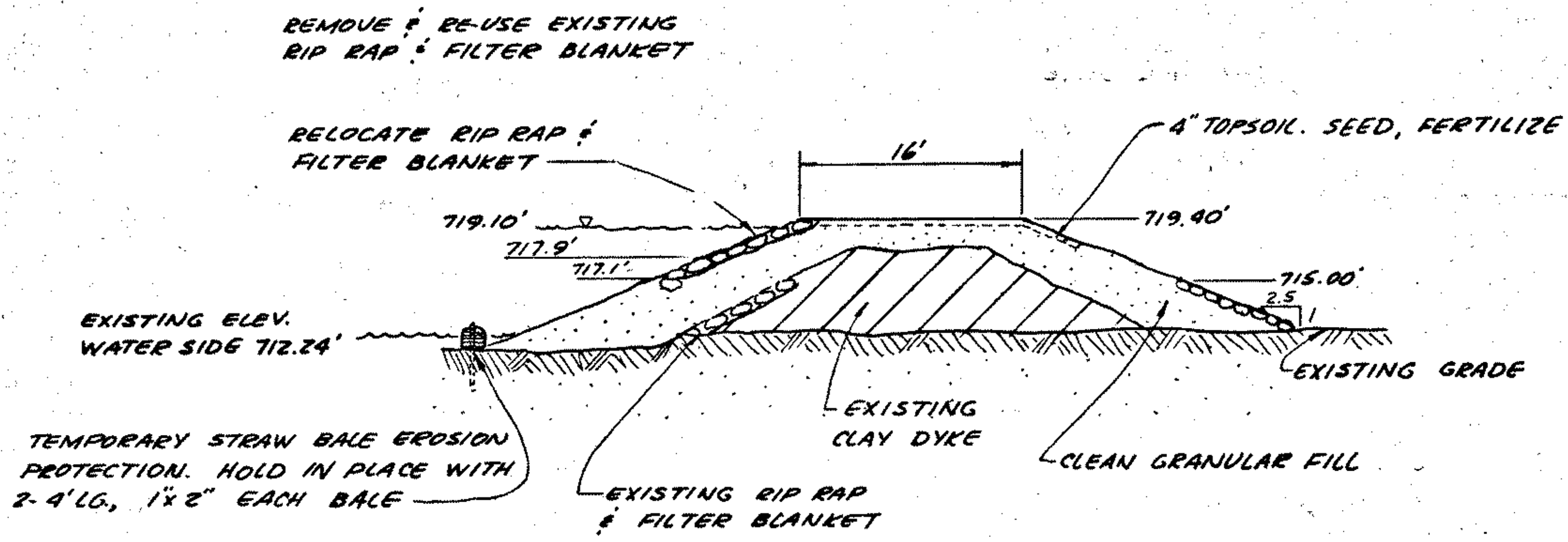
HESPERIA DAM
WHITE RIVER

NORDLUND & ASSOCIATES, INC.
LUDINGTON, MICHIGAN

SITE PLAN

DWN. T.C.B. DATE 3/87 SCALE: 1" = 20'
CKD. DATE SHEET 1 OF 3 REV.

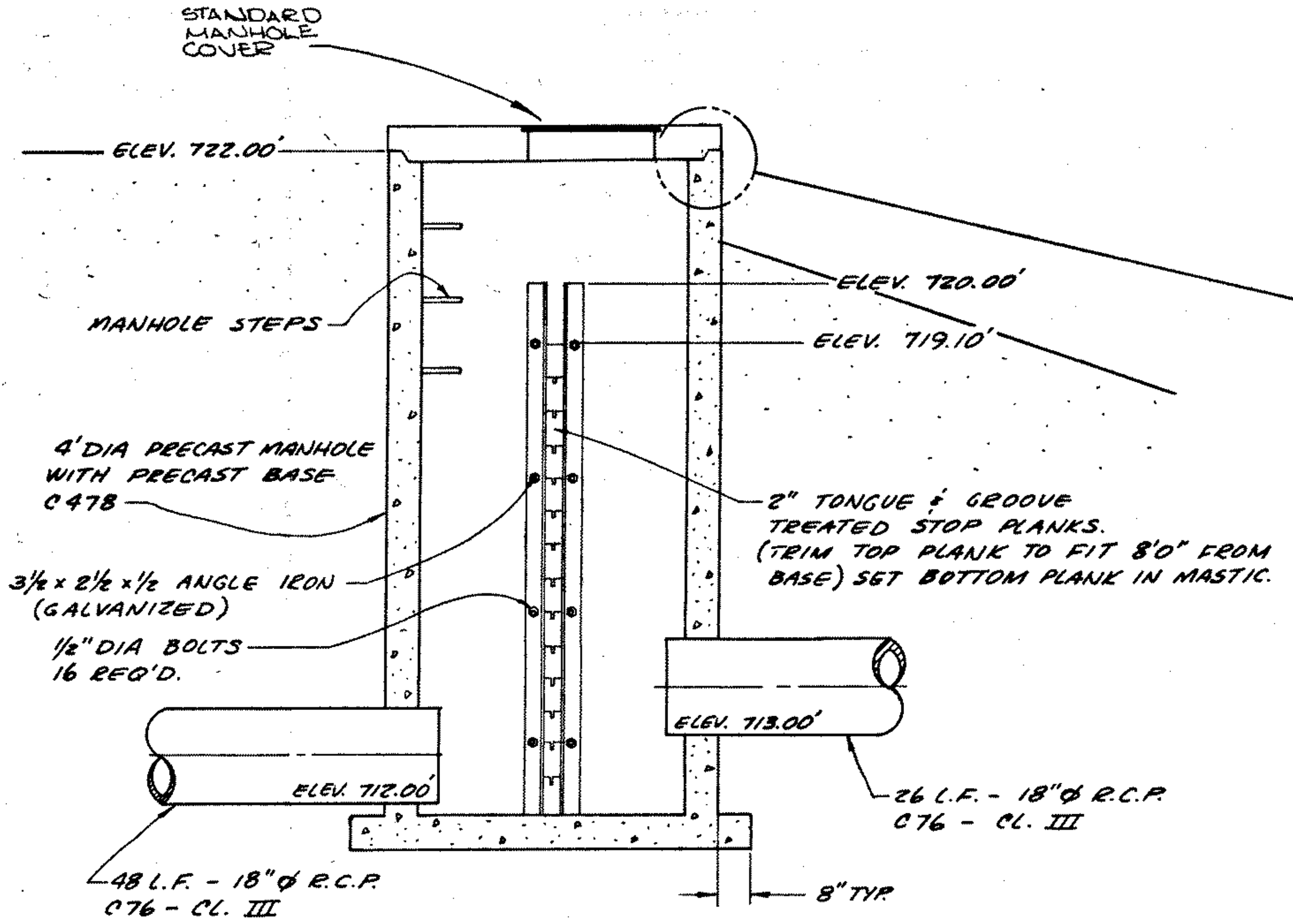
FILE: 241-S



SECTION B-B

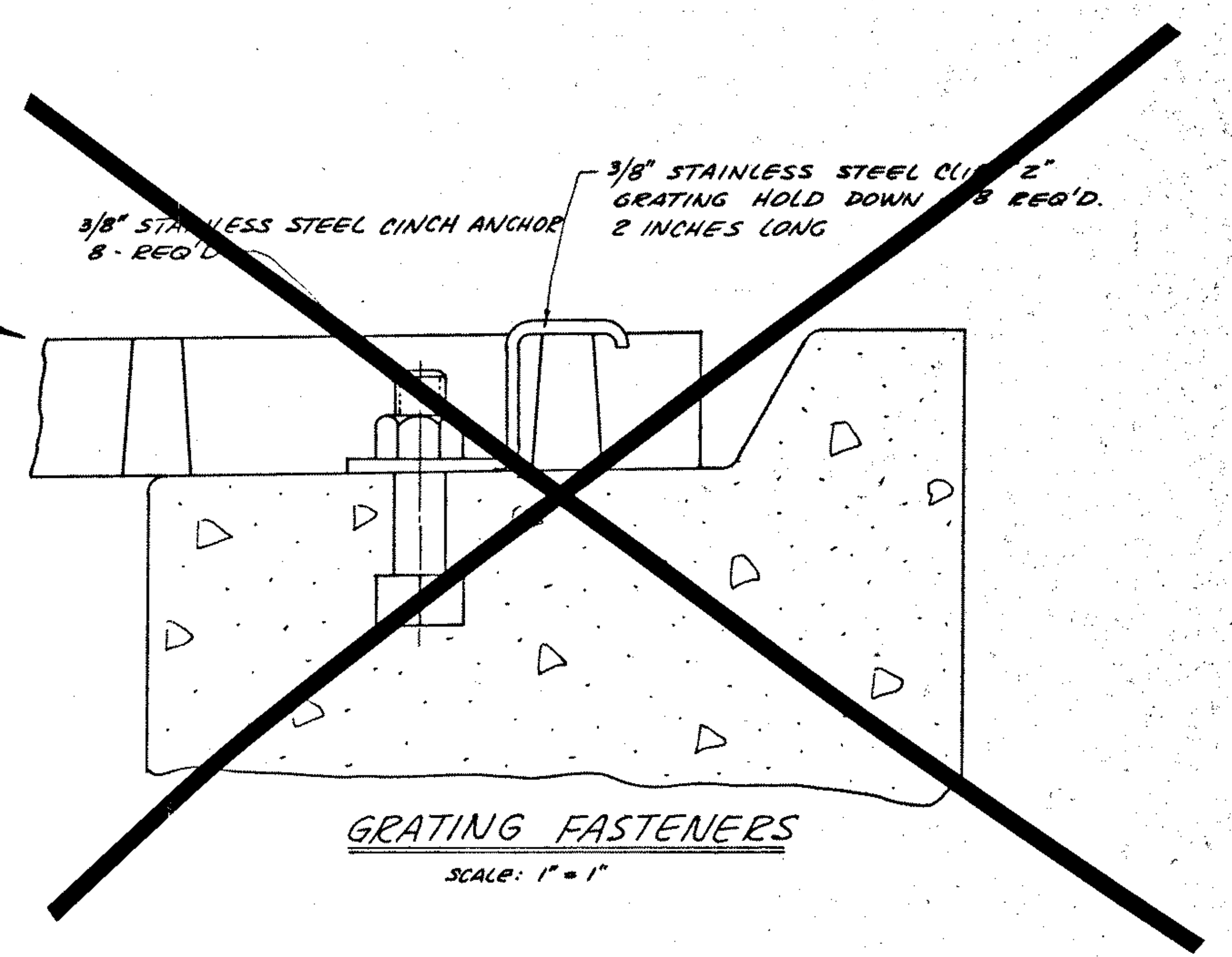
SCALE: 1" = 10'

NOTE:
ALL SLOPES THAT WILL BE EXPOSED FOR MORE THAN 30 DAYS WILL BE SEEDED WITH ANNUAL RYE GRASS & MULCHED.



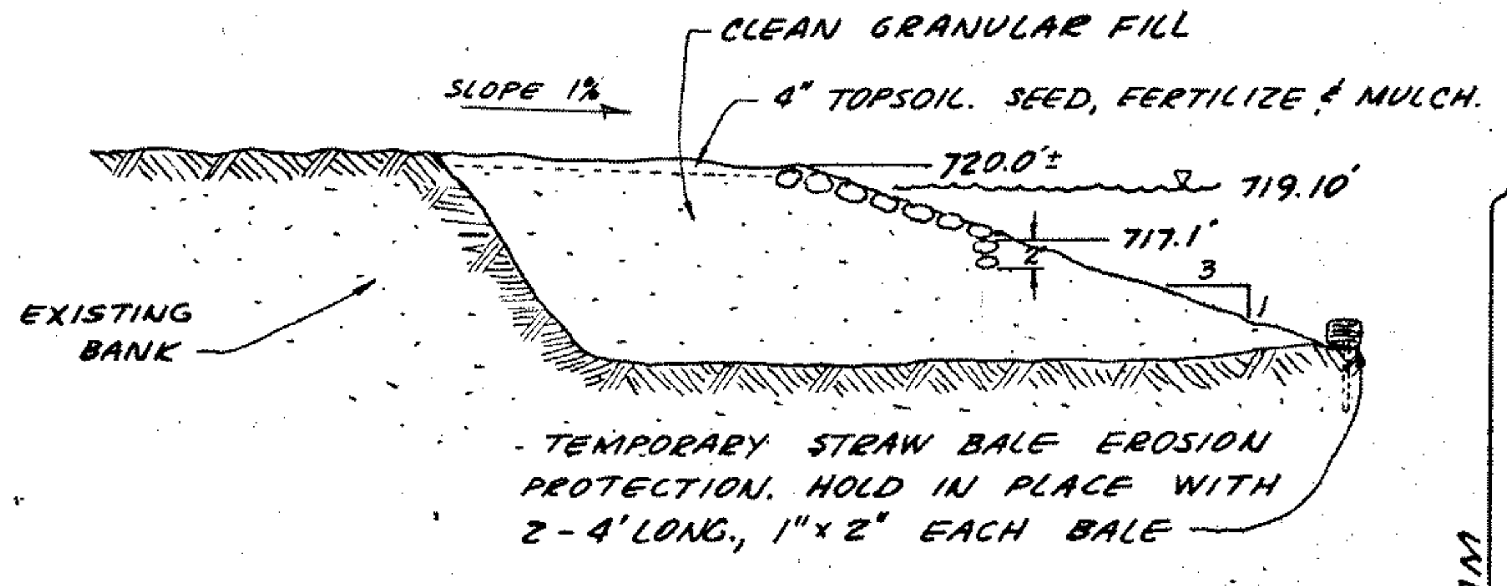
SECTION F-F

SCALE: 1" = 2'0"



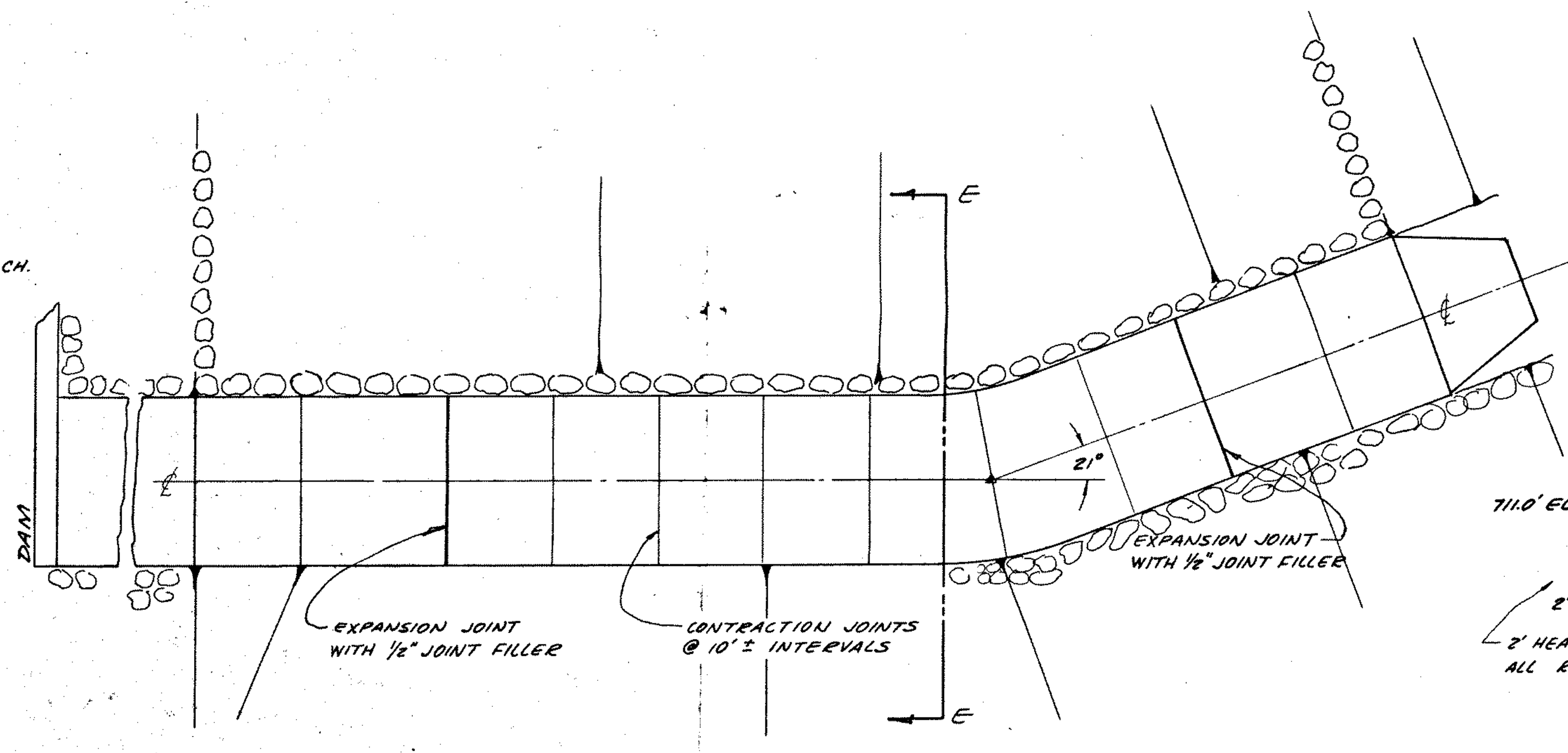
GRATING FASTENERS

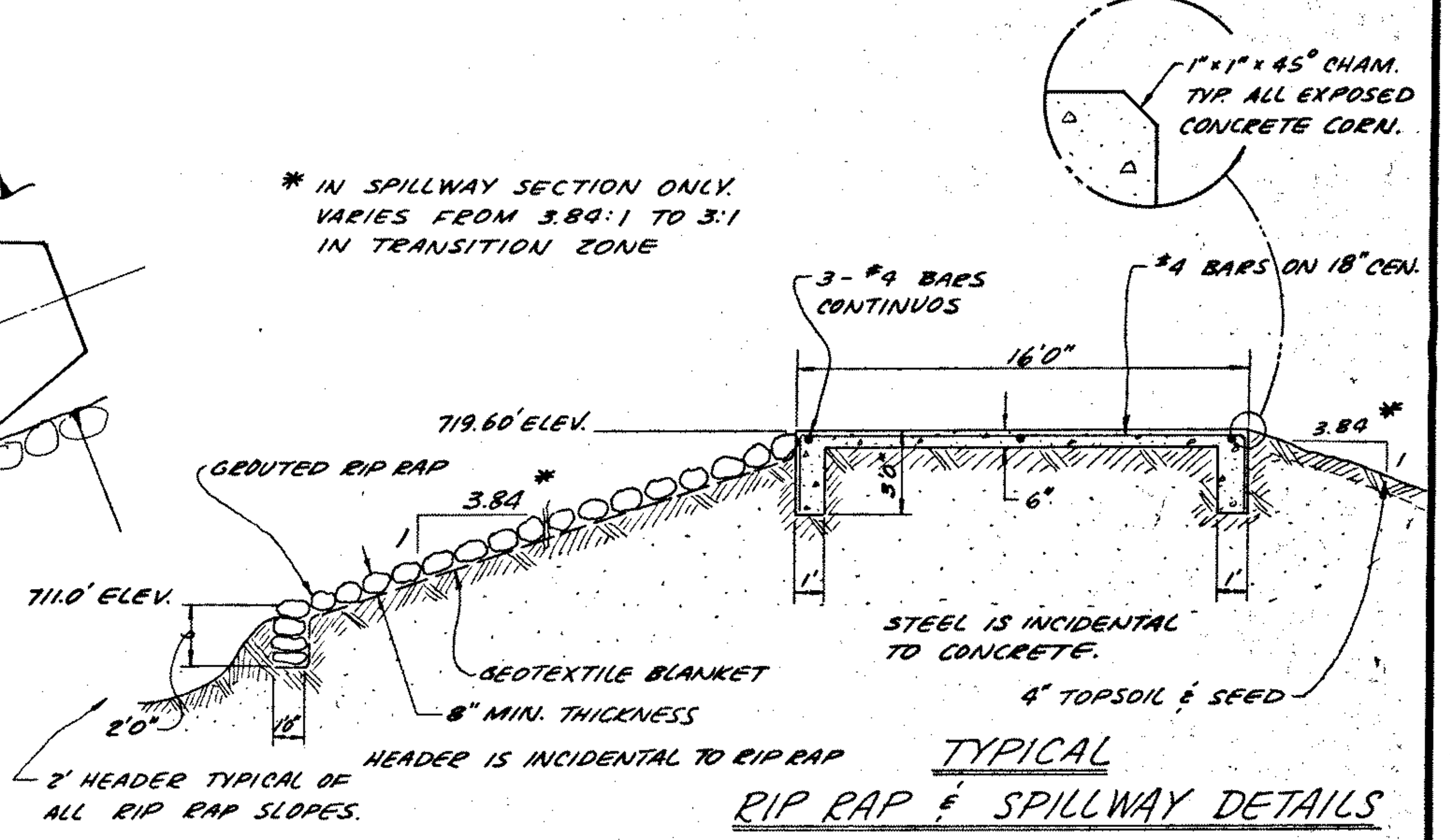
SCALE: 1" = 1"



SECTION C-C

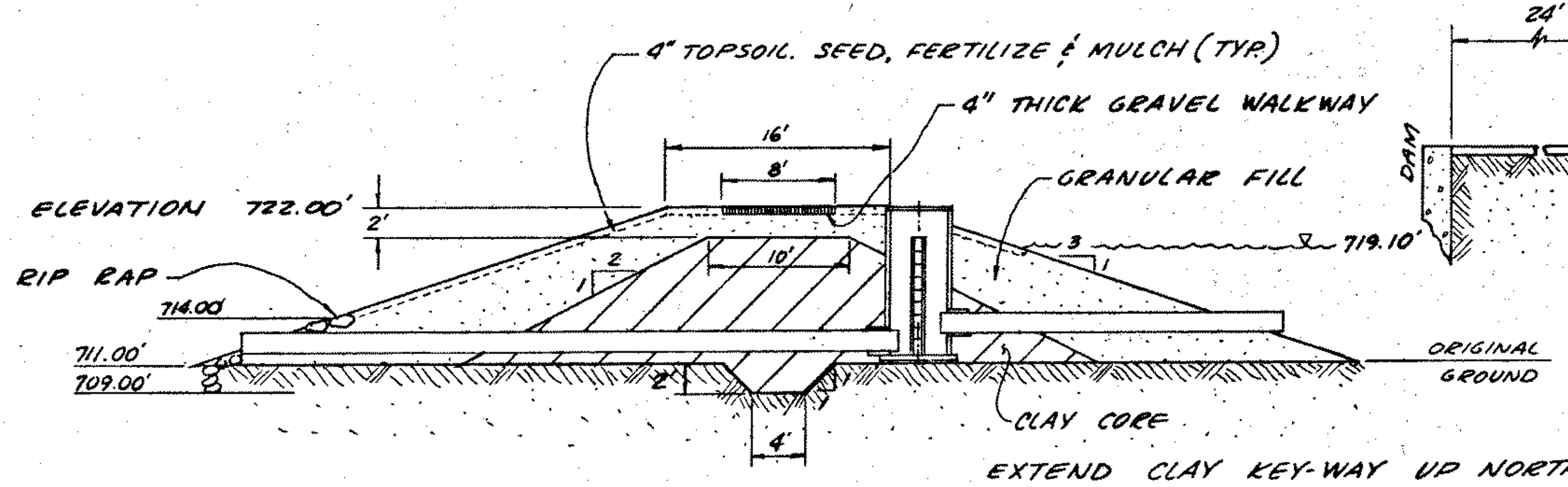
SCALE: 1" = 10'





TYPICAL
RIP RAP & SPILLWAY DETAILS
SECTION E-E

SCALE: 1" = 5'0"



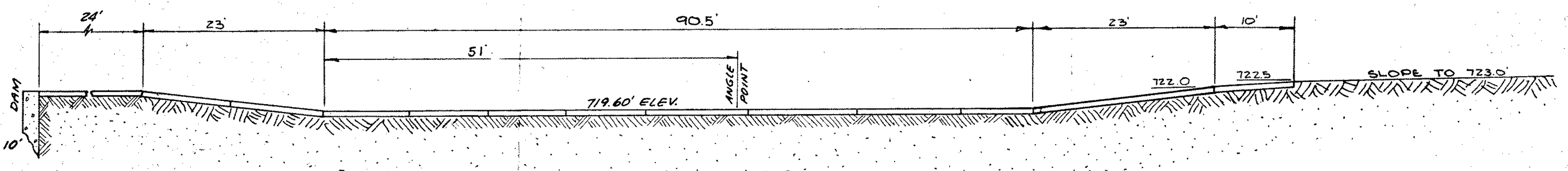
SECTION A-A

SCALE: 1" = 10'

EXTEND CLAY KEY-WAY UP NORTH ABUTMENT & UP RESHAPED EXISTING SOUTH EMBANKMENT TO LEVEL OF TOP OF CLAY.

NOTE:
CLAY SHALL NOT CONTAIN MORE THAN 30% FINER IN SIZE THAN 0.002 MM, & THE BURROW PIT SHALL BE PRE-APPROVED BY THE ENGINEER.

NOTE:
DAM REPAIR SECTION SHOWN BEYOND THE CONTROL STRUCTURE ON SECTION A-A WILL BE USED FOR THE REPAIR OF THE BREECHED SECTION OF THE DAM. I.E. THE NORTH 70 FT. ±. THE REMAINING FILL FOR AREA SOUTH OF THE NORTH 70 FT. WILL BE GRANULAR.



SECTION D-D

SCALE: 1" = 10'

VILLAGE OF HESPERIA
OCEANA COUNTY

NO.	DESCRIPTION	DATE	BY
1	"AS-BUILTS"	12/88	TG

REVISIONS

HESPERIA DAM
WHITE RIVER

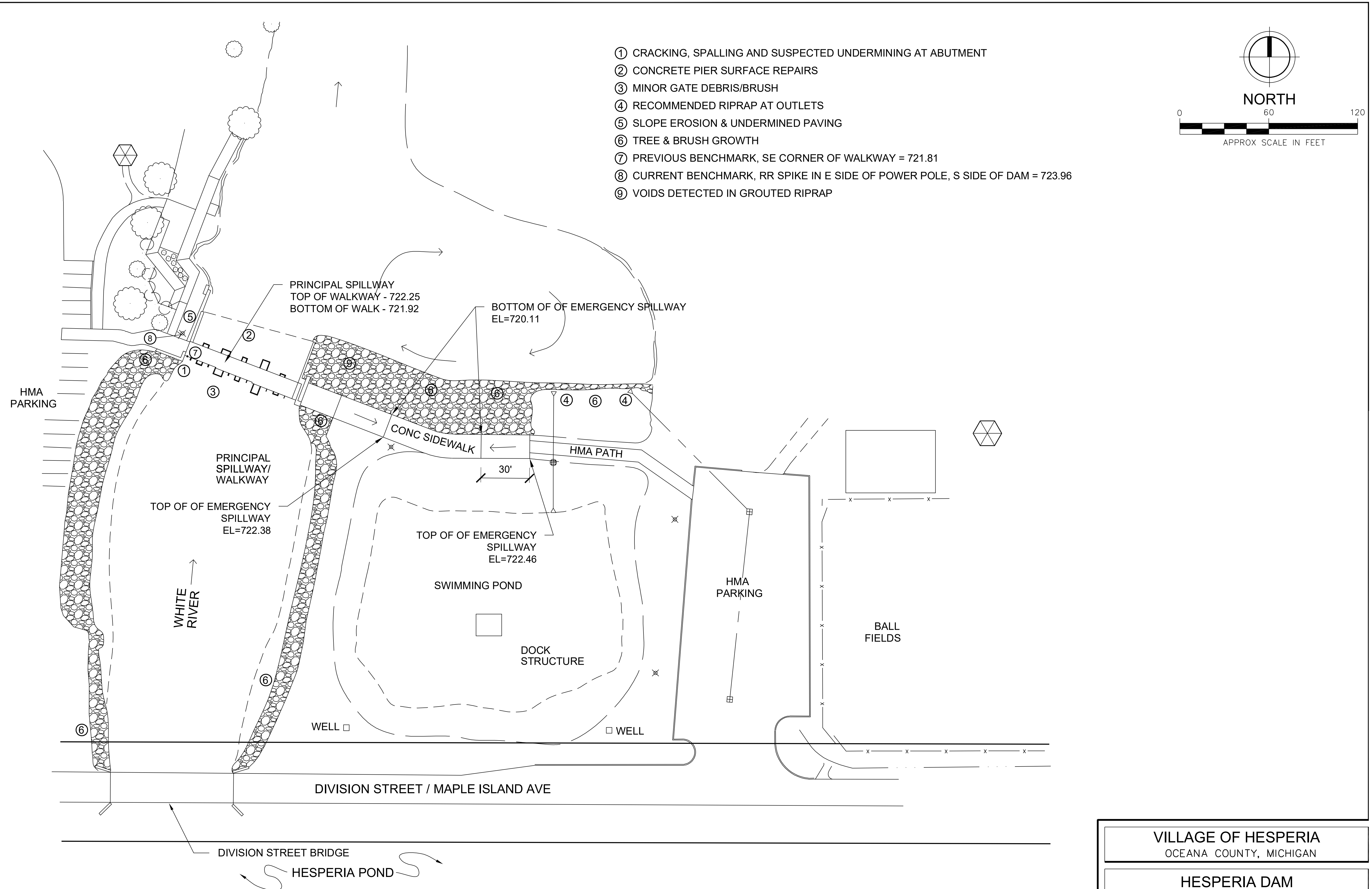
NORDLUND & ASSOCIATES, INC.
LUDINGTON, MICHIGAN

SECTION VIEWS

DWN. T.C.B.	DATE 3/87	SCALE: AS SHOWN	
CKD.	DATE	SHEET 2 OF 3	REV.

FILE: 241-5

34892_



① CRACKING, SPALLING AND SUSPECTED UNDERMINING AT ABUTMENT
② CONCRETE PIER SURFACE REPAIRS
③ MINOR GATE DEBRIS/BRUSH
④ RECOMMENDED RIPRAP AT OUTLETS
⑤ SLOPE EROSION & UNDERMINED PAVING
⑥ TREE & BRUSH GROWTH
⑦ PREVIOUS BENCHMARK, SE CORNER OF WALKWAY = 721.81
⑧ CURRENT BENCHMARK, RR SPIKE IN E SIDE OF POWER POLE, S SIDE OF DAM = 723.96
⑨ VOIDS DETECTED IN GROUTED RIPRAP

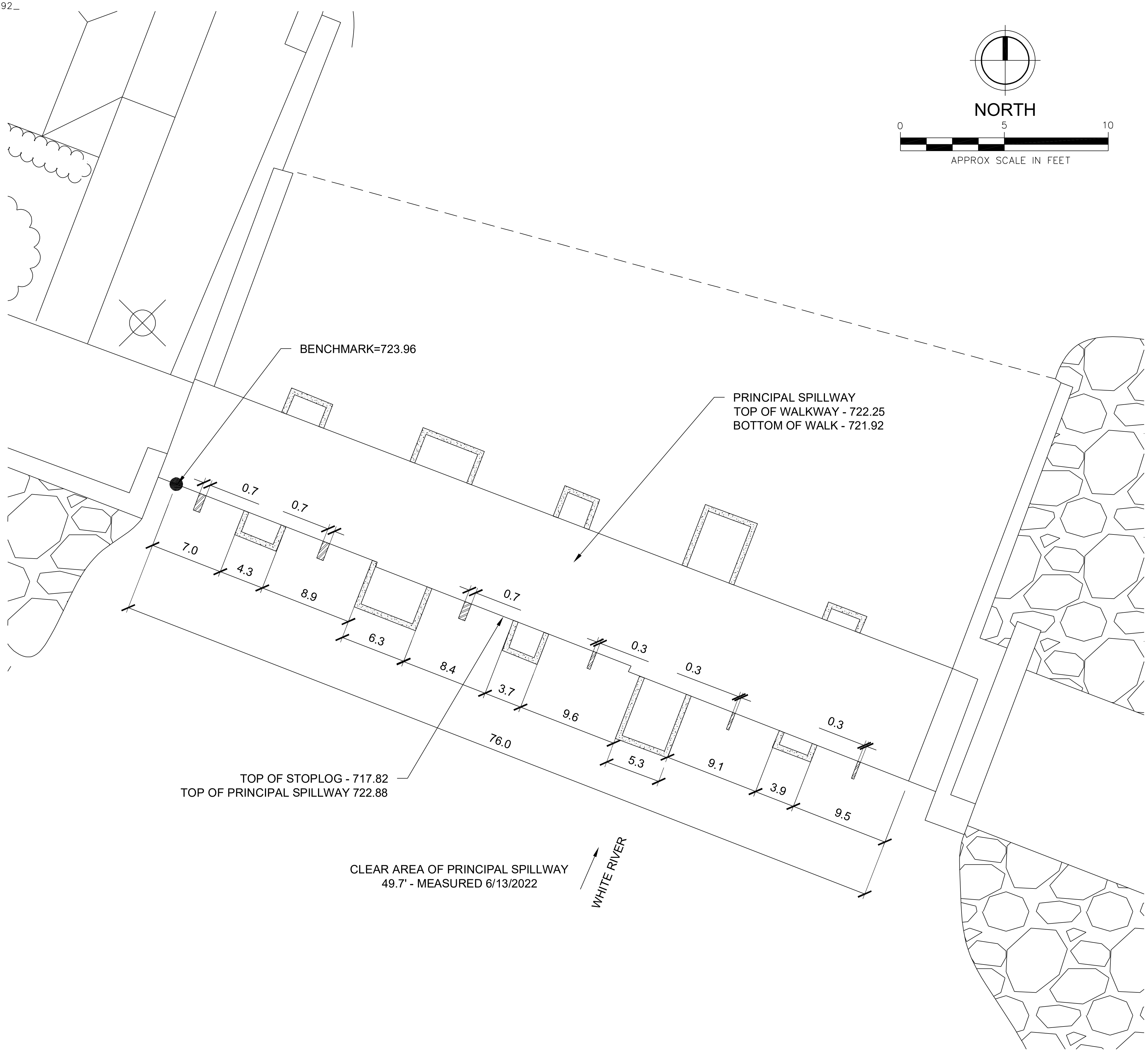
FLEIS & VANDENBRINK ENGINEERING, INC.

VILLAGE OF HESPERIA
OCEANA COUNTY, MICHIGAN

HESPERIA DAM
SCHEMATIC PLAN

OCT 2021
34892

34892_



Hesperia Dam Flow Calculations
Supplement to the 2021 Inspection Report

Geometric Information

Top of Spillway Elevation	712.88 ft
Top of Stoplog Elevation	717.80 ft
Bottom of Concrete Walkway Elevation	721.92 ft
Top of Concrete Walkway Elevation	722.25 ft
Bottom of Emergency Spillway Elevation	720.11 ft
Top of Emergency Spillway Elevation	722.40 ft
Clear Width of Principal Spillway	49.7 ft
Overall Width of Principal Spillway	76 ft
Bottom Width of Emergency Spillway	85 ft
Top Width of Emergency Spillway	145 .

Calculate principal spillway flow from Hw > 7.26 feet as a contracted sharp crested weir

Q = Cw * H_1^(3/2)*(Lps-0.1*N*H_1) [3]
Cw = 3.33 (sharp-crested weir coefficient)
Lps = 49.7 ft (total clear flow width)
N = 6

Calculate principal spillway flow with stoplogs removed as a series of contracted rectangular broad-crested weirs.

Q = Cw * H_1^(3/2)*(Lps-0.1*N*H_1) [3]
Cw = 3.09 (broad-crested weir coefficient)
Lps = 49.7 ft (total clear flow width)
N = 6

Calculate emergency spillway flow as a trapezoidal broad-crested weir.

Q = Cw * Les * H^1.5 (rectangular portion)
Q = 0.4 * Cw * Z * H^2.5 (each sloping portion)
Cw = 3.09 (broad-crested weir coefficient)
Z = 13.1 side slope (Z horizontal to 1 vertical)
Les = 85 ft (bottom width)

	Principal Spillway			Emergency Spillway		Total
Condition	**WSE**	**H (ft)**	**Q(cfs)**	**H (ft)**	**Q(cfs)**	**Flow (cfs)**
Water Surface at Top of Stoplog Elevation[1]	717.80	4.9	1,699	0.0	0	1,699
Water Surface at Bottom of Emergency Spillway[2]	720.11	7.2	2,725	0.0	0	2,725
Water Surface at Bottom of Concrete Walkway[2]	721.92	9.0	3,719	1.8	782	4,501

[1] Calculated as contracted sharp crested weir with stoplogs in
[2] Calculated as contracted broad crested weir with stoplogs out
[3] Francis Equation, per Water Measurement Manual US Bureau of Reclamation

Estimated Peak Flows per Michigan EGLE Water Resources Division 11/10/2021

100 yr	3900 cfs
200 yr	4400 cfs
500 yr	4500 cfs

Design Storm per Michigan EGLE Water Resources Division 11/10/2021

200 yr	4400 cfs

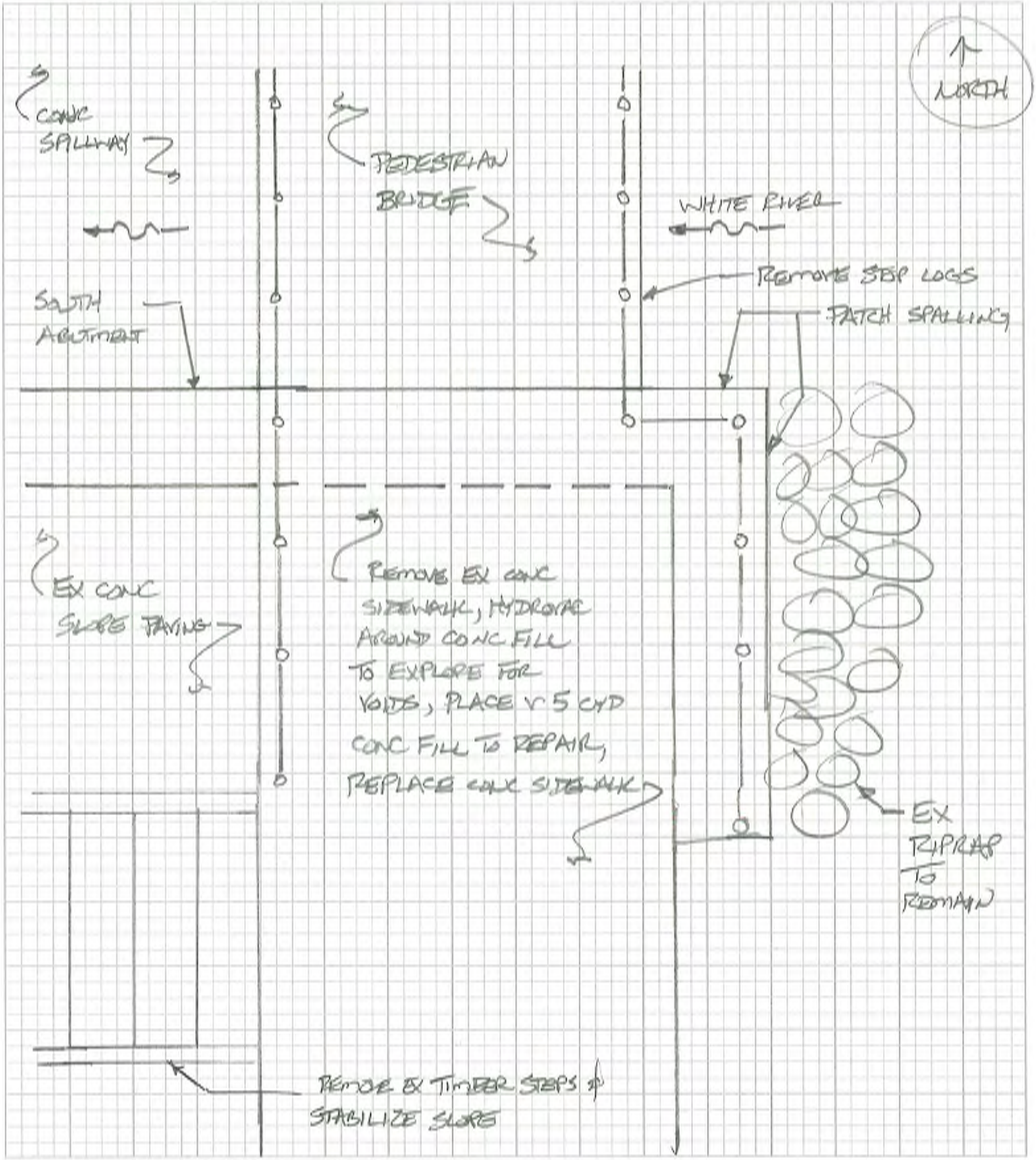
VILLAGE OF HESPERIA
OCEANA COUNTY, MICHIGAN

HESPERIA DAM
PRINCIPAL SPILLWAY DIMENSIONS
JUNE 202
34892

FLEIS & VANDENBRINK ENGINEERING, INC.

FLEIS&VANDENBRINK
DESIGN. BUILD. OPERATE.

Subject HESPERIA DAM REPAIRS
Client VILLAGE OF HESPERIA
Computed by maxer **Job No.** 348720
Checked by **Date** 9/15/23



REMOVE STOP LOGS

PATCH SPALLING

REMOVE EX CONC SIDEWALK, HYDROVAC AROUND CONC FILL TO EXPLORE FOR VOIDS, PLACE ~5 CYD CONC FILL TO REPAIR, REPLACE CONC SIDEWALK

REMOVE EX TIMBER STEPS & STABILIZE SLOPE

Sheet 1 of 1

NORTHEAST CORNER OF SOUTH
ABUTMENT LOOKING SOUTH

VIEW OF STRUCTURE LOOKING NORTHWEST

CONCRETE VOID FILL BEHIND SOUTH
ABUTMENT LOOKING NORTHWEST

CONCRETE VOID FILL BEHIND SOUTH ABUTMENT LOOKING NORTHEAST

CONCRETE VOID FILL BEHIND SOUTH ABUTMENT LOOKING NORTH

CONCRETE VOID FILL UNDER STAIRS TO
THE WEST OF THE SOUTH ABUTMENT

CONCRETE VOID FILL UNDER STAIRS TO THE WEST OF THE SOUTH ABUTMENT

EAST ELEVATION OF THE STRUCTURE
LOOKING WEST


VIEW OF THE NORTH BANK OF THE
IMPOUNDMENT LOOKING NORTHEAST

BARRICADES IN PLACE TO CLOSE AREA
TO PEDESTRIAN TRAFFIC

CONCRETE VOID FILL BEHIND THE SOUTH ABUTMENT LOOKING NORTH

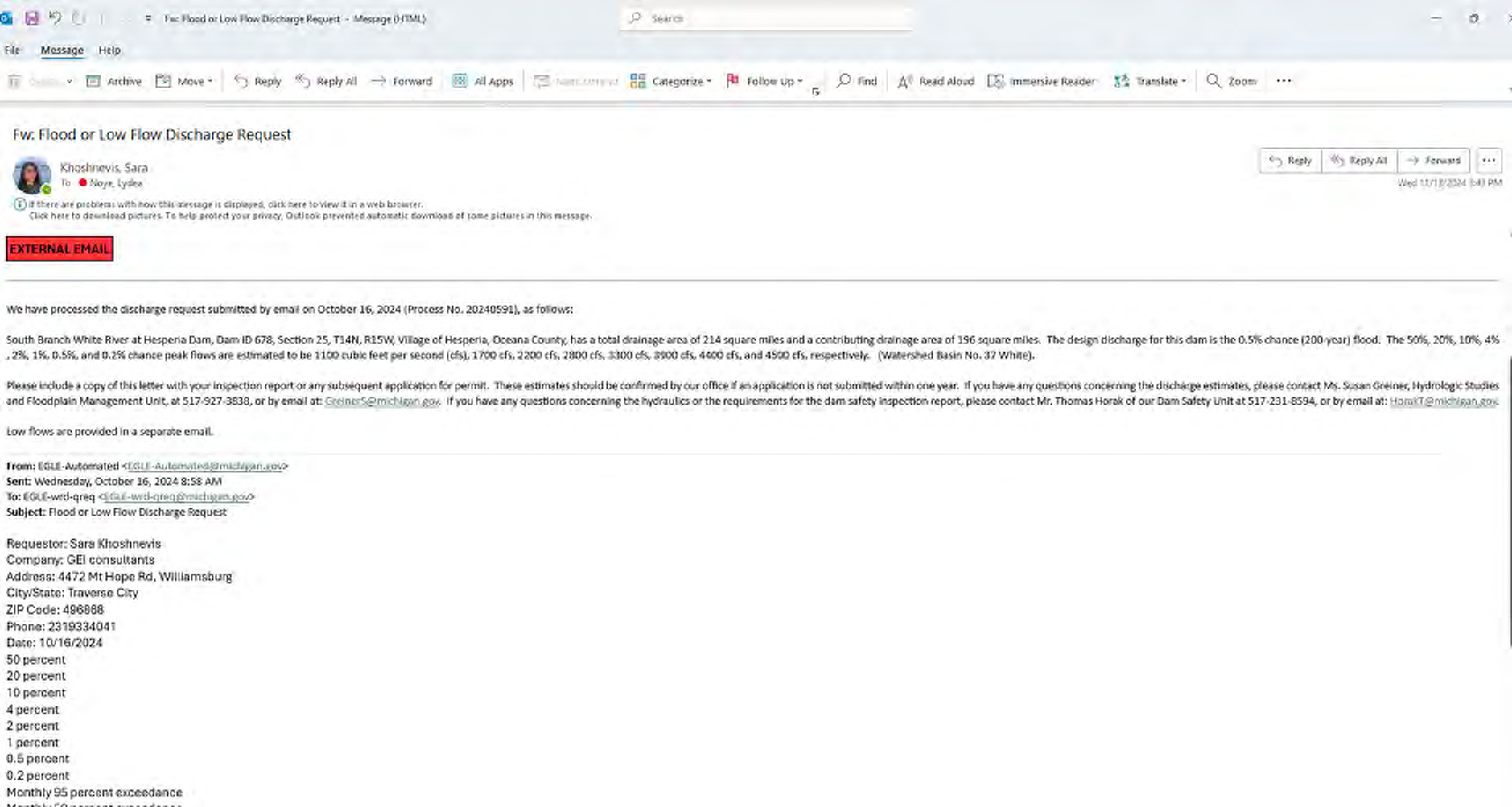

CONCRETE VOID FILL BEHIND THE SOUTH ABUTMENT LOOKING NORTHWEST

CONCRETE VOID FILL BEHIND THE SOUTH
ABUTMENT LOOKING NORTHEAST

CONSTRUCTION FENCING TO PROTECT
OPEN STAIR AREA

VIEW OF SPILLWAY AREA LOOKING NORTH

A.3. EGLE Flood Flow Request



Fw: Flood or Low Flow Discharge Request

Khoshnevis, Sara
To Noye, Lydea

Wed 11/13/2024 3:43 PM

If there are problems with how this message is displayed, click here to view it in a web browser.
Click here to download pictures. To help protect your privacy, Outlook prevented automatic download of some pictures in this message.

EXTERNAL EMAIL

We have processed the discharge request submitted by email on October 16, 2024 (Process No. 20240591), as follows:

South Branch White River at Hesperia Dam, Dam ID 678, Section 25, T14N, R15W, Village of Hesperia, Oceana County, has a total drainage area of 214 square miles and a contributing drainage area of 196 square miles. The design discharge for this dam is the 0.5% chance (200-year) flood. The 50%, 20%, 10%, 4% , 2%, 1%, 0.5%, and 0.2% chance peak flows are estimated to be 1100 cubic feet per second (cfs), 1700 cfs, 2200 cfs, 2800 cfs, 3300 cfs, 3900 cfs, 4400 cfs, and 4500 cfs, respectively. (Watershed Basin No. 37 White).

Please include a copy of this letter with your inspection report or any subsequent application for permit. These estimates should be confirmed by our office if an application is not submitted within one year. If you have any questions concerning the discharge estimates, please contact Ms. Susan Greiner, Hydrologic Studies and Floodplain Management Unit, at 517-927-3838, or by email at: GreinerS@michigan.gov. If you have any questions concerning the hydraulics or the requirements for the dam safety inspection report, please contact Mr. Thomas Horak of our Dam Safety Unit at 517-231-8594, or by email at: HorakT@michigan.gov.

Low flows are provided in a separate email.

From: EGLE-Automated <EGLE-Automated@michigan.gov>
Sent: Wednesday, October 16, 2024 8:58 AM
To: EGLE-wrd-qreq <EGLE-wrd-qreq@michigan.gov>
Subject: Flood or Low Flow Discharge Request

Requestor: Sara Khoshnevis
Company: GEI consultants
Address: 4472 Mt Hope Rd, Williamsburg
City/State: Traverse City
ZIP Code: 496868
Phone: 2319334041
Date: 10/16/2024
50 percent
20 percent
10 percent
4 percent
2 percent
1 percent
0.5 percent
0.2 percent
Monthly 95 percent exceedance

A.4. EGLE Low Flow Request

This reply is being sent via email only.

We have estimated the low flow discharges requested in your email of October 16, 2024 (Process No.11361), as follows:

> South Branch White River at Hesperia Dam #678, NE ¼ of the SE ¼ of Section 25, T14N, R15W, Village of Hesperia, Oceana County, with a drainage area of 214 square miles. The lowest monthly 95% exceedance, lowest monthly 50% exceedance, harmonic mean, and 90-day once in 10-year (90Q10) flows are estimated to be 110 cubic feet per second (cfs), 150 cfs, 200 cfs, and 120 cfs, respectively. The monthly 50% exceedance, 95% exceedance, and mean flows in cfs are:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
50%	220	230	290	310	250	200	150	150	150	180	220	220
95%	160	150	180	200	170	130	110	110	110	120	140	150
Mean	240	250	340	360	280	220	170	160	170	200	240	250

The attached Excel file contains the flow exceedance curve data. If you have any questions, please contact Mr. Steve Holden, Hydrologic Studies and Floodplain Management Unit, Water Resources Division, at 517-331-2642, or by e-mail at: holdens@michigan.gov.

Sincerely,

Mario Fusco, Jr., M.S., P.E., Supervisor
Hydrologic Studies and Floodplain Management Unit
Water Resources Division
517-256-4458

SWH
cc: , EGLE (P-18-SE)

Appendix B Field Investigation

B.1. Geotechnical Data Report

B.2. Base Map Survey

B.1. Geotechnical Data

Geotechnical Data Report

Hesperia Dam

Oceana County, Michigan
Dam I.D. No. 678

Submitted to:
Village of Hesperia
33 E. Michigan Avenue
Hesperia, Michigan 49421

Submitted by:
GEI Consultants of Michigan, P.C.
109 W. Baraga Avenue
Marquette, Michigan 49855
906.451.4021

June 3, 2025
Project No. 2403886

Morgan E Carden

Morgan E. Carden, P.E.
Project Engineer

Micheal D. Carpenter, P.E.
Senior Consultant

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MEC/MDC:lmc/taw

\\geiconsultants.com\data\Data_Storage\Working\VILLAGE OF HESPERIA\2403886 Hesperia Dam Rehabilitation Feas. Study\06_ENG\GEO\3_GDR\Hesperia GDR_FINAL.docx

1. Introduction

GEI Consultants of Michigan, P.C. (GEI) contracted with the Village of Hesperia, MI, to provide a geotechnical data report to better understand the subsurface conditions at Hesperia Dam. This report presents the results of our field exploration and laboratory testing. A Site Location Diagram is included as **Figure 1**.

1.1. Background and Site History

The Hesperia Dam (I.D. No. 678) is in the Village of Hesperia in Oceana County, Michigan, and is classified by the State as a Significant Hazard dam. The dam is owned and operated by the Village of Hesperia Department of Public Works. The dam is located on the White River and consists of a concrete principal spillway structure, a grouted riprap auxiliary spillway, and earthen embankments. The dam has a structural height of 11 feet with a 16-foot crest width and 3H:1V upstream and downstream slopes. The dam maintains approximately 7 feet of head and a 50-acre impoundment.

The left primary embankment extends approximately 30 feet to the left abutment, and the right embankment extends approximately 240 feet to the right abutment. The six span concrete spillway sits between the embankments and is approximately 70 feet wide, with five piers with stop logs. The history of the construction of the spillway is unknown, but is assumed to be rock-filled timber crib and masonry which was typical for this era. At some unknown date, the dam was encased with a reinforced concrete cap. An asphalt/concrete sidewalk traverses the crest of the embankments. Approximately 170 feet of the right embankment starting adjacent to the primary spillway functions as the auxiliary spillway.

Historic records indicate that during flood events the dam has been overtopped along the right embankment in 1975, 1986, 2013, 2014, and 2018. In response to the threat of overtopping in 1986, the right embankment was mechanically breached at the spillway right abutment. As part of the repairs to the right embankment, a formal auxiliary spillway, consisting of a lower crest and with grouted riprap to prevent erosion during spilling was constructed. In addition to the spillway, the upstream pond was constructed.

A swimming pond is present upstream of the right embankment and auxiliary spillway, which is separated from the river by an earthen berm. The swimming pond area was designed to not limit function or reduce the capacity of the auxiliary spillway. Under usual conditions, the pond is filled by artesian wells. Water discharges from the pond are routed to the river downstream of the dam through a concrete outlet pipe with a control valve located at the right abutment.

The dam was originally constructed to generate hydroelectric power; however, this capability was removed in the 1950s by Consumers Energy, which relinquished ownership, operation, and maintenance of the dam to the Village of Hesperia. Based on available photos the powerhouse that was originally constructed adjacent to the primary spillway left abutment was also removed.

1.2. Purpose

The purpose of this subsurface exploration program is to provide subsurface soil and groundwater information to for an alternatives analysis and support potential repair, reconstruction, or abandonment design options for the Hesperia Dam site.

1.3. Data Review

The following reference documents and information were reviewed:

- Construction Plans for Repairs to Dam on White River, Nordlund, Dunlap & Associates, Inc., August 1986.
- Dam Safety Inspection Report: Hesperia Dam – Dam ID No. 678, Jonathan W. Moxey, P.E., Fleis & VandenBrink Engineering, Inc., October 22, 2021

Pertinent historical information related to this Geotechnical Data Report can be found in **Appendix D**.

1.4. Scope of Work

GEI performed the following tasks for this geotechnical data report:

- Reviewed available site data related to site structures, soil, and groundwater conditions.
- Engaged Pearson Drilling, Inc. (Pearson) as a drilling subcontractor to drill four (4) borings and install four (4) open standpipe piezometers (OSP).
- Performed geotechnical laboratory testing on soil samples obtained from the borings to determine the parameters of the soils for use in proposed future analyses.
- Prepared this Geotechnical Data Report.

1.5. Elevation Datum, Horizontal Coordinate and Stationing

Elevations cited in this report are in feet and are referenced to the North American Vertical Datum of 1988 (NAVD88) unless otherwise noted. The horizontal coordinate system used for this project is the Michigan State Plane coordinate system (MI-83CIF) which is based on the North American Datum of 1983 (NAD 83). A new stationing system was established for this project; see **Figure 1** for more detail.

2. Subsurface Exploration and Testing Procedures

The 2024 subsurface exploration program included:

- Advancement of geotechnical soil borings at three (3) locations along the crest alignment of the dam and one (1) location at the toe of the Left Embankment.
- Installation of four (4) OSPs within or adjacent to drilled soil borings. Three (3) OSPs were installed at the crest of the embankment and one (1) OSP was installed at the toe of the downstream embankment.

2.1. Boring Selection and Layout

Boring locations were selected based on accessibility and to sample and characterize the various strata of geotechnical interest. Borings are identified as B-01 through B-04 for the embankment Borings. Information about the proposed borings is shown in **Table 3-1**, including termination depths and ground surface elevations.

The as-drilled locations were surveyed by Fleis & VandenBrink Engineering, Inc. The final boring locations are illustrated in **Figure 1**.

2.2. Drilling and Sampling

Pearson mobilized an Acker Renegade track mounted rig. Borings started on October 21, 2024, and were completed on October 22, 2024.

Borings were advanced using hollow-stem augers (HSA) consistent with the recommendations in U.S. Army Corps of Engineers Engineering Manual ER 1110-1-1807 (Ref. USACE, 2014). Borings were sampled using a conventional split-barrel sampler at 2-foot intervals from the surface through the first 15 feet of embankment material then at 5-foot intervals thereafter to the boring completion depth. Split spoon samples were performed in accordance with ASTM D1586 “Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.” Blow counts were recorded during advancement of the split spoon. Fill and native soil samples recovered during drilling were classified in the field by a geotechnical professional. Samples were retained in jars supplied by Pearson. All jar soil samples collected during this field exploration were shipped to the GEI laboratories in Marquette, Michigan, for laboratory testing.

2.3. Monitoring Wells

A total of four (4) OSPs were installed within the borings. The OSP locations are shown on **Figure 1** with a summary provided in **Table 3-3** of Section 3.4.

The OSP casings installed at the crest are 2-inch interior diameter (I.D.) PVC pipe and fitted with a 5-foot slotted PVC screen. The active zone of filter sand was isolated using a bentonite seal. The borehole was backfilled with cement bentonite grout with a concrete-sealed flush mount at the existing ground surface. The piezometers were fully developed.

2.4. Boring Logs

Field boring logs were completed by GEI personnel. Information collected on the field logs included:

- Project name, number, and location.
- Boring name, start and completion dates.
- Driller and drilling company identification, and equipment used.
- Sample identification, depth, and type (split spoon or Shelby tube).
- Sample recovery and blow counts.
- Sample description (field description augmented by laboratory test results) and corresponding Unified Soil Classification System (USCS) designation.
- Depth of water encountered.

Boreholes were tremie-filled with a cement/bentonite grout mixture. Borehole abandonment details are provided on the boring logs in **Appendix A.1**.

Upon completion of the field work, the logs were entered into gINT software to standardize the collected information into a presentable graphic form. Copies of the completed boring logs are included in **Appendix A.1**.

2.5. Laboratory Testing

Index testing on selected soil samples from the borings were performed to evaluate index properties for classification purposes and to evaluate the visual descriptions of the soils classified. Soil samples were tested at GEI's Marquette Michigan geotechnical laboratory. Results of the analyses are discussed in Section 3 of this report. Tests included:

- Soil Classification per ASTM D2487
- Combined Sieve and Hydrometer per ASTM D6913
- Grain Size per ASTM D422
- Atterberg Limits per ASTM D431

3. Exploration and Testing Results

3.1. Site and Regional Geology

Multiple advances and retreats of continental glaciers over the State of Michigan during the Pliestocene epoch (beginning approximately 1.8 million years ago) have left a thick sequence of glacial tills, outwash, and lacustrine deposits. The most recent glacial advance was the Wisconsinan glaciation, which ended in Lower Michigan approximately 12,000 years ago. These glaciers left behind debris consisting of gravels, sands, silts, and clays. The distribution of various soil types is dependent on the depositional environment related to the proximity of the glacier. In Oceana County, the thickness of the glacial deposits range from approximately 100 to 600 feet. Glacial deposits in the area consist of lacustrine deposits, glacial till, and outwash sand and gravels. Sand-and-gravels are dominate within the alluvial deposits common within river channels, like the White River.

The bedrock beneath the glacial deposits consists of Jurassic “red beds” and the Saginaw Formation (Farrand and Bell, 1982). The Jurassic “red beds” are generally 50- to 150-feet thick and are considered to be a confining unit in Michigan.

3.2. Historical Borings

There are no known previous subsurface explorations conducted at the site.

3.3. Soil Conditions

The generalized subsurface conditions encountered in the borings are described below and summarized in **Table 3-1**. The boring logs contained in **Appendix A.1** should be referenced for detailed descriptions of the subsurface conditions encountered at each boring. Variations in the soil profile should be anticipated throughout the proposed site. A photolog documenting site conditions at the time of drilling inspection are included in **Appendix C.**

Table 3-1. Soil Borings

ID	Type	Location	Approximate Ground Surface Elevation	Depth (ft)
GEI-B-01A	SPT Soil Boring	Crest of Right Primary Embankment	720.0	Refusal at 6.5, Prior to Planned Depth
GEI-B-01B	SPT Soil Boring	Crest of Right Primary Embankment	720.0	Refusal at 0.5, Prior to Planned Depth
GEI-B-01C	SPT Soil Boring	Crest of Right Primary Embankment	721.7	30
GEI-B-02A	SPT Soil Boring	Crest of Right Primary Embankment	720.0	Refusal at 8.5, Prior to Planned Depth
GEI-B-02B	SPT Soil Boring	Crest of Right Primary Embankment	720.2	30
GEI-B-02C	SPT Soil Boring	Crest of Right Primary Embankment	720.3	30 (Blind Drilled to 18)
GEI-B-03	SPT Soil Boring	Crest of Left Primary Embankment	722*	30
GEI-B-04	SPT Soil Boring	Toe of Left Primary Embankment	719.0*	30

Embankment Soils – Fill soils were encountered from the ground surface to an average depth of 11.75 feet within embankment borings B-01C, B-02B, B-03, and B-04. See **Table 3-2** for summary of elevations. Encountered fill soils primarily consisted of fine to coarse sand, with gravel, cobbles, and silt included at varying depths. N values ranged from 2 to 64 in fill soils; however, they averaged to about 11. In addition, layers of saw dust were encountered in borings B-03 and B-04. This is consistent with information provided from the Village about the demolition of the old saw mill and the area being partially backfilled with saw dust.

Foundation Soils – The embankment fill soils were underlain by alluvial foundation soils that primarily consisted of fine sands and silty fine to medium sands, with and gravel layers also observed, with N values ranging from Weight of Hammer to 78, and averaging around 28.

Table 3-2. Generalized Subsurface Profile

ID	Ground Surface Elevation (ft)	Bottom of Fill Elevation (ft)
GEI-B-01C	721.7	709.7
GEI-B-02B	720.2	712.2
GEI-B-03	722.1	710.1
GEI-B-04	718.9	703.9

3.4. Groundwater Conditions

Groundwater was encountered during drilling or sampling within each of the borings. The groundwater elevations indicated on the soil boring logs in **Appendix A.1** represent conditions at the time and location indicated. Groundwater levels at this site are tied to fluctuations in reservoir and tailwater levels. The normal reservoir and tailwater levels are El. 717.8 and 710.7, respectively.

3.5. Open Standpipe Piezometers

OSPs were installed at B-01C, B-02B, B-03, and B-04 to record long term groundwater elevations. Readings were obtained during drilling and installation of the wells. Additional readings will be taken during the feasibility and design phases as needed. A summary of the GEI OSP wells is provided in **Table 3-3**. Detailed groundwater monitoring well installation diagrams are included in **Appendix A.2**.

Table 3-3. GEI Monitoring Well Summary

Well ID	Top of Pipe Elevation (ft)	Bottom of Pipe Elevation (ft)	Screen Interval Elevations (ft)	Monitored Geologic Unit	Water Level Reading 10/21/2024 Elevation (ft) [Depth (ft)]
H-1	721.7	691.7	706.7-701.7	Natural Foundation Soil, SP/SP-SM	713.2 [8.5]
H-2	720.2	690.2	707.2-702.2	Natural Foundation Soil, SP	715.4 [4.8]
H-3	722.1	692.1	714.1-709.1	Natural Foundation Soil, SP/SP-SM	716.7 [5.4]
H-4	718.9	688.9	708.9-703.9	Natural Foundation Soil, SM/SP-SM	714.5 [4.4]

3.6. Laboratory Testing Results

Laboratory testing was performed on several disturbed samples collected during the exploration. Testing was completed by GEI's laboratories in Marquette, Michigan. A brief description and summary of the laboratory test data is provided in the following sections. The laboratory test results are included in **Appendix B**. A full summary of test results is included in **Appendix B.1**. A summary of the index testing is provided in **Table 3-4** below.

Table 3-4. Summary of Index Properties

					Grain Size Analysis							
							Fines			**Atterberg Limits**		
Boring	**Sample**	**Average Elevation (ft)**	**Fill/ Natural**	**USCS(1)**	**Gravel (%)**	**Sand (%)**	**Total (%)**	**Silt (%)**	**Clay (%)**	**Liquid Limit**	**Plastic Limit**	**Plasticity Index**
B-01C	S-2B	719	Fill	SM	1.0	54.3	44.7					
B-01c	S-6	711	Fill	SP-SM	5.1	88.5	6.4					
B-01C	S-8	707	Natural	SP-SM	13.7	80.6	5.7					
B-01C	S-10	698	Natural	ML						22	22	NP
B-02B	S-2	718	Fill	SP	34.9	60.3	4.8					
B-02B	S-6	709	Natural	SP	0.6	94.0	5.4					
B-02C	S-2	696	Natural	GP	70.3	27.5	2.2					
B-03	S-2	719	Fill	SP-SM	12.5	76	11.5					
B-03	S-9	702	Natural	SP-SM	0	92.9	7.1					
B-04	S-3	714	Fill	SP-SM	3	88.4	8.6					
B-04	S-7	706	Fill	SP-SM	32.5	59.9	7.6					
B-04	S-9	700	Natural	SM	0.1	55.0	44.9	41.7	3.2			

1. The material description and USCS symbol with this test refers only to the minus No. 40 sieve material and therefore may differ from the full soil description. See the "Particle Size Distribution Report," hydrometer reports, and soil boring logs for complete sample USCS classification.

3.6.1. Soil Classification (Unified Soil Classification System, USCS)

The soil samples were visually field classified in general accordance with ASTM D2488. Select samples were visually classified in the lab in general accordance with ASTM D2478. The visual classifications are included on the final boring logs in **Appendix A.1**.

3.6.2. Sieve and Hydrometer (Combined Analysis)

Grain size and hydrometer combined tests were completed in general accordance with ASTM D6913. Sieve analysis results are included in **Appendix B.2**.

3.6.3. Sieve Analysis

Grain size tests were completed in general accordance with ASTM D422. Sieve analysis results are included in **Appendix B.3.**

3.6.4. Atterberg Limits

Atterberg limits were performed on visually classified cohesive soils in general accordance with ASTM D4318. Atterberg limit results are included in **Appendix B.4**.

4. Limitations

This report has been prepared in general accordance with our proposal dated November 17, 2022. This report follows generally accepted geotechnical engineering practices to aid in the evaluation of this site and to assist the owner and/or engineer in the design of this project. No other warranty, either expressed or implied, is made. The scope is limited to the specific project and location described herein, and our description of the project represents our understanding of the significant aspects relevant to the geotechnical characteristics. This report is intended to satisfy the requirements of the Heron geotechnical investigation and is not intended as a preliminary or final design document. Design would be completed in subsequent phases of this project.

The observations provided in this report are based on data obtained from soil borings performed at locations indicated on the location diagram and from information discussed in this report. This report does not reflect any variations which may occur between borings. In the performance of subsurface explorations, specific information is obtained at specific locations at specific times. However, it is a well-known fact that variations in soil and rock conditions exist on most sites between boring locations, and that seasonal and annual fluctuations in groundwater levels will likely occur. The nature and extent of variations may not become evident until the course of construction. If variations then appear evident, it will be necessary for a re-evaluation of recommendations contained in this report after performing on-site observations during the construction period and noting characteristics of the variations.

5. References

(Farrand and Bell, 1982) Farrand W.R. and Bell D.L. 1982. Quaternary geology of northern and southern Michigan: Lansing, Mich., Michigan Geological Survey Division, scale 1:500,000, 1982.

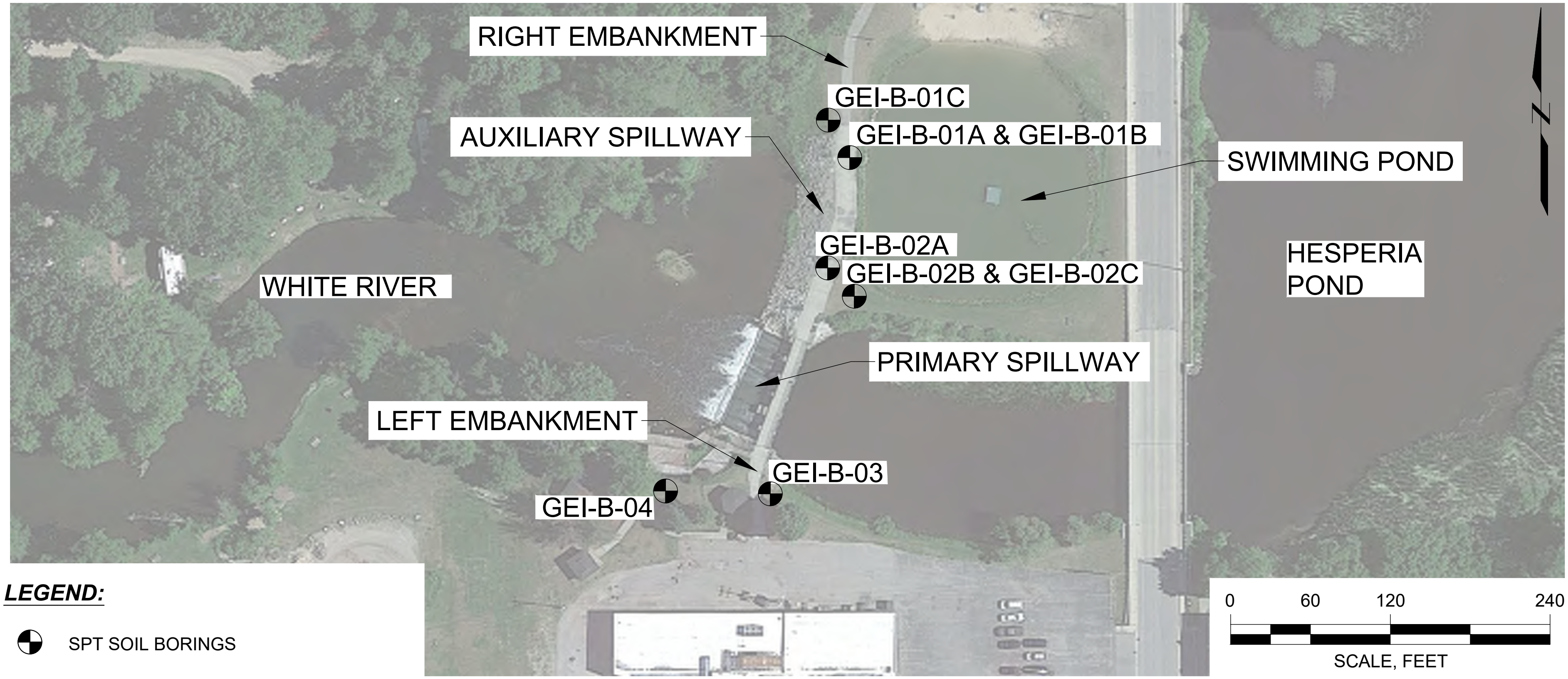
(USACE, 2014) U.S. Army Corps of Engineers (USACE) Engineering Manual ER 1110-1-1807. “Drilling in Earth Embankment Dams and Levees.” December 2014.

Figures

Figure 1 – Site Location Diagram

EXPLORATORY SOIL BORING SUMMARY TABLE

ID	TYPE	LOCATION	GROUND SURFACE ELEV (ft)	DEPTH (ft)	OSP INSTALLED
GEI-B-01A	SPT SOIL BORING	CREST OF RIGHT EMBANKMENT	720.0	REFUSAL AT 6.5	NO
GEI-B-01B	SPT SOIL BORING	CREST OF RIGHT EMBANKMENT	720.0	REFUSAL AT 0.5	NO
GEI-B-01C	SPT SOIL BORING	CREST OF RIGHT EMBANKMENT	721.7	30	YES
GEI-B-02A	SPT SOIL BORING	CREST OF RIGHT EMBANKMENT	720.0	REFUSAL AT 8.5	NO
GEI-B-02B	SPT SOIL BORING	CREST OF RIGHT EMBANKMENT	720.2	30	NO
GEI-B-02C	SPT SOIL BORING	CREST OF RIGHT EMBANKMENT	720.3	30 (BLIND DRILLED TO 18 FT)	YES
GEI-B-03	SPT SOIL BORING	CREST OF LEFT EMBANKMENT	722.1	30	YES
GEI-B-04	SPT SOIL BORING	TOE OF LEFT EMBANKMENT	718.9	30	YES



LEGEND:

◐ SPT SOIL BORINGS

NOTES:

1. SOURCE: PLAN BASED ON MAP PREPARED BY GOOGLE EARTH.
2. OSP = OPEN STANDPIPE PIEZOMETER

FEASIBILITY STUDY
HESPERIA DAM
HESPERIA, MICHIGAN

VILLAGE OF HESPERIA
HESPERIA, MICHIGAN

GEI Consultants

Project 2403886

BORING LOCATION MAP

FEBRUARY 2025

Fig. 1

CARDEN, MORGAN B:\Working\VILLAGE OF HESPERIA\2403886 Hesperia Dam Rehabilitation Feas. Study\06_ENG\GEO\0_DPP\Appendix A - Location Diagram\FIG 1.dwg - 5/27/2025

Appendix A Soil Boring Logs and Monitoring Well

A.1. Soil Boring Logs (GEI, 2024)

A.2. Monitoring Well Installation Logs (GEI, 2024)

A.3. General Soil Classification

A.1. Soil Boring Logs (GEI, 2024)

GEI Consultants

CLIENT:
Village of Hesperia

PROJECT NAME:
Hesperia Dam

LOG OF BORING NUMBER **B-01A**

ARCHITECT-ENGINEER
GEI Consultants of MI, P.C.

LOCATION: Hesperia, MI

DESCRIPTION OF MATERIAL

SURFACE ELEVATION (ft.) 720.1

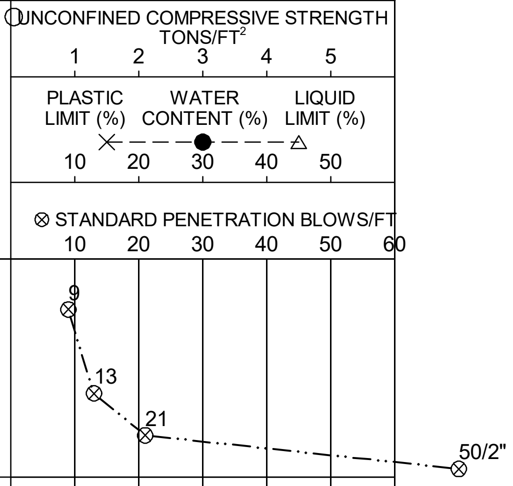
DEPTH (FT)	ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL
				Concrete
		1	SS	0.5 Fill: Fine sand - trace silt and fine to coarse gravel - brown - loose to medium dense - moist to wet (S)
		2	SS	
		3A	SS	5.0 Fill: Fine to coarse sand - some fine to coarse gravel - trace to some silt - dark brown - medium dense - wet (SP-SM)
		3B	SS	5.5 Fill: Fine sand - trace silt - brown - extremely dense - wet (SP)
				Note: Driller reported auger refusal at 6.5 feet due to riprap or large boulders. Boring offset; see B-01B for additional information.
				6.5 End of Boring
10	710			
20	700			
30	690			

Boring advanced to 5.0 feet with hollow-stem auger.
Standard Penetration Tests performed with safety hammer.
Boring backfilled with cement bentonite grout.

SAMPLE DISTANCE

RECOVERY

UNIT DRY WT. LBS/FT³



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL: 3.0' WS	BORING STARTED **10/21/2024**	GEI OFFICE **Marquette, MI**	
	BORING COMPLETED **10/21/2024**	ENTERED BY **LJE**	APPROVED BY **CRA**
NORTHING EASTING	RIG/FOREMAN **Acker Renegade / WP (Pearson)**	GEI PROJECT NO. **2403886**	PAGE NO. **1** OF **1**

GEI Consultants

CLIENT:
Village of Hesperia

PROJECT NAME:
Hesperia Dam

LOG OF BORING NUMBER **B-01B**

ARCHITECT-ENGINEER
GEI Consultants of MI, P.C.

LOCATION: Hesperia, MI

DESCRIPTION OF MATERIAL

SURFACE ELEVATION (ft.) 720.1

DEPTH (FT)	ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS/FT³	○ UNCONFINED COMPRESSIVE STRENGTH TONS/FT² 1 2 3 4 5 PLASTIC LIMIT (%) ✕ WATER CONTENT (%) ● LIQUID LIMIT (%) △ 10 20 30 40 50 ⊗ STANDARD PENETRATION BLOWS/FT 10 20 30 40 50 60
		1	SS			Concrete		
0.5						Driller reported auger refusal immediately below the concrete surface. Boring offset; see B-01C for additional information		
10	710							
20	700							
30	690							

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL:	BORING STARTED **10/21/2024**	GEI OFFICE **Marquette, MI**	
	BORING COMPLETED **10/21/2024**	ENTERED BY **LJE**	APPROVED BY **CRA**
NORTHING EASTING	RIG/FOREMAN **Acker Renegade / WP (Pearson)**	GEI PROJECT NO. **2403886**	PAGE NO. **1** OF **1**

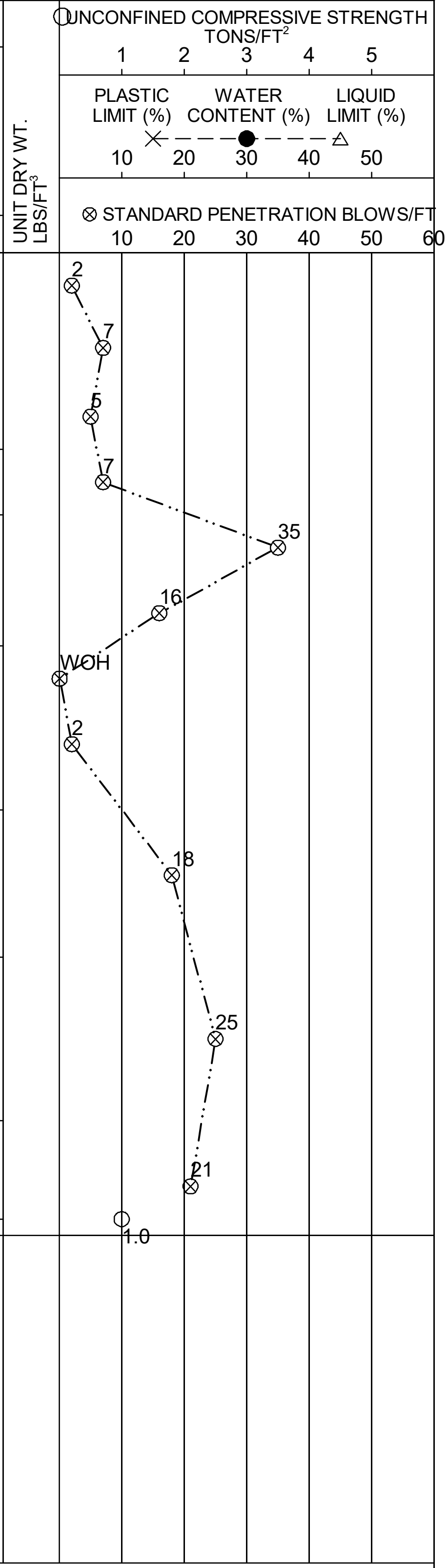
CLIENT: **Village of Hesperia**	LOG OF BORING NUMBER **B-01C**
PROJECT NAME: **Hesperia Dam**	ARCHITECT-ENGINEER **GEI Consultants of MI, P.C.**

LOCATION: Hesperia, MI

SURFACE ELEVATION (ft.) 721.7

DEPTH (FT)	ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL
0.0	721.7	1, 2A, 2B, 3	SS	Fill: Fine sand - trace silt and fine to coarse gravel - frequent silty sand pockets - brown and dark brown - very loose to loose - moist (SP) Note: S-2B material consisted of Silty sand (SM)
6.0		4	SS	Fill: Fine to coarse sand - some fine to coarse gravel - trace to some silt - dark brown - loose - moist (SP-SM)
8.0		5, 6	SS	Fill: Fine to medium sand - trace to some silt and fine gravel - trace coarse sand - brown - dense to medium dense - moist to wet (SP-SM)
12.0		7, 8	SS	Fine to coarse sand - some fine gravel - trace to some silt - dark brown - loose to very loose - wet (SP-SM)
17.0		9	SS	Fine to medium sand - trace silt and fine to coarse gravel - dark brown - medium dense - wet (SP)
21.5		10	SS	Sandy silt - gray - medium dense - wet (ML)
26.5		11A	SS	Fine to medium sand - trace silt - gray - medium dense - wet (SP)
29.5		11B	SS	Silty clay - some fine sand - gray - stiff (CL)
30.0				End of Boring

Boring advanced to 28.0 feet with hollow-stem auger.
Standard Penetration Tests performed with safety hammer.
Boring backfilled with cement bentonite grout.



Sample	SPT blows/ft	Unconfined compressive strength (tons/ft^2)
1	2	
2A	7	
3	5	
4	7	
5	35	
6	16	
7	WOH	
8	2	
9	18	
10	25	
11A	21	
11B		1.0

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL: 11.0' WS	BORING STARTED **10/21/2024**	GEI OFFICE **Marquette, MI**	
	BORING COMPLETED **10/21/2024**	ENTERED BY **LJE**	APPROVED BY **CRA**
NORTHING EASTING	RIG/FOREMAN **Acker Renegade / WP (Pearson)**	GEI PROJECT NO. **2403886**	PAGE NO. **1** OF **1**

GEI Consultants	CLIENT: **Village of Hesperia**	LOG OF BORING NUMBER **B-02A**
	PROJECT NAME: **Hesperia Dam**	ARCHITECT-ENGINEER **GEI Consultants of MI, P.C.**

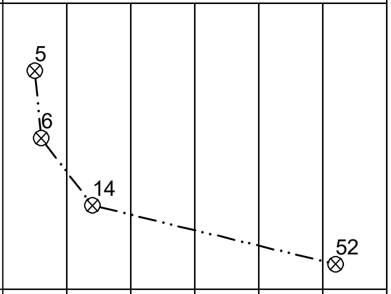
LOCATION: Hesperia, MI

DEPTH (FT)	ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS/FT^3
						SURFACE ELEVATION (ft.) 720.1	
						Concrete	
		1	SS			0.5 Fill: Fine to medium sand - trace to some fine to coarse gravel - trace silt - brown - loose - moist to wet (SP)	
		2	SS				
		3	SS			5.0 Fill: Gravelly fine to coarse sand - trace to some silt - brown - medium dense to very dense - wet (SP-SM) ***Note: Driller reported split spoon and auger refusal at 8.5 feet below grade on buried riprap or large boulders.***	
		4	SS				
10	710					8.5 End of Boring Boring advanced to 8.5 feet with hollow-stem auger. Standard Penetration Tests performed with safety hammer. Boring backfilled with cement bentonite grout.	
20	700						
30	690						

○ UNCONFINED COMPRESSIVE STRENGTH TONS/FT^2
1 2 3 4 5

PLASTIC LIMIT (%) ✕ WATER CONTENT (%) ● LIQUID LIMIT (%) △
10 20 30 40 50

⊗ STANDARD PENETRATION BLOWS/FT
10 20 30 40 50 60



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL: 3.0' WS	BORING STARTED **10/21/2024**	GEI OFFICE **Marquette, MI**	
	BORING COMPLETED **10/21/2024**	ENTERED BY **LJE**	APPROVED BY **CRA**
NORTHING EASTING	RIG/FOREMAN **Acker Renegade / WP (Pearson)**	GEI PROJECT NO. **2403886**	PAGE NO. **1** OF **1**

MIDWEST BORING LOG 2403886 - HESPERIA DAM - CRA.GPJ GEI DATA TEMPLATE.GDT 1/16/25

GEI Consultants

CLIENT: **Village of Hesperia**

PROJECT NAME: **Hesperia Dam**

LOG OF BORING NUMBER **B-02B**

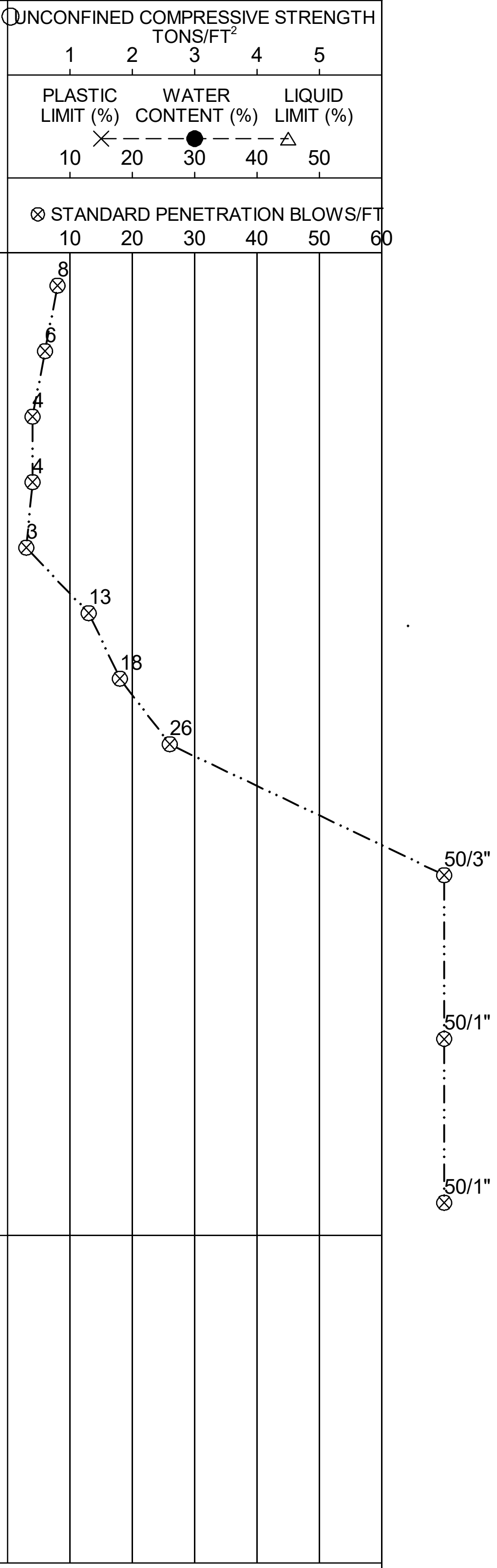
ARCHITECT-ENGINEER **GEI Consultants of MI, P.C.**

LOCATION: Hesperia, MI

SURFACE ELEVATION (ft.) 720.2

DEPTH (FT)	ELEVATION (FT)	DESCRIPTION OF MATERIAL
0	720	Driller reported topsoil
0.5		Fill: Gravelly fine to coarse sand - trace silt and topsoil - brown and dark brown - loose - moist (SP)
4.0		Fill: Gravelly fine to coarse sand - trace to some silt - dark brown - loose - moist to wet (SP-SM)
6.0		Fill: Fine to medium sand - trace to some silt and topsoil - dark brown and black - loose - wet (SP-SM)
8.0		Fine to coarse sand - some fine to coarse gravel - trace silt - frequent cobbles below 18 feet - brown - very loose to extremely dense - wet (SP)
10	710	
20.0	700	***Note: Driller reported no recovery while sampling S-10 and S-11. Boring offset; see boring B-02C for additional information.***
30.0	690	End of Boring Boring advanced to 28.0 feet with hollow-stem auger. Standard Penetration Tests performed with safety hammer. Boring backfilled with cement bentonite grout.

SAMPLE NO.	SAMPLE TYPE
1	SS
2	SS
3	SS
4	SS
5	SS
6	SS
7	SS
8	SS
9	SS
10	SS
11	SS



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL: 5.0' WS

BORING STARTED **10/21/2024**

BORING COMPLETED **10/21/2024**

GEI OFFICE **Marquette, MI**

ENTERED BY **LJE**

APPROVED BY **CRA**

NORTHING

EASTING

RIG/FOREMAN **Acker Renegade / WP (Pearson)**

GEI PROJECT NO. **2403886**

GEI Consultants	CLIENT: **Village of Hesperia**
PROJECT NAME: **Hesperia Dam**	LOG OF BORING NUMBER **B-02C**
ARCHITECT-ENGINEER **GEI Consultants of MI, P.C.**	

LOCATION: Hesperia, MI

SURFACE ELEVATION (ft.) 720.3

○ UNCONFINED COMPRESSIVE STRENGTH TONS/FT^2: 1 2 3 4 5

PLASTIC LIMIT (%) × — WATER CONTENT (%) ● — LIQUID LIMIT (%) △: 10 20 30 40 50

⊗ STANDARD PENETRATION BLOWS/FT: 10 20 30 40 50 60

DEPTH (FT)	ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS/FT^3	⊗ STANDARD PENETRATION BLOWS/FT
	720			Driller blind drilled to 18 feet below grade		
10	710					
		1	SS	18.0 Sandy coarse gravel - trace silt and fine gravel - frequent cobbles and boulders - brown - extremely dense - wet (GP)		50/1"
20	700					
		2	SS			50/<1"
		3	SS	28.0 Fine sand - trace to some silt and fine to coarse gravel - brown - extremely dense - wet (SP-SM)		50/6"
30	690			30.0 End of Boring Boring advanced to 28.0 feet with hollow-stem auger. Standard Penetration Tests performed with safety hammer. Boring backfilled with cement bentonite grout.		

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL: 5.0' WD	BORING STARTED **10/21/2024**	GEI OFFICE **Marquette, MI**
	BORING COMPLETED **10/21/2024**	ENTERED BY **LJE** | APPROVED BY **CRA**
NORTHING | EASTING	RIG/FOREMAN **Acker Renegade / WP (Pearson)**	GEI PROJECT NO. **2403886** | PAGE NO. **1** OF **1**

CLIENT: **Village of Hesperia**	LOG OF BORING NUMBER **B-03**
PROJECT NAME: **Hesperia Dam**	ARCHITECT-ENGINEER **GEI Consultants of MI, P.C.**

LOCATION: Hesperia, MI

DESCRIPTION OF MATERIAL

SURFACE ELEVATION (ft.) 722.0

DEPTH (FT) | ELEVATION (FT) | SAMPLE NO. | SAMPLE TYPE | SAMPLE DISTANCE | RECOVERY | UNIT DRY WT. LBS/FT^3

SAMPLE NO.	SAMPLE TYPE
1A	SS
1B	SS
2	SS
3	SS
4	SS
5	SS
6	SS
7	SS
8	SS
9	SS
10	SS
11	SS

Driller reported topsoil

1.0
Fill: Fine to medium sand - some fine to coarse gravel - trace to some silt - brown - loose to medium dense - moist (SP-SM)

5.0
Fill: Gravelly fine to coarse sand - trace to some silt - brown - medium dense - wet (SP-SM)

6.5
Fill: Fine to medium sand - trace silt and fine to coarse gravel - brown and dark brown - loose - wet (SP)

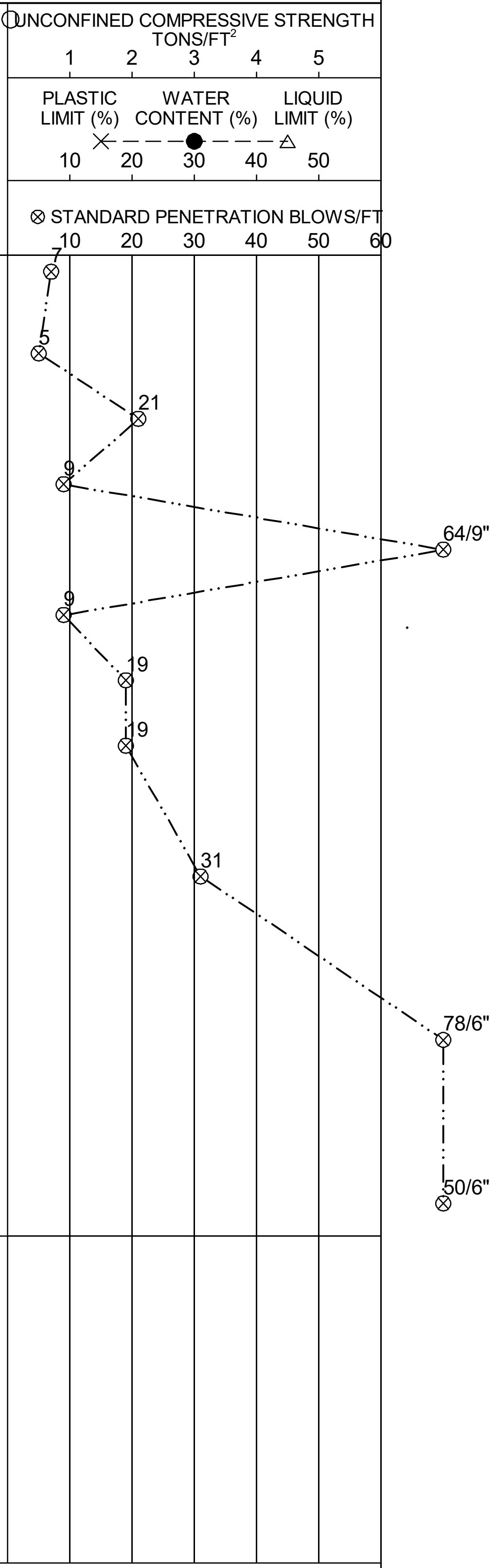
8.0
Fill: Gravelly fine to coarse sand - trace to some silt - frequent wood pieces - brown and dark brown - extremely dense to loose - wet (SP-SM)

12.0
Buried wood - trace fine sand - black (PT)

14.5
Fine sand - trace to some silt - trace medium sand and fine to coarse gravel - brown - medium dense to extremely dense - wet (SP-SM)

30.0
End of Boring

Boring advanced to 28.0 feet with hollow-stem auger.
Standard Penetration Tests performed with safety hammer.
Boring backfilled with cement bentonite grout.



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL: 5.0' WS	BORING STARTED **10/22/2024**	GEI OFFICE **Marquette, MI**	
	BORING COMPLETED **10/22/2024**	ENTERED BY **LJE**	APPROVED BY **CRA**
NORTHING EASTING	RIG/FOREMAN **Acker Renegade / WP (Pearson)**	GEI PROJECT NO. **2403886**	PAGE NO. **1** OF **1**

GEI Consultants	LOG OF BORING NUMBER **B-04**
CLIENT: **Village of Hesperia**	
PROJECT NAME: **Hesperia Dam**	ARCHITECT-ENGINEER **GEI Consultants of MI, P.C.**

LOCATION: Hesperia, MI

SURFACE ELEVATION (ft.) 719.0

SAMPLE NO.	SAMPLE TYPE
1	SS
2	SS
3	SS
4	SS
5	SS
6	SS
7	SS
8	SS
9	SS
10	SS
11A	SS
11B	SS

DEPTH (FT): 10, 20, 30

ELEVATION (FT): 710, 700, 690, 680

DESCRIPTION OF MATERIAL

Driller reported topsoil

1.0
Fill: Fine to coarse sand - trace to some silt - trace fine to coarse gravel, topsoil, and saw dust - brown and dark brown - very loose to loose - moist (SP-SM)

Note: 2 inch layers of sawdust encountered between 4 feet to 10 feet

9.0
Fill: Fine to medium sand - some silt - black - very loose - moist (SM/Buried Topsoil)

10.0
Possible Fill: Gravelly fine to medium sand - trace to some silt - trace topsoil - brown and dark brown - loose to medium dense - moist wet (SP-SM)

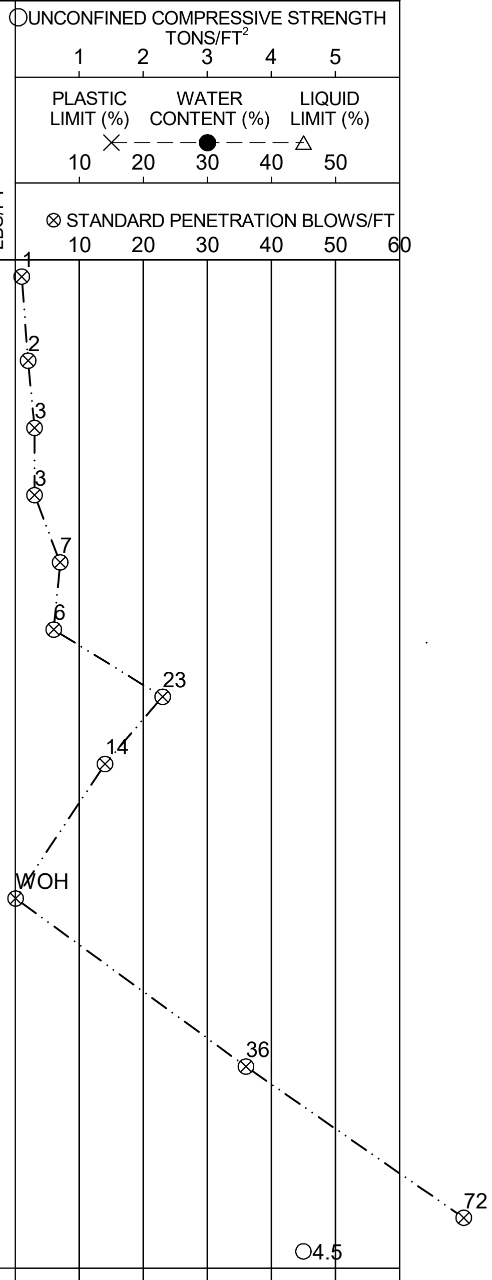
15.0
Silty fine sand - trace clay, medium to coarse sand, and fine gravel - brown - very dense - wet (SM)

29.0
Silty clay - trace fine sand - brown - hard (CL)

30.0
End of Boring

Boring advanced to 28.0 feet with hollow-stem auger.
Standard Penetration Tests performed with safety hammer.
Boring backfilled with cement bentonite grout.

UNIT DRY WT. LBS/FT³



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL: 12.0' WS	BORING STARTED **10/22/2024**	GEI OFFICE **Marquette, MI**	
	BORING COMPLETED **10/22/2024**	ENTERED BY **LJE**	APPROVED BY **CRA**
NORTHING **0.000** EASTING **8.000**	RIG/FOREMAN **Acker Renegade / WP (Pearson)**	GEI PROJECT NO. **2403886**	PAGE NO. **1** OF **1**

A.2. Monitoring Well Installation Logs (GEI, 2024)

Groundwater Well Installation Log

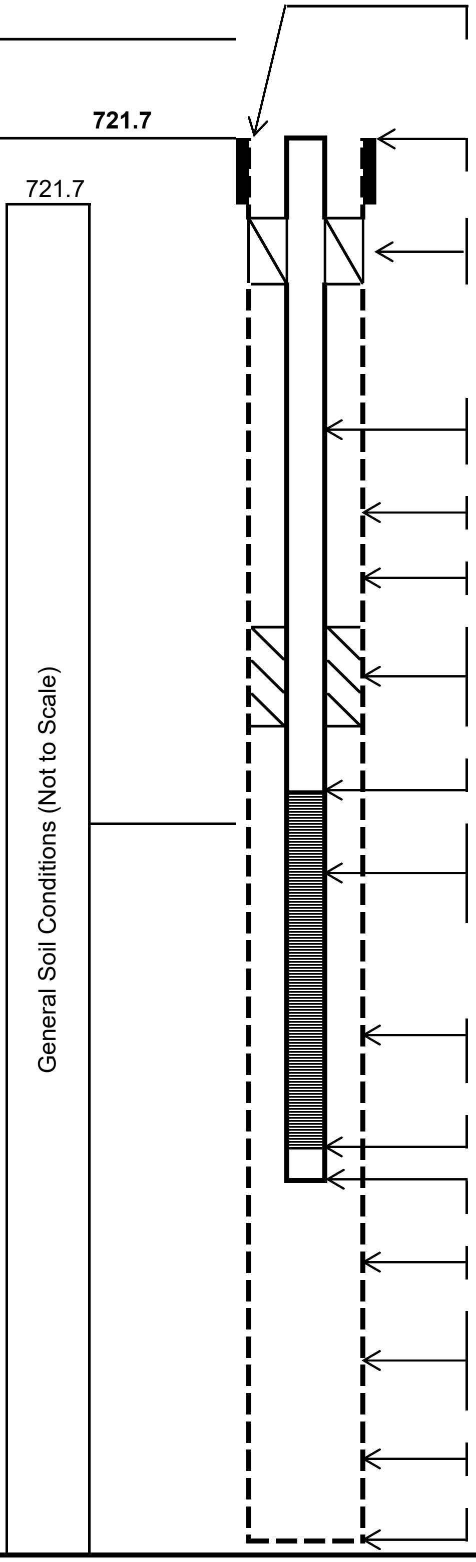
Project Hesperia Dam
City / Town Hesperia, MI
Client Village of Hesperia
Contractor Pearson Drilling
Driller Will Pearson **GEI Rep.** M. Lemanski

GEI Proj. No. 2403886
Location B-01C
Name H-1
Install Date 10/21/2024

Survey Datum:

Top PVC Elevation: **721.7**

Ground Elev.: 721.7



Date	Time	Distance to ▼ below top of riser pipe
10/21/2024	-	8.5

Length of Surface Casing above Ground 0.0 ft
Dist. Top of Surf. Casing to Top of Riser Pipe -0.5 ft
Casing Type
Top Seal Type Flush Mounted Casing
ID and OD of Riser Pipe 2.0 ID / 2.125 in. OD
Type of Riser Pipe PVC
Type of Backfill around Riser Pipe Cement-Bentonite Grout
Diameter of Borehole 6.0 in
Depth Top of Filter Material 12.0 ft
Type of Seal Bentonite Seal
Depth Bottom of Seal 13.0 ft
Depth Top of Screened Section 15.0 ft
Type of Screen 5 ft Sch. 40 PVC Pipe
Description of Screen Openings
ID and OD of Screened Section 2.0 in. ID / 2.125 in. OD
Type of Filter Material Sand
Depth Bottom of Screened Section 20 ft
Depth of Silt Trap N/A
Depth Bottom of Filter Material 30.0 ft
Depth Top of Seal NA
Type of Seal NA
Depth Bottom of Seal NA
Type of Backfill below Filter Material Sand
Bottom of Borehole 30.0 ft

Notes: This monitoring well was installed in the Borehole B-01C

GEI Consultants

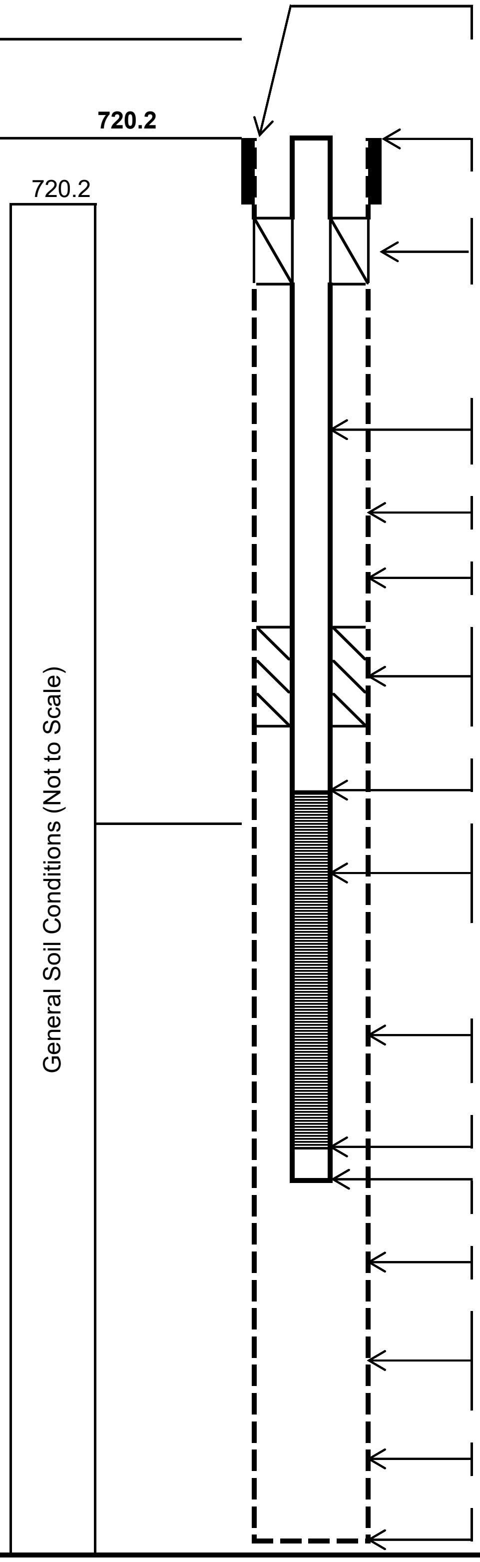
Groundwater Well Installation Log

Project	Hesperia Dam	**GEI Proj. No.**	2403886
City / Town	Hesperia, MI	**Location**	B-02B
Client	Village of Hesperia	**Name**	H-2
Contractor	Pearson Drilling		
Driller	Will Pearson **GEI Rep.** M. Lemanski	**Install Date**	10/21/2024

Survey Datum: ____________

Top PVC Elevation: 720.2

Ground Elev.: 720.2



Date	Time	Distance to ▼ below top of riser pipe
10/21/2024	-	4.8

Length of Surface Casing above Ground	0.0 ft
Dist. Top of Surf. Casing to Top of Riser Pipe	-0.5 ft
Casing Type	
Top Seal Type	Flush Mounted Casing
ID and OD of Riser Pipe	2.0 ID / 2.125 in. OD
Type of Riser Pipe	PVC
Type of Backfill around Riser Pipe	Cement-Bentonite Grout
Diameter of Borehole	6.0 in
Depth Top of Filter Material	10.0 ft
Type of Seal	Bentonite Seal
Depth Bottom of Seal	11.0 ft
Depth Top of Screened Section	13.0 ft
Type of Screen	5 ft Sch. 40 PVC Pipe
Description of Screen Openings	
ID and OD of Screened Section	2.0 in. ID / 2.125 in. OD
Type of Filter Material	Sand
Depth Bottom of Screened Section	18 ft
Depth of Silt Trap	N/A
Depth Bottom of Filter Material	30.0 ft
Depth Top of Seal	NA
Type of Seal	NA
Depth Bottom of Seal	NA
Type of Backfill below Filter Material	Sand
Bottom of Borehole	30.0 ft

Notes: This monitoring well was installed in the Borehole B-02B

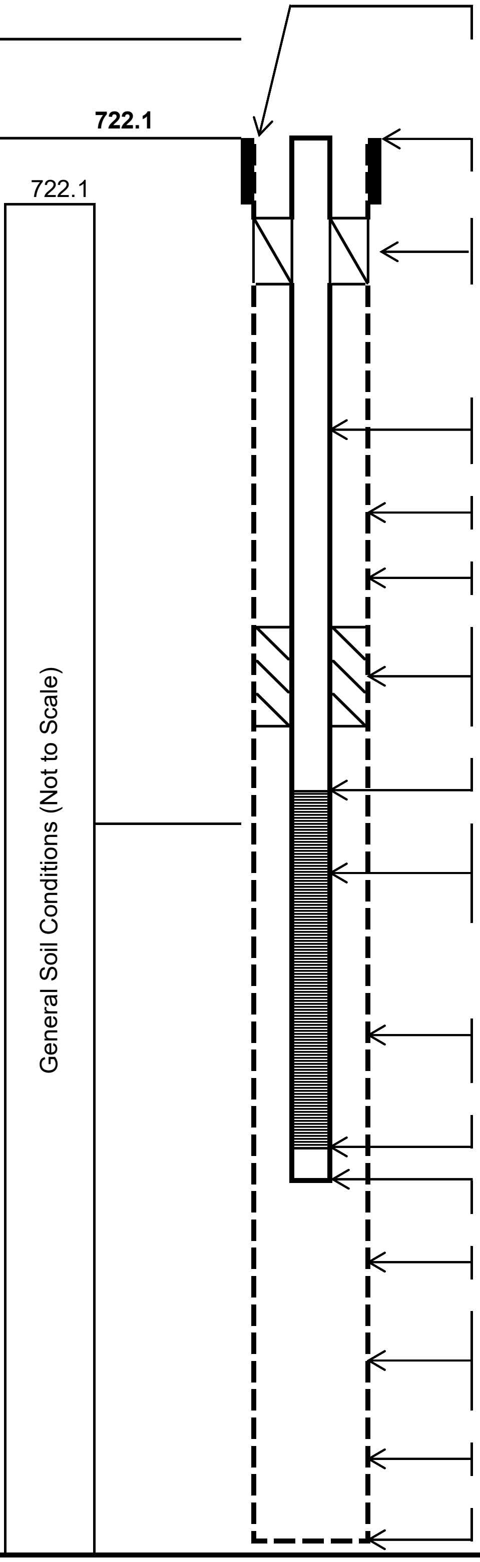
Groundwater Well Installation Log

Project	Hesperia Dam	**GEI Proj. No.**	2403886
City / Town	Hesperia, MI	**Location**	B-03
Client	Village of Hesperia	**Name**	H-3
Contractor	Pearson Drilling		
Driller	Will Pearson **GEI Rep.** M. Lemanski	**Install Date**	10/22/2024

Survey Datum:

Top PVC Elevation: **722.1**

Ground Elev.: 722.1



Length of Surface Casing above Ground	0.0 ft
Dist. Top of Surf. Casing to Top of Riser Pipe	-0.5 ft
Casing Type	
Top Seal Type	Flush Mounted Casing
ID and OD of Riser Pipe	2.0 ID / 2.125 in. OD
Type of Riser Pipe	PVC
Type of Backfill around Riser Pipe	Cement-Bentonite Grout
Diameter of Borehole	6.0 in
Depth Top of Filter Material	5.0 ft
Type of Seal	Bentonite Seal
Depth Bottom of Seal	6.0 ft
Depth Top of Screened Section	8.0 ft
Type of Screen	5 ft Sch. 40 PVC Pipe
Description of Screen Openings	
ID and OD of Screened Section	2.0 in. ID / 2.125 in. OD
Type of Filter Material	Sand
Depth Bottom of Screened Section	13 ft
Depth of Silt Trap	N/A
Depth Bottom of Filter Material	30.0 ft
Depth Top of Seal	NA
Type of Seal	NA
Depth Bottom of Seal	NA
Type of Backfill below Filter Material	Sand
Bottom of Borehole	30.0 ft

Date	Time	Distance to ▼ below top of riser pipe
10/22/2024	-	5.4

Notes: This monitoring well was installed in the Borehole B-3

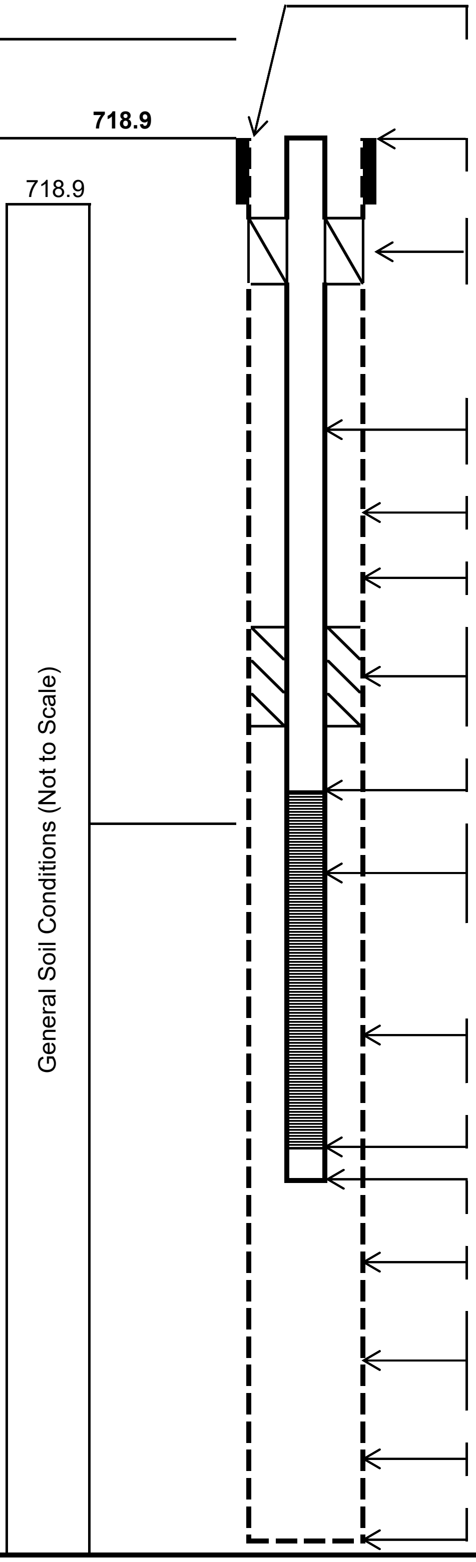
Groundwater Well Installation Log

Project	Hesperia Dam	**GEI Proj. No.**	2403886
City / Town	Hesperia, MI	**Location**	B-04
Client	Village of Hesperia	**Name**	H-4
Contractor	Pearson Drilling		
Driller	Will Pearson **GEI Rep.** M. Lemanski	**Install Date**	10/22/2024

Survey Datum:

Top PVC Elevation: **718.9**

Ground Elev.: 718.9



Length of Surface Casing above Ground	0.0 ft
Dist. Top of Surf. Casing to Top of Riser Pipe	-0.5 ft
Casing Type	
Top Seal Type	Flush Mounted Casing
ID and OD of Riser Pipe	2.0 ID / 2.125 in. OD
Type of Riser Pipe	PVC
Type of Backfill around Riser Pipe	Cement-Bentonite Grout
Diameter of Borehole	6.0 in
Depth Top of Filter Material	7.0 ft
Type of Seal	Bentonite Seal
Depth Bottom of Seal	8.0 ft
Depth Top of Screened Section	10.0 ft
Type of Screen	5 ft Sch. 40 PVC Pipe
Description of Screen Openings	
ID and OD of Screened Section	2.0 in. ID / 2.125 in. OD
Type of Filter Material	Sand
Depth Bottom of Screened Section	15 ft
Depth of Silt Trap	N/A
Depth Bottom of Filter Material	30.0 ft
Depth Top of Seal	NA
Type of Seal	NA
Depth Bottom of Seal	NA
Type of Backfill below Filter Material	Sand
Bottom of Borehole	30.0 ft

Date	Time	Distance to ▼ below top of riser pipe
10/22/2024	-	4.4

Notes: This monitoring well was installed in the Borehole B-04

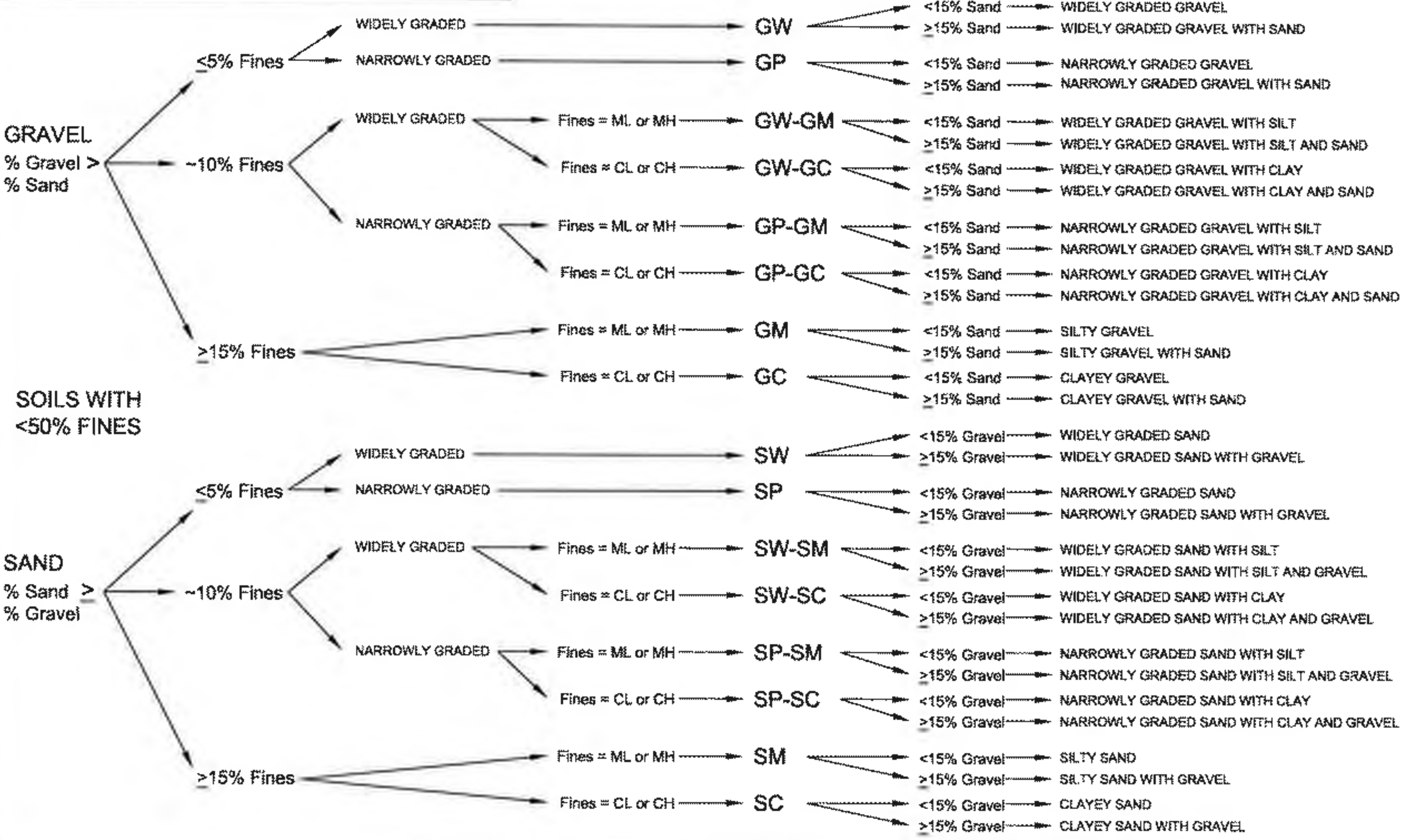
A.3. General Soil Classification Procedures

GEI Consultants

COARSE-GRAINED SOILS
VISUAL-MANUAL DESCRIPTIONS

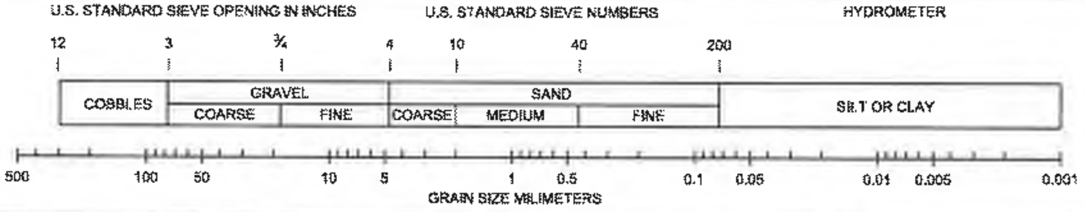
TYPICAL SOIL COLORS

- 🟨 YELLOW
- 🟩 OLIVE
- 🟫 LIGHT BROWN
- 🟫 BROWN
- 🟥 REDDISH BROWN
- 🟥 RED
- ⬜ GRAY
- ⬛ BLACK



SOILS WITH <50% FINES

				GROUP SYMBOL		GROUP NAME
GRAVEL % Gravel > % Sand	≤5% Fines	WIDELY GRADED		GW	<15% Sand	WIDELY GRADED GRAVEL
					≥15% Sand	WIDELY GRADED GRAVEL WITH SAND
		NARROWLY GRADED		GP	<15% Sand	NARROWLY GRADED GRAVEL
					≥15% Sand	NARROWLY GRADED GRAVEL WITH SAND
	~10% Fines	WIDELY GRADED	Fines = ML or MH	GW-GM	<15% Sand	WIDELY GRADED GRAVEL WITH SILT
					≥15% Sand	WIDELY GRADED GRAVEL WITH SILT AND SAND
			Fines = CL or CH	GW-GC	<15% Sand	WIDELY GRADED GRAVEL WITH CLAY
					≥15% Sand	WIDELY GRADED GRAVEL WITH CLAY AND SAND
		NARROWLY GRADED	Fines = ML or MH	GP-GM	<15% Sand	NARROWLY GRADED GRAVEL WITH SILT
					≥15% Sand	NARROWLY GRADED GRAVEL WITH SILT AND SAND
			Fines = CL or CH	GP-GC	<15% Sand	NARROWLY GRADED GRAVEL WITH CLAY
					≥15% Sand	NARROWLY GRADED GRAVEL WITH CLAY AND SAND
	≥15% Fines		Fines = ML or MH	GM	<15% Sand	SILTY GRAVEL
					≥15% Sand	SILTY GRAVEL WITH SAND
			Fines = CL or CH	GC	<15% Sand	CLAYEY GRAVEL
					≥15% Sand	CLAYEY GRAVEL WITH SAND
SAND % Sand ≥ % Gravel	≤5% Fines	WIDELY GRADED		SW	<15% Gravel	WIDELY GRADED SAND
					≥15% Gravel	WIDELY GRADED SAND WITH GRAVEL
		NARROWLY GRADED		SP	<15% Gravel	NARROWLY GRADED SAND
					≥15% Gravel	NARROWLY GRADED SAND WITH GRAVEL
	~10% Fines	WIDELY GRADED	Fines = ML or MH	SW-SM	<15% Gravel	WIDELY GRADED SAND WITH SILT
					≥15% Gravel	WIDELY GRADED SAND WITH SILT AND GRAVEL
			Fines = CL or CH	SW-SC	<15% Gravel	WIDELY GRADED SAND WITH CLAY
					≥15% Gravel	WIDELY GRADED SAND WITH CLAY AND GRAVEL
		NARROWLY GRADED	Fines = ML or MH	SP-SM	<15% Gravel	NARROWLY GRADED SAND WITH SILT
					≥15% Gravel	NARROWLY GRADED SAND WITH SILT AND GRAVEL
			Fines = CL or CH	SP-SC	<15% Gravel	NARROWLY GRADED SAND WITH CLAY
					≥15% Gravel	NARROWLY GRADED SAND WITH CLAY AND GRAVEL
	≥15% Fines		Fines = ML or MH	SM	<15% Gravel	SILTY SAND
					≥15% Gravel	SILTY SAND WITH GRAVEL
			Fines = CL or CH	SC	<15% Gravel	CLAYEY SAND
					≥15% Gravel	CLAYEY SAND WITH GRAVEL



1. GROUP NAME and (SYMBOL)
2. Structure , if any. (stratified layer thicknesses, lenses, varves, gradational changes)
3. Describe sand, gravel and fines components, with percentages, in order of predominance. Include max gravel size. For test pits give percent cobbles and boulders, by volume, and include max size.
4. Color
5. Sheen, odor, roots, ash, brick, cementation, reaction with HCL, etc.
6. "Fill," local name or geologic name, if known

ROUNDED

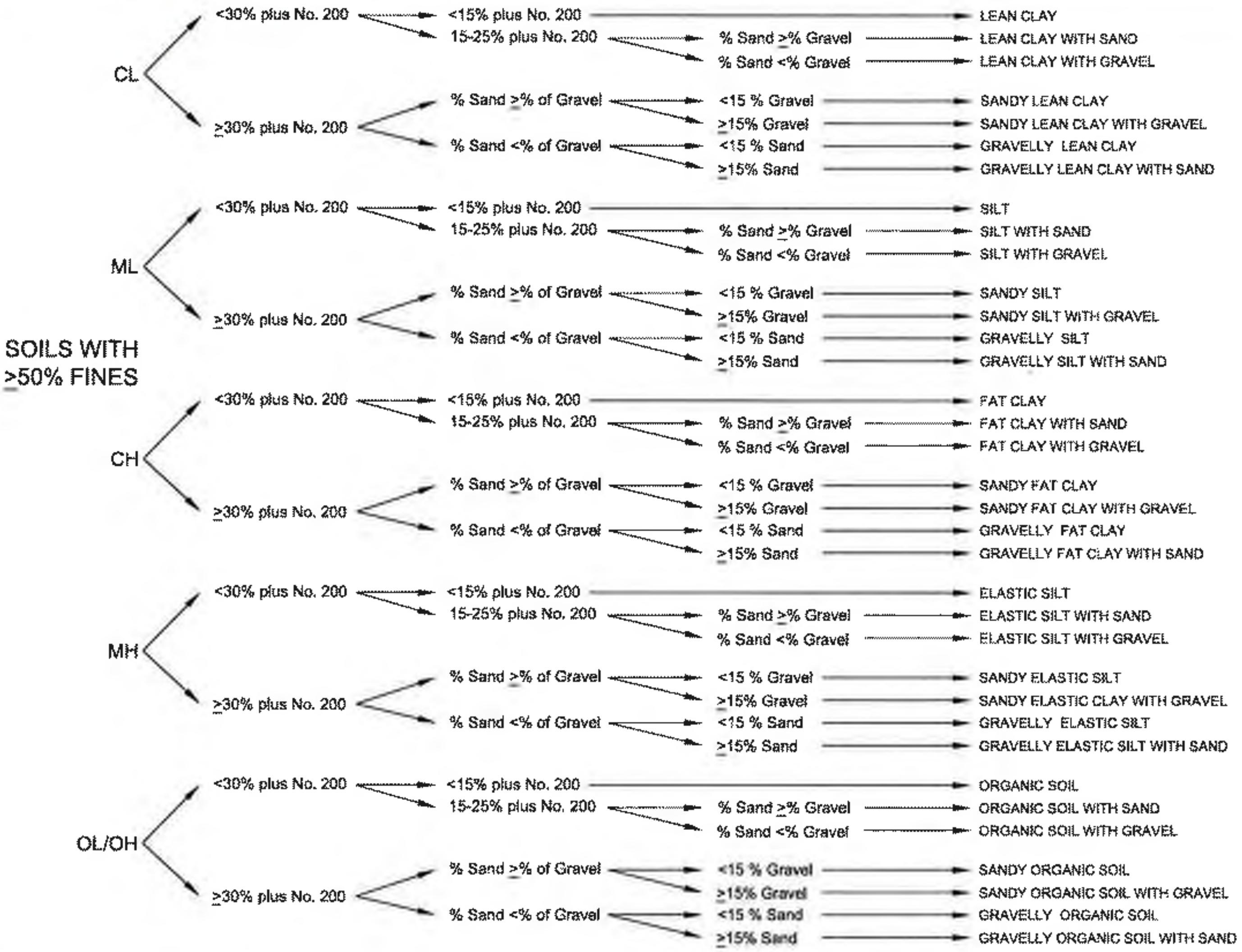
SUBROUNDED

SUBANGULAR

ANGULAR

FINE-GRAINED SOILS

VISUAL-MANUAL DESCRIPTIONS



ID OF INORGANIC FINE SOILS FROM MANUAL TESTS

Symbol	Name	Dry Strength	Dilatancy	Toughness*
ML	Silt	None to low	Slow to rapid	Low or thread cannot be formed
CL	Lean Clay	Medium to high	None to slow	Medium
MH	Elastic Silt	Low to medium	None to slow	Low to medium
CH	Fat Clay	High to very high	None	High

1. GROUP NAME and (SYMBOL)
2. Describe fines, sand, and gravel components, in order of predominance. Include plasticity of fines. Include percentages of sand and gravel.
3. Color
4. Sheen, odor, roots, ash, brick, cementation, torvane and penetrometer results, etc.
5. "Fill," local name or geologic name, if known

PEAT

Peat refers to a sample composed primarily of vegetable matter in varying stages of decomposition. The description should begin: PEAT (PT) and need not include percentages of sand, gravel or fines.

CRITERIA FOR DESCRIBING PLASTICITY

Description	Criteria
Nonplastic ML	A 1/8-in. (3 -mm) thread cannot be rolled at any water content
Low Plasticity ML, MH	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit *
Medium Plasticity MH, CL	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High Plasticity CH	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

* Toughness refers to the strength of the thread near plastic limit. The lump refers to a lump of soil drier than the plastic, similar to dry strength.

GENERAL NOTES

Drilling and Sampling Symbols:

SS: Split-Spoon, 1 3/8-inch ID, 2-inch OD
Unless otherwise noted
ST: Shelby Tube
PA: Power Auger
DB: Diamond Bit
AS: Auger Sample
JS: Jar Sample
VS: Vane Shear
WOH: Weight of Hammer

OS: Osterburg Sampler
HSA: Hollow Stem Auger
WS: Wash Sample
FT: Fish Tail
RB: Rock Bit
BS: Bulk Sample
PMT: Pressuremeter Test
GS: Giddings Sampler

Standard Penetration Test (STP) Value: Blows per foot of a 140-pound hammer falling 30 inches on a 2-inch OD split-spoon sampler, except where otherwise noted.

Water Level Measurement Symbols:

WL: Water Level
WS: While Sampling
WD: While Drilling
AB: After Boring

WCI: Wet Cave-in
DCI: Dry Cave-in
BCI: Before Casing Installation
BCR: Before Casing Removal
ACR: After Casing Removal

Water levels indicated on the boring logs are the levels measured in the boring at the time indicated. In permeable soils, the indicated elevations can be considered a reliable groundwater level. In impervious soils, the accurate determination of groundwater elevations may not be possible, even after several days of observations. In these cases, groundwater monitoring wells may need to be constructed and monitored for an extended period of time to determine the actual groundwater level.

Gradation Description and Terminology:

Coarse-grained or granular soils are defined as having more than 50% of their dry weight retained on the No. 200 sieve. Coarse grained soils include boulders, cobbles, gravel, and/or sand. Fine-grained soils are defined as having less than 50% of their dry weight retained on the No. 200 sieve. Fine grained soils include clay or clayey silt (cohesive), and silt (non-cohesive). In addition to gradation, granular soils are further defined based on their relative in-place density. Fine-grained soils are further defined based of their strength or consistency and plasticity. Additional information is provided below.

Major Component of Sample	Size Range	Other Components Present in Sample	Dry Weight, %
Boulders	Over 8 inches (200 mm)	Trace	1 to 5
Cobbles	8 inches to 3 inches (200 mm to 75 mm)	Trace to Some	5 to 12
Gravel	3 inches to No. 4 sieve	Some	12 to 34
Sand	Nos. 4 to 200 sieves (4.76 mm to 0.074 mm)	And	34 to 50
Silt	Passing No. 200 sieve (0.074 mm to 0.005 mm)		
Clay	Smaller than 0.005 mm		

Consistency of Cohesive Soils		Relative Density of Granular Soils	
Unconfined Compressive Strength, Qu, tsf	Consistency	N, blows per foot	Relative Density
<0.25	Very Soft	0 to 3	Very Loose
0.25 to 0.49	Soft	4 to 9	Loose
0.50 to 0.99	Medium (firm)	10 to 29	Medium Dense
1.0 to 1.99	Stiff	30 to 49	Dense
2.00 to 3.99	Very Stiff	50 – 80	Very Dense
4.00 to 8.00	Hard	>80	Extremely Dense
>8.00	Very Hard		

FIELD AND LABORATORY PROCEDURES

Field Sampling Procedures

Auger Sampling (AS)

In this procedure, soil samples are collected from cuttings off the auger flights as they are removed from the ground. Such samples provide a general indication of subsurface conditions; however, they do not provide undisturbed samples, nor do they provide samples from discrete depths.

Split-Barrel Sampling (SS) – (ASTM Standard D-1586-99)

In the split-barrel sampling procedures, a 2-inch O.D. split-barrel sampler is driven into the soil a distance of 18 inches by means of a 140-pound hammer falling 30 inches. The value of the Standard Penetration Resistance is obtained by counting the number of blows of the hammer over the final 12 inches of driving. The value provides a qualitative indication of the in-place relative density of cohesionless soils. The indication is only qualitative, however, since many factors can significantly affect the Standard Penetration Resistance Value, and direct correlation of results obtained by drill crews using different rigs, frilling procedures, and hammer-rod-spoon assemblies should not be made. A portion of the recovered sample is place in a sample jar and returned to the laboratory for further analysis and testing.

Shelby Tube Sampling Procedure (ST) - (ASTM D-1587-94)

In the Shelby tube sampling procedure, a thin-walled steel seamless tube with a sharp cutting edge is pushed hydraulically into the soil and a relatively undisturbed sample is obtained. This procedure is generally employed in cohesive soils. The tubes are identified, sealed, and carefully handled in the field to avoid excessive disturbance and are returned to the laboratory for extrusion and further analysis and testing.

Giddings Sampler (GS)

This type of sampling device consists of 5-foot sections of thin-wall tubing, which are capable of retrieving continuous columns of soil in 5-foot maximum increments. Because of a continuous slot in the sampling tubes, the sampler allows field determination of stratification boundaries and containerization of soil samples from any sampling depth within the 5-foot interval.

FIELD AND LABORATORY PROCEDURES

Subsurface Exploration Field Procedures

Hand-Auger Drilling (HA)

In this procedure, a sampling device is driven into the soil by repeated blows of a sledge hammer or a drop hammer. When the sampler is driven to the desired depth, the soil sample is retrieved. The hole is then advanced by manually turning the hand auger until the next sampling depth increment is reached. The hand auger drilling between sampling intervals also helps to clean and enlarge the borehole in preparation for obtaining the next sample.

Power Auger Drilling (PA)

In this type of drilling procedures, continuous flight augers are used to advance the boreholes. They are turned and hydraulically advanced by a truck, trailer, or track-mounted unit as site accessibility dictates. In auger drilling, casing and drilling mud are not required to maintain open boreholes.

Hollow-Stem Auger Drilling (HS)

In this drilling procedure, continuous flight augers (with open stems) are used to advance the boreholes. The open stem allows the sampling tool to be used without removing the augers from the borehole. Hollow-stem augers thus provide support to the sides of the borehole during the sampling operations.

Rotary Drilling (RD)

In employing rotary drilling methods, various cutting bits are used to advance the boreholes. In this process, surface casing and/or drilling fluids are used to maintain open boreholes.

Diamond Core Drilling (DB)

Diamond core drilling is used to sample cemented formations. In this procedure, a double tube (or triple tube) core barrel with a diamond bit cuts an annular space around a cylindrical prism of the material sampled. The sample is retrieved by a catcher just above the bit. Samples recovered by this procedure are placed in study containers in sequential order.

FIELD AND LABORATORY PROCEDURES

Laboratory Procedures

Water Content (Wc)

The water content of a soil is the ratio of the weight of water in a given soil mass to the weight of the dry soil. Water content is generally expressed as a percentage.

Hand Penetrometer (Qp)

In the hand penetrometer gtest, the unconfined compressive strength of a soil is determined to a maximum value of 4.5 tons per square foot (tsf) or 7.0 tsf, depending on the testing device utilized, by measuring the resistance of the soil sample to penetration by a small spring-calibrated cylinder. The hand penetrometer test has been carefully correlated with unconfined compressive strength tests and thereby provides a useful and a relative simple testing procedure in which soil strength can be quickly and easily estimated.

Unconfined Compression Tests (Qu)

In the unconfined compression strength test, an undisturbed prism of soil is loaded axially until failure or until 20% strain has been reached, whichever comes first.

Dry Density (γd)

The dry density is a measure of the amount of solids in a unit volume of soil. Use of this value is often made when measuring the degree of compaction of a soil.

Classification of Samples

In conjunction with the sample testing program, all soil samples are examined in our laboratory and visually classified on the basis of their texture and plasticity in general accordance with the Unified Soil Classification System. The soil descriptions on the boring logs are derived from this system, as well as the component gradation terminology, consistency of cohesive soils, and relative density of granular soils, as described on a separate sheet entitled General Notes. The estimated groups symbols, included in parentheses following the soil descriptions on the boring logs, are in general conformance with the Unified Soil Classification System (USCS).

FIELD AND LABORATORY PROCEDURES

Standard Boring Log Procedures

In the process of obtaining and testing samples and preparing this report, standard procedures are followed regarding field logs, laboratory data sheets, and samples.

Field logs are prepared during performance of the drilling and sampling operations and are intended to essentially portray field occurrences, sampling locations, and procedures.

Samples obtained in the field are frequently subjected to additional testing an re-classification in the laboratory by experienced Geotechnical Engineers; and therefore, differences between the field logs and the final logs may exist. The engineer preparing the report reviews the field logs, laboratory test data, and classifications and then, using judgement and experience in interpreting this data, may make further changes. It is common practice in the geotechnical engineering profession not to include field logs and laboratory data sheets in engineering reports, because they do not represent the engineer's final opinions as to appropriate descriptions for conditions encountered in the exploration and testing work. Results of laboratory tests are generally shown on the boring logs or are described in the text of the report, as appropriate.

Samples taken in the field, some of which are later subjected to laboratory tests, are retained in our laboratory for 60 days and then discarded, unless special disposition is requested by our client. Samples retained over a long period of time, even though in sealed jars, are subject to moisture loss, which changes the apparent strength of cohesive soil, generally increasing the strength from what was originally encountered in the field. Since they are then no longer representative of the moisture conditions initially encountered, observers of these samples need to recognize this factor.

Appendix B Laboratory Test Results

B.1. Summary of Laboratory Testing

B.2. Hydrometer

B.3. Sieve Analysis

B.4. Atterberg Limits

B.1. Summary of Laboratory Testing

Appendix B: Hesperia GDR Summary Table

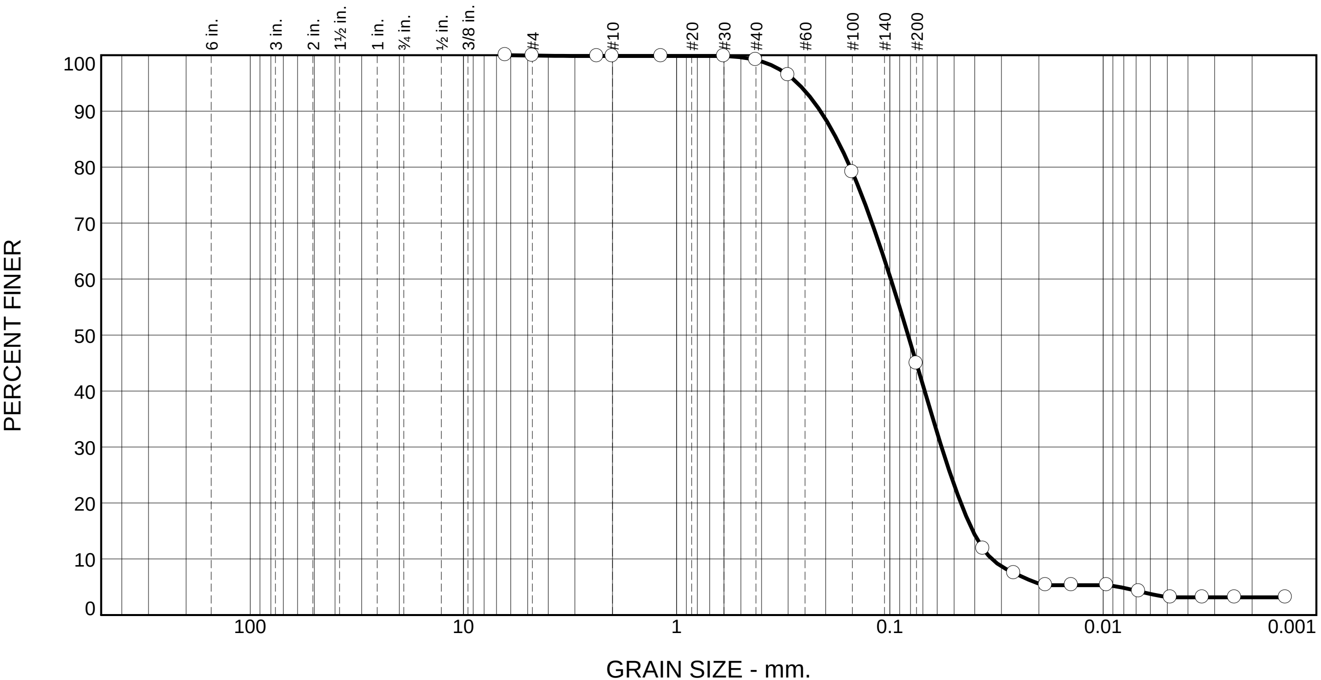
Table 1. Summary of Laboratory Testing

Boring	Sample	Average Elevation (ft)	Fill/ Natural	USCS[1]	Grain Size Analysis					Atterberg Limits		
					Gravel (%)	Sand (%)	Fines					
							Total (%)	Silt (%)	Clay (%)	Liquid Limit	Plastic Limit	Plasticity Index
B-01C	S-2B	719	Fill	SM	1.0	54.3	44.7	-	-	-	-	-
B-01C	S-6	711	Fill	SP-SM	5.1	88.5	6.4	-	-	-	-	-
B-01C	S-8	707	Natural	SP-SM	13.7	80.6	5.7	-	-	-	-	-
B-01C	S-10	698	Natural	ML	-	-	-	-	-	22	22	NP
B-02B	S-2	718	Fill	SP	34.9	60.3	4.8	-	-	-	-	-
B-02B	S-6	709	Natural	SP	0.6	94.0	5.4	-	-	-	-	-
B-02C	S-2	696	Natural	GP	70.3	27.5	2.2	-	-	-	-	-
B-03	S-2	719	Fill	SP-SM	12.5	76	11.5	-	-	-	-	-
B-03	S-9	702	Natural	SP-SM	0.0	92.9	7.1	-	-	-	-	-
B-04	S-3	714	Fill	SP-SM	3.0	88.4	8.6	-	-	-	-	-
B-04	S-7	706	Fill	SP-SM	32.5	59.9	7.6	-	-	-	-	-
B-04	S-9	700	Natural	SM	0.1	55.0	44.9	41.7	3.2	-	-	-

1. The material description and USCS symbol with this test refers only to the minus No. 40 sieve material and therefore may differ from the full soil description. See the "Particle Size Distribution Report", and soil boring logs for complete sample USCS classification.

B.2. Hydrometer

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.1	0.7	54.2	41.7	3.2

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1/4"	100.0		
#4	99.9		
#8	99.8		
#10	99.8		
#16	99.8		
#30	99.8		
#40	99.1		
#50	96.4		
#100	79.1		
#200	44.9		
0.0366 mm.	11.8		
0.0261 mm.	7.5		
0.0186 mm.	5.3		
0.0140 mm.	5.3		
0.0096 mm.	5.3		
0.0068 mm.	4.2		
0.0048 mm.	3.2		
0.0034 mm.	3.2		
0.0024 mm.	3.2		
0.0014 mm.	3.2		

* (no specification provided)

Material Description

Silty fine sand- trace clay, medium to coarse sand, and fine gravel- brown

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 0.2118	D_{85}= 0.1774	D_{60}= 0.0990
D_{50}= 0.0822	D_{30}= 0.0572	D_{15}= 0.0408
D_{10}= 0.0333	C_u= 2.98	C_c= 0.99

Remarks

Date Received: 10/22/2024 **Date Tested:** 12/27/2024

Tested By: Kevin Rautiola

Checked By: Chris Abraham, PE

Title: QA Manager

Location: B-04

Sample Number: S-9 **Depth:** 18.0 to 20.0 Feet

Date Sampled: 10/22/2024

GEI Consultants of Michigan, P.C.

Marquette, Michigan

Client: Village of Hesperia

Project: Hesperia Dam

Project No: 2403886 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

1/3/2025

Client: Village of Hesperia
Project: Hesperia Dam
Project Number: 2403886
Location: B-04
Depth: 18.0 to 20.0 Feet **Sample Number:** S-9
Material Description: Silty fine sand- trace clay, medium to coarse sand, and fine gravel- brown
Sample Date: 10/22/2024
Date Received: 10/22/2024 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: SM **AASHTO Classification:** A-4(0)
Grain Size Test Method: ASTM D 422
#200 Wash Method: ASTM D 1140
Tested By: Kevin Rautiola **Test Date:** 12/27/2024
Checked By: Chris Abraham, PE **Title:** QA Manager

Sieve Test Data

Post #200 Wash Test Weights (grams): **Dry Sample and Tare =** 512.40
Tare Wt. = 346.40
Minus #200 from wash = 35.0%

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
601.90	346.40	1-1/2"			
		1"			
		3/4"			
		1/2"			
		3/8"			
		1/4"	0.00	0.00	100.0
		#4	0.20	0.00	99.9
		#8	0.20	0.00	99.8
		#10	0.00	0.00	99.8
		#16	0.00	0.00	99.8
		#30	0.00	0.00	99.8
		#40	1.80	0.00	99.1
		#50	6.90	0.00	96.4
		#100	44.30	0.00	79.1
		#200	87.30	0.00	44.9

Hydrometer Test Data

Hydrometer test uses material passing #10

Percent passing #10 based upon complete sample = 99.8

Weight of hydrometer sample =55.63

Hygroscopic moisture correction:

Moist weight and tare = 600.30

Dry weight and tare = 556.00

Tare weight = 346.40

Hygroscopic moisture = 21.1%

Table of composite correction values:

Temp., deg. C:	23.1	22.0	21.0	20.0	19.0	18.2
Comp. corr.:	-2.1	-2.4	-2.7	-3.0	-3.3	-3.8

Meniscus correction only = 0.5

Specific gravity of solids = 2.65

Hydrometer type = 152H

Hydrometer effective depth equation: L = 16.294964 - 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
2.00	21.5	8.0	5.5	0.0134	8.5	14.9	0.0366	11.8
4.00	21.5	6.0	3.5	0.0134	6.5	15.2	0.0261	7.5
8.00	21.5	5.0	2.5	0.0134	5.5	15.4	0.0186	5.3
14.00	21.5	5.0	2.5	0.0134	5.5	15.4	0.0140	5.3
30.00	21.5	5.0	2.5	0.0134	5.5	15.4	0.0096	5.3
60.00	21.5	4.5	2.0	0.0134	5.0	15.5	0.0068	4.2
120.00	21.5	4.0	1.5	0.0134	4.5	15.6	0.0048	3.2
240.00	21.5	4.0	1.5	0.0134	4.5	15.6	0.0034	3.2
480.00	21.5	4.0	1.5	0.0134	4.5	15.6	0.0024	3.2
1440.00	21.5	4.0	1.5	0.0134	4.5	15.6	0.0014	3.2

Fractional Components

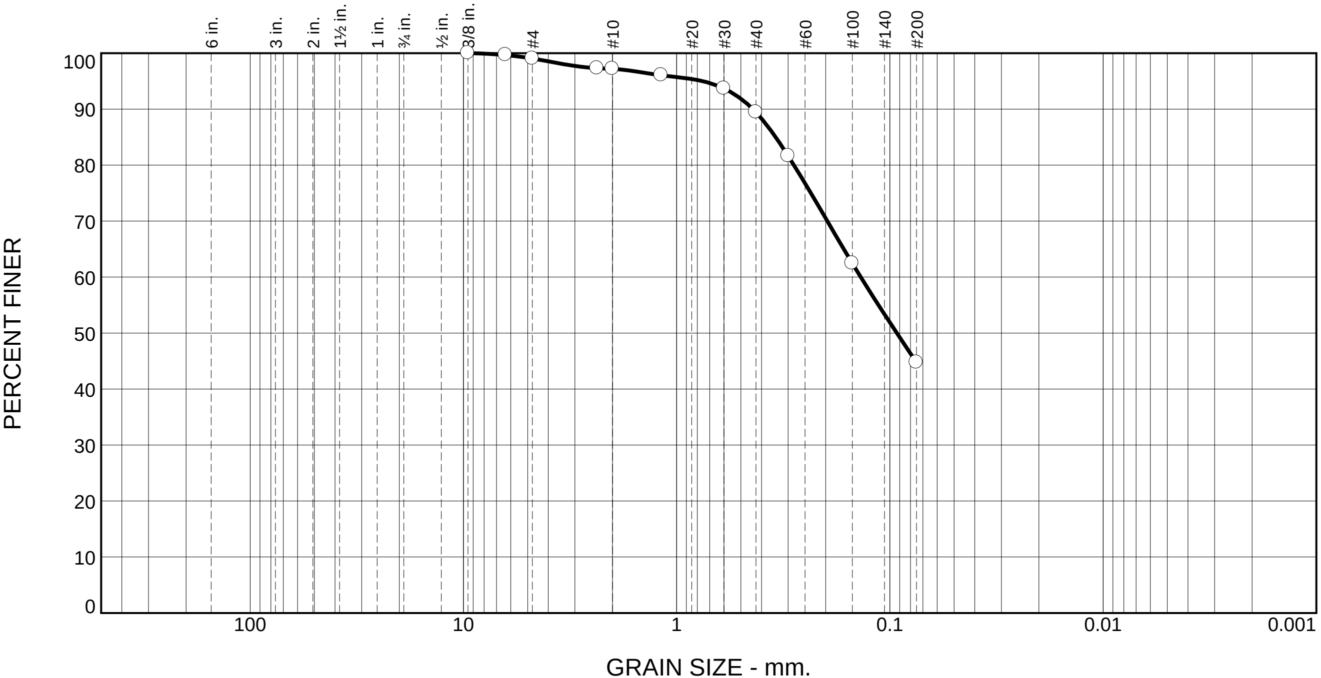
Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.1	0.1	0.1	0.7	54.2	55.0	41.7	3.2	44.9

D_{5}	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.0084	0.0333	0.0408	0.0465	0.0572	0.0687	0.0822	0.0990	0.1536	0.1774	0.2118	0.2711

Fineness Modulus	C_u	C_c
0.25	2.98	0.99

B.3. Sieve Analysis

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.0	1.8	7.8	44.7	44.7	

Test Results (ASTM C 136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/8"	100.0		
1/4"	99.7		
#4	99.0		
#8	97.3		
#10	97.2		
#16	96.0		
#30	93.7		
#40	89.4		
#50	81.6		
#100	62.4		
#200	44.7		

* (no specification provided)

Material Description

Silty fine to medium sand- trace coarse sand and fine gravel- brown

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 0.4392	D_{85}= 0.3436	D_{60}= 0.1370
D_{50}= 0.0928	D_{30}=	D_{15}=
D_{10}=	C_u=	C_c=

Remarks

Date Received: 10/21/2024 **Date Tested:** 12/27/2024

Tested By: Ben Carden

Checked By: Chris Abraham, PE

Title: QA Manager

Location: B-01C

Sample Number: S-2B **Depth:** 2.0 to 4.0 Feet

Date Sampled: 10/21/2024

GEI Consultants of Michigan, P.C.

Marquette, Michigan

Client: Village of Hesperia

Project: Hesperia Dam

Project No: 2403886 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

1/3/2025

Client: Village of Hesperia
Project: Hesperia Dam
Project Number: 2403886
Location: B-01C
Depth: 2.0 to 4.0 Feet   **Sample Number:** S-2B
Material Description: Silty fine to medium sand- trace coarse sand and fine gravel- brown
Sample Date: 10/21/2024
Date Received: 10/21/2024   **PL:** NP   **LL:** NV   **PI:** NP
USCS Classification: SM   **AASHTO Classification:** A-4(0)
Grain Size Test Method: ASTM C 136
#200 Wash Method: ASTM C 117
Tested By: Ben Carden   **Test Date:** 12/27/2024
Checked By: Chris Abraham, PE   **Title:** QA Manager

Sieve Test Data

Post #200 Wash Test Weights (grams): **Dry Sample and Tare =** 466.00
Tare Wt. = 347.20
Minus #200 from wash = 42.7%

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
554.60	347.20	1-1/2"			
		1"			
		3/4"			
		1/2"			
		3/8"	0.00	0.00	100.0
		1/4"	0.70	0.00	99.7
		#4	1.30	0.00	99.0
		#8	3.60	0.00	97.3
		#10	0.20	0.00	97.2
		#16	2.40	0.00	96.0
		#30	4.90	0.00	93.7
		#40	8.80	0.00	89.4
		#50	16.20	0.00	81.6
		#100	39.80	0.00	62.4
		#200	36.70	0.00	44.7

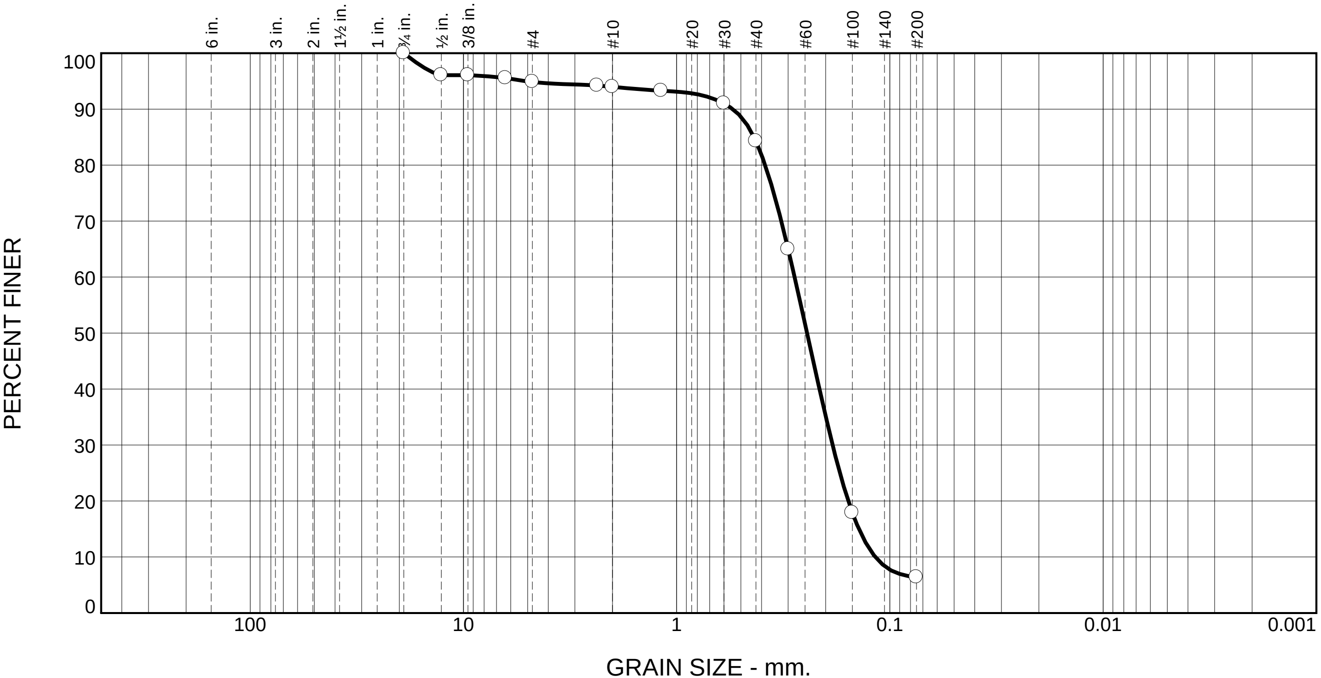
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	1.0	1.0	1.8	7.8	44.7	54.3			44.7

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
						0.0928	0.1370	0.2819	0.3436	0.4392	0.7582

Fineness Modulus
0.70

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	5.1	0.9	9.7	77.9	6.4	

Test Results (ASTM C 136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/4"	100.0		
1/2"	96.1		
3/8"	96.1		
1/4"	95.5		
#4	94.9		
#8	94.2		
#10	94.0		
#16	93.3		
#30	91.0		
#40	84.3		
#50	65.0		
#100	17.9		
#200	6.4		

* (no specification provided)

Material Description

Fine to medium sand- trace to some silt and fine gravel- trace coarse sand- brown

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 0.5453 D_{85}= 0.4338 D_{60}= 0.2797
D_{50}= 0.2446 D_{30}= 0.1856 D_{15}= 0.1398
D_{10}= 0.1170 C_u= 2.39 C_c= 1.05

Remarks

Date Received: 10/21/2024 **Date Tested:** 12/27/2024

Tested By: Ben Carden

Checked By: Chris Abraham, PE

Title: QA Manager

Location: B-01C **Date Sampled:** 10/21/2024
Sample Number: S-6 **Depth:** 10.0 to 12.0 Feet

GEI Consultants of Michigan, P.C.

Marquette, Michigan

Client: Village of Hesperia
Project: Hesperia Dam

Project No: 2403886 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

1/3/2025

Client: Village of Hesperia
Project: Hesperia Dam
Project Number: 2403886
Location: B-01C
Depth: 10.0 to 12.0 Feet **Sample Number:** S-6
Material Description: Fine to medium sand- trace to some silt and fine gravel- trace coarse sand- brown
Sample Date: 10/21/2024
Date Received: 10/21/2024 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: SP-SM **AASHTO Classification:** A-3
Grain Size Test Method: ASTM C 136
#200 Wash Method: ASTM C 117
Tested By: Ben Carden **Test Date:** 12/27/2024
Checked By: Chris Abraham, PE **Title:** QA Manager

Sieve Test Data

Post #200 Wash Test Weights (grams): **Dry Sample and Tare =** 551.60
Tare Wt. = 348.20
Minus #200 from wash = 5.7%

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
563.90	348.20	1-1/2"			
		1"			
		3/4"	0.00	0.00	100.0
		1/2"	8.50	0.00	96.1
		3/8"	0.00	0.00	96.1
		1/4"	1.10	0.00	95.5
		#4	1.50	0.00	94.9
		#8	1.40	0.00	94.2
		#10	0.50	0.00	94.0
		#16	1.50	0.00	93.3
		#30	4.90	0.00	91.0
		#40	14.50	0.00	84.3
		#50	41.60	0.00	65.0
		#100	101.60	0.00	17.9
		#200	24.80	0.00	6.4

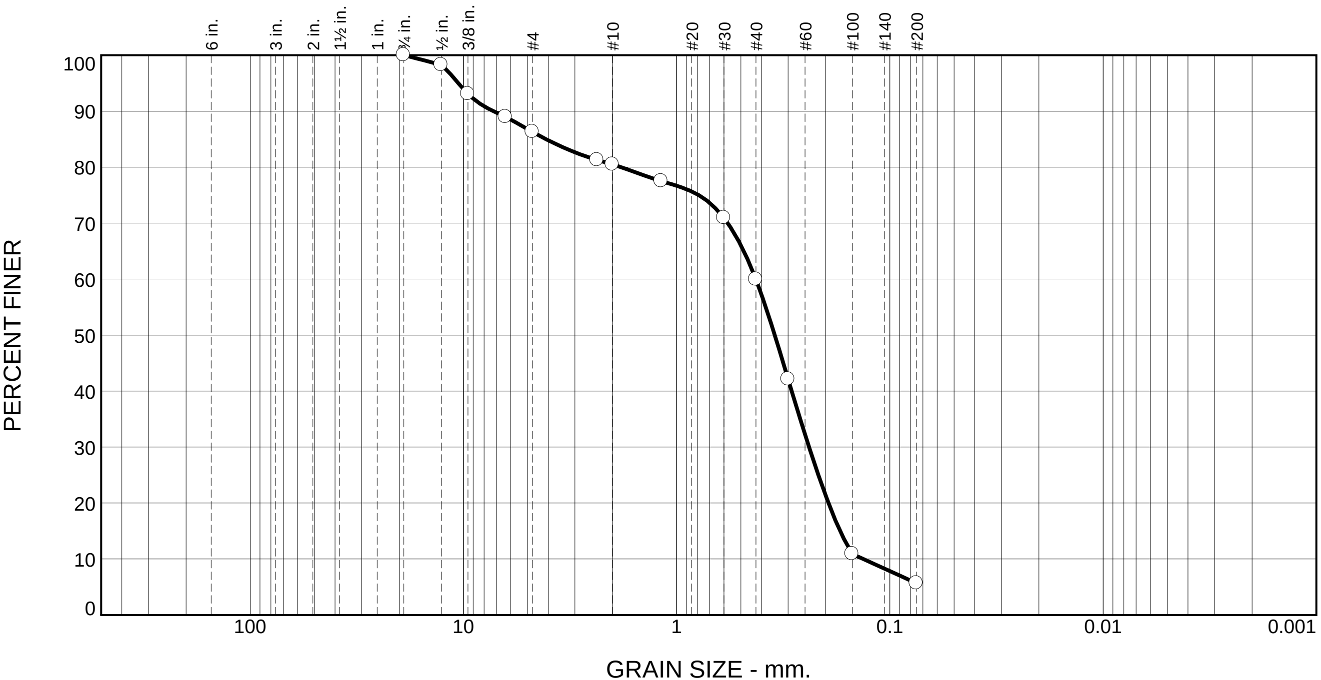
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	5.1	5.1	0.9	9.7	77.9	88.5			6.4

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.1170	0.1398	0.1567	0.1856	0.2140	0.2446	0.2797	0.3846	0.4338	0.5453	5.0941

Fineness Modulus	C_u	C_c
1.48	2.39	1.05

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	13.7	5.8	20.6	54.2	5.7	

Test Results (ASTM C 136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/4"	100.0		
1/2"	98.3		
3/8"	93.1		
1/4"	89.0		
#4	86.3		
#8	81.3		
#10	80.5		
#16	77.5		
#30	70.9		
#40	59.9		
#50	42.1		
#100	10.9		
#200	5.7		

* (no specification provided)

Material Description

Fine to coarse sand- some fine gravel- trace to some silt - dark brown

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-3

Coefficients

D_{90}=	7.2440	D_{85}=	4.1068	D_{60}=	0.4256
D_{50}=	0.3468	D_{30}=	0.2394	D_{15}=	0.1711
D_{10}=	0.1332	C_u=	3.20	C_c=	1.01

Remarks

Date Received: 10/21/2024 **Date Tested:** 12/27/2024

Tested By: Ben Carden

Checked By: Chris Abraham, PE

Title: QA Manager

Location: B-01C

Sample Number: S-8 **Depth:** 16.0 to 18.0 Feet

Date Sampled: 10/21/2024

GEI Consultants of Michigan, P.C.

Marquette, Michigan

Client: Village of Hesperia

Project: Hesperia Dam

Project No: 2403886 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

1/3/2025

Client: Village of Hesperia
Project: Hesperia Dam
Project Number: 2403886
Location: B-01C
Depth: 16.0 to 18.0 Feet **Sample Number:** S-8
Material Description: Fine to coarse sand- some fine gravel- trace to some silt- dark brown
Sample Date: 10/21/2024
Date Received: 10/21/2024 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: SP-SM **AASHTO Classification:** A-3
Grain Size Test Method: ASTM C 136
#200 Wash Method: ASTM C 117
Tested By: Ben Carden **Test Date:** 12/27/2024
Checked By: Chris Abraham, PE **Title:** QA Manager

Sieve Test Data

Post #200 Wash Test Weights (grams): **Dry Sample and Tare =** 612.70
Tare Wt. = 348.80
Minus #200 from wash = 4.8%

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
625.90	348.80	1-1/2"			
		1"			
		3/4"	0.00	0.00	100.0
		1/2"	4.80	0.00	98.3
		3/8"	14.40	0.00	93.1
		1/4"	11.40	0.00	89.0
		#4	7.40	0.00	86.3
		#8	13.90	0.00	81.3
		#10	2.20	0.00	80.5
		#16	8.30	0.00	77.5
		#30	18.20	0.00	70.9
		#40	30.40	0.00	59.9
		#50	49.40	0.00	42.1
		#100	86.50	0.00	10.9
		#200	14.50	0.00	5.7

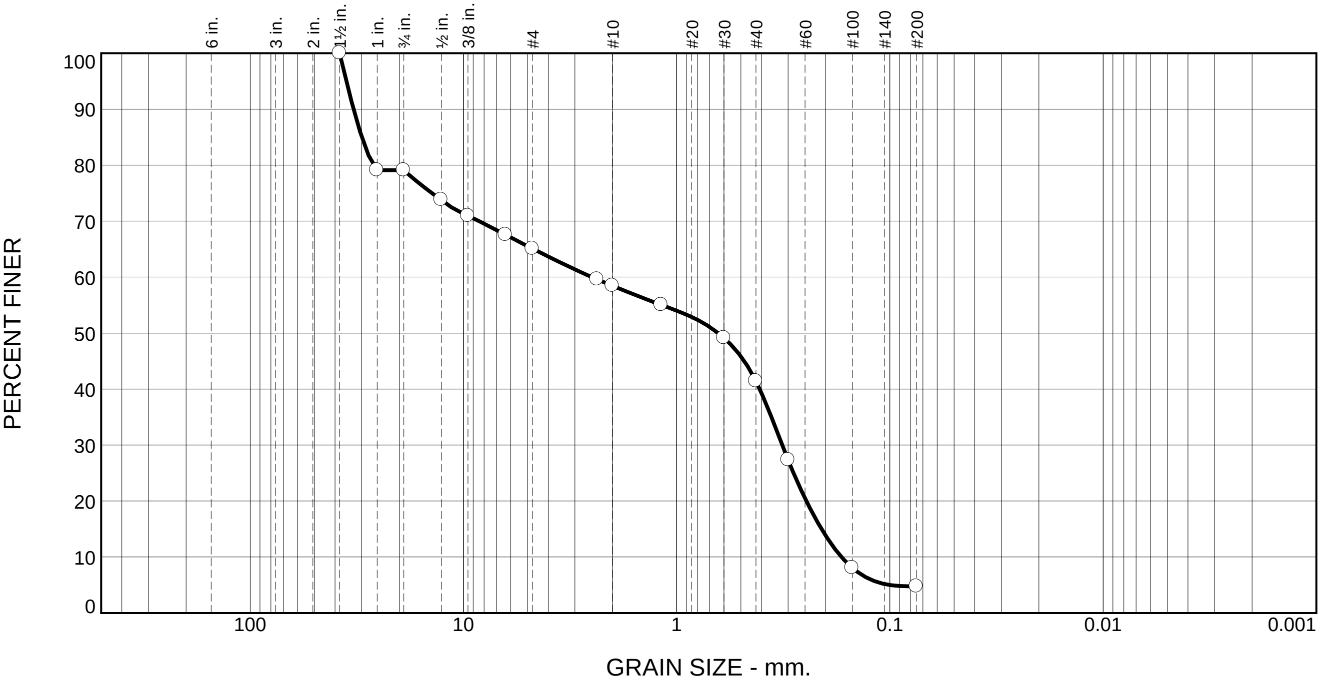
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	13.7	13.7	5.8	20.6	54.2	80.6			5.7

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.1332	0.1711	0.1942	0.2394	0.2887	0.3468	0.4256	1.8283	4.1068	7.2440	10.5789

Fineness Modulus	C_u	C_c
2.38	3.20	1.01

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	20.9	14.0	6.6	17.1	36.6	4.8	

Test Results (ASTM C 136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1-1/2"	100.0		
1"	79.1		
3/4"	79.1		
1/2"	73.8		
3/8"	71.0		
1/4"	67.6		
#4	65.1		
#8	59.6		
#10	58.5		
#16	55.0		
#30	49.1		
#40	41.4		
#50	27.3		
#100	8.1		
#200	4.8		

* (no specification provided)

Material Description

Gravelly fine to coarse sand- trace silt- brown

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 32.7446	D_{85}= 29.9671	D_{60}= 2.4971
D_{50}= 0.6396	D_{30}= 0.3197	D_{15}= 0.2093
D_{10}= 0.1687	C_u= 14.80	C_c= 0.24

Remarks

Date Received: 10/21/2024 **Date Tested:** 12/27/2024

Tested By: Ben Carden

Checked By: Chris Abraham, PE

Title: QA Manager

Location: B-02B

Sample Number: S-2 **Depth:** 2.0 to 4.0 Feet

Date Sampled: 10/21/2024

GEI Consultants of Michigan, P.C.

Marquette, Michigan

Client: Village of Hesperia

Project: Hesperia Dam

Project No: 2403886 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

1/3/2025

Client: Village of Hesperia
Project: Hesperia Dam
Project Number: 2403886
Location: B-02B
Depth: 2.0 to 4.0 Feet **Sample Number:** S-2
Material Description: Gravelly fine to coarse sand- trace silt- brown
Sample Date: 10/21/2024
Date Received: 10/21/2024 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: SP **AASHTO Classification:** A-1-b
Grain Size Test Method: ASTM C 136
#200 Wash Method: ASTM C 117
Tested By: Ben Carden **Test Date:** 12/27/2024
Checked By: Chris Abraham, PE **Title:** QA Manager

Sieve Test Data

Post #200 Wash Test Weights (grams): **Dry Sample and Tare =** 567.00
Tare Wt. = 348.60
Minus #200 from wash = 3.9%

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
575.80	348.60	1-1/2"	0.00	0.00	100.0
		1"	47.50	0.00	79.1
		3/4"	0.00	0.00	79.1
		1/2"	12.00	0.00	73.8
		3/8"	6.50	0.00	71.0
		1/4"	7.70	0.00	67.6
		#4	5.60	0.00	65.1
		#8	12.50	0.00	59.6
		#10	2.60	0.00	58.5
		#16	7.80	0.00	55.0
		#30	13.40	0.00	49.1
		#40	17.50	0.00	41.4
		#50	32.00	0.00	27.3
		#100	43.80	0.00	8.1
		#200	7.50	0.00	4.8

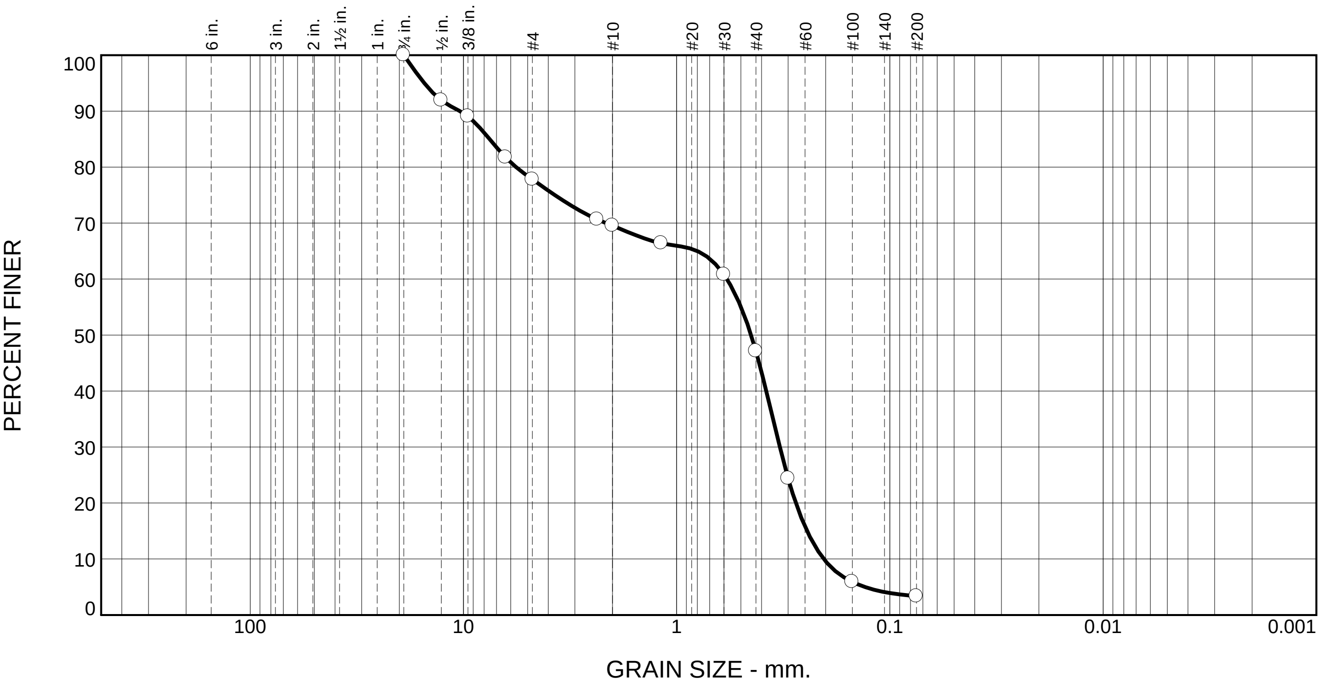
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	20.9	14.0	34.9	6.6	17.1	36.6	60.3			4.8

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1000	0.1687	0.2093	0.2465	0.3197	0.4080	0.6396	2.4971	26.4326	29.9671	32.7446	35.3916

Fineness Modulus	C_u	C_c
3.86	14.80	0.24

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	22.2	8.3	22.4	43.7	3.4	

Test Results (ASTM C 136 & ASTM C 117)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/4"	100.0		
1/2"	91.9		
3/8"	89.1		
1/4"	81.7		
#4	77.8		
#8	70.7		
#10	69.5		
#16	66.4		
#30	60.8		
#40	47.1		
#50	24.4		
#100	5.9		
#200	3.4		

* (no specification provided)

Material Description

Fine to coarse sand- some fine gravel- trace silt- brown

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 10.3895 D_{85}= 7.5368 D_{60}= 0.5809
D_{50}= 0.4477 D_{30}= 0.3281 D_{15}= 0.2447
D_{10}= 0.2043 C_u= 2.84 C_c= 0.91

Remarks

Date Received: 10/21/2024 **Date Tested:** 12/27/2024

Tested By: Ben Carden

Checked By: Chris Abraham, PE

Title: QA Manager

Location: B-02B
Sample Number: S-6 **Depth:** 10.0 to 12.0 Feet
Date Sampled: 10/21/2024

GEI Consultants of Michigan, P.C.

Marquette, Michigan

Client: Village of Hesperia
Project: Hesperia Dam
Project No: 2403886 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

1/6/2025

Client: Village of Hesperia
Project: Hesperia Dam
Project Number: 2403886
Location: B-02B
Depth: 10.0 to 12.0 Feet **Sample Number:** S-6
Material Description: Fine to coarse sand- some fine gravel- trace silt- brown
Sample Date: 10/21/2024
Date Received: 10/21/2024 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: SP **AASHTO Classification:** A-1-b
Grain Size Test Method: ASTM C 136
#200 Wash Method: ASTM C 117
Tested By: Ben Carden **Test Date:** 12/27/2024
Checked By: Chris Abraham, PE **Title:** QA Manager

Sieve Test Data

Post #200 Wash Test Weights (grams): **Dry Sample and Tare =** 618.50
Tare Wt. = 349.10
Minus #200 from wash = 2.8%

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
626.20	349.10	1-1/2"			
		1"			
		3/4"	0.00	0.00	100.0
		1/2"	22.40	0.00	91.9
		3/8"	7.90	0.00	89.1
		1/4"	20.30	0.00	81.7
		#4	10.90	0.00	77.8
		#8	19.80	0.00	70.7
		#10	3.10	0.00	69.5
		#16	8.70	0.00	66.4
		#30	15.50	0.00	60.8
		#40	37.90	0.00	47.1
		#50	63.00	0.00	24.4
		#100	51.20	0.00	5.9
		#200	7.10	0.00	3.4

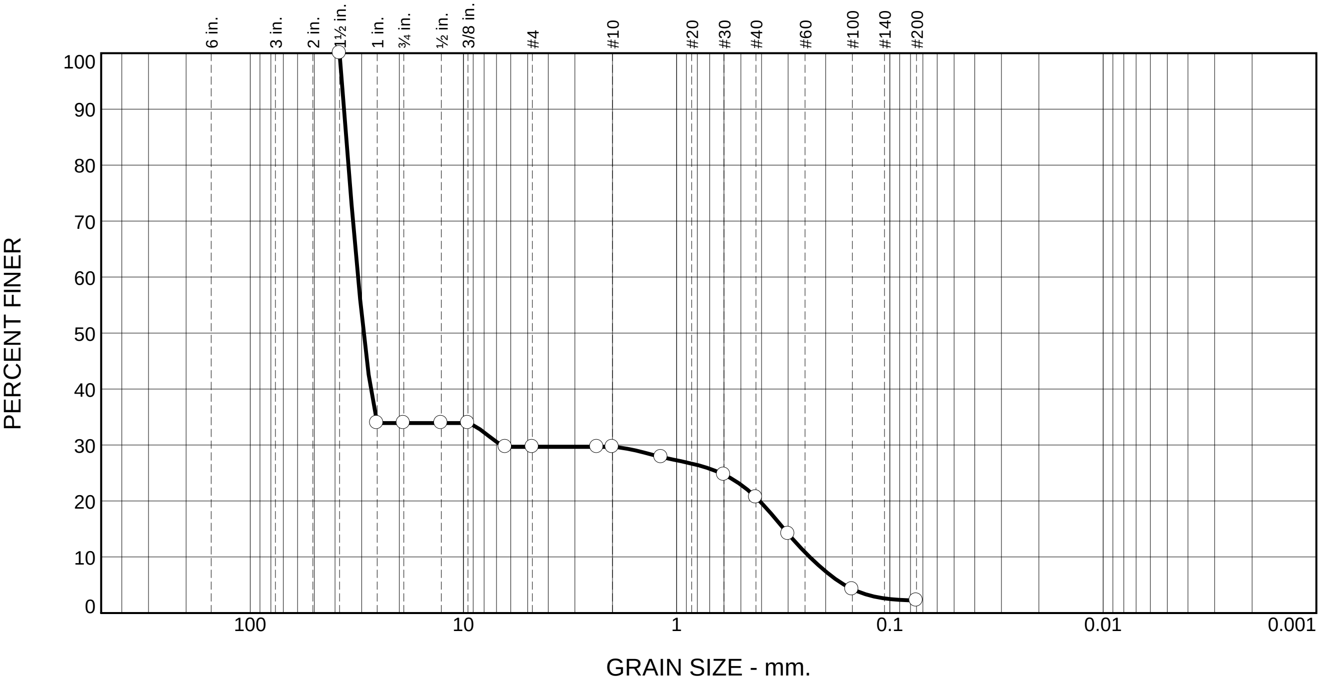
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	22.2	22.2	8.3	22.4	43.7	74.4			3.4

D_{5}	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1309	0.2043	0.2447	0.2760	0.3281	0.3800	0.4477	0.5809	5.6666	7.5368	10.3895	15.2626

Fineness Modulus	C_{u}	C_{c}
3.05	2.84	0.91

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	66.1	4.2	0.0	9.0	18.5	2.2	

Test Results (ASTM C 136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1-1/2"	100.0		
1"	33.9		
3/4"	33.9		
1/2"	33.9		
3/8"	33.9		
1/4"	29.7		
#4	29.7		
#8	29.7		
#10	29.7		
#16	27.9		
#30	24.7		
#40	20.7		
#50	14.2		
#100	4.3		
#200	2.2		

* (no specification provided)

Material Description

Sandy coarse gravel- trace silt and fine gravel- brown

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= GP **AASHTO (M 145)=** A-1-a

Coefficients

D_{90}= 36.3474 D_{85}= 35.4915 D_{60}= 31.2235
D_{50}= 29.3836 D_{30}= 6.6327 D_{15}= 0.3134
D_{10}= 0.2376 C_u= 131.42 C_c= 5.93

Remarks

Date Received: 10/21/2024 **Date Tested:** 12/27/2024

Tested By: Ben Carden

Checked By: Chris Abraham, PE

Title: QA Manager

Location: B-02C
Sample Number: S-2 **Depth:** 23.0 to 25.0 Feet

Date Sampled: 10/21/2024

GEI Consultants of Michigan, P.C.

Marquette, Michigan

Client: Village of Hesperia
Project: Hesperia Dam

Project No: 2403886 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

1/3/2025

Client: Village of Hesperia
Project: Hesperia Dam
Project Number: 2403886
Location: B-02C
Depth: 23.0 to 25.0 Feet **Sample Number:** S-2
Material Description: Sandy coarse gravel- trace silt and fine gravel- brown
Sample Date: 10/21/2024
Date Received: 10/21/2024 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: GP **AASHTO Classification:** A-1-a
Grain Size Test Method: ASTM C 136
#200 Wash Method: ASTM C 117
Tested By: Ben Carden **Test Date:** 12/27/2024
Checked By: Chris Abraham, PE **Title:** QA Manager

Sieve Test Data

Post #200 Wash Test Weights (grams): **Dry Sample and Tare =** 392.10
Tare Wt. = 348.60
Minus #200 from wash = 2.2%

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
393.10	348.60	1-1/2"	0.00	0.00	100.0
		1"	29.40	0.00	33.9
		3/4"	0.00	0.00	33.9
		1/2"	0.00	0.00	33.9
		3/8"	0.00	0.00	33.9
		1/4"	1.90	0.00	29.7
		#4	0.00	0.00	29.7
		#8	0.00	0.00	29.7
		#10	0.00	0.00	29.7
		#16	0.80	0.00	27.9
		#30	1.40	0.00	24.7
		#40	1.80	0.00	20.7
		#50	2.90	0.00	14.2
		#100	4.40	0.00	4.3
		#200	0.90	0.00	2.2

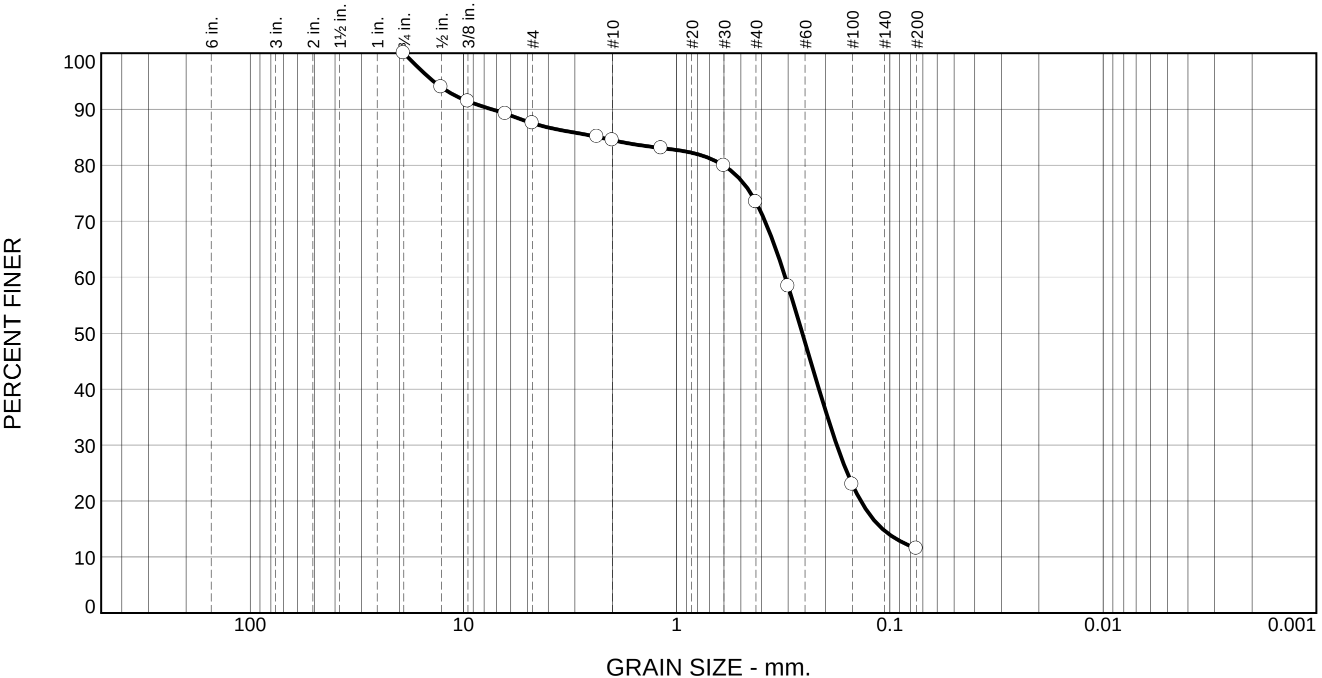
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	66.1	4.2	70.3	0.0	9.0	18.5	27.5			2.2

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1628	0.2376	0.3134	0.4080	6.6327	27.2325	29.3836	31.2235	34.6432	35.4915	36.3474	37.2155

Fineness Modulus	C_u	C_c
6.02	131.42	5.93

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	12.5	3.0	11.1	61.9	11.5	

Test Results (ASTM C 136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/4"	100.0		
1/2"	93.9		
3/8"	91.4		
1/4"	89.2		
#4	87.5		
#8	85.1		
#10	84.5		
#16	83.0		
#30	79.9		
#40	73.4		
#50	58.4		
#100	22.9		
#200	11.5		

* (no specification provided)

Material Description

Fine to medium sand- some fine gravel- trace to some silt- trace coarse sand- brown

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}=	7.4140	D_{85}=	2.3225	D_{60}=	0.3096
D_{50}=	0.2574	D_{30}=	0.1774	D_{15}=	0.1082
D_{10}=		C_u=		C_c=	

Remarks

Date Received: 10/22/2024 **Date Tested:** 12/27/2024

Tested By: Ben Carden

Checked By: Chris Abraham, PE

Title: QA Manager

Location: B-03
Sample Number: S-2 **Depth:** 2.0 to 4.0 Feet
Date Sampled: 10/22/2024

GEI Consultants of Michigan, P.C.

Marquette, Michigan

Client: Village of Hesperia
Project: Hesperia Dam
Project No: 2403886 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

1/3/2025

Client: Village of Hesperia
Project: Hesperia Dam
Project Number: 2403886
Location: B-03
Depth: 2.0 to 4.0 Feet **Sample Number:** S-2
Material Description: Fine to medium sand- some fine gravel- trace to some silt- trace coarse sand- brown
Sample Date: 10/22/2024
Date Received: 10/22/2024 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: SP-SM **AASHTO Classification:** A-2-4(0)
Grain Size Test Method: ASTM C 136
#200 Wash Method: ASTM C 117
Tested By: Ben Carden **Test Date:** 12/27/2024
Checked By: Chris Abraham, PE **Title:** QA Manager

Sieve Test Data

Post #200 Wash Test Weights (grams): **Dry Sample and Tare =** 575.10
Tare Wt. = 347.30
Minus #200 from wash = 8.0%

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
594.90	347.30	1-1/2"			
		1"			
		3/4"	0.00	0.00	100.0
		1/2"	15.10	0.00	93.9
		3/8"	6.20	0.00	91.4
		1/4"	5.50	0.00	89.2
		#4	4.20	0.00	87.5
		#8	6.00	0.00	85.1
		#10	1.50	0.00	84.5
		#16	3.50	0.00	83.0
		#30	7.80	0.00	79.9
		#40	16.00	0.00	73.4
		#50	37.30	0.00	58.4
		#100	87.70	0.00	22.9
		#200	28.30	0.00	11.5

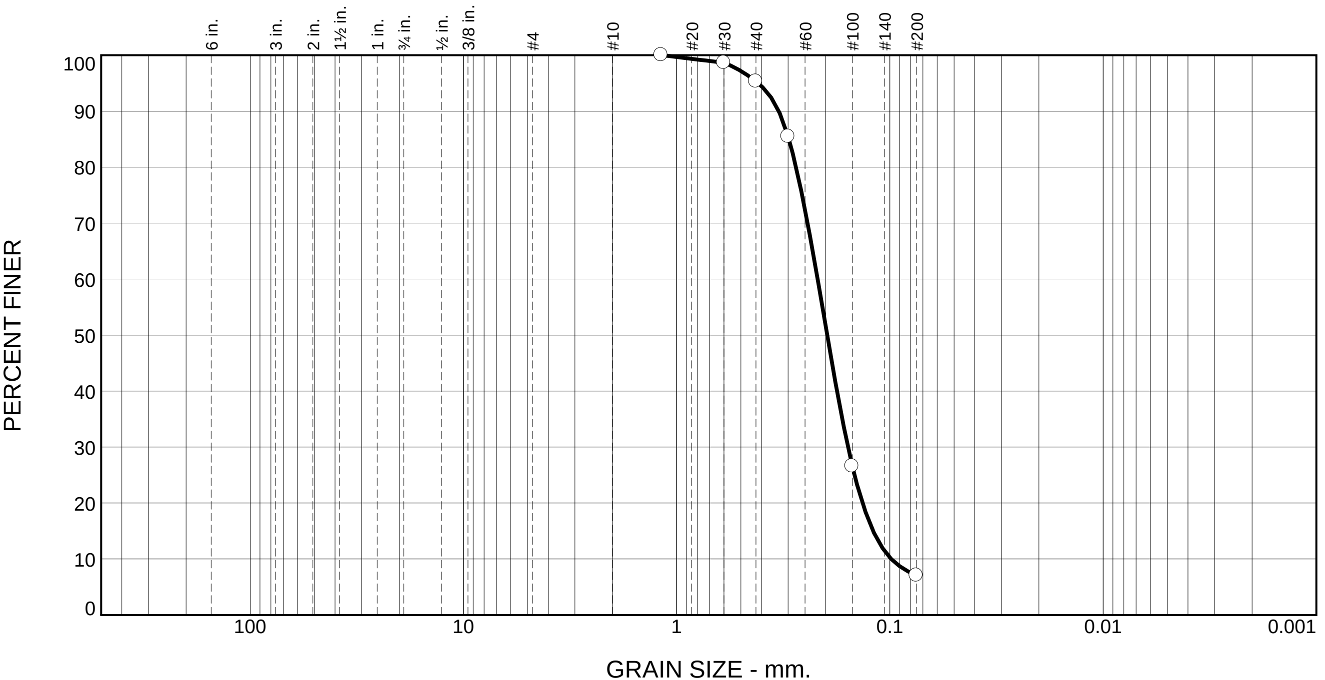
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	12.5	12.5	3.0	11.1	61.9	76.0			11.5

D_{5}	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
		0.1082	0.1369	0.1774	0.2153	0.2574	0.3096	0.6066	2.3225	7.4140	13.8521

Fineness Modulus
1.92

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	4.7	88.2	7.1	

Test Results (ASTM C 136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#16	100.0		
#30	98.6		
#40	95.3		
#50	85.5		
#100	26.6		
#200	7.1		

* (no specification provided)

Material Description

Fine sand- trace to some silt- trace medium sand- brown

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-3

Coefficients

D_{90}=	0.3321	D_{85}=	0.2976	D_{60}=	0.2183
D_{50}=	0.1968	D_{30}=	0.1572	D_{15}=	0.1198
D_{10}=	0.0985	C_u=	2.22	C_c=	1.15

Remarks

Date Received: 10/22/2024 **Date Tested:** 12/27/2024

Tested By: Ben Carden

Checked By: Chris Abraham, PE

Title: QA Manager

Location: B-03

Sample Number: S-9 **Depth:** 18.0 to 20.0 Feet

Date Sampled: 10/22/2024

GEI Consultants of Michigan, P.C.

Marquette, Michigan

Client: Village of Hesperia

Project: Hesperia Dam

Project No: 2403886 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

1/3/2025

Client: Village of Hesperia
Project: Hesperia Dam
Project Number: 2403886
Location: B-03
Depth: 18.0 to 20.0 Feet **Sample Number:** S-9
Material Description: Fine sand- trace to some silt- trace medium sand- brown
Sample Date: 10/22/2024
Date Received: 10/22/2024 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: SP-SM **AASHTO Classification:** A-3
Grain Size Test Method: ASTM C 136
#200 Wash Method: ASTM C 117
Tested By: Ben Carden **Test Date:** 12/27/2024
Checked By: Chris Abraham, PE **Title:** QA Manager

Sieve Test Data

Post #200 Wash Test Weights (grams): **Dry Sample and Tare =** 555.10
Tare Wt. = 351.50
Minus #200 from wash = 4.1%

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
563.90	351.50	1-1/2"			
		1"			
		3/4"			
		1/2"			
		3/8"			
		1/4"			
		#4			
		#8			
		#10			
		#16	0.00	0.00	100.0
		#30	2.90	0.00	98.6
		#40	7.10	0.00	95.3
		#50	20.90	0.00	85.5
		#100	125.10	0.00	26.6
		#200	41.40	0.00	7.1

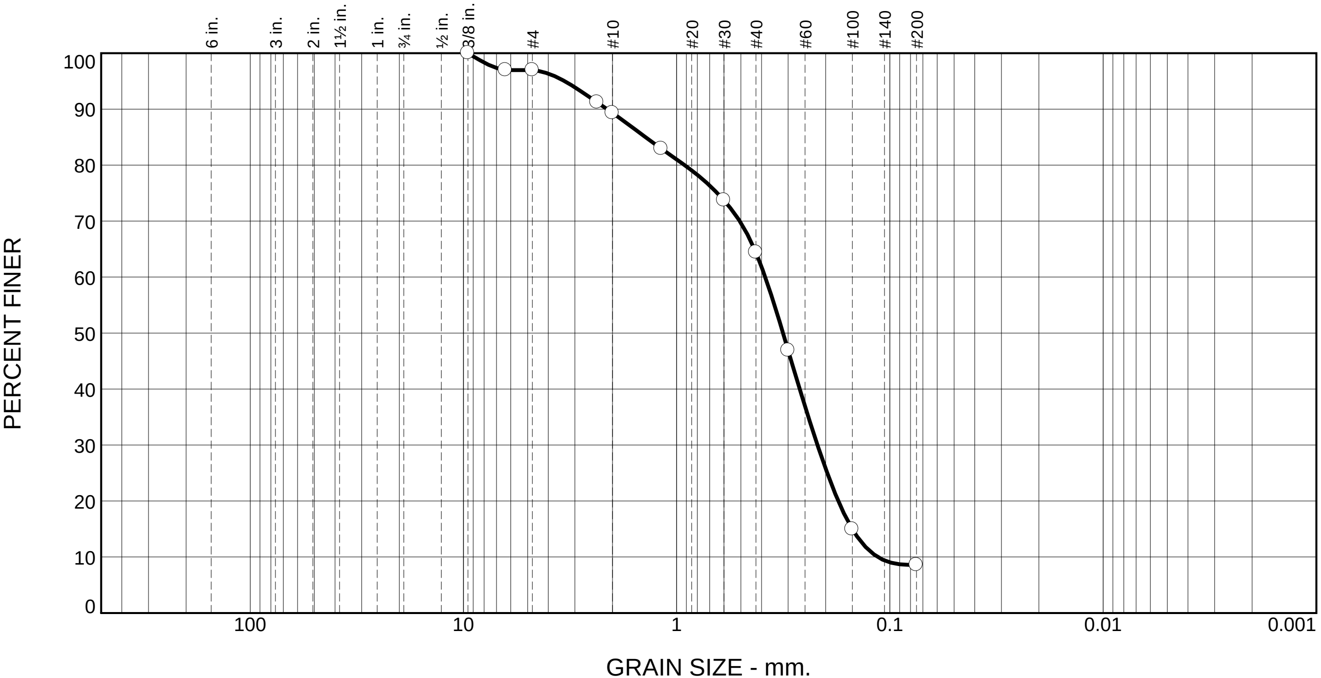
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	4.7	88.2	92.9			7.1

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0985	0.1198	0.1345	0.1572	0.1770	0.1968	0.2183	0.2753	0.2976	0.3321	0.4159

Fineness Modulus	C_u	C_c
0.89	2.22	1.15

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.0	7.7	24.9	55.8	8.6	

Test Results (ASTM C 136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/8"	100.0		
1/4"	97.0		
#4	97.0		
#8	91.2		
#10	89.3		
#16	82.9		
#30	73.7		
#40	64.4		
#50	46.9		
#100	15.0		
#200	8.6		

* (no specification provided)

Material Description

Fine to coarse sand- trace to some silt- trace fine gravel- brown

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-3

Coefficients

D_{90}=	2.1222	D_{85}=	1.4005	D_{60}=	0.3842
D_{50}=	0.3172	D_{30}=	0.2187	D_{15}=	0.1501
D_{10}=	0.1140	C_u=	3.37	C_c=	1.09

Remarks

Date Received: 10/22/2024 **Date Tested:** 12/27/2024

Tested By: Ben Carden

Checked By: Chris Abraham, PE

Title: QA Manager

Location: B-04

Sample Number: S-3 **Depth:** 4.0 to 6.0 Feet

Date Sampled: 10/22/2024

GEI Consultants of Michigan, P.C.

Marquette, Michigan

Client: Village of Hesperia

Project: Hesperia Dam

Project No: 2403886 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

1/3/2025

Client: Village of Hesperia
Project: Hesperia Dam
Project Number: 2403886
Location: B-04
Depth: 4.0 to 6.0 Feet
Sample Number: S-3
Material Description: Fine to coarse sand- trace to some silt- trace fine gravel- brown
Sample Date: 10/22/2024
Date Received: 10/22/2024 **PL:** NP
LL: NV
PI: NP
USCS Classification: SP-SM
AASHTO Classification: A-3
Grain Size Test Method: ASTM C 136
#200 Wash Method: ASTM C 117
Tested By: Ben Carden
Test Date: 12/27/2024
Checked By: Chris Abraham, PE
Title: QA Manager

Sieve Test Data

Post #200 Wash Test Weights (grams): **Dry Sample and Tare =** 447.00
Tare Wt. = 356.50
Minus #200 from wash = 5.2%

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
452.00	356.50	1-1/2"			
		1"			
		3/4"			
		1/2"			
		3/8"	0.00	0.00	100.0
		1/4"	2.90	0.00	97.0
		#4	0.00	0.00	97.0
		#8	5.50	0.00	91.2
		#10	1.80	0.00	89.3
		#16	6.10	0.00	82.9
		#30	8.80	0.00	73.7
		#40	8.90	0.00	64.4
		#50	16.70	0.00	46.9
		#100	30.50	0.00	15.0
		#200	6.10	0.00	8.6

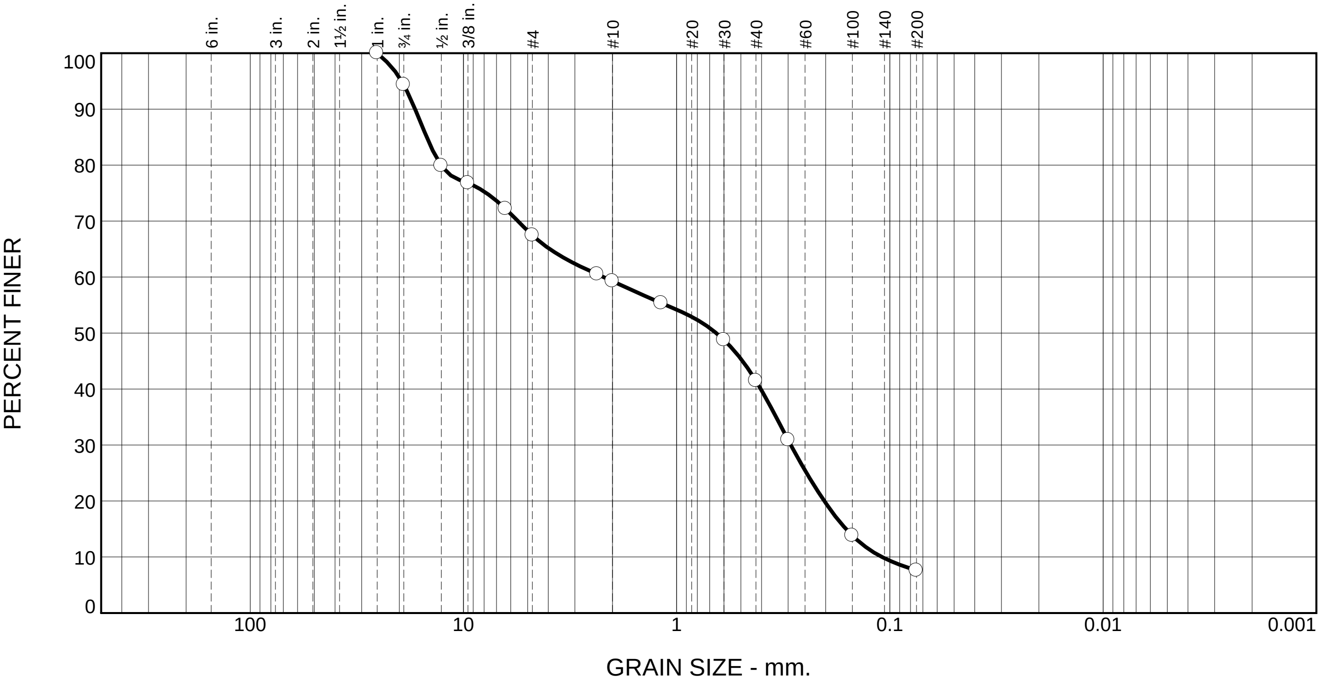
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	3.0	3.0	7.7	24.9	55.8	88.4			8.6

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.1140	0.1501	0.1745	0.2187	0.2647	0.3172	0.3842	0.9185	1.4005	2.1222	3.3567

Fineness Modulus	C_u	C_c
1.93	3.37	1.09

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	5.7	26.8	8.2	17.8	33.9	7.6	

Test Results (ASTM C 136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1"	100.0		
3/4"	94.3		
1/2"	79.9		
3/8"	76.8		
1/4"	72.2		
#4	67.5		
#8	60.5		
#10	59.3		
#16	55.3		
#30	48.8		
#40	41.5		
#50	30.9		
#100	13.8		
#200	7.6		

* (no specification provided)

Material Description

Gravelly fine to coarse sand- trace to some silt- brown

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 16.8667 D_{85}= 14.8720 D_{60}= 2.2017
D_{50}= 0.6523 D_{30}= 0.2913 D_{15}= 0.1606
D_{10}= 0.1088 C_u= 20.23 C_c= 0.35

Remarks

Date Received: 10/22/2024 **Date Tested:** 12/27/2024

Tested By: Ben Carden

Checked By: Chris Abraham, PE

Title: QA Manager

Location: B-04
Sample Number: S-7 **Depth:** 12.0 to 14.0 Feet
Date Sampled: 10/22/2024

GEI Consultants of Michigan, P.C.

Marquette, Michigan

Client: Village of Hesperia
Project: Hesperia Dam
Project No: 2403886 **Figure**

GRAIN SIZE DISTRIBUTION TEST DATA

1/3/2025

Client: Village of Hesperia
Project: Hesperia Dam
Project Number: 2403886
Location: B-04
Depth: 12.0 to 14.0 Feet **Sample Number:** S-7
Material Description: Gravelly fine to coarse sand- trace to some silt- brown
Sample Date: 10/22/2024
Date Received: 10/22/2024 **PL:** NP **LL:** NV **PI:** NP
USCS Classification: SP-SM **AASHTO Classification:** A-1-b
Grain Size Test Method: ASTM C 136
#200 Wash Method: ASTM C 117
Tested By: Ben Carden **Test Date:** 12/27/2024
Checked By: Chris Abraham, PE **Title:** QA Manager

Sieve Test Data

Post #200 Wash Test Weights (grams): **Dry Sample and Tare =** 602.30
Tare Wt. = 354.60
Minus #200 from wash = 6.4%

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer
619.30	354.60	1-1/2"			
		1"	0.00	0.00	100.0
		3/4"	15.00	0.00	94.3
		1/2"	38.20	0.00	79.9
		3/8"	8.20	0.00	76.8
		1/4"	12.20	0.00	72.2
		#4	12.50	0.00	67.5
		#8	18.40	0.00	60.5
		#10	3.30	0.00	59.3
		#16	10.40	0.00	55.3
		#30	17.40	0.00	48.8
		#40	19.30	0.00	41.5
		#50	28.00	0.00	30.9
		#100	45.20	0.00	13.8
		#200	16.50	0.00	7.6

Fractional Components

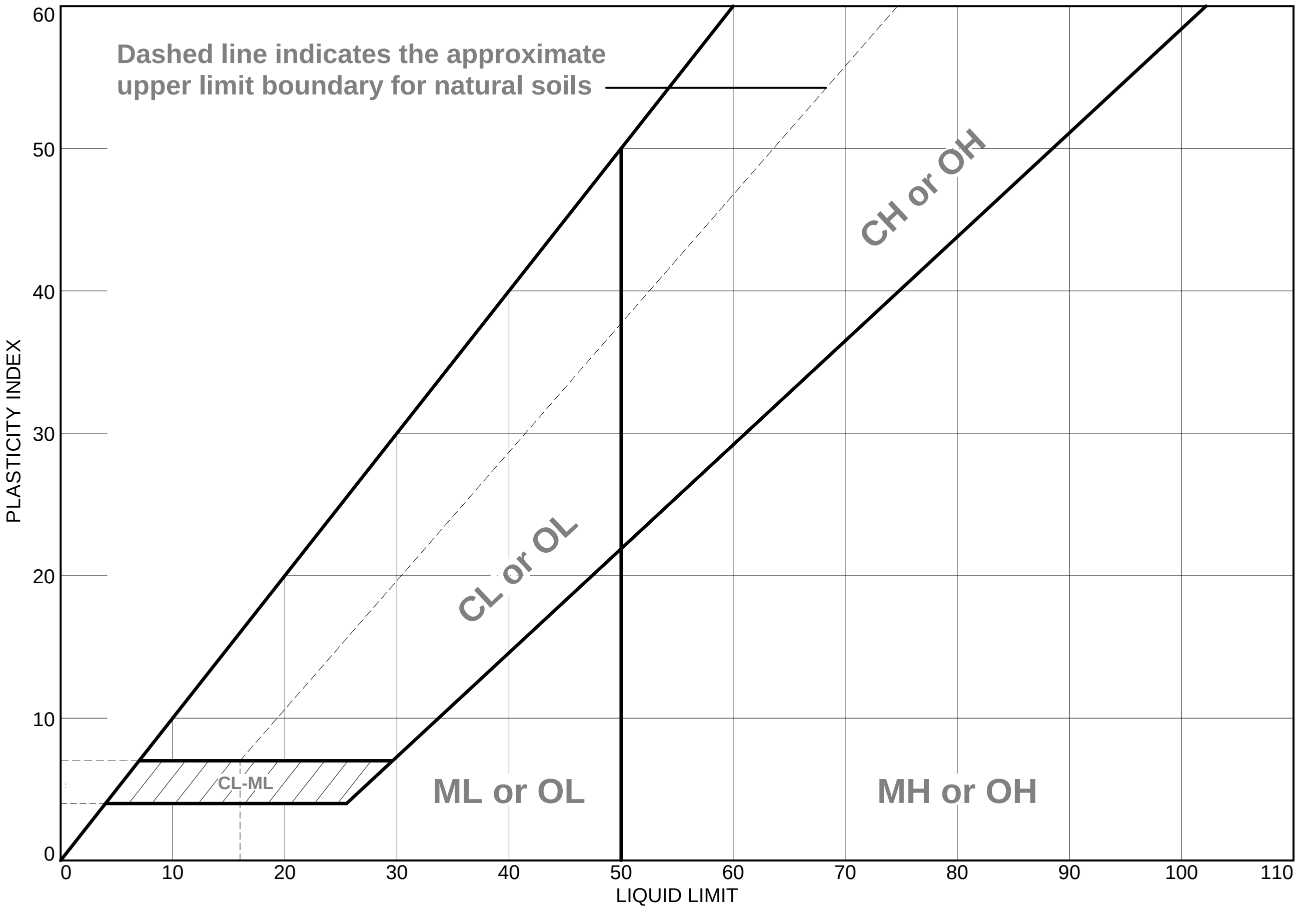
Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	5.7	26.8	32.5	8.2	17.8	33.9	59.9			7.6

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.1088	0.1606	0.2031	0.2913	0.4030	0.6523	2.2017	12.7527	14.8720	16.8667	19.4909

Fineness Modulus	C_u	C_c
3.52	20.23	0.35

B.4. Atterberg Limits

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sandy silt- gray	22	22	NP	NA	NA	ML

Project No. 2403886 **Client:** Village of Hesperia

Project: Hesperia Dam

●**Location:** B-01C **Depth:** 23.0 to 25.0 Feet **Sample Number:** S-10

Remarks:

GEI Consultants of Michigan, P.C.

Marquette, Michigan

Figure

Tested By: Kevin Rautiola **Checked By:** Chris Abraham, PE

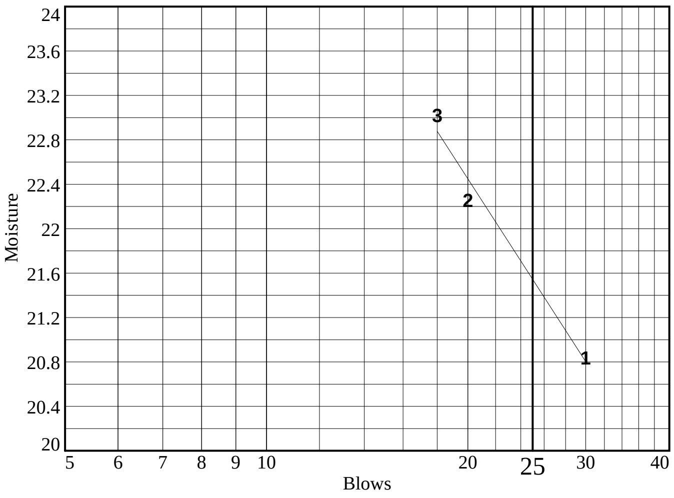
LIQUID AND PLASTIC LIMIT TEST DATA

1/3/2025

Client: Village of Hesperia
Project: Hesperia Dam
Project Number: 2403886
Location: B-01C
Depth: 23.0 to 25.0 Feet **Sample Number:** S-10
Material Description: Sandy silt- gray
%<#40: NA **%<#200:** NA **USCS:** ML **AASHTO:** NA
Tested by: Kevin Rautiola **Checked by:** Chris Abraham, PE

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	33.05	32.31	34.95			
Dry+Tare	31.02	30.36	32.41			
Tare	21.28	21.60	21.38			
# Blows	30	20	18			
Moisture	20.8	22.3	23.0			



Liquid Limit= 22
Plastic Limit= 22
Plasticity Index= NP
Natural Moisture= 22.3

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	29.04	29.24			
Dry+Tare	27.58	27.78			
Tare	21.04	21.12			
Moisture	22.3	21.9			

Natural Moisture Data

Wet+Tare	Dry+Tare	Tare	Moisture
33.67	31.44	21.42	22.3

GEI Consultants of Michigan, P.C.

Appendix C Photographs

Drilling Observation Photos

Date: 10/21/24 – 10/22/24
GEI Project No.: 2403886
Client: Village of Hesperia

Drilling Observation Photos

Date: 10/21/24 – 10/22/24
GEI Project No.: 2403886
Client: Village of Hesperia

Photo No. 1 – Pearson Drilling Drill Rig Set up ar Right Embankment Before Starting Boring B-01A

Photo No. 2 – Pearson Drilling Attmepting to Advance Hollow Stem Auger at B-01B

Photo No. 3 – B-01A After Abandonment

Photo No. 4 – B-01B After Abandonment

Photo No. 5 – B-01C After Completion and Installation of Monitoring Well

Photo No. 6 – B-02A After Abandonment

Drilling Observation Photos

Date: 10/21/24 – 10/22/24
GEI Project No.: 2403886
Client: Village of Hesperia

Photo No. 7 – B-02B After Completion and Installation of Monitoring Well

Photo No. 8 – B-02A After Abandonment

Photo No. 9 – B-02B After Completion and Installation of Monitoring Well

Photo No. 10 – B-02C After Abandonment

Photo No. 11 – Dam Primary and Auxilliary Spillways, and Left Embankment, Looking Upstream

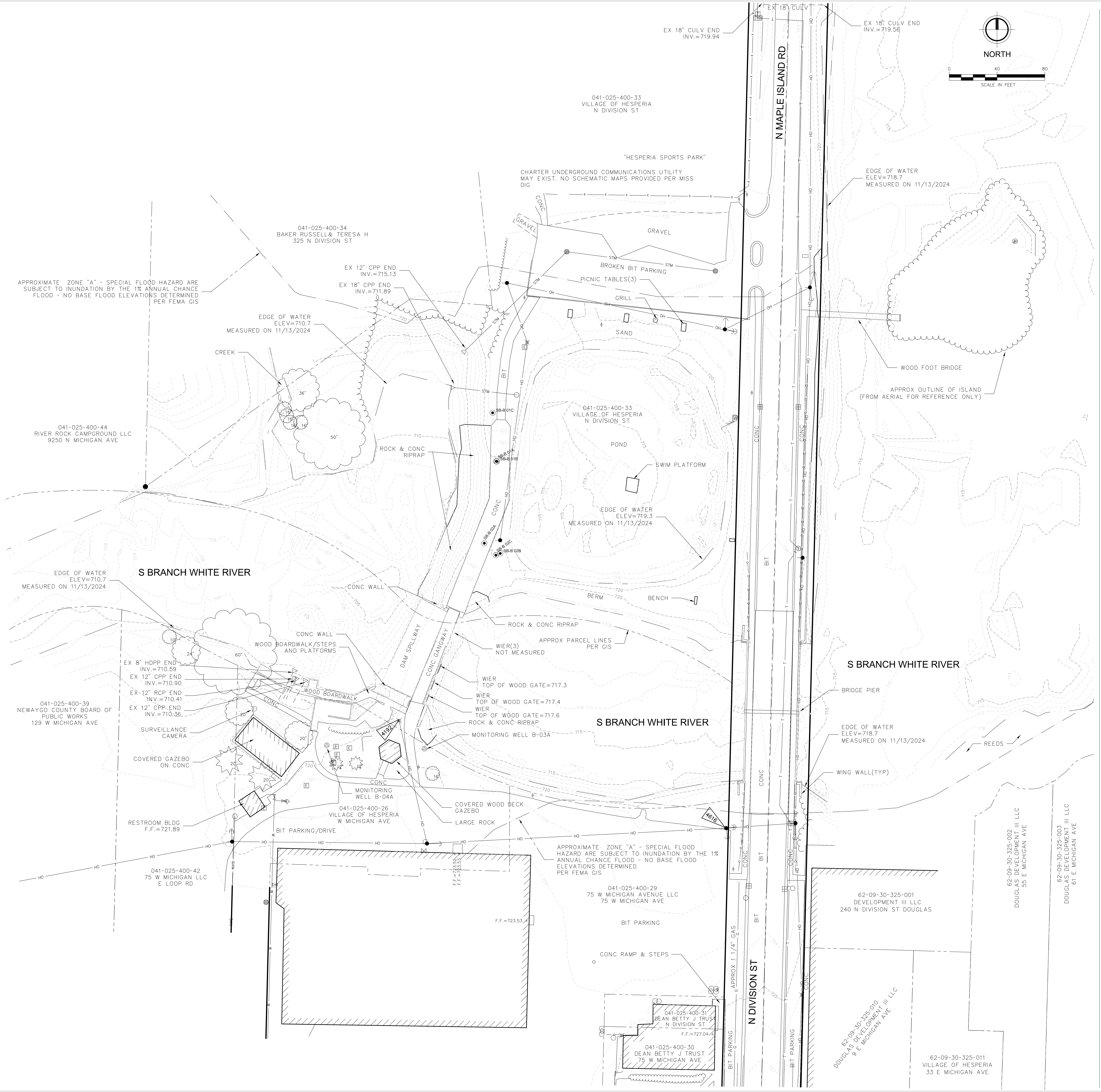
B.2. Base Map Survey

BM #3 EL. 714.65'
LAG BOLT N FACE LP CENTER OF VIDA WEAVER PARK, ±52' W OF FENCE
(NAVD88 VIA VRS & GPS OBSV)

BM #4 EL. 718.62'
LAG BOLT N FACE PP @ NW QUAD MICHIGAN & LYNX
(NAVD88 VIA VRS & GPS OBSV)

BM #4616 EL. 723.46'
NAIL E FACE PP, W SIDE DIVISION @ NE COR MARKET PARKING LOT
(NAVD88 VIA VRS & GPS OBSV)

BM #4192 EL. 723.93'
RR SPIKE E FACE LP @ S END DAM GANGWAY
(NAVD88 VIA VRS & GPS OBSV)



NOTES:

1.THE LOCATION OF UTILITIES DEPICTED ON THIS DRAWING WERE DETERMINED FROM ON-SITE OBSERVATION AND FROM RECORDS PROVIDED BY OTHERS. SOME UTILITIES MAY NOT BE SHOWN, BUT ARE PRESENT. UTILITIES MAY NOT BE IN THE EXACT POSITION SHOWN. BEFORE CONSTRUCTION OR ANY SUBSURFACE WORK CONTACT MISS DIG AND EXERCISE CAUTION.

2. FLEIS AND VANDENBRINK ENGINEERING, INC. HAS NOT REVIEWED THIS PROJECT FOR ENVIRONMENTAL CONCERNS, SOIL CONTENT, FLOOD ZONE OR WETLAND CONCERNS EXCEPT AS SHOWN.

3. BEARINGS ARE BASED ON: NAD83 MICHIGAN STATE PLANE, SOUTH ZONE, INTERNATIONAL FOOT

4. THE VERTICAL DATUM USED FOR THIS PROJECT IS: NAVD88

5. THE PARCEL(S) DEPICTED ON THIS SURVEY WERE TAKEN FROM NEWAYGO AND OCEANA COUNTY GIS

6. ACCORDING TO FEMA, FLOOD INSURANCE RATE MAP, 26127C0350C, EFFECTIVE DATE AUGUST 4, 2014 THE SUBJECT PROPERTY LIES WITHIN FLOOD ZONE "A - SPECIAL FLOOD HAZARD AREA SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD - NO BASE FLOOD ELEVATION DETERMINED"
100 YEAR FLOODPLAIN AS ESTABLISHED BY DEPARTMENT OF ENVIRONMENTAL QUALITY IS ESTIMATED AT 9 FEET ABOVE UNIFORM BOTTOM OF THE SOUTH BRANCH OF THE WHITE RIVER. THE FLOOD PLAIN IS APPROXIMATELY 716(NAVD88) PER SOUTH BRANCH CONDOMINIUM, BY MITCHELL SURVEYS INC, JAN, 2002

7. THE BUILDING(S) DEPICTED ON THIS SURVEY ARE APPROXIMATE. NO BUILDING MEASUREMENTS AT GROUND LEVEL WERE ASKED TO BE REVIEWED AS A PART OF THIS SURVEY. HENCE, SAID BUILDING LAYOUT AND DIMENSIONS SHOULD NOT BE USED FOR ARCHITECTURAL DESIGN PURPOSES.

8. THE CONTOURS DEPICTED ON THIS SURVEY WERE GENERATED FROM A TOPOGRAPHIC SURVEY COMPLETED BY FLEIS AND VANDENBRINK ENGINEERING, INC IN NOVEMBER, 2024. CONTOUR INTERVAL = 1'.

9. ANY ELECTRONIC REPRODUCTION OF THIS SURVEY SHOWING A COPY OF THE SIGNATURE AND IMPRESSION OF A PROFESSIONAL SURVEYOR'S SEAL IS PROVIDED FOR COURTESY PURPOSES ONLY AND SHALL NOT BE CONSIDERED AS THE ACTUAL SURVEY DOCUMENT. FLEIS & VANDENBRINK ENGINEERING, INC. IS NOT RESPONSIBLE FOR ANY UNAUTHORIZED USE, MISUSE OR COPY OF THIS DOCUMENT. THE ORIGINAL OF THIS DOCUMENT SHOWS THE RAISED STAMP AND HAS BEEN SIGNED USING BLUE INK.

EXISTING FEATURES LEGEND

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
✿	TREE (DECIDUOUS)	🄲	CABLE BOX	▲	SURVEY CONTROL POINT
❀	BUSH	🅃	TELEPHONE RISER	BM#1 ▷	BENCHMARK
✹	TREE (CONIFEROUS)	Ⓣ	TELEPHONE MANHOLE	⊕	SECTION CORNER
✳	DEAD TREE	THH	TELEPHONE HANDHOLE		BOUNDARY LINE
⊚	STUMP	🄴	ELECTRICAL RISER		PROPERTY LINE
○	MANHOLE	Ⓔ	ELECTRICAL MANHOLE	W	WATERMAIN
◦	SANITARY CLEANOUT	EHH	ELECTRICAL HANDHOLE	SAN	SANITARY SEWER
⊕	RD. CATCH BASIN	●	POWER POLE	STM	STORM SEWER
⊞	SQ. CATCH BASIN	⊠	LIGHT POLE		CULVERT (21" AND UNDER)
▷	CULVERT END	○	GUY POLE		CULVERT (24" AND UP)
⌖	FIRE HYDRANT	☽	GUY ANCHOR	CATV	CABLE T.V.
⋈	WATER VALVE	○□	PED CROSSING SIGNAL	T	TELEPHONE
⊗	CURB STOP & BOX	⌘	YARD LIGHT	E	ELECTRIC
Ⓦ	WELL	ϕ	SIGN	G	GAS
Ⓦ	WATER MANHOLE	▭	MAILBOX	OH	OVERHEAD LINES
Ⓜ	WATER METER	○	POST	o	GUARDRAIL
◉ B#	SOIL BORING	■	FOUND CONC. MONUMENT	X	FENCE
△	MONITORING WELL	●	FOUND IRON ROD		WOODLINE
⋈	GAS VALVE	○	SET IRON ROD		BUSH/HEDGE ROW
🄶	GAS RISER				

NOTE: ALL ITEMS LISTED ON THE LEGEND MAY NOT BE PRESENT ON DRAWING.

shaned/M:\Proj867001-869000\868500 GEI – Hesperia Dam Feasibility\Cad\868500Topo.dwg

FLEIS&VANDENBRINK
DESIGN. BUILD. OPERATE.

2960 Lucerne Drive SE
Grand Rapids, MI 49546
P: 616.977.1000
F: 616.977.1005

REVISION:

VILLAGE OF HESPERIA
TOWN 14 NORTH, RANGE 15 WEST, OCEANA COUNTY
TOWN 14 NORTH, RANGE 14 WEST, NEWAYGO COUNTY

TOPOGRAPHIC SURVEY

DESIGN TEAM:
JVD, CJ, SAD, KBC
CHECK BY:
DRAWING INFORMATION:
868500Topo
shaned

NOVEMBER 2024
F&V PROJECT NO.
868500

Appendix C Desktop Study

C.1. Property Ownership

C.2. Threatened and Endangered Species

C.1. Property Ownership

Limits of Ownership Per Tax Description

🟥 To Bank

🟦 To Centerline

🟩 Not Specified

🟨 Ownership Unknown

REAL ESTATE EVALUATION

VILLAGE OF HESPERIA
NEWAYGO & OCEANA COUNTIES, MICHIGAN

F&V

C.2. Threatened and Endangered Species

MICHIGAN STATE UNIVERSITY | Extension

MSU EXTENSION

Michigan Natural Features Inventory

PO Box 13036
Lansing MI 48901

(517) 284-6200
Fax (517) 373-9566

mnfi.anr.msu.edu

Zack Pitman
GEI Consultants
4472 Mount Hope Road
Suite A
Williamsburg, MI 49690

January 23, 2025

Re: Rare Species Review #5302 – Hesperia Dam - White River in Oceana County, Michigan.

Hello:

The location for the proposed project was checked against known localities for rare species and unique natural features, which are recorded in the Michigan Natural Features Inventory (MNFI) natural heritage database. This continuously updated database is a comprehensive source of existing data on Michigan's endangered, threatened, or otherwise significant plant and animal species, natural plant communities, and other natural features. Records in the database indicate that a qualified observer has documented the presence of special natural features. The absence of records in the database for a particular site may mean that the site has not been surveyed. The only way to obtain a definitive statement on the status of natural features is to have a competent biologist perform a complete field survey.

Under Act 451 of 1994, the Natural Resources and Environmental Protection Act, Part 365, Endangered Species Protection, “a person shall not take, possess, transport, …fish, plants, and wildlife indigenous to the state and determined to be endangered or threatened,” unless first receiving an Endangered Species Permit from the Michigan Department of Natural Resources (MDNR), Wildlife Division. Responsibility to protect endangered and threatened species is not limited to the lists below. Other species may be present that have not been recorded in the database.

Several at-risk species and/or natural communities have been documented within 1.5 miles of the project location and it is possible that adverse impacts will occur. This response reflects a desktop review of the database and MNFI cannot fully evaluate this project without visiting the area. MNFI offers several levels of [Rare Species Reviews](), including field surveys which I would be happy to discuss with you.

Sincerely,

Dan Earl

Dan Earl
Environmental Review Assistant/Zoologist
Michigan Natural Features Inventory

Comments for Rare Species Review #5302

It is important to note that it is the applicant's responsibility to comply with both state and federal threatened and endangered species legislation. Therefore, if a state listed species occurs at a project site, and you think you need an endangered species permit, please contact Amy Bleisch at DNR-Wildlife Division, DNR-StateTEPermit@michigan.gov and review details on the MDNR's Threatened/Endangered Species resource page. If a federally listed species is involved and, you think a permit is needed, please contact Jessica Pruden, U.S. Fish and Wildlife Service, East Lansing office, 517-351-8316, or Jessica_Pruden@fws.gov.

NOTE: Special concern species and natural communities are not protected under endangered species legislation, but efforts should be taken to minimize any or all impacts. Please consult MNFI's Rare Species pages for additional information on Michigan's rare plants and animals.

Table 1: Occurrences of Threatened & Endangered Species within 1.5 miles of Project Site

Element Category	Scientific Name	Common Name	Federal Status	State Status	G Rank	S Rank	EO Rank	First Observed Date	Last Observed Date
Animal	*Bombus pensylvanicus*	American bumble bee		E	G3G4	S1	H	1970-08-30	1970-08-30
Animal	*Glyptemys insculpta*	Wood turtle		T	G2G3	S2	E	2004-09-27	2004-09-27
Animal	*Notropis dorsalis*	Bigmouth shiner		T	G5	S2	E	1997-08-21	1997-08-21

Species Comments for Table 1

Wood turtle (*Glyptemys insculpta*)

Habitat

Wood turtles are found primarily in or near moving water and associated riparian habitats. They prefer clear, medium-sized (range 7-100 ft / 2.1-30.5 m), hard-bottomed streams and rivers with sand and/or gravel substrates and moderate flow. Wood turtles also require partially shaded, wet-mesic herbaceous vegetation such as raspberries, strawberries, grasses, willows, and alders along or near the river for foraging. Forested floodplains (deciduous and coniferous) with numerous sunlit openings and a dense mixture of low herbs and shrubs seem to provide ideal habitat for this species. They also have been found in non-forested habitats such as willow and alder thickets, sphagnum bogs, swamps, wet meadows, and old fields within or near the floodplain. Wood turtles also require sandy or sandy-gravelly areas along the river for nesting but will utilize gravel pits, railroad crossings, clearcuts, roadways, utility right-of-ways, and residential yards and gardens if natural nesting habitat is not available. Wood turtles are known to occur within 1 mile the proposed project area, in the White River northeast of the Hesperia Pond.

Management Recommendations

The most serious threat to this species is poaching for commercial pet trade and incidental collecting by the general public. The public should be informed and educated that this species is protected under the Director's order and should not be collected or harmed. Maintaining good water quality, controlling sedimentation, restricting pesticide use near waterways, implementing minimum development set-back distances, and leaving buffer zones along streams during timber harvest, grazing, agricultural, and construction operations can help preserve wood turtle habitat. Maintaining stream dynamics that create sandy areas along the river is crucial for providing suitable nesting habitat. Maintaining or creating small openings in floodplain forests can provide foraging, basking, and/or nesting habitat. Management practices such as sand traps, streambank stabilization, stream channelization and dams can eliminate or reduce good wood turtle habitat and should be avoided. Predator control may be necessary at nesting areas to enable successful reproduction or recruitment. Road construction near streams and rivers should be avoided or minimized, especially during the wood turtle active season from late April through August.

For more information, see the *Glyptemys insculpta* species page on the MNFI website.

Table 2: Occurrences of Special Concern Species and Natural Communities within 1.5 miles of Project Site

Element Category	Scientific Name	Common Name	Federal Status	State Status	G Rank	S Rank	EO Rank	First Observed Date	Last Observed Date
Animal	*Necturus maculosus*	Mudpuppy		SC	G5	S3S4	E	2008-09-23	2013-04-30
Animal	*Necturus maculosus*	Mudpuppy		SC	G5	S3S4	E	2013-04-30	2013-04-30
Animal	*Necturus maculosus*	Mudpuppy		SC	G5	S3S4	E	2013-04-30	2013-04-30

Species Comments for Table 2

Mudpuppy (*Necturus maculosus*)

Habitat

Mudpuppies live in permanent waters including rivers, perennial streams, ponds, inland lakes, Great Lakes bays and shallows, reservoirs, canals, and ditches. They prefer medium to large rivers and lakes, and aquatic habitats with abundant shelter or cover, such as riprap, talus, boulder/rock piles, rocks, especially flat rock slabs, large submerged logs or woody debris, dense mats of submergent vegetation, eroded or undercut banks, and tree roots. They inhabit clear and silty waters and areas with or without aquatic vegetation. Mudpuppies are rarely seen, hiding under rocks or other cover objects during the day and becoming active only at night, especially in clear water, or being active both day and night in habitats with shallow water and thick aquatic vegetation. They typically move to shallower water in the spring and move to deeper water in the summer and winter (e.g., as deep as 56 ft in Lake Erie and 100 ft in Lake Michigan). Mudpuppies primarily walk on the bottom of rivers and lakes but they can also swim through the water column. Young mudpuppies may use separate habitats from adults, frequently occurring in densely vegetated shallow water areas along the edges of lakes and streams. Several populations of mudpuppies are known to occur in the proposed project area, particularly in the White River immediately adjacent to the Hesperia dam on either side, and in nearby ponds.

Management Recommendations

Maintaining and protecting existing populations, particularly those with larger population sizes and successful recruitment, will help sustain the species in perpetuity. Improving water quality and reducing chemical contamination and siltation from agricultural, industrial and residential practices in occupied habitats would improve health and survival of mudpuppies since they are highly vulnerable to pollutants and decreased water quality. Limiting the use of lampricide for controlling sea lampreys and limiting algal blooms and botulism outbreaks in occupied sites would reduce mass mortality of mudpuppies. Controlling invasive species, such as zebra mussels and Eurasian watermilfoil, would help mitigate changes to aquatic communities caused by these species and benefit mudpuppy populations. Additional surveys and research are needed to identify priority populations in the state and obtain information on their status, viability, and site-specific ecology and threats to inform and implement effective conservation measures. It also is critical to protect this species because it is the only host of the state threatened Salamander Mussel (*Simpsonaias ambigua*).

For more information, see the *Necturus maculosus* species page on the MNFI website.

Codes to accompany table

State Protection Status Code Definitions

E = Endangered
T = Threatened
SC = Special concern

Federal Protection Status Code Definitions

LE = listed endangered
LT = listed threatened
LELT = partly listed endangered and partly listed threatened
PDL = proposed delist
E(S/A) = endangered based on similarities/appearance
PS = partial status (federally listed in only part of its range)
C = species being considered for federal status

Global Heritage Status Rank Definitions (G RANK)

The priority assigned by NatureServe's national office for data collection and protection based upon the element's status throughout its entire world-wide range. Criteria not based only on number of occurrences; other critical factors also apply. Note that ranks are frequently combined.

G1 = critically imperiled globally because of extreme rarity (5 or fewer occurrences range-wide or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.
G2 = imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.
G3 = Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g. a single western state, a physiographic region in the East) or because of other factor(s) making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100.
G4 = Apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery.
G5 = Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.
Q = Taxonomy uncertain

State Heritage Status Rank Definitions (S RANK)

The priority assigned by the Michigan Natural Features Inventory for data collection and protection based upon the element's status within the state. Criteria not based only on number of occurrences; other critical factors also apply. Note that ranks are frequently combined.

S1 = Critically imperiled in the state because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation in the state.
S2 = Imperiled in state because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state.
S3 = Rare or uncommon in state (on the order of 21 to 100 occurrences). S4 = apparently secure in state, with many occurrences.
S5 = demonstrably secure in state and essentially ineradicable under present conditions.
SX = apparently extirpated from state.

EO Rank Codes

Element Occurrence (EO) ranks refer to the viability or ecological integrity of the occurrence; they provide an assessment of the likelihood that if current conditions prevail the EO will persist for a defined period of time, typically 20-100 years.

A - Excellent estimated viability/ecological integrity
A? - Possibly excellent estimated viability/ecological integrity
AB - Excellent or good estimated viability/ecological integrity
AC - Excellent, good, or fair estimated viability/ecological integrity
B - Good estimated viability/ecological integrity
B? - Possibly good estimated viability/ecological integrity
BC - Good or fair estimated viability/ecological integrity
BD - Good, fair, or poor estimated viability/ecological integrity
C - Fair estimated viability/ecological integrity
C? - Possibly fair estimated viability/ecological integrity
CD - Fair or poor estimated viability/ecological integrity
D - Poor estimated viability/ecological integrity
D? - Possibly poor estimated viability/ecological integrity
E - Verified extant (viability/ecological integrity not assessed)
F - Failed to find
F? - Possibly failed to find
H - Historical
H? - Possibly historical
X - Extirpated
X? - Possibly extirpated
U - Unrankable
NR - Not ranked

Section 7 Comments for Rare Species Review #5302
Hesperia Dam - White River in Oceana County, Michigan.
Zack Pitman
GEI Consultants
4472 Mount Hope Road
Suite A
Williamsburg, MI 49690

January 23, 2025

For projects involving Federal funding or a federal agency authorization

The following information is provided to assist you with Section 7 compliance of the Federal Endangered Species Act (ESA). The ESA directs all Federal agencies “to work to conserve endangered and threatened species. Section 7 of the ESA, called "Interagency Cooperation," is the means by which Federal agencies ensure their actions, including those they authorize or fund, do not jeopardize the existence of any listed species.”

The project falls within the range of the following federally listed/proposed/candidate species which have been identified by the U.S. Fish and Wildlife Service (USFWS) to occur in Oceana County, Michigan:

Federally Endangered

Indiana bat – there does appear to be suitable habitat within 1.5 miles of the project. Indiana bats (*Myotis sodalis*) are found only in the eastern United States and are typically confined to the southern three tiers of counties in Michigan. Indiana bats that summer in Michigan winter in caves in Indiana and Kentucky. This species forms colonies and forages in riparian and mature floodplain habitats. Nursery roost sites are usually located under loose bark or in hollows of trees near riparian habitat. Indiana bats typically avoid houses or other artificial structures and typically roost underneath loose bark of dead elm, maple and ash trees. Other dead trees used include oak, hickory and cottonwood. Foraging typically occurs over slow-moving, wooded streams and rivers as well as in the canopy of mature trees. Movements may also extend into the outer edge of the floodplain and to nearby solitary trees. A summer colony's foraging area usually encompasses a stretch of stream over a half-mile in length. Upland areas isolated from floodplains and non-wooded streams are generally avoided.

Management and Conservation: Every March, the USFWS publishes survey guidelines to assist project proponents (both Federal and non-Federal) with conservation planning for Federally listed bats in Michigan. We strongly encourage project managers and their designated representatives to use the U.S. Fish and Wildlife Service (USFWS) online planning tool Information for Planning and Consultation (IPaC) to evaluate potential effects of proposed activities on listed bats and other Federally listed species in Michigan. Projects that complete consultation or coordination through IPaC automatically adhere to the recommendations provided in these guidelines and are not required to implement any additional conservation measures for listed bats.

Piping plover – there does not appear to be suitable habitat within 1.5 miles of the project site. In the Great Lakes region, the federal and state endangered piping plover *(Charadrius melodus)* prefers to nest and forage on sparse or non-vegetated sand-pebble beaches with less than 5% vegetative cover. Nests are simple depressions in the sand are generally placed in level areas between the water’s edge and the first dune. Associated bodies of water and interdunal wetlands enhance these areas by increasing food availability. Optimal foraging areas are especially crucial along Lake Superior, where shoreline and benthic invertebrate communities are known to be naturally sparse. While feeding, open shoreline is preferred to vegetated beach areas. Piping plovers begin arriving in mid- to late-April. The nesting season is under way by mid-May and lasts until mid-August.

Management and Conservation - this species is declining throughout the Midwest due to habitat destruction and disturbance. The nests are simple depressions in the sand and are difficult to see. People walking on the beach may inadvertently destroy nests. Dogs on the beach can be especially dangerous for chicks and adults. Piping plovers are protected under the Federal Endangered Species Act and are very sensitive to human disturbance. Please avoid activity along the shoreline in this compartment between May and September.

Karner blue butterfly - there does not appear to be suitable habitat within 1.5 miles of the project site. The federally endangered and state threatened Karner blue butterfly *(Lycaeides melissa samuelis)* was historically found in open-canopied barrens communities, including oak and oak-pine savanna or barrens found prior to European settlement. Since their historical habitat suffers from fire suppression efforts, the butterfly often occurs in openings, old fields, and rights-of-way. Karner blue larvae feed exclusively on wild lupine (*Lupinus perennis*), an early successional species that can become abundant after appropriate disturbances. Adults visit a wide variety of flowering plants for nectar.

The Karner blue has two generations per year, with the later, or summer, generation typically having three to four times the number of adults as the earlier, or spring, brood. Adults are active most of the day, decreasing activity during midday and during cool, rainy weather. Females can live up to two weeks in the field, but typically live an average of five days. Peak flight dates are mid-May through early June and mid-July through early August, with stragglers found between.

Management and Conservation: recommendations for management of Karner blue butterfly habitat will be pertinent only if the host plant, wild lupine (*Lupinus perennis*) is present. If lupine is present the following guidelines should be followed: (1) mower blades should be set no lower than 6 inches; (2) mowing should not occur before August 15th (i.e. no spring mowing at all!); (3) no burning of habitat where lupine exists, and; (4) contact us if planting or logging will occur in lupine areas.

Federally Threatened

Rufa red knot – there does not appear to be suitable habitat within 1.5 miles of the project site. The rufa red knot (*Calidris canutus rufa*) is one of the longest-distance migrants in the animal kingdom, flying some 18,000 miles annually between its breeding grounds in the Canadian Arctic to the wintering grounds at the southern-most tip of South America. Primarily occurring along the Atlantic and Gulf coasts, small groups of this shorebird regularly use the interior of the United States such as the Great Lakes during the annual migration. The Great Lakes shorelines provide vital stopover habitat for resting and refueling during their long annual journey.

The largest concentration of rufa red knots is found in May in Delaware Bay, where the birds stop to gorge on the eggs of spawning horseshoe crabs; a spectacle attracting thousands of birdwatchers to the area. In just a few days, the birds nearly double their weight to prepare for the final leg of their long journey to the Arctic. This species may be especially vulnerable to climate change which affects coastal habitats due to rising sea levels.

Management and Conservation applies to actions that occur along coastal areas during the Red Knot migratory window of MAY 1 - SEPTEMBER 30.

Northern long-eared bat – Northern long-eared bat (*M. septentrionalis*) numbers in the northeast US have declined up to 99 percent. Loss or degradation of summer habitat, wind turbines, disturbance to hibernacula, predation, and pesticides have contributed to declines in Northern long-eared bat populations. However, no other threat has been as severe to the decline as White-nose Syndrome (WNS). WNS is a fungus that thrives in the cold, damp conditions in caves and mines where bats hibernate. The disease is believed to disrupt the hibernation cycle by causing bats to repeatedly awake thereby depleting vital energy reserves. This species was federally listed in May 2015 primarily due to the threat from WNS.

Although no known hibernacula or roost trees have been documented within 1.5 miles of the project site, this activity occurs within the designated WNS zone (i.e., within 150 miles of positive counties/districts impacted by WNS. Also, there does appear to be suitable habitat within 1.5 miles of the project.

Also called northern bat or northern myotis, this bat is distinguished from other *Myotis* species by its long ears. In Michigan, northern long-eared bats hibernate in abandoned mines and caves in the Upper Peninsula; they also commonly hibernate in the Tippy Dam spillway in Manistee County. This species is a regional migrant with migratory distance largely determined by locations of suitable hibernacula sites.

Northern long-eared bats typically roost and forage in forested areas. During the summer, these bats roost singly or in colonies underneath bark, in cavities or in crevices of both living and dead trees. Roost trees are selected based on the suitability to retain bark or provide cavities or crevices. Common roost trees in southern Lower Michigan include species of ash, elm and maple. Foraging occurs primarily in areas along woodland edges, woodland clearings and over small woodland ponds. Moths, beetles, and small flies are common food items. Like all temperate bats this species typically produces only 1-2 young per year.

Management and Conservation: Every March, the USFWS publishes survey guidelines to assist project proponents (both Federal and non-Federal) with conservation planning for Federally listed bats in Michigan. We strongly encourage project managers and their designated representatives to use the U.S. Fish and Wildlife Service (USFWS) online planning tool Information for Planning and Consultation (IPaC) to evaluate potential effects of proposed activities on listed bats and other Federally listed species in Michigan. Projects that complete consultation or coordination through IPaC automatically adhere to the recommendations provided in these guidelines and are not required to implement any additional conservation measures for listed bats.

Pitcher's thistle – there does not appear to be suitable habitat within 1.5 miles of the project site. The federal and state threatened Pitcher's thistle *(Cirsium pitcheri)* grows on open sand dunes and occasionally on lag gravel associated with dunes. All of its habitats are along the Great Lakes shores, or in very close proximity. This monocarpic (once-flowering) plant produces a rosette that will mature to flowering in 2-8 years, after which the plant dies. Seeds germinate in June, and most seedlings (rosettes) appear within 1-3 meters of parent plants. The taproot of this thistle, which can reach 2 m in length, enhances its ability to survive the often-desiccating conditions of its dune habitat. Pitcher's thistle blooms from approximately late-June to early September.

Management and Conservation - Pitcher's thistle can be locally extirpated by destruction or major disturbance of its habitat (e.g. by shoreline development, vehicular or ORV traffic, heavy foot traffic and/or intensive recreation).

Eastern massasauga rattlesnake (EMR) – there does not appear to be suitable habitat within 1.5 miles of the project. The project falls outside Tier 1/Tier 2 EMR habitat as designated by the U.S. Fish & Wildlife Service (USFWS). The federally threatened and state special concern Eastern massasauga rattlesnake *(Sistrurus catenatus)* is Michigan's only venomous snake and is found in a variety of wetland habitats including bogs, fens, shrub swamps, wet meadows, marshes, moist grasslands, wet prairies, and floodplain forests. Eastern massasaugas occur throughout the Lower Peninsula but are not found in the Upper Peninsula. Populations in southern Michigan are typically associated with open wetlands, particularly prairie fens, while those in northern Michigan are better known from lowland coniferous forests, such as cedar swamps. These snakes normally overwinter in crayfish or small mammal burrows often close to the groundwater level and emerge in spring as water levels rise. During late spring, these snakes move into adjacent uplands they spend the warmer months foraging in shrubby fields and grasslands in search of mice and voles, their favorite food.

Often described as "shy and sluggish", these snakes avoid human confrontation and are not prone to strike, preferring to leave the area when they are threatened. However, like any wild animal, they will protect themselves from anything they see as a potential predator. Their short fangs can easily puncture skin and they do possess potent venom. Like many snakes, the first human reaction may be to kill the snake, but it is important to remember that all snakes play vital roles in the ecosystem. Some may eat harmful insects. Others like the massasauga consider rodents a delicacy and help control their population. Snakes are also a part of a larger food web and can provide food to eagles, herons, and several mammals.

Management and Conservation: protection of extant populations and suitable wetland and adjacent upland habitats is crucial for successful conservation of the Eastern Massasauga. Maintaining or restoring open habitat conditions is critical for this species. Fragmentation of suitable wetland-upland habitat complexes by roads or other barriers should be avoided or minimized. Land management practices such as timber harvesting, mowing, disking or prescribed burning should be conducted in such a manner so as to minimize the potential for adverse impacts to massasaugas (e.g., conducting management activities during the snakes’ inactive season (November through early March) or on days when snakes are less likely to be active on the surface during the active season). Protecting suitable hibernation sites also is critical.

USFWS Section 7 Consultation Technical Assistance can be found at:

https://www.fws.gov/service/esa-section-7-consultation

The website offers step-by-step instructions to guide you through the Section 7 consultation process with prepared templates for documenting “no effect” as well as requesting concurrence on "may affect, but not likely to adversely affect" determinations.

Please let us know if you have questions.

Dan Earl
Environmental Review Assistant/Zoologist
Michigan Natural Features Inventory

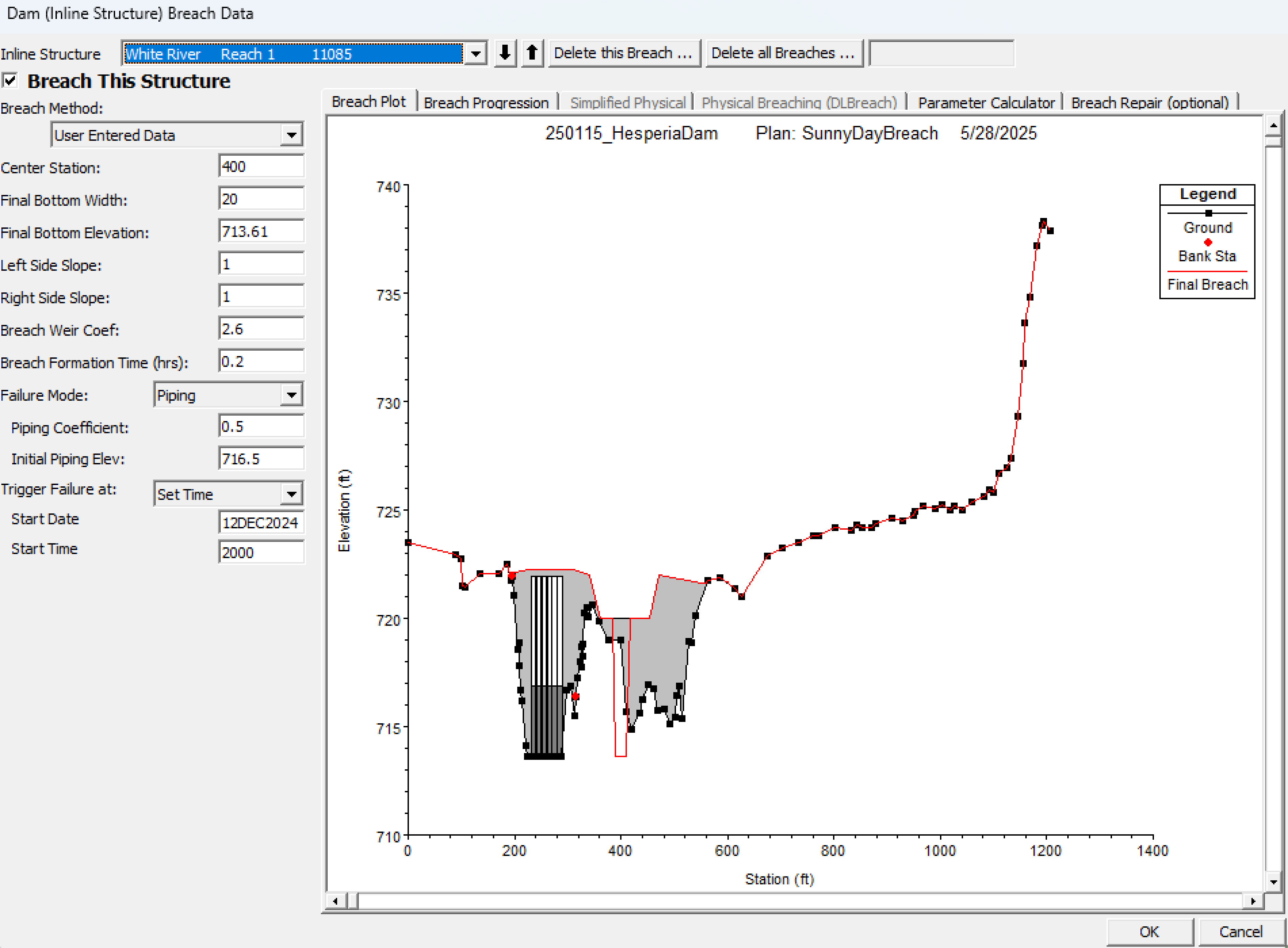
Appendix D Existing Conditions Analysis

D.1. Hydrologic and Hydraulic

D.2. Geotechnical

D.3. Structural

D.1. Hydrologic and Hydraulic



Dam (Inline Structure) Breach Data

Inline Structure: White River Reach 1 11085

☑ **Breach This Structure**

Breach Method: User Entered Data

Center Station: 400

Final Bottom Width: 20

Final Bottom Elevation: 713.61

Left Side Slope: 1

Right Side Slope: 1

Breach Weir Coef: 2.6

Breach Formation Time (hrs): 0.2

Failure Mode: Piping

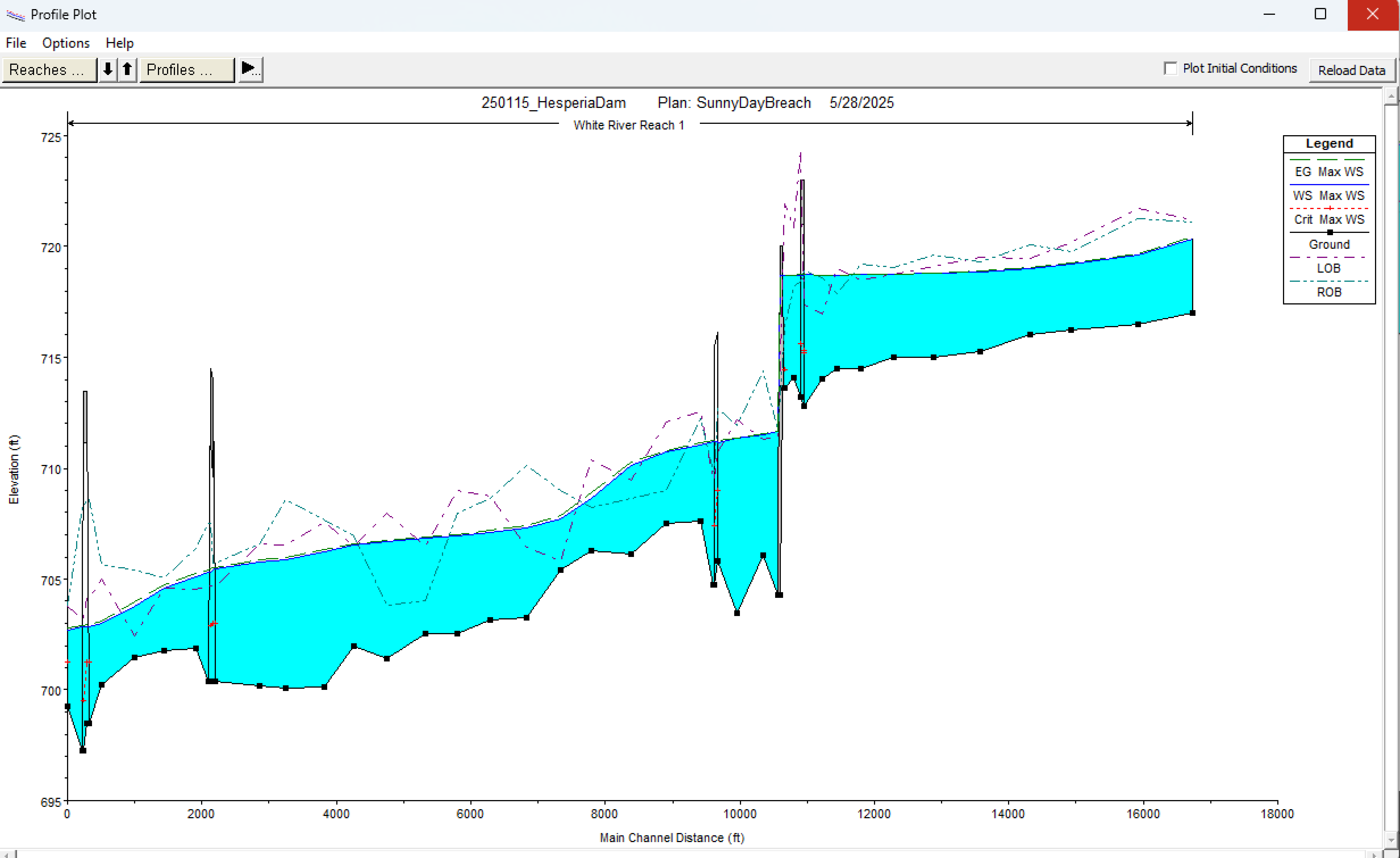
Piping Coefficient: 0.5

Initial Piping Elev: 716.5

Trigger Failure at: Set Time

Start Date: 12DEC2024

Start Time: 2000


Profile Plot
File
Options
Help
Reaches ...
Profiles ...
☐ Plot Initial Conditions
Reload Data
250115_HesperiaDam Plan: SunnyDayBreach 5/28/2025
White River Reach 1
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
LOB
ROB
Elevation (ft)
725
720
715
710
705
700
695
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
Main Channel Distance (ft)

D.2. Geotechnical

GEI Consultants

CALCULATION COVER PAGE

Page	i
Rev. No.	0
Client	Village of Hesperia
Project	Hesperia Dam Feasibility Study

Project No.	2403886	**Document No.**	N/A

Summary

This section summarizes the preliminary geotechnical analyses for the earthen embankments. The right earthen embankment adjacent to the auxiliary spillway structure was selected for evaluation as it is the steepest unarmored earthen section. Key components of the geotechnical analysis include estimating material properties and completing embankment seepage and slope stability analysis.

Record of Revisions

Rev.	Description	Code	Pages/Sections	Name	Date
0	Final – Feasibility Study	P	All	J. Roell	5/6/2025
		R	All	M. Carden	6/10/2025
		A	All	M. Carpenter	6/10/2025

Codes: P = Prepared; C = Checked; A = Approved

GEI Consultants	**Client**	Village of Hesperia			**Page**	1
	Project	Hesperia Dam Feasibility Study			**Pg. Rev.**	0
	By	J. Roell	**Chk.**	M. Carden	**App.**	M. Carpenter
	Date	5/6/2025	**Date**	6/10/2025	**Date**	6/10/2025
Project No.	2403886	**Document No.**	N/A			
Subject	Geotechnical Analysis Criteria and Summary					

Analysis Criteria

This section summarizes the geotechnical analyses for the earthen embankments. The right earthen embankment adjacent to the auxiliary spillway structure was selected for evaluation as it is the steepest unarmored earthen section. Key components of the geotechnical analysis include estimating material properties and completing embankment seepage and slope stability analysis.

Representative Cross Section

As discussed above, one representative section was chosen through the right embankment with the steepest downstream embankment slope. The existing geometry has a crest El. of approximately 722 feet with upstream and downstream slopes of 3H:1V and 2.5H:1V, respectively. There is no documentation of the construction of the embankment via record drawings, therefore the section is assumed to be homogeneous without the presence of a core, cutoff wall or drains. This is a conservative assumption for the purposes of this analysis.

Modeling

A SLOPE/W model was run on the representative section and the existing phreatic surface was estimated based on based on the normal pool headwater elevation, the water level from borings B- 01C and B-02B, and normal tailwater elevation at right earthen embankment. The stability model for the existing condition is attached.

Seismic Considerations

The Design Basis Earthquake (DBE) Peak Ground Acceleration (PGA) is based on the 2014 USGS Hazard Maps (Ref. USGS, 2014) for a probabilistic earthquake event having a 2% probability in 50 years (2,500-year return period). The 2014 USGS seismic hazard map for Michigan shows a PGA of about 0.03g in bedrock, with a 2% probability of exceedance in 50 years (approximately equal to 2,500-year return period), with modest amplification to the dam crest, this design earthquake acceleration would be about 1/2 of the 0.1g FERC-specified threshold for considering earthquake impacts. Therefore, based on commonly accepted standards of practice as defined by the FERC Engineering Guidelines, it is not considered necessary to perform a site-specific seismic hazard analysis; therefore, the design did not account for seismic loading.

Material Parameter Development

GEI Consultants

CLIENT:
Village of Hesperia

PROJECT NAME:
Hesperia Dam

LOG OF BORING NUMBER **B-01C**

ARCHITECT-ENGINEER
GEI Consultants of MI, P.C.

3

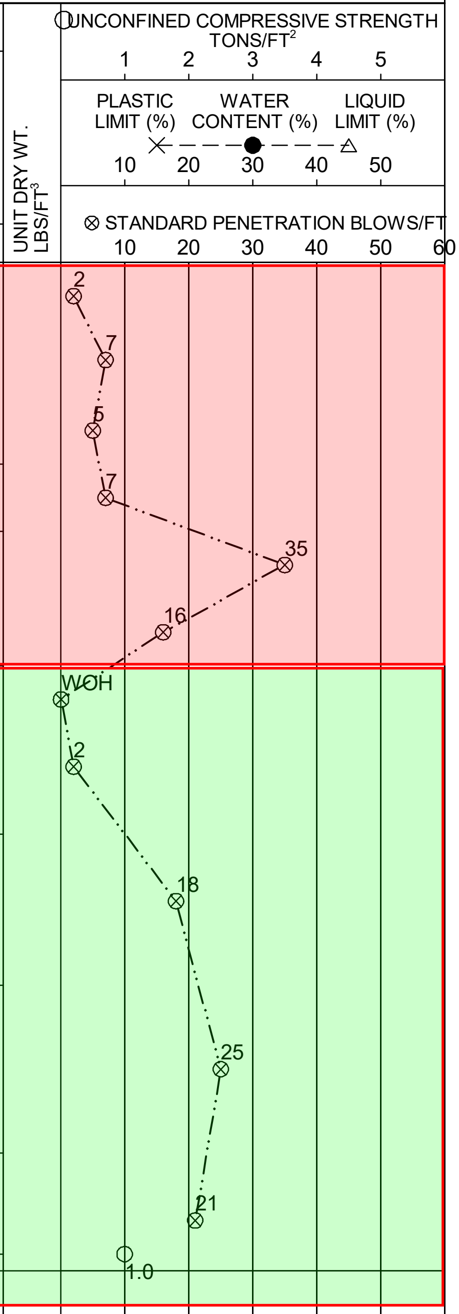
LOCATION: Hesperia, MI

SURFACE ELEVATION (ft.) 721.7

Water @ 713.2' during MW Installation

709.7'

DEPTH (FT)	ELEVATION (FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL
	720	1	SS	Fill: Fine sand - trace silt and fine to coarse gravel - frequent silty sand pockets - brown and dark brown - very loose to loose - moist (SP) Note: S-2B material consisted of Silty sand (SM)
		2A 2B	SS SS	
		3	SS	
		4	SS	6.0 Fill: Fine to coarse sand - some fine to coarse gravel - trace to some silt - dark brown - loose - moist (SP-SM)
		5	SS	8.0 Fill: Fine to medium sand - trace to some silt and fine gravel - trace coarse sand - brown - dense to medium dense - moist to wet (SP-SM)
10	710	6	SS	
		7	SS	12.0 Fine to coarse sand - some fine gravel - trace to some silt - dark brown - loose to very loose - wet (SP-SM)
		8	SS	
		9	SS	17.0 Fine to medium sand - trace silt and fine to coarse gravel - dark brown - medium dense - wet (SP)
20	700	10	SS	21.5 Sandy silt - gray - medium dense - wet (ML)
		11A 11B	SS SS	26.5 Fine to medium sand - trace silt - gray - medium dense - wet (SP)
30				29.5 Silty clay - some fine sand - gray - stiff (CL)
	690			30.0 End of Boring Boring advanced to 28.0 feet with hollow-stem auger. Standard Penetration Tests performed with safety hammer. Boring backfilled with cement bentonite grout.



The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL: 11.0' WS

711.7'

BORING STARTED
10/21/2024

BORING COMPLETED
10/21/2024

GEI OFFICE
Marquette, MI

ENTERED BY
LJE

APPROVED BY
CRA

NORTHING

EASTING

RIG/FOREMAN
Acker Renegade / WP (Pearson)

GEI PROJECT NO.
2403886

PAGE NO. **1** OF **1**

GEI Consultants

CLIENT:
Village of Hesperia

PROJECT NAME:
Hesperia Dam

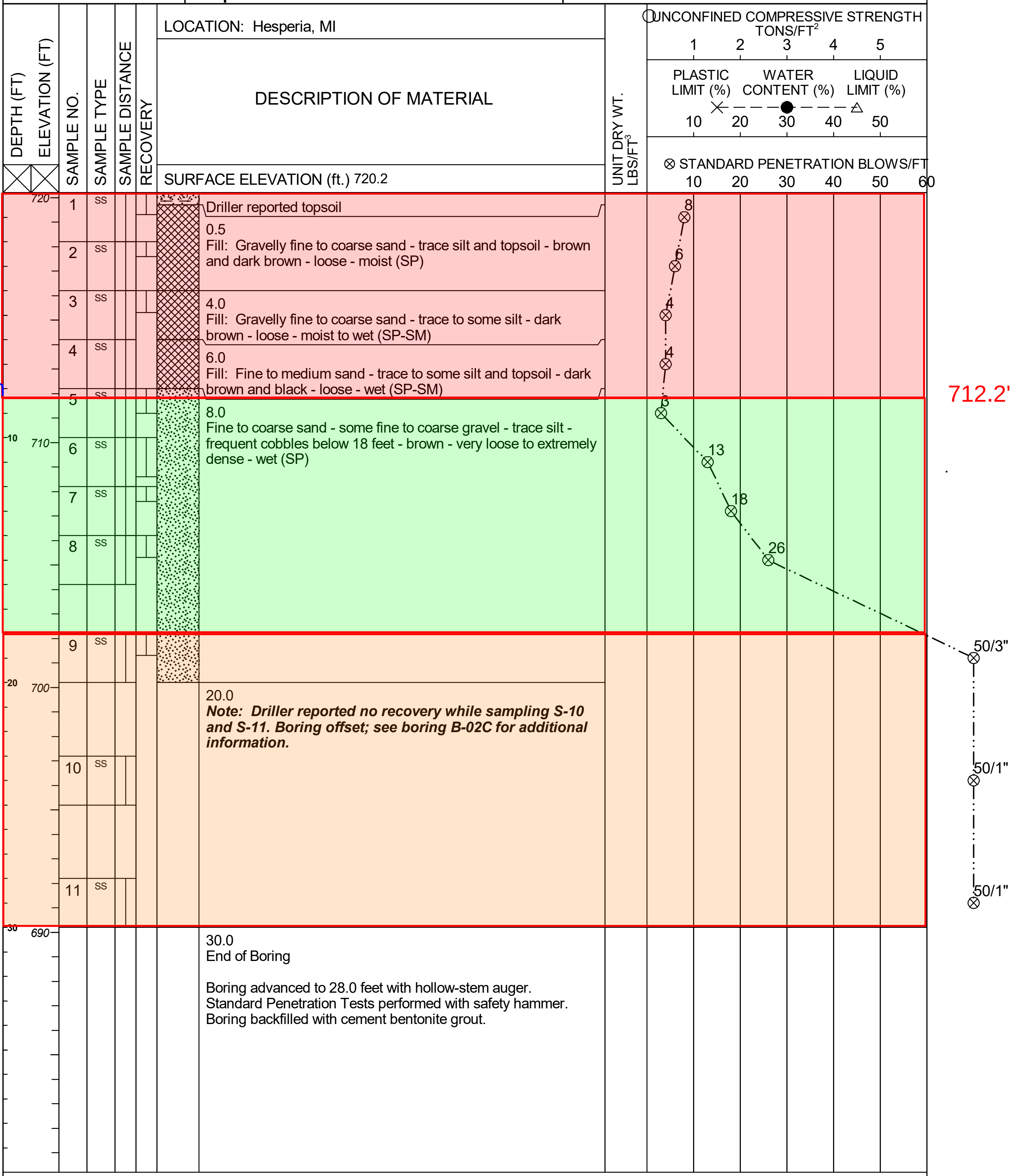
LOG OF BORING NUMBER **B-02B**

ARCHITECT-ENGINEER
GEI Consultants of MI, P.C.

4

LOCATION: Hesperia, MI

SURFACE ELEVATION (ft.) 720.2



Water @ 715.4' during MW Installation

Driller reported topsoil

0.5
Fill: Gravelly fine to coarse sand - trace silt and topsoil - brown and dark brown - loose - moist (SP)

4.0
Fill: Gravelly fine to coarse sand - trace to some silt - dark brown - loose - moist to wet (SP-SM)

6.0
Fill: Fine to medium sand - trace to some silt and topsoil - dark brown and black - loose - wet (SP-SM)

8.0
Fine to coarse sand - some fine to coarse gravel - trace silt - frequent cobbles below 18 feet - brown - very loose to extremely dense - wet (SP)

20.0
Note: Driller reported no recovery while sampling S-10 and S-11. Boring offset; see boring B-02C for additional information.

30.0
End of Boring

Boring advanced to 28.0 feet with hollow-stem auger.
Standard Penetration Tests performed with safety hammer.
Boring backfilled with cement bentonite grout.

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL: 5.0' WS

715.2'

BORING STARTED
10/21/2024

BORING COMPLETED
10/21/2024

GEI OFFICE
Marquette, MI

ENTERED BY
LJE

APPROVED BY
CRA

NORTHING

EASTING

RIG/FOREMAN
Acker Renegade / WP (Pearson)

GEI PROJECT NO.
2403886

PAGE NO. **1** OF **1**

GEI Consultants

CLIENT:
Village of Hesperia

PROJECT NAME:
Hesperia Dam

LOG OF BORING NUMBER **B-02C**

ARCHITECT-ENGINEER
GEI Consultants of MI, P.C.

5

LOCATION: Hesperia, MI

DESCRIPTION OF MATERIAL

SURFACE ELEVATION (ft.) 720.3

DEPTH (FT) | ELEVATION (FT) | SAMPLE NO. | SAMPLE TYPE | SAMPLE DISTANCE | RECOVERY | UNIT DRY WT. LBS/FT^3

○ UNCONFINED COMPRESSIVE STRENGTH TONS/FT^2: 1 2 3 4 5

PLASTIC LIMIT (%) ✕ — WATER CONTENT (%) ● — LIQUID LIMIT (%) △: 10 20 30 40 50

⊗ STANDARD PENETRATION BLOWS/FT: 10 20 30 40 50 60

Depth (ft)	Elevation (ft)	Sample No.	Sample Type	Description of Material	Standard Penetration
	720			Driller blind drilled to 18 feet below grade	
10	710				
		1	SS	18.0 Sandy coarse gravel - trace silt and fine gravel - frequent cobbles and boulders - brown - extremely dense - wet (GP)	50/1"
20	700				
		2	SS		50/<1"
		3	SS	28.0 Fine sand - trace to some silt and fine to coarse gravel - brown - extremely dense - wet (SP-SM)	50/6"
30	690			30.0 End of Boring	

Boring advanced to 28.0 feet with hollow-stem auger.
Standard Penetration Tests performed with safety hammer.
Boring backfilled with cement bentonite grout.

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WATER LEVEL: 5.0' WD

BORING STARTED **10/21/2024**

BORING COMPLETED **10/21/2024**

GEI OFFICE **Marquette, MI**

ENTERED BY **LJE**

APPROVED BY **CRA**

NORTHING

EASTING

RIG/FOREMAN **Acker Renegade / WP (Pearson)**

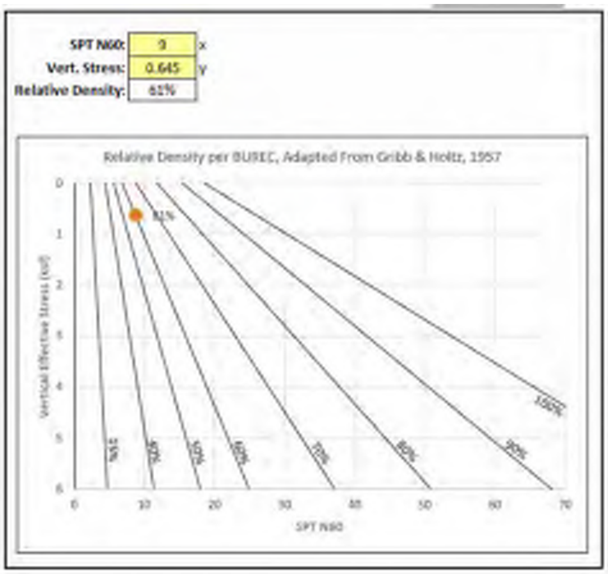
GEI PROJECT NO. **2403886**

PAGE NO. **1** OF **1**

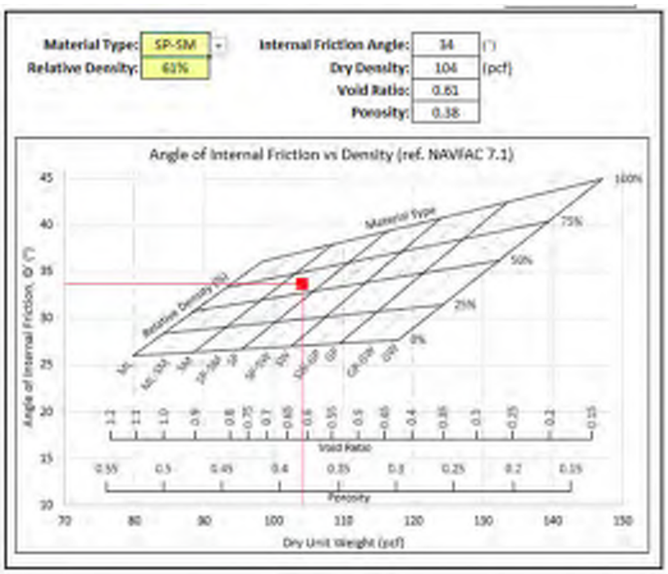
MIDWEST BORING LOG 2403886 - HESPERIA DAM - CRA.GPJ GEI DATA TEMPLATE.GDT 1/16/25

GEI Consultants	**Client**	Village of Hesperia		**Page**	6
	Project	Hesperia Dam Feasibility Study		**Pg. Rev.**	0
	By	J. Roell	**Chk.** M. Carden	**App.**	M. Carpenter
	Date	5/6/2025	**Date** 6/10/2025	**Date**	6/10/2025
Project No.	2403886	**Document No.**	N/A		
Subject	Geotechnical Analysis Criteria and Summary				

Embankment Material

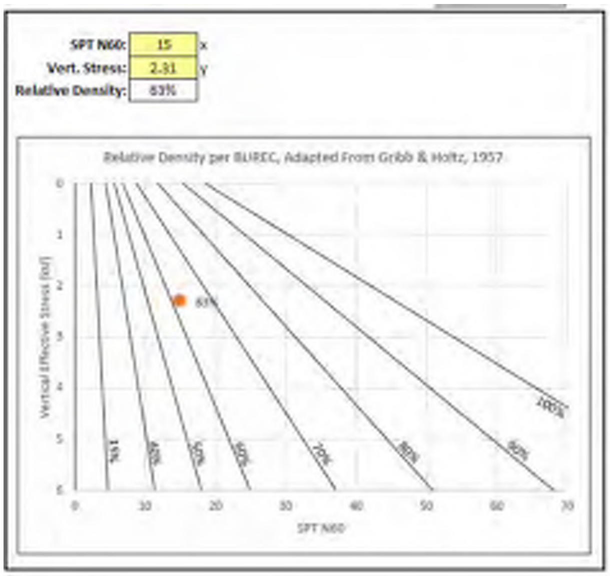


SPT N60: 9 x
Vert. Stress: 0.645 y
Relative Density: 61%

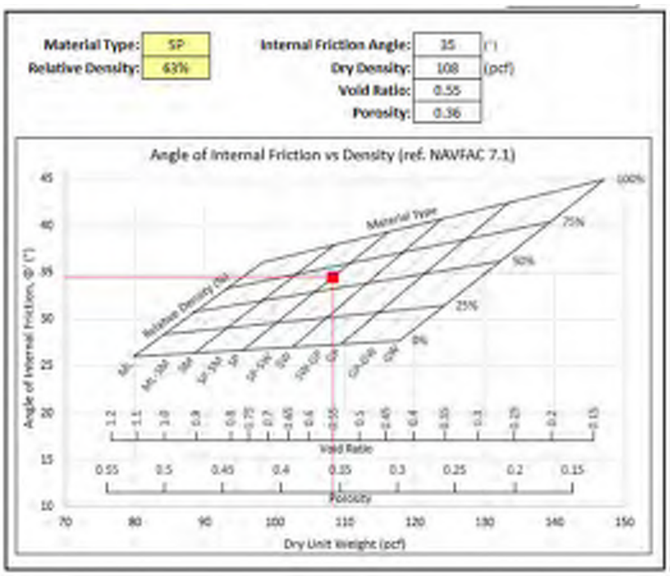


Material Type: SP-SM
Relative Density: 61%
Internal Friction Angle: 34 (°)
Dry Density: 104 (pcf)
Void Ratio: 0.61
Porosity: 0.38

Foundation Material



SPT N60: 15 x
Vert. Stress: 2.31 y
Relative Density: 63%



Material Type: SP
Relative Density: 63%
Internal Friction Angle: 35 (°)
Dry Density: 108 (pcf)
Void Ratio: 0.55
Porosity: 0.36

GEI Consultants	**Client**	Village of Hesperia			**Page**	7
	Project	Hesperia Dam Feasibility Study			**Pg. Rev.**	0
	By	J. Roell	**Chk.**	M. Carden	**App.**	M. Carpenter
	Date	5/6/2025	**Date**	6/10/2025	**Date**	6/10/2025
Project No.	2403886	**Document No.**	N/A			
Subject	Geotechnical Analysis Criteria and Summary					

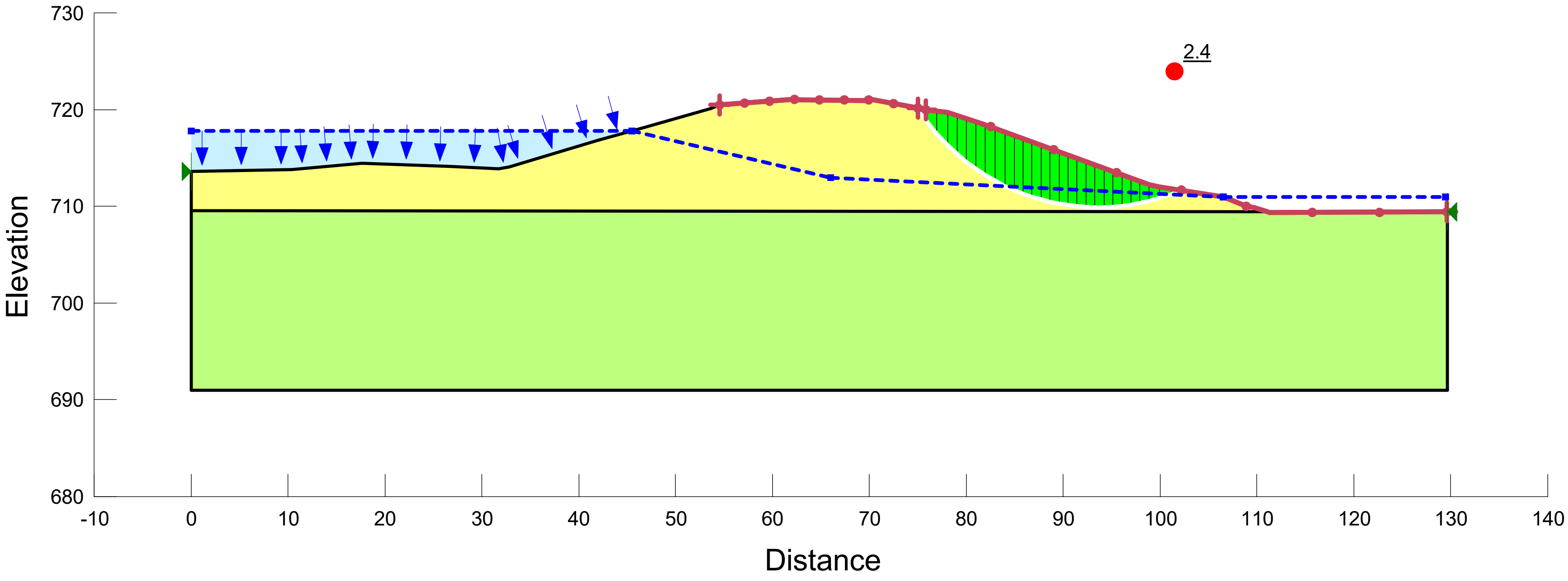
Slope Stability Model

RIGHT EMBANKMENT SECTION

ANALYSIS: Right Embankment

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Friction Angle (°)
🟨	Embankment Fill	Mohr-Coulomb	129	34
🟩	Foundation	Mohr-Coulomb	130	35

COMPUTED
SAFETY FACTOR: 2.4



Hesperia Dam
Embankment Stability

The Village of Hesperia

GEI Consultants

RIGHT EMBANKMENT

Project: 2403886

02/10/2025

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D.3. Structural

GEI Consultants

CALCULATION COVER PAGE

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Rev. No. 0

Client Village of Hesperia

Project Hesperia Dam Feasibility Study

Project No. 2403886

Document No. N/A

Summary

This section summarizes the preliminary structural analyses for the existing spillway structure. The principal spillway structure is approximately 70 feet wide and includes 6 bays with wooden stop logs, which are operated by manual lifting from the walkway above. The history of the construction of the principal spillway is unknown, but is assumed to be rock-filled timber crib and masonry which was typical for the era. At some unknown date, the dam was encased with a reinforced concrete cap.

Record of Revisions

Rev.	Description	Code	Pages/Sections	Name	Date
0	Final – Feasibility Study	P	All	J. Probstfeld	3/15/2025
		R	All	J. Burch	5/15/2025
		A	All	M. Carden	5/15/2025

Codes: P = Prepared; C = Checked; A = Approved

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	By	J. Probstfeld	**Chk.**	J. Burch	**App.**	M. Carden
	Date	03/15/2025	**Date**	05/15/2025	**Date**	05/15/2025
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Hesperia Stability Analysis

Figure 1 - Site Overview

Purpose

The purpose of the following calcs is to perform a high-level stability analysis of the existing dam on the White River in the village of Hesperia, MI.

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	Date	03/15/2025	Date	05/15/2025	Date	05/15/2025
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References:

1. Drawings – ‘Village of Hesperia - Hesperia Dam Principal Spillway Measurements and Flow Calcs’
2. Drawings – ‘Norland, Dunlap, & Associates – Village of Hesperia – Dam Repairs’
3. USACE EM-1110-2-2200 – Gravity Dam Design
4. USACE EM-1110-2-2104 – Strength Design for Reinforced Concrete Hydraulic Structures
5. ACI 318-19 – Building Code Requirements for Structural Concrete
6. USACE EM-1110-2-2100 - Stability Analysis of Concrete Structures

Site Parameters:

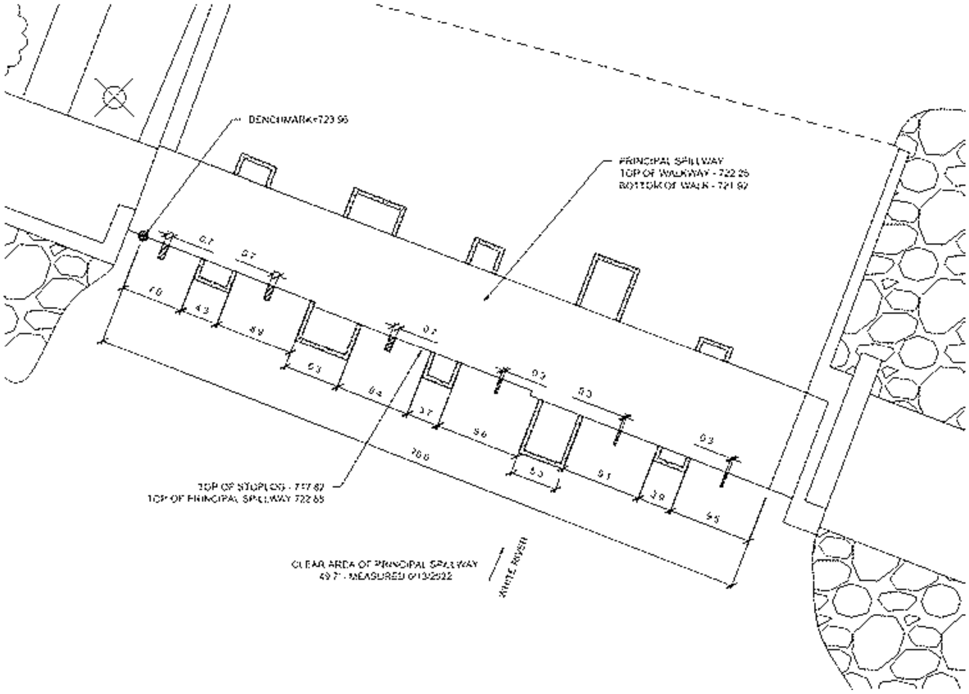
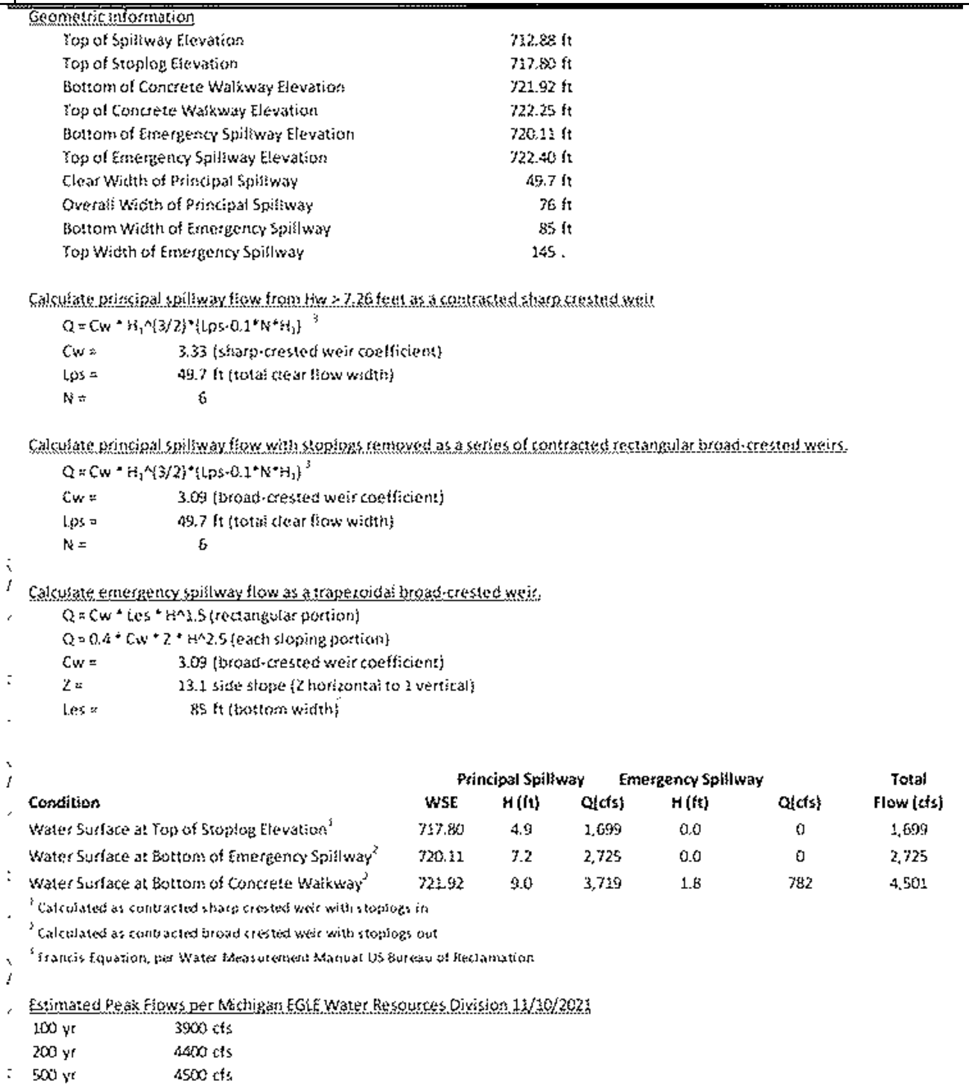


Figure 2 - Pier Dimensions



Geometric Information

Top of Spillway Elevation	712.88 ft
Top of Stoplog Elevation	717.80 ft
Bottom of Concrete Walkway Elevation	721.92 ft
Top of Concrete Walkway Elevation	722.25 ft
Bottom of Emergency Spillway Elevation	720.11 ft
Top of Emergency Spillway Elevation	722.40 ft
Clear Width of Principal Spillway	49.7 ft
Overall Width of Principal Spillway	76 ft
Bottom Width of Emergency Spillway	85 ft
Top Width of Emergency Spillway	145 .

Calculate principal spillway flow from Hw > 7.26 feet as a contracted sharp crested weir

Q = Cw * H_1^(3/2)*(Lps-0.1*N*H_1) [3]

Cw = 3.33 (sharp-crested weir coefficient)

Lps = 49.7 ft (total clear flow width)

N = 6

Calculate principal spillway flow with stoplogs removed as a series of contracted rectangular broad-crested weirs.

Q = Cw * H_1^(3/2)*(Lps-0.1*N*H_1) [3]

Cw = 3.09 (broad-crested weir coefficient)

Lps = 49.7 ft (total clear flow width)

N = 6

Calculate emergency spillway flow as a trapezoidal broad-crested weir.

Q = Cw * Les * H^1.5 (rectangular portion)

Q = 0.4 * Cw * Z * H^2.5 (each sloping portion)

Cw = 3.09 (broad-crested weir coefficient)

Z = 13.1 side slope (Z horizontal to 1 vertical)

Les = 85 ft (bottom width)

	Principal Spillway			Emergency Spillway		Total
Condition	WSE	H (ft)	Q(cfs)	H (ft)	Q(cfs)	Flow (cfs)
Water Surface at Top of Stoplog Elevation[1]	717.80	4.9	1,699	0.0	0	1,699
Water Surface at Bottom of Emergency Spillway[2]	720.11	7.2	2,725	0.0	0	2,725
Water Surface at Bottom of Concrete Walkway[2]	721.92	9.0	3,719	1.8	782	4,501

[1] Calculated as contracted sharp crested weir with stoplogs in

[2] Calculated as contracted broad crested weir with stoplogs out

[3] Francis Equation, per Water Measurement Manual US Bureau of Reclamation

Estimated Peak Flows per Michigan EGLE Water Resources Division 11/10/2021

100 yr	3900 cfs
200 yr	4400 cfs
500 yr	4500 cfs

Figure 3 - Site Elevations

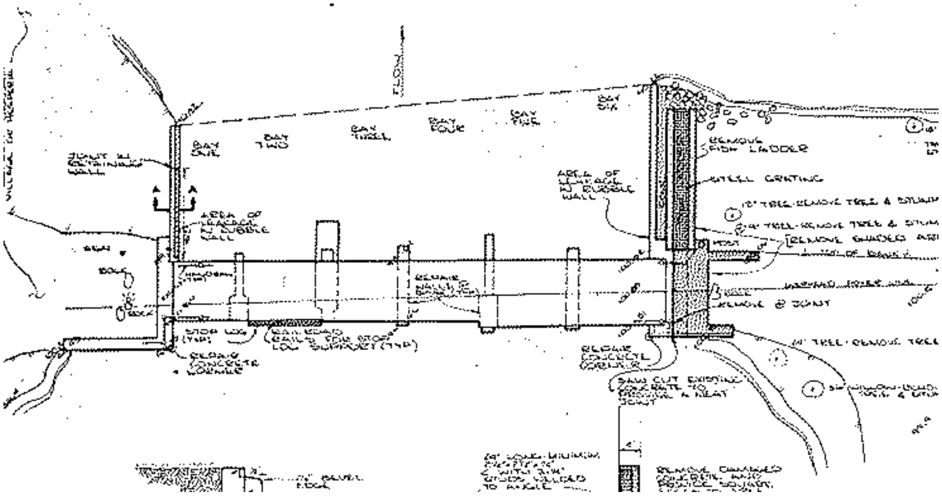


Figure 4 - Hesperia Plan View

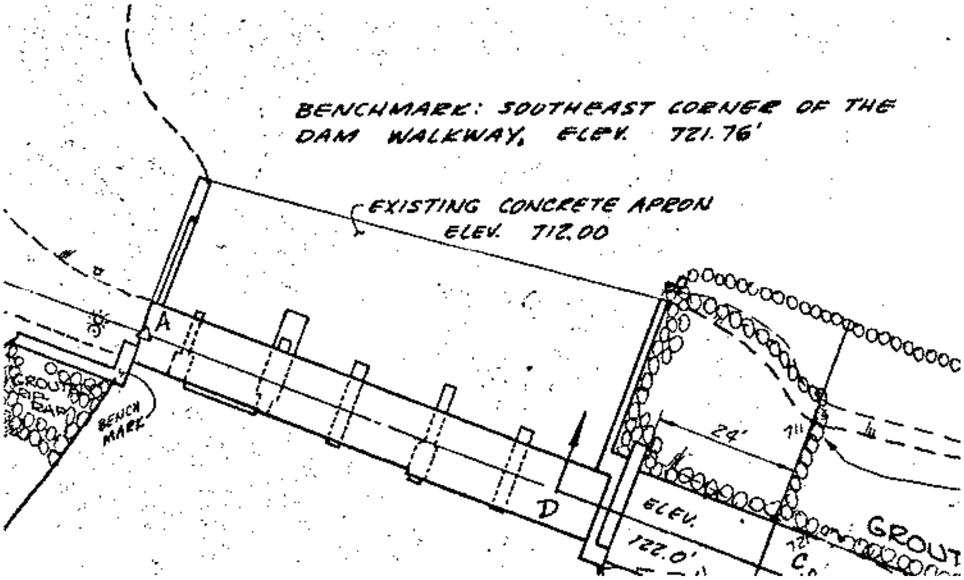


Figure 5 - Concrete Apron t/c Elevation

Pertinent Site Elevations:

Top of Walkway Deck: $El_{top.walkway}$ = 722.25 ft

Top of Pier Elevation: $El_{top.pier}$ = 721 ft (Assumed)

Top of Stop Log Elevation: $El_{top.stoplog}$ = 717.8 ft

Top of Concrete Apron Slab: $El_{tslab.curtain}$ = 712 ft

Bottom of Concrete Walkway: $El_{bottom.walkway}$ = 721.9 ft

Bottom of Pier: $El_{bottom.pier}$ = 711 ft

Bottom of Concrete Apron Slab: $El_{bottom.apron}$ = 711 ft

Width of Principal Spillway: $L_{p.spillway}$ = 76 ft Ref #2

Hydrostatic Elevations:

Normal Pool Elevation: El_{np} = 717.8 ft

PMF Elevation Stop Logs in: El_{PMFc} = 721 ft

Tail Water Elevation: $El_{tailwater}$ = 712 ft

2D Global Stability Analysis: The global stability analysis was performed under two conditions. Condition 1 assumes that the structure acts as a rigid unit as shown in figure 6. Condition 1 is valid with a thick apron slab that is heavily reinforced. Condition 2 assumes that the apron slab cracks at the toe of the piers, due to high stress within the slab. In condition 2 the piers and connecting apron slab are analyzed as a rigid unit.

Stability Criteria:

Ref # 3 Table #-2, 4-1

Usual

- Sliding: $FS_{slide.n}$ = 3.0 Ref # 3 Table 3-3
- Overturn: Resultant within middle 1/3 of base

Extreme

- Sliding: $Fs_{slide.ex}$ = 2.2 Ref # 3 Table 3-3
- Overturn: Resultant within Base

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Stability Analysis Condition 1:

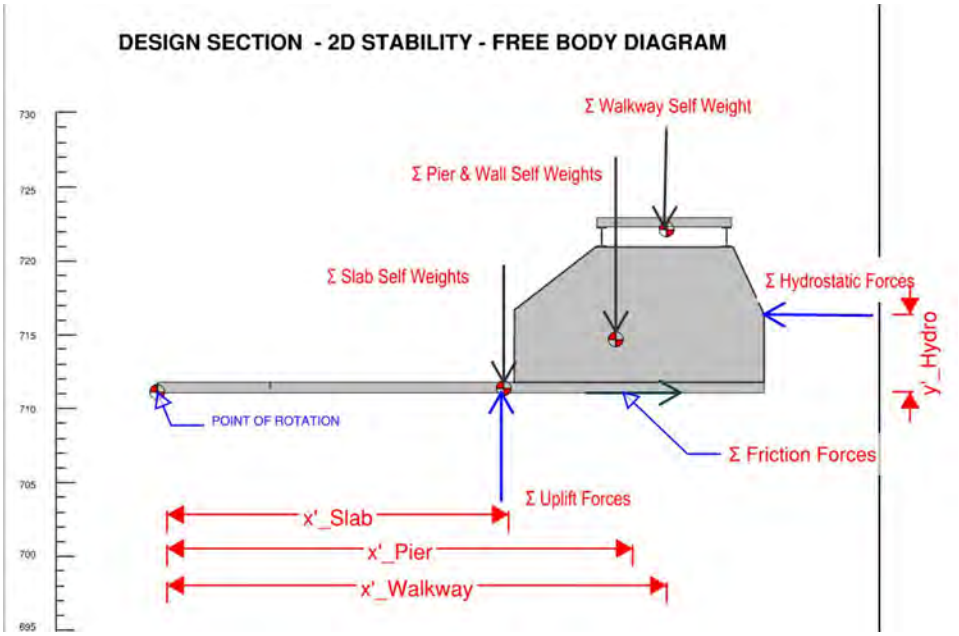

Figure 6 - 2D FBD - Overturning & Sliding Forces – Condition 1

Driving Forces:

*Hydrostatic Pressure:*Normal Pool:

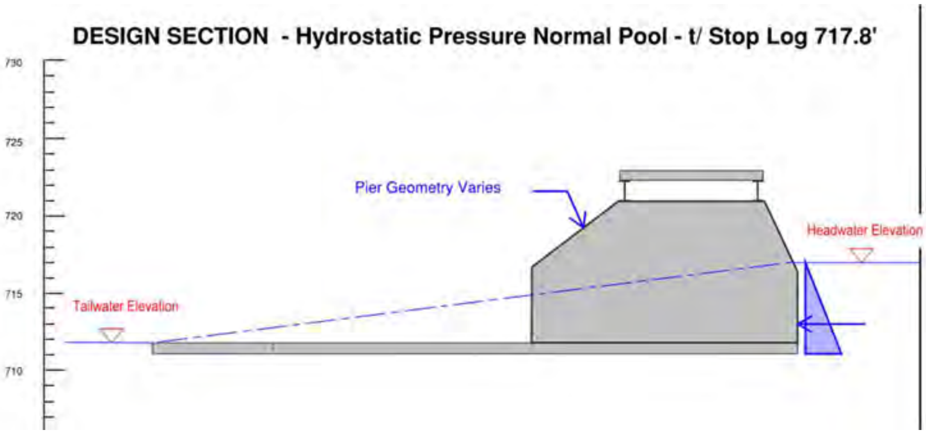

Figure 7 - Normal Pool Hydrostatic Pressure Diagram

Unit Weight of Water:	$\gamma_w = 62.4$ pcf
Depth of Water at stop logs:	$H_{water} = El_{top.stoplog} - El_{bottom.pier} = \mathbf{6.80}$ ft
Hydrostatic Pressure @ Base of Stop Log:	$p_{base} = \gamma_w * H_{water} = \mathbf{424.32}$ psf
Total Hydrostatic Line Load:	$w_{hydro} = (p_{base} * H_{water})/2 = \mathbf{1.44}$ kip/ft

Total Hydrostatic Driving Force +X: $D_{hydro} = w_{hydro} * L_{p.spillway} = \mathbf{109.64}$ kip

Moment arm to centroid of pressure: $y'_{hydro} = H_{water} / 3 = \mathbf{2.27}$ ft

Overturning Moment: $M_{overturn.hydro} = D_{hydro} * y'_{hydro} = \mathbf{248527.05}$

Uplift:

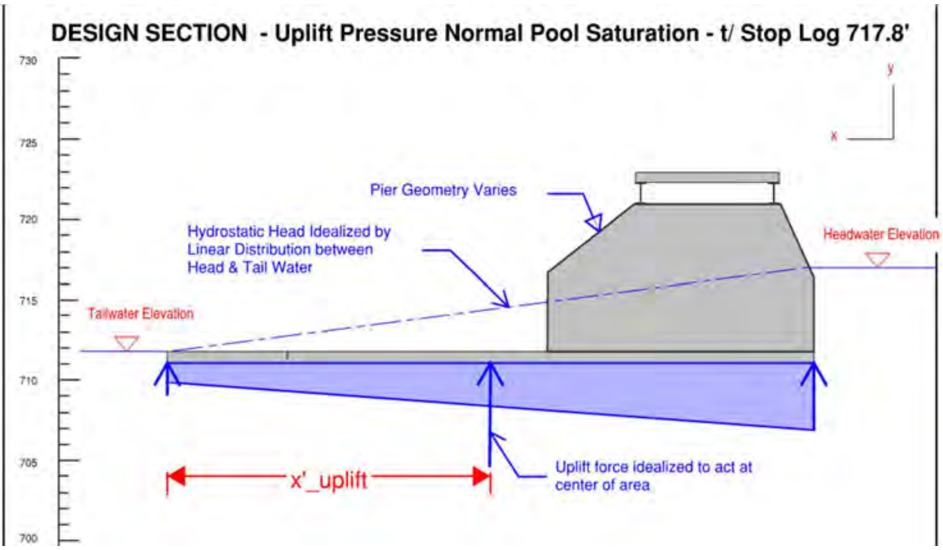

Figure 8 - Uplift Pressure Diagram

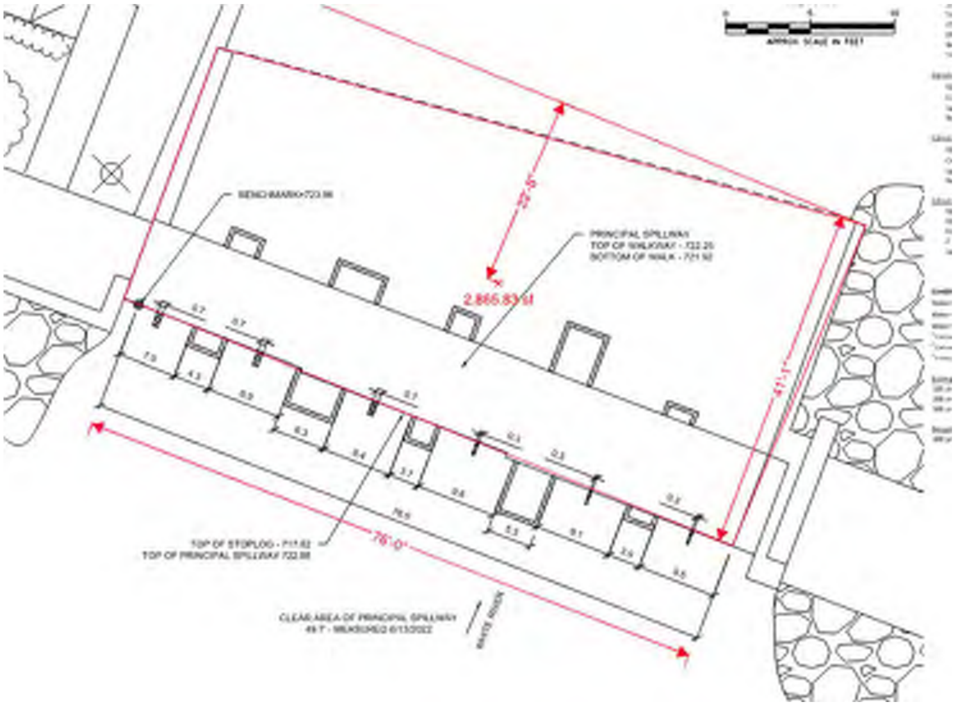

Figure 9 - Pier & Apron Area

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Distance between heel & toe of foundation: L_{apron} = 41ft

Head Differential @ Heel: $H_{water.heel} = El_{np} – El_{bottom.pier}$ = **6.80** ft

Uplift Pressure @ Heel: $p_{uplift.heel} = \gamma_w * H_{water.heel}$ = **424.32** psf

Head Differentail @ Toe: $H_{water.toe} = El_{tailwater} – El_{bottom.apron}$ = **1.00** ft

Uplift Pressure @ Toe: $p_{uplift.toe} = H_{water.toe} * \gamma_w$ = **62.40** psf

Uplift Line Load: $w_{uplift} = ((p_{uplift.toe} + p_{uplift.heel}) / 2) * L_{apron}$ = **9.98** kip/ft

Total Uplift Force: $P_{uplift} = w_{uplift} * L_{apron}$ = **409.09** kip

Uplift Center Force Location(from toe): $x'_{uplift} = (L_{apron} * (p_{uplift.toe} + (2* p_{uplift.heel}))) / (3 * (p_{uplift.toe} + p_{uplift.heel}))$ = **25.58** ft

Area of Apron Slab : A_{slab} = 2865 ft^2

Total Overturning Moment: $M_{overturning.uplift} = P_{uplift} * x'_{uplift}$ = **10464.96** kip_ft

Resisting Forces:

Concrete Self Weight: Concrete Unit Weight (Normal Weight Concrete): γ_c = 145 pcf

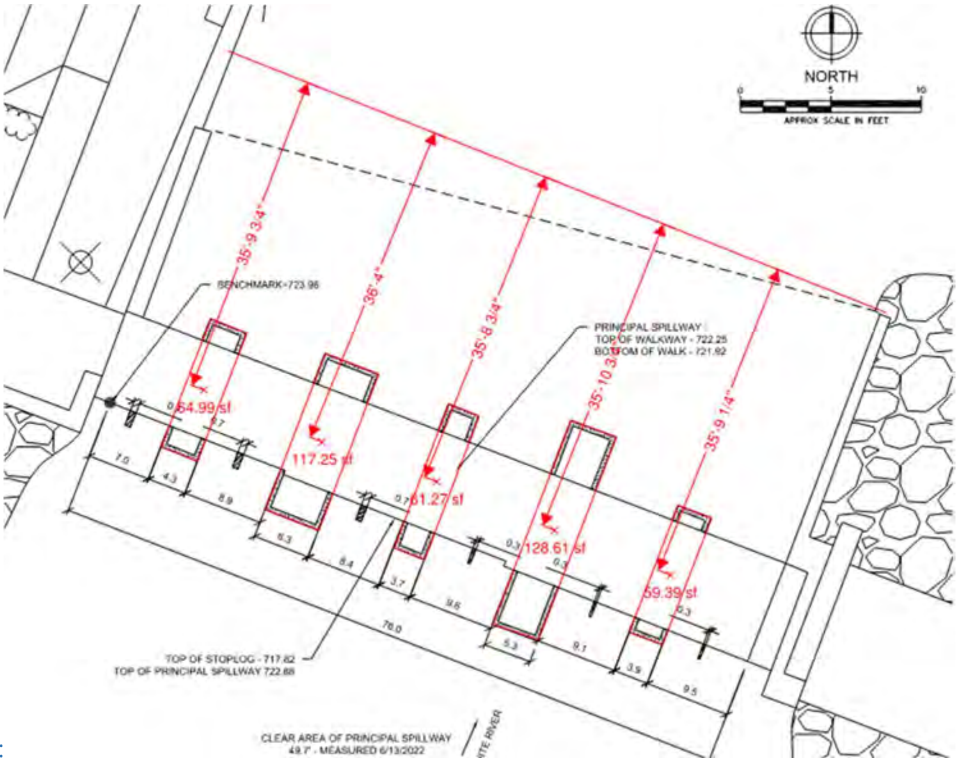


Figure 10 - Pier Slab Areas - Center of Areas

Concrete Piers:

Pier 1:

Area of Pier 1 (See Figure 10): A_{pier1} = 64.99 ft^2

Height of Pier: $t_{pier1} = El_{top.pier} - El_{bottom.pier}$ = **10.00** ft

Self-Weight of Pier 1: $P_{pier1} = \gamma_c * A_{pier1} * t_{pier1}$= **94.24** kip

Moment arm from Toe: x'_{pier1} = 35.81 ft

Restoring Moment Pier 1: $M_{pier1} = P_{pier1} * x'_{pier1}$ = **3368.92** kip_ft

Pier 2:

Area of Pier 2 (See Figure 10): A_{pier2} = 117.25 ft^2

Height of Pier: $t_{pier2} = El_{top.pier} - El_{bottom.pier}$ = **10.00** ft

Self-Weight of Pier 2: $P_{pier2} = \gamma_c * A_{pier2} * t_{pier2}$= **170.01** kip

Moment arm from Toe: $x'_{pier2} = 36.33$ ft

Restoring Moment Pier 2: $M_{pier2} = P_{pier2} * x'_{pier2} = \mathbf{6176.55}$ kip_ft

Pier 3:

Area of Pier 3 (See Figure 10): $A_{pier3} = 61.27\ ft^2$

Height of Pier: $t_{pier3} = El_{top.pier} - El_{bottom.pier} = \mathbf{10.00}$ ft

Self-Weight of Pier 3: $P_{pier3} = \gamma_c * A_{pier3} * t_{pier3} = \mathbf{88.84}$ kip

Moment arm from Toe: $x'_{pier3} = 35.72$ ft

Restoring Moment Pier 3: $M_{pier3} = P_{pier3} * x'_{pier3} = \mathbf{3173.42}$ kip_ft

Pier 4:

Area of Pier 4 (See Figure 10): $A_{pier4} = 128.61\ ft^2$

Height of Pier: $t_{pier4} = El_{top.pier} - El_{bottom.pier} = \mathbf{10.00}$ ft

Self-Weight of Pier 4: $P_{pier4} = \gamma_c * A_{pier4} * t_{pier4} = \mathbf{186.48}$ kip

Moment arm from Toe: $x'_{pier4} = 35.89$ ft

Restoring Moment Pier 4: $M_{pier4} = P_{pier4} * x'_{pier4} = \mathbf{6692.93}$ kip_ft

Pier 5:

Area of Pier 5 (See Figure 10): $A_{pier5} = 59.39\ ft^2$

Height of Pier: $t_{pier5} = El_{top.pier} - El_{bottom.pier} = \mathbf{10.00}$ ft

Self-Weight of Pier 5: $P_{pier5} = \gamma_c * A_{pier5} * t_{pier5} = \mathbf{86.12}$ kip

Moment arm from Toe: $x'_{pier5} = 35.77$ ft

Restoring Moment Pier 5: $M_{pier5} = P_{pier5} * x'_{pier5} = \mathbf{3080.35}$ kip_ft

Total Weight of Piers: $P_{pier.total} = (P_{pier5} + P_{pier4} + P_{pier3} + P_{pier2} + P_{pier1}) = \mathbf{625.69\ kip}$

Total Restoring Moment Piers: $M_{total.pier} = (M_{pier5} + M_{pier4} + M_{pier3} + M_{pier2} + M_{pier1}) = \mathbf{22492.17}$ kip_ft

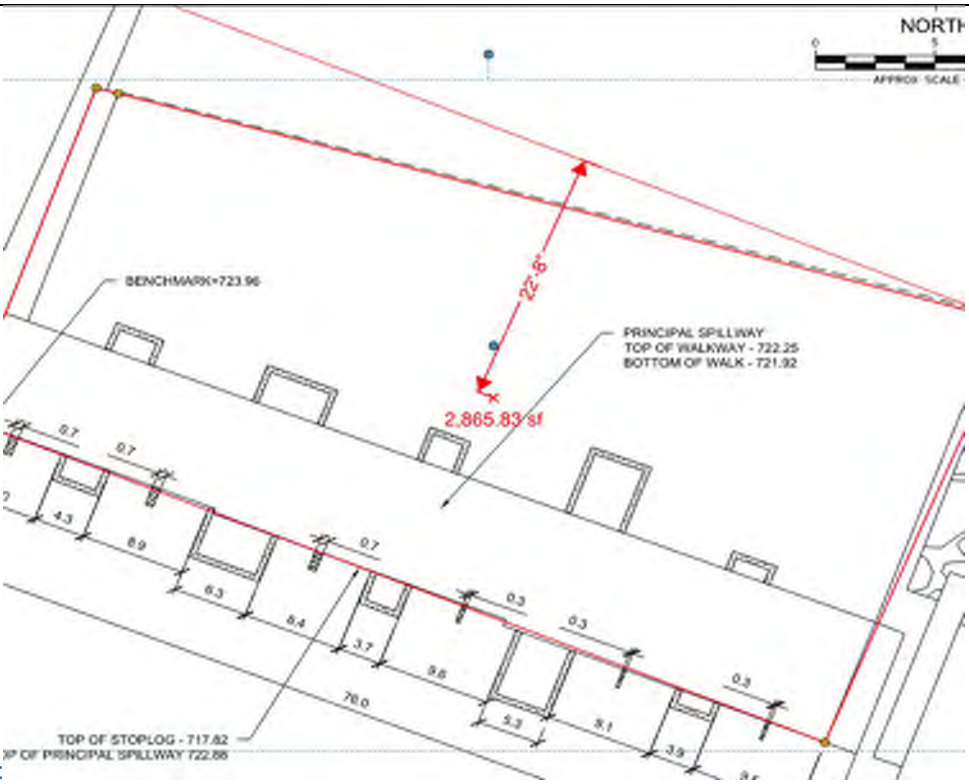


Figure 11 - Apron Slab Area - Center of Area

Concrete Apron:

Area of Apron Slab (See Figure 9): $A_{apron.slab}$ = 2865 ft^2

Thickness Apron Slab: t_{slab} = 1 ft

Self-Weight of Apron Slab: $P_{apron.slab} = \gamma_c * A_{apron.slab} * t_{slab}$= **415.43** kip

Moment arm from Toe: $x'_{apron.sw}$ = 22.8 ft

Restoring Moment Apron Slab: $M_{restore.apron} = P_{apron.slab} * x'_{apron.sw}$ = **9471.69** kip_ft

Concrete Walkway & Steel:

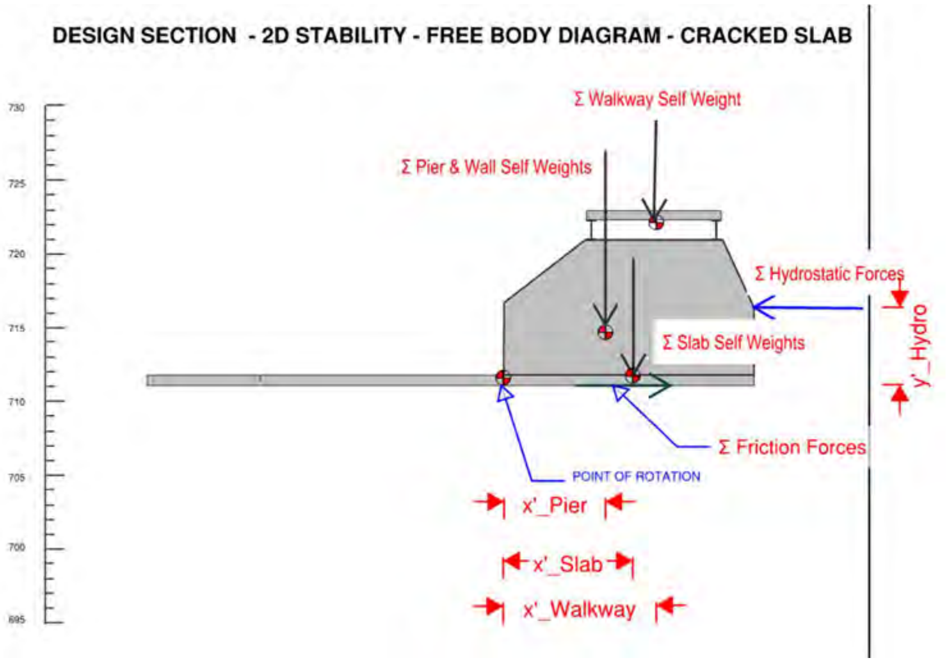
Concrete Walkway and Steel Not Required for stability in condition 1, and was not considered in this analysis.

Base Friction:

Coefficient of Friction: $\mu_{concret.sand}$ = 0.7

Total Friction Force: $P_{friction.c1} = (P_{pier.total} + P_{apron.slab} - P_{uplift}) * \mu_{concret.sand}$ = **442.42** kip

Stability Analysis Condition 2:



Driving Forces:

Figure 12 - Figure 6 - 2D FBD - Overturning & Sliding Forces – Condition 2

*Hydrostatic Pressure:*Normal Pool:

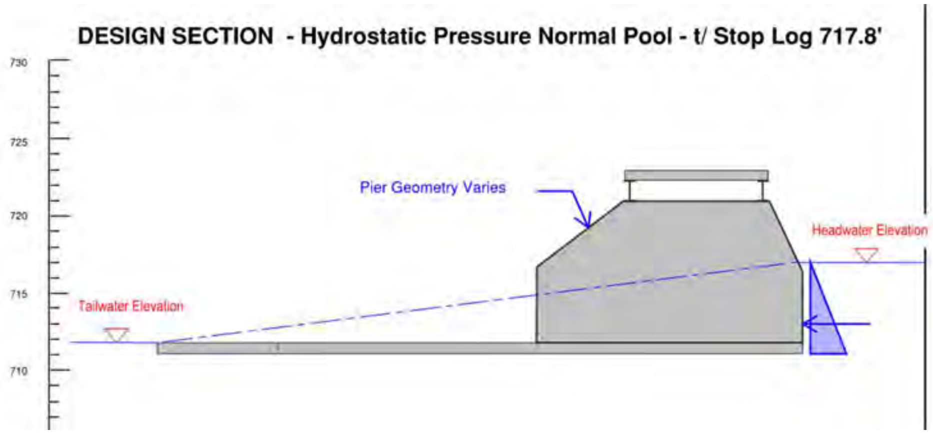


Figure 13 - Normal Pool Hydrostatic Pressure Diagram

Unit Weight of Water: γ_w = 62.4 pcf

Depth of Water at stop logs: $H_{water} = El_{top.stoplog} – El_{bottom.pier}$ = **6.80** ft

Hydrostatic Pressure @ Base of Stop Log: $p_{base} = \gamma_w * H_{water}$ = **424.32** psf

Total Hydrostatic Line Load: $w_{hydro} = (p_{base} * H_{water}) /2$ = **1.44** kip/ft

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Total Hydrostatic Driving Force +X: $D_{hydro} = w_{hydro} * L_{p.spillway} = \mathbf{109.64}$ kip

Moment arm to centroid of pressure: $y'_{hydro} = H_{water} / 3 = \mathbf{2.27}$ ft

Uplift:

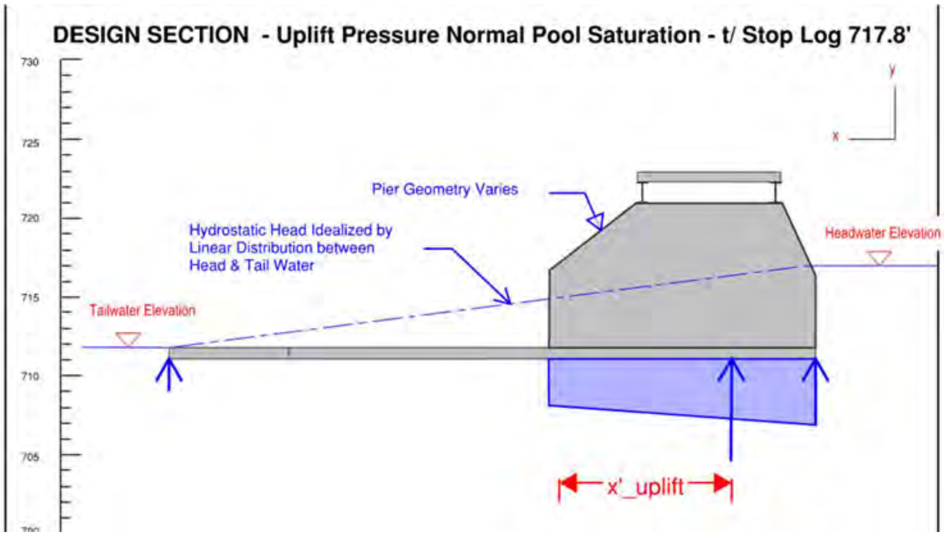

Figure 14 - Uplift Pressure Diagram

Distance between heel & toe of foundation: $L_{apron.c2} = 15$ft

Head Differential @ Heel: $H_{water.heel} = El_{np} – El_{bottom.pier} = \mathbf{6.80}$ ft

Uplift Pressure @ Heel: $p_{uplift.heel} = \gamma_w * H_{water.heel} = \mathbf{424.32}$ psf

Head Differentail @ Toe: $H_{water.toe} = El_{tailwater} – El_{bottom.apron} = \mathbf{1.00}$ ft

Uplift Pressure @ Toe: $p_{uplift.toe} = H_{water.toe} * \gamma_w = \mathbf{62.40}$ psf

Rate of Head differential decrease: $\Delta_h = (p_{uplift.heel} – p_{uplift.toe}) / L_{apron} = \mathbf{8.83}$ psf/ft

Distance from heel to toe of pier: $L_{pier} = 15$ ft (Varies per Pier average)

Uplift Pressure @ Pier Toe: $p_{uplift.pier.t} = p_{uplift.heel} – (L_{pier} * \Delta_h) = \mathbf{291.91}$ psf

Uplift Line Load: $w_{uplift.pier} = ((p_{uplift.pier.t} + p_{uplift.heel}) / 2) * L_{pier} = \mathbf{5.37}$ kip/ft

Total Uplift Force: $P_{uplift.pier.c2} = w_{uplift.pier} * L_{pier} = \mathbf{80.58}$ kip

Uplift Center Force Location(from toe): $x'_{uplift.pier} = (L_{pier} * (p_{uplift.pier.t} + (2 * p_{uplift.heel}))) / (3 * (p_{uplift.pier.t} + p_{uplift.heel})) = \mathbf{7.96}$ ft

Total Overturning Moment: $M_{overturning.uplift.pier} = P_{uplift.pier} * x'_{uplift.pier} = \mathbf{641.56}$ kip_ft

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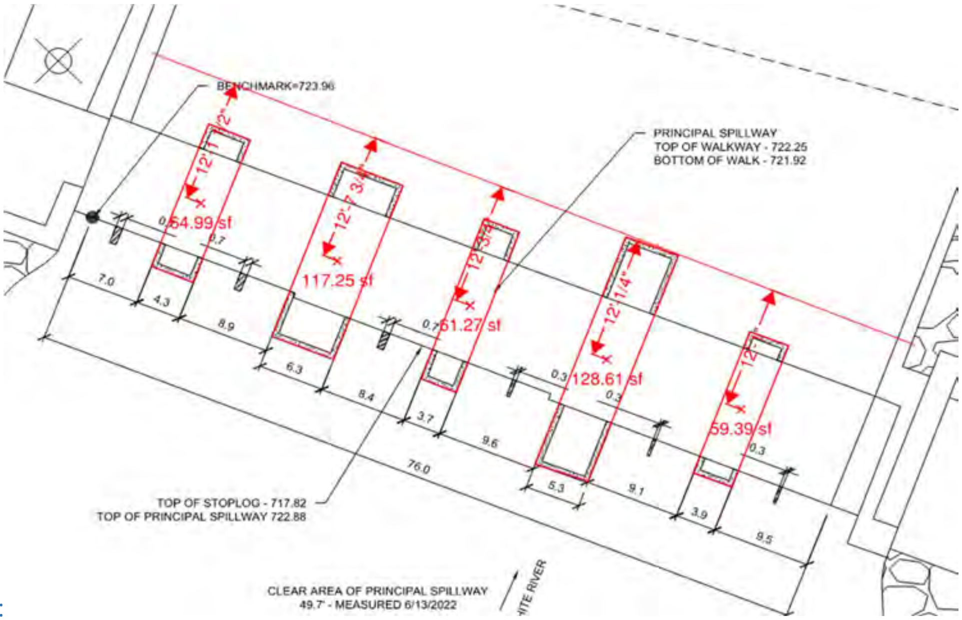
Resisting Forces:

Concrete Self Weight: Concrete Unit Weight (Normal Weight Concrete): γ_c = 145 pcf



Concrete Piers:

Figure 15 - Pier Slab Areas - Center of Areas - Condition 2

Pier 1:

Area of Pier 1 (See Figure 10): $A_{pier1.c2} = 64.99\ ft^2$

Height of Pier: $t_{pier1.c2} = El_{top.pier} - El_{bottom.pier} = \mathbf{10.00}\ ft$

Self-Weight of Pier 1: $P_{pier1.c2} = \gamma_c * A_{pier1} * t_{pier1} = \mathbf{94.24}\ kip$

Moment arm from Toe: $x'_{pier1.c2} = 12.125\ ft$

Restoring Moment Pier 1: $M_{pier1.c2} = P_{pier1.c2} * x'_{pier1.c2} = \mathbf{1142.61}\ kip\_ft$

Pier 2:

Area of Pier 2 (See Figure 10): $A_{pier2.c2} = 117.25\ ft^2$

Height of Pier: $t_{pier2.c2} = El_{top.pier} - El_{bottom.pier} = \mathbf{10.00}\ ft$

Self-Weight of Pier 2: $P_{pier2.c2} = \gamma_c * A_{pier2.c2} * t_{pier2.c2} = \mathbf{170.01}\ kip$

Moment arm from Toe: $x'_{pier2.c2} = 12.64\ ft$

Restoring Moment Pier 2: $M_{pier2.c2} = P_{pier2.c2} * x'_{pier2.c2} = \mathbf{2148.96}\ kip\_ft$

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Pier 3:

Area of Pier 3 (See Figure 10): $A_{pier3.c2} = 61.27\ ft^2$

Height of Pier: $t_{pier3.c2} = El_{top.pier} - El_{bottom.pier} = \mathbf{10.00}\ ft$

Self-Weight of Pier 3: $P_{pier3.c2} = \gamma_c * A_{pier3.c2} * t_{pier3.c2} = \mathbf{88.84}\ kip$

Moment arm from Toe: $x'_{pier3.c2} = 12.0625\ ft$

Restoring Moment Pier 3: $M_{pier3.c2} = P_{pier3.c2} * x'_{pier3.c2} = \mathbf{1071.65}\ kip\_ft$

Pier 4:

Area of Pier 4 (See Figure 10): $A_{pier4.c2} = 128.61\ ft^2$

Height of Pier: $t_{pier4.c2} = El_{top.pier} - El_{bottom.pier} = \mathbf{10.00}\ ft$

Self-Weight of Pier 4: $P_{pier4.c2} = \gamma_c * A_{pier4.c2} * t_{pier4.c2} = \mathbf{186.48}\ kip$

Moment arm from Toe: $x'_{pier4.c2} = 12.02\ ft$

Restoring Moment Pier 4: $M_{pier4.c2} = P_{pier4.c2} * x'_{pier4.c2} = \mathbf{2241.54}\ kip\_ft$

Pier 5:

Area of Pier 5 (See Figure 10): $A_{pier5.c2} = 59.39\ ft^2$

Height of Pier: $t_{pier5.c2} = El_{top.pier} - El_{bottom.pier} = \mathbf{10.00}\ ft$

Self-Weight of Pier 5: $P_{pier5.c2} = \gamma_c * A_{pier5.c2} * t_{pier5.c2} = \mathbf{86.12}\ kip$

Moment arm from Toe: $x'_{pier5.c2} = 12.08\ ft$

Restoring Moment Pier 5: $M_{pier5.c2} = P_{pier5.c2} * x'_{pier5.c2} = \mathbf{1040.28}\ kip\_ft$

Total Weight of Piers: $P_{pier.total.c2} = (P_{pier5.c2} + P_{pier4.c2} + P_{pier3.c2} + P_{pier2.c2} + P_{pier1.c2}) = \mathbf{625.69\ kip}$

Total Restoring Moment Piers: $M_{total.pier.c2} = (M_{pier5.c2} + M_{pier4.c2} + M_{pier3.c2} + M_{pier2.c2} + M_{pier1.c2}) =$ $\mathbf{7645.03}\ kip\_ft$

Concrete Apron:Area of Apron Slab (See Figure 9): $A_{apron.slab.c2} = 1700\ ft^2$

Thickness Apron Slab: $t_{slab} = 1\ ft$

Self-Weight of Apron Slab: $P_{apron.slab.c2} = \gamma_c * A_{apron.slab.c2} * t_{slab} = \mathbf{246.50}$ kip

Moment arm from Toe: $x'_{apron.sw.c2}$ = 11.75 ft

Restoring Moment Apron Slab: $M_{restore.apron.c2} = P_{apron.slab.c2} * x'_{apron.sw.c2}$ = **2896.37** kip_ft

Concrete Walkway & Steel:

Concrete Walkway and Steel Not Considered in this analysis

Base Friction:

Coefficient of Friction: $\mu_{concret.sand}$ = 0.7

Total Friction Force: $P_{friction.c2} = (P_{pier.total.c2} + P_{apron.slab.c2} - P_{uplift.pier.c2}) * \mu_{concret.sand}$ = **554.13** kip

Stability Results:

Sliding:*Condition 1:*

Factor of Safety Against Sliding condition 1: $FS_{s.c1} = P_{friction.c1} / D_{hydro}$ = **4.04**

Check_condition1_sliding = if($FS_{s.c1} > FS_{slide.n}$, “ The Hesperia dam as shown in condition 1 is sufficient factor of safety against sliding” , “ Hesperia Dam is insufficient for Sliding”) = **" The Hesperia dam as shown in condition 1 is sufficient factor of safety against sliding"**

Condition 2:

Factor of Safety Against Sliding condition 2: $FS_{s.c2} = P_{friction.c2} / D_{hydro}$ = **5.05**

Check_condition2_sliding = if($FS_{s.c2} > FS_{slide.n}$, “ The Hesperia dam as shown in condition 2 is sufficient factor of safety against sliding” , “ Hesperia Dam is insufficient for Sliding”) = **" The Hesperia dam as shown in condition 2 is sufficient factor of safety against sliding"**

Overturning :*Condition 1:*Resultant Location Condition 1: $R.c1 = (- M_{overturn.hydro} - M_{overturning.uplift} + M_{total.pier} + M_{restore.apron}) / (P_{apron.slab} + P_{pier.total})$ = **20.41** ft

1/3 span length: $x_{third.c1} = L_{apron} / 3$ = **13.67** ft

Check_condition1_overturning = if(AND($R.c1 > x_{third.c1}$, $R.c1 < 2 * x_{third.c1}$) , “Hesperia Dam base found to be 100% in compression” , “Hesperia Dam base found to NOT be 100% in compression”) =**"Hesperia Dam base found to be 100% in compression"**

GEI Consultants	Client	City of Hesperia			Page	L9
	Project	Hesperia Dam – Rehabilitation Feasibility			Pg. Rev.	0
	By	J. Probstfeld	Chk.	J. Burch	App.	M. Carden
	Date	03/15/2025	Date	05/15/2025	Date	05/15/2025
Project No.	2403886	Document No.	N/A			
Subject	Hesperia Dam – Global Stability					

*Condition 2:*Resultant Location Condition 2: $R.c1 = (- M_{overturn.hydro} - M_{overturning.uplift.pier} + M_{total.pier.c2} + M_{restore.apron.c2}) / (P_{apron.slab.c2} + P_{pier.total.c2}) =$ **11.07** ft

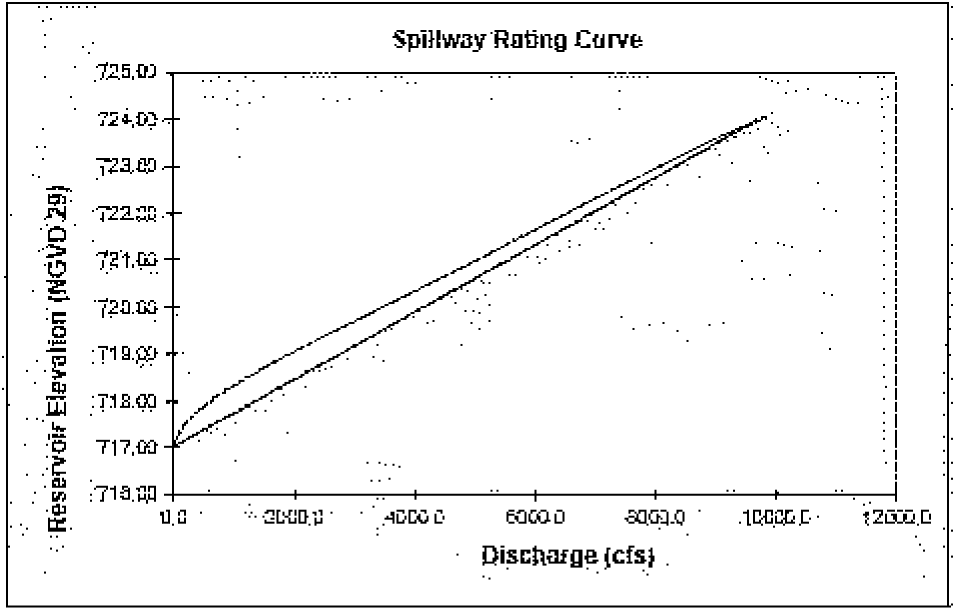
1/3 span length: $x_{third.c2} = L_{pier} / 3 =$ **5.00** ft

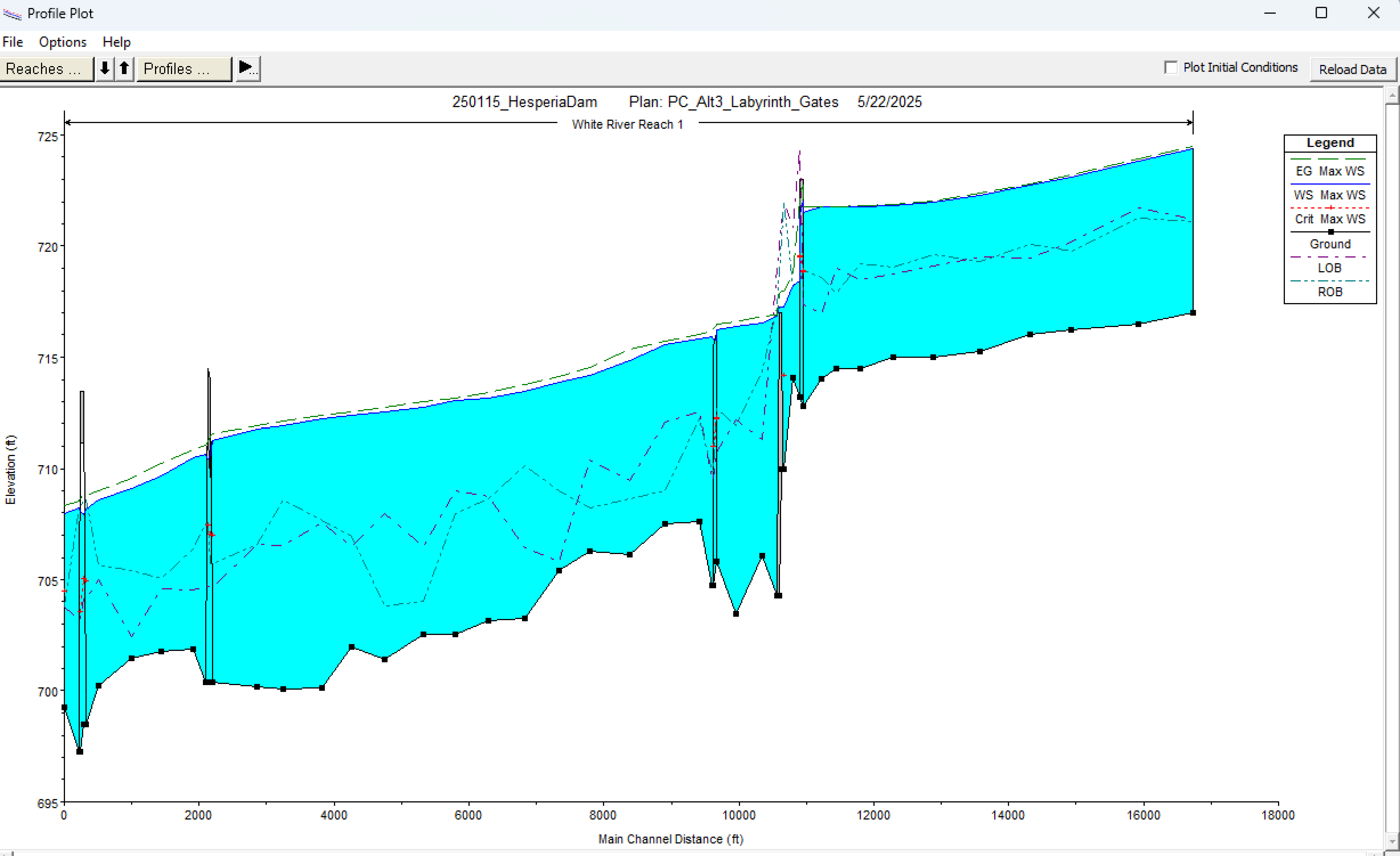
Check_condition2_overturning = if(AND(R.c1 > $x_{third.c2}$, R.c1 < 2 * $x_{third.c2}$) , “Hesperia Dam base found to be 100% in compression” , “Hesperia Dam base found to NOT be 100% in compression”) = **"Hesperia Dam base found to NOT be 100% in compression"**

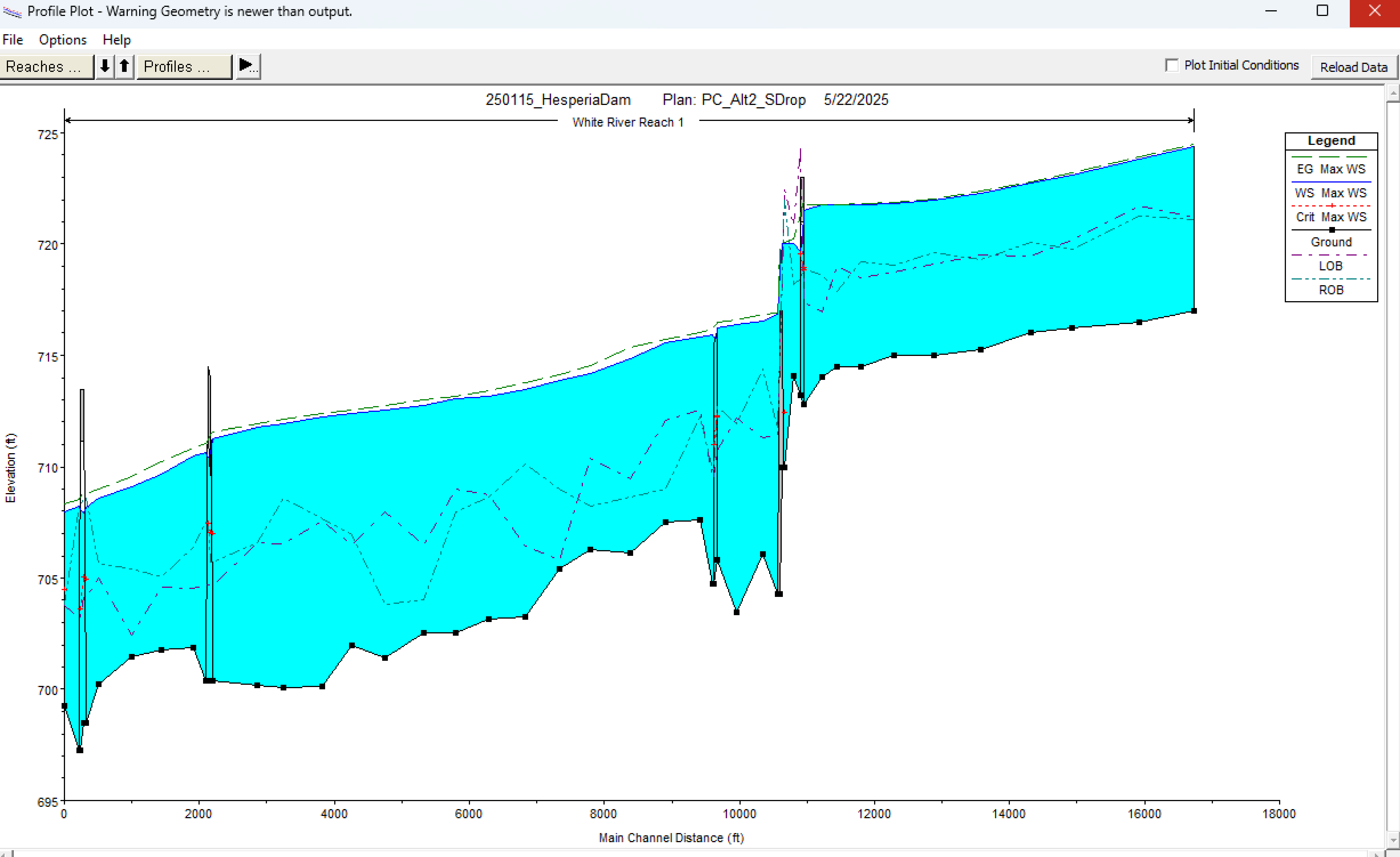
Appendix E Alternative Analysis

Gated Labyrinth RATING CURVE

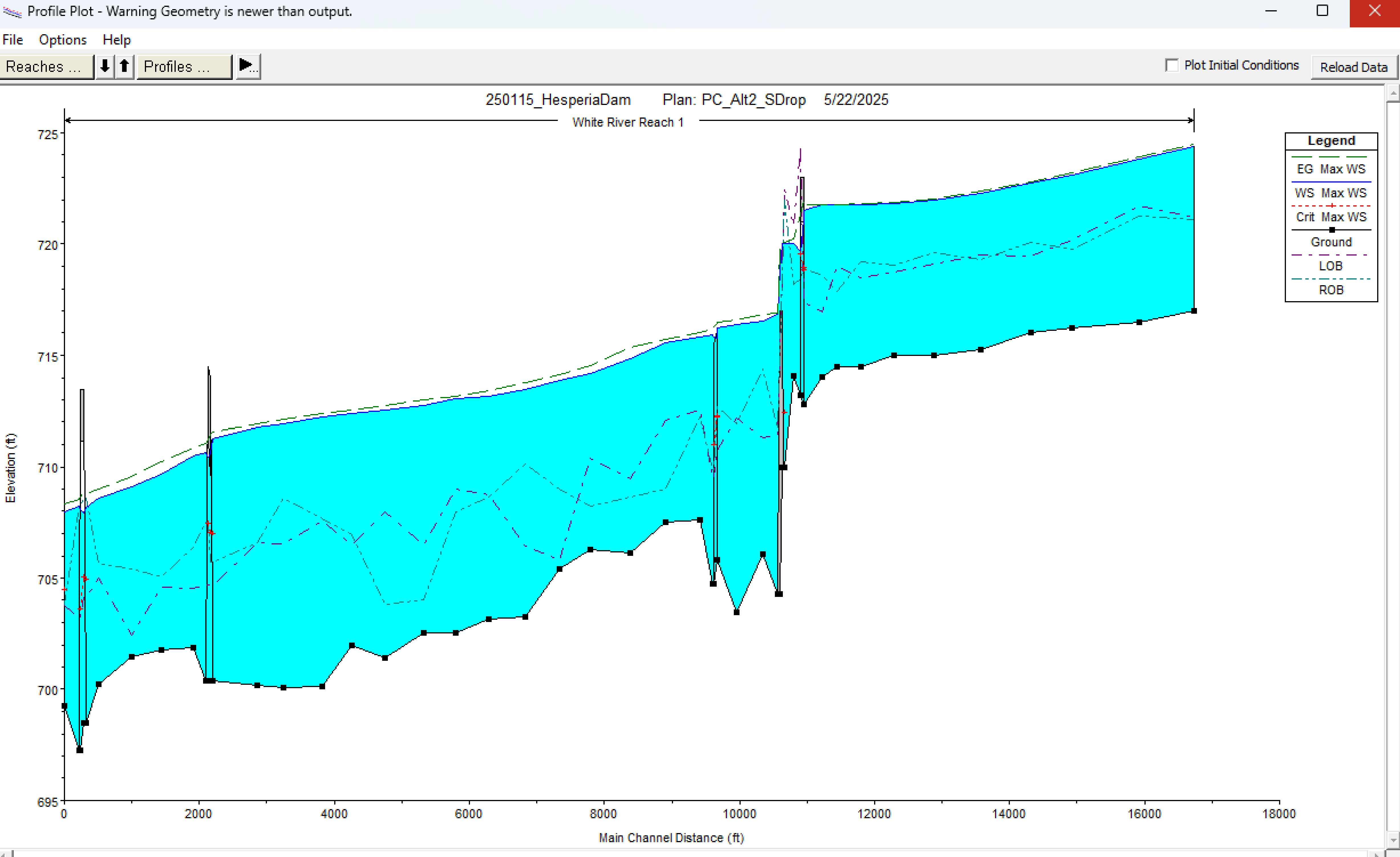
RES EL NGVD29	HEAD	H_o/P	C_{lower}	C_{upper}	C_d	Q	RES EL. NGVD29
717	0.00	0.00	0.49	0.49	0.49	0	717.00
724	7.00	1.00	0.42	0.52	0.52	9711	724.00
723.5	6.50	0.93	0.43	0.53	0.53	8880	723.50
723	6.00	0.86	0.45	0.54	0.54	8075	723.00
722.5	5.50	0.79	0.46	0.56	0.56	7299	722.50
722	5.00	0.71	0.48	0.58	0.58	6544	722.00
721.5	4.50	0.64	0.50	0.60	0.60	5796	721.50
721	4.00	0.57	0.53	0.62	0.62	5042	721.00
720.5	3.50	0.50	0.55	0.65	0.65	4274	720.50
720	3.00	0.43	0.58	0.67	0.66	3492	720.00
719.5	2.50	0.36	0.60	0.68	0.68	2708	719.50
719	2.00	0.29	0.62	0.68	0.68	1945	719.00
718.5	1.50	0.21	0.62	0.67	0.67	1241	718.50
718	1.00	0.14	0.61	0.64	0.64	644	718.00
717.5	0.50	0.07	0.56	0.58	0.58	207	717.50
717	0.00	0.00	0.49	0.49	0.49	0	717.00




Profile Plot
File
Options
Help
Reaches ...
Profiles ...
☐ Plot Initial Conditions
Reload Data
250115_HesperiaDam
Plan: PC_Alt3_Labyrinth_Gates
5/22/2025
White River Reach 1
Legend
EG Max WS
WS Max WS
Crit Max WS
Ground
LOB
ROB
Elevation (ft)
725
720
715
710
705
700
695
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
Main Channel Distance (ft)



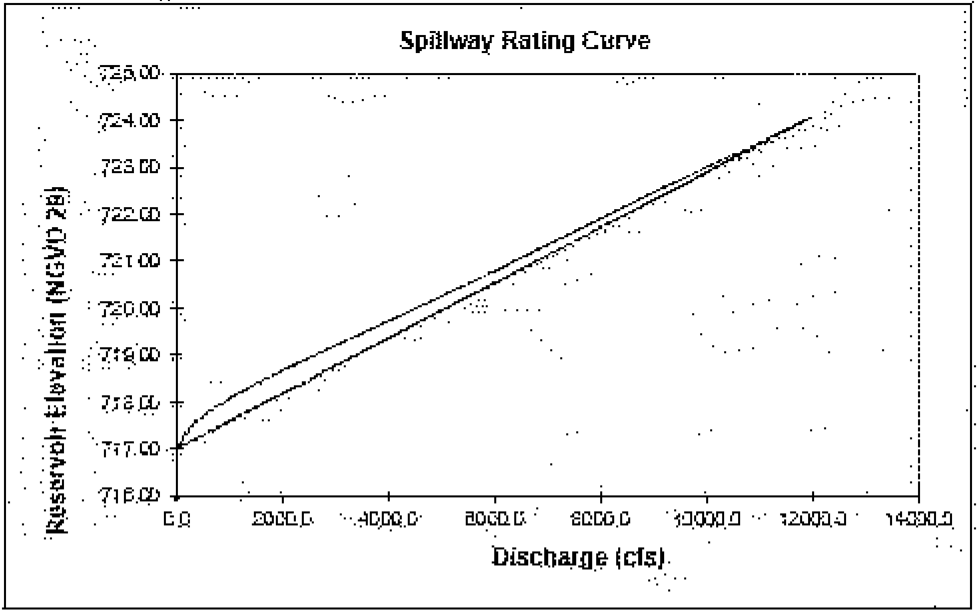
Profile Plot - Warning Geometry is newer than output.



Profile Plot - Warning Geometry is newer than output.

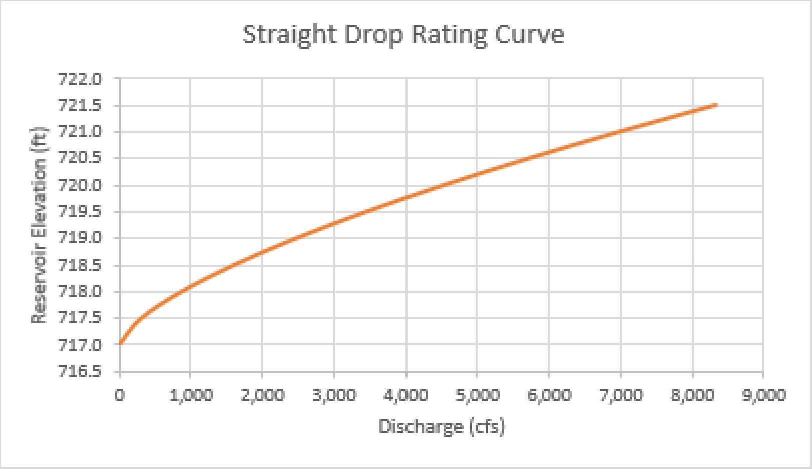
Labyrinth RATING CURVE

RES EL. NGVD29	HEAD	H_o/P	C_{lower}	C_{upper}	C_d	Q	RES EL. NGVD29
717	0.00	0.00	0.49	0.49	0.49	0	717.00
724	7.00	1.00	0.42	0.52	0.44	11856	724.00
723.5	6.50	0.93	0.43	0.53	0.45	10945	723.50
723	6.00	0.86	0.45	0.54	0.46	9995	723.00
722.5	5.50	0.79	0.46	0.56	0.48	9059	722.50
722	5.00	0.71	0.48	0.58	0.50	8151	722.00
721.5	4.50	0.64	0.50	0.60	0.52	7263	721.50
721	4.00	0.57	0.53	0.62	0.54	6376	721.00
720.5	3.50	0.50	0.56	0.65	0.57	5470	720.50
720	3.00	0.43	0.58	0.67	0.59	4535	720.00
719.5	2.50	0.36	0.60	0.68	0.61	3575	719.50
719	2.00	0.29	0.62	0.68	0.63	2615	719.00
718.5	1.50	0.21	0.62	0.67	0.63	1700	718.50
718	1.00	0.14	0.61	0.64	0.61	899	718.00
717.5	0.50	0.07	0.56	0.58	0.57	295	717.50
717	0.00	0.00	0.49	0.49	0.49	0	717.00



Stright Drop Rating Curve

Reservoir El. (ft)	Head, H (ft)	H/L	Weir Coeff.,C	D/S Slope Adjust[1].	Adjusted Weir Coeff.,C[2]	Effective Length (ft), L'	Discharge (cfs)
717.0	0.00	0.0	2.91	1.00	2.91	300.0	0
717.5	0.50	0.0	2.91	1.00	2.91	299.9	309
718.0	1.00	0.0	2.91	1.00	2.91	299.8	873
718.5	1.50	0.1	2.91	1.00	2.91	299.7	1,603
719.0	2.00	0.1	2.91	1.00	2.91	299.6	2,468
719.5	2.50	0.1	2.91	1.00	2.91	299.5	3,448
720.0	3.00	0.1	2.91	1.00	2.91	299.4	4,531
720.5	3.50	0.1	2.91	1.00	2.91	299.3	5,713
721.0	4.00	0.1	2.91	1.00	2.91	299.2	6,977
721.5	4.50	0.2	2.91	1.00	2.91	299.1	8,323

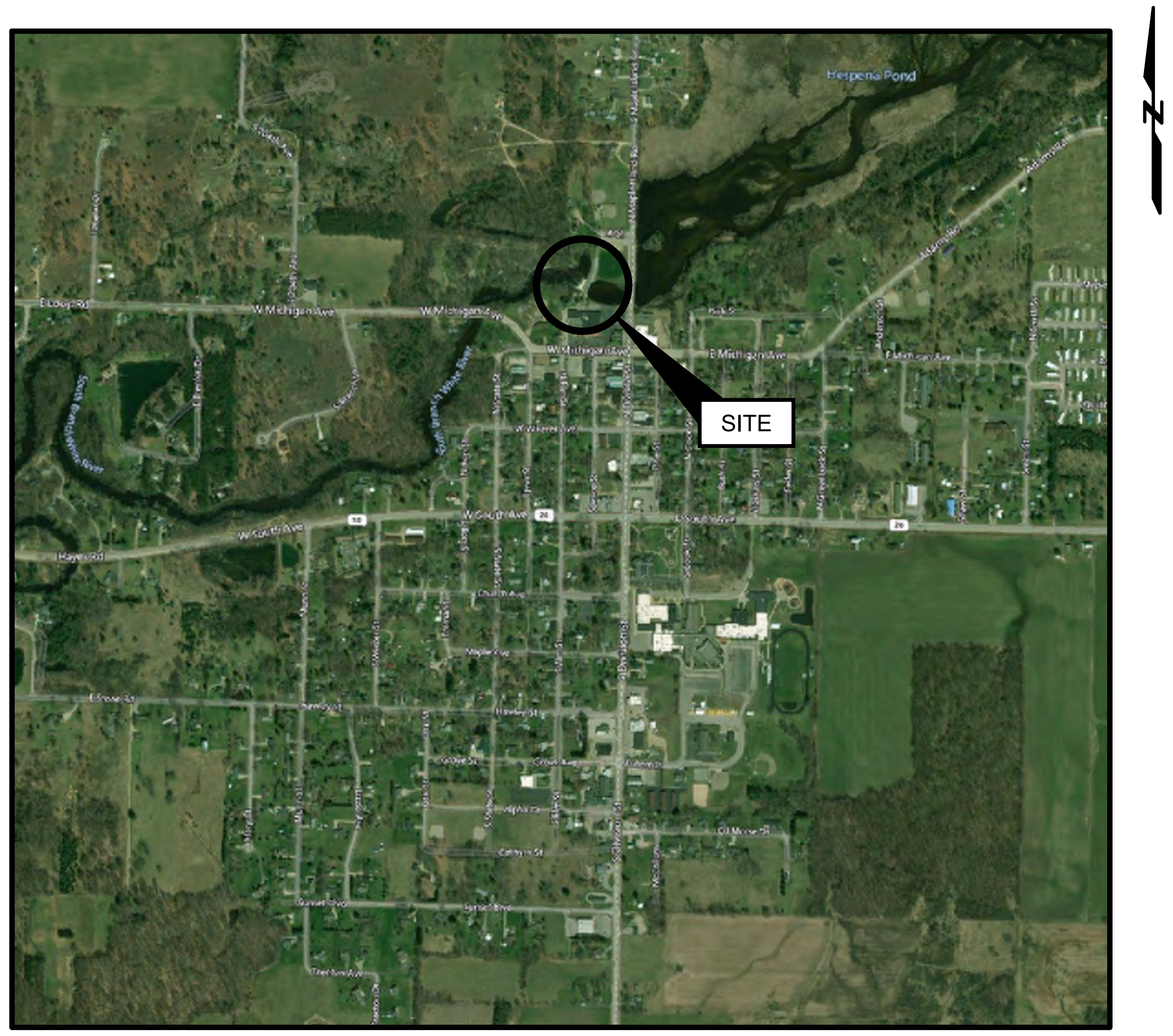


Appendix F Rehabilitation Alternatives Conceptual Drawings

HESPERIA DAM REHABILITATION

HESPERIA, MI

STATE or COUNTY MAP
(NOT TO SCALE)



SOURCE:
BING MAPS

SITE LOCATION MAP
(NOT TO SCALE)

Sheet List Table

	Sheet Number	Sheet Title
	G-100	COVER SHEET
	G-101	GENERAL NOTES AND LEGEND
	G-102	EXISTING PLAN AND PROFILE
	G-103	EXISTING SPILLWAY PLAN, ELEVATION, AND SECTION
	G-104	EXISTING EMBANKMENT SECTIONS
	D-100	DEMOLITION PLAN
	D-101	DEMOLITION PHOTOS
ALT 1	C-100	ALT 1 - PLAN AND PROFILE
	C-101	ALT 1 - DIVERSION BERM PLAN AND SECTIONS
	CW-102	ALT 1 - CONTROL OF WATER
ALT 2	C-200	ALT 2 - PLAN AND PROFILE
	C-201	ALT 2 - DIVERSION BERM PLAN AND SECTIONS
	CW-202	ALT 2 - CONTROL OF WATER
ALT 3	C-300	ALT 3 PLAN AND PROFILE
	C-301	ALT 3 - DIVERSION BERM PLAN AND SECTIONS
	CW-302	ALT 3 - CONTROL OF WATER
FW 1	C-400	FW 1 - PLAN AND PROFILE
	C-401	FW 1 - SECTIONS
FW 2	C-402	FW 2 - PLAN AND PROFILE

Summary Table

Designation	Description
ALT 1	110 FT WIDE LABYRINTH SPILLWAY
ALT 2	200 FT WIDE GATE WEIR SPILLWAY
ALT 3	90 FT WIDE GATED LABYRINTH SPILLWAY
FW 1	NATURALIZED FISHWAY
FW 2	TECHNICAL FISH LADDER

PREPARED FOR:

VILLAGE OF HESPERIA
33 E MICHIGAN AVE
HESPERIA, MI 49421
(231) 854-6205

PREPARED BY:

GEI CONSULTANTS OF MICHIGAN, P.C.
4472 MOUNT HOPE RD
SUITE A
WILLIAMSBURG, MI 49690
(231)933-4041

GEI PROJECT NO. 2403886

Concept Plans

0	06/06/2025	CONCEPTUAL PLANS	DD
NO.	DATE	ISSUE/REVISION	APP

DRAFT

SHEET NO.
G-100

SPATIAL DATUM INFORMATION

- VERTICAL: NATIONAL AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
- HORIZONTAL: NORTH AMERICAN DATUM OF 1983 (NAD83), MICHIGAN STATE PLANE, SOUTH ZONE, INTERNATIONAL FOOT.
- CONTROL MONUMENTS ON-SITE SHALL BE REFERRED TO CONFIRM HORIZONTAL AND VERTICAL MEASUREMENTS.

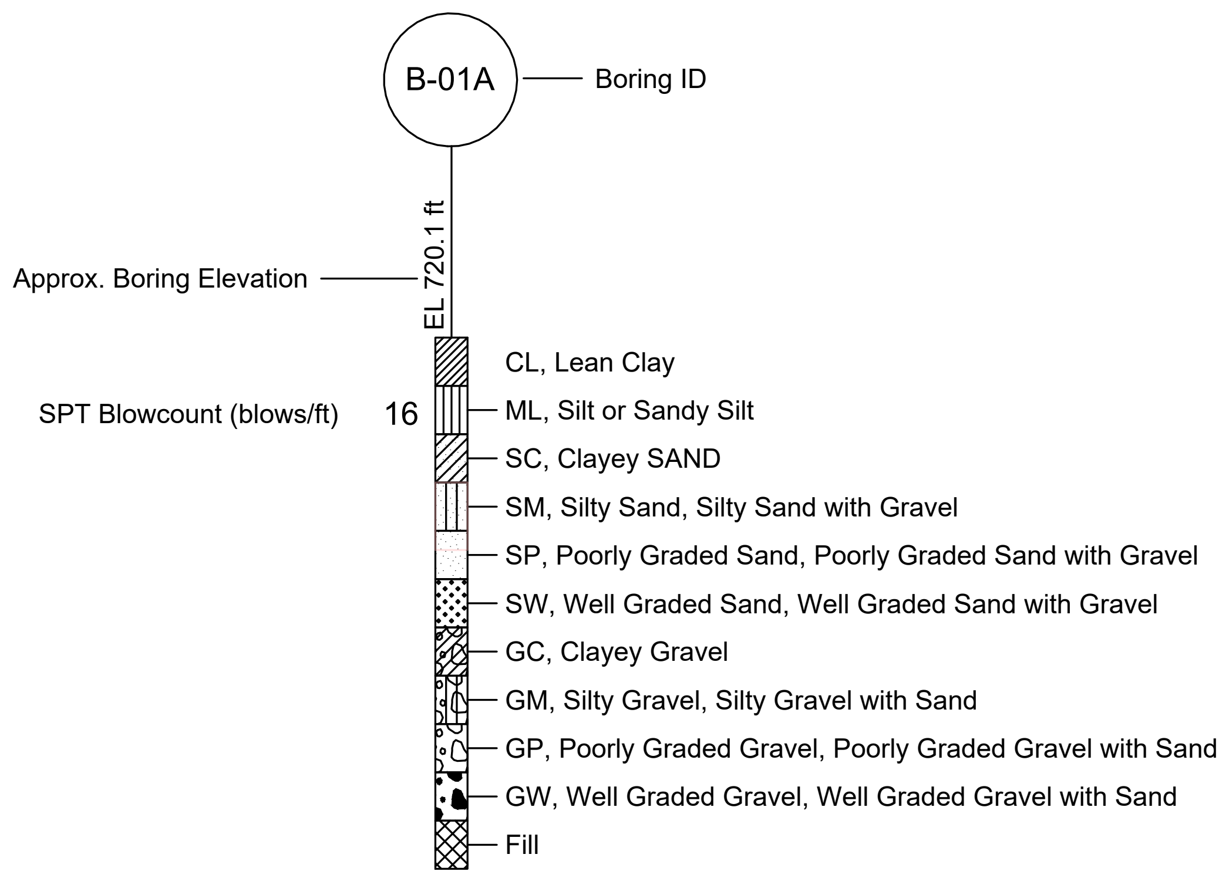
BASEMAP DATA

- SITE TOPOGRAPHY OBTAINED FROM FLIES & VANDENBRINK, 2025
- BATHYMETRY OBTAINED FROM FLIES & VANDENBRINK, 2025
- LIDAR DATA OBTAINED FROM NEWAYGO & OCEANA COUNTIES, 2025

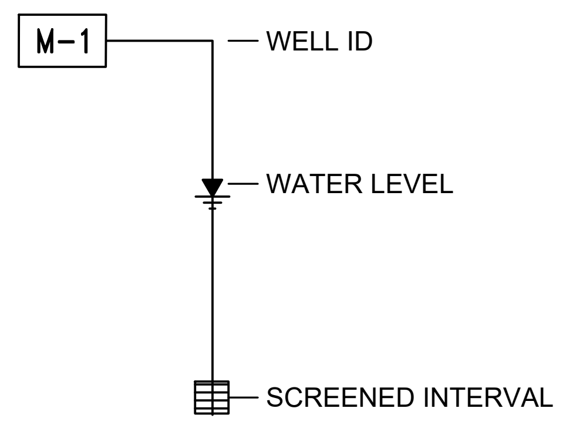
ABBREVIATIONS

APP = APPROXIMATELY
℄ = CENTER LINE
EL = ELEVATION (FEET)
EX = EXISTING
FW1 = FISHWAY 1
FW2 = FISHWAY 2
HW = HEADWATER
O/E = OVERHEAD ELECTRIC
STA = STATION
TW = TAILWATER
V:H = VERTICAL:HORIZONTAL
WOH = WEIGHT OF HAMMER
WSE = WATER SURFACE ELEVATION
YR = YEAR

SPT BORING LOG LEGEND

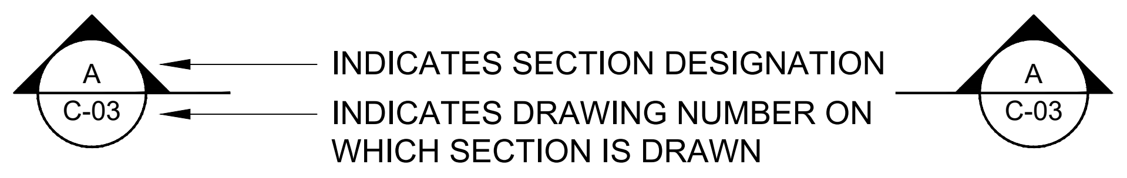


MONITORING WELL LEGEND



SECTION AND DETAIL LEGEND

SECTION / DETAIL



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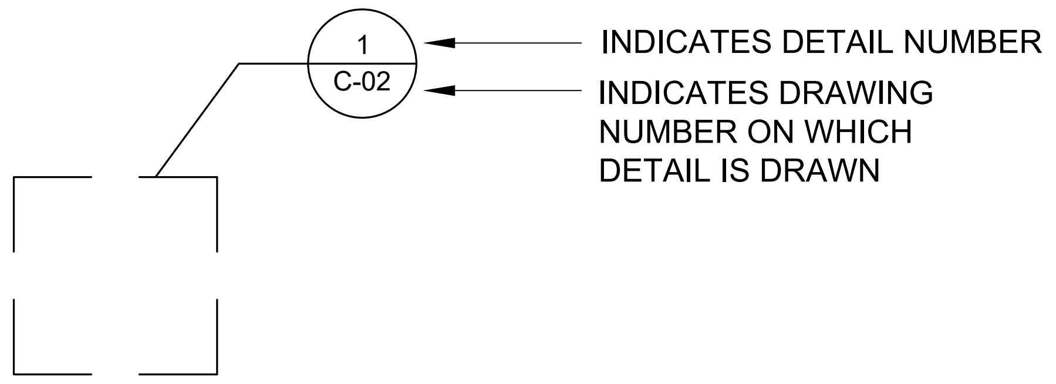
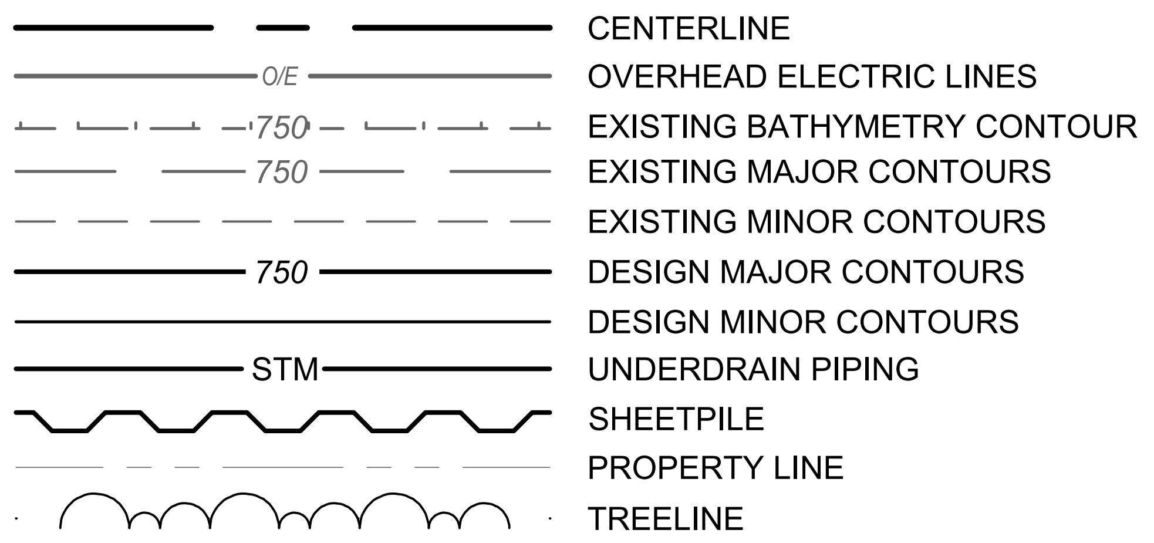
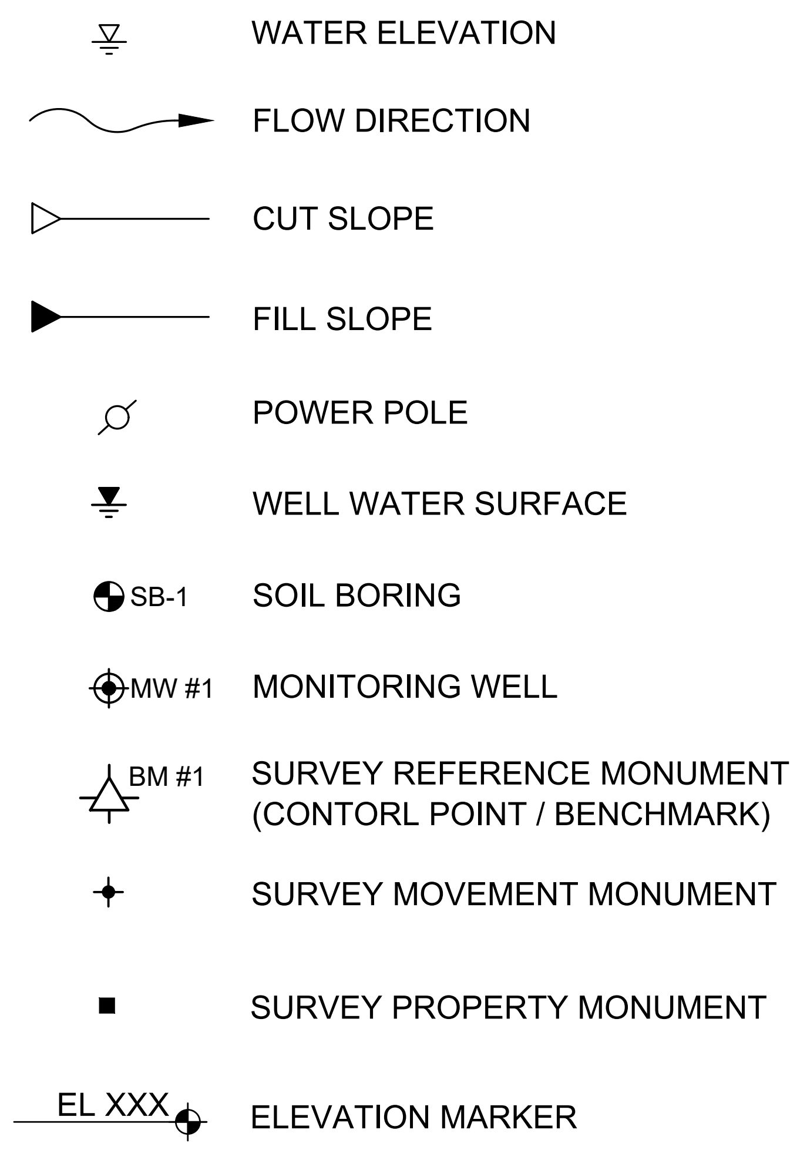


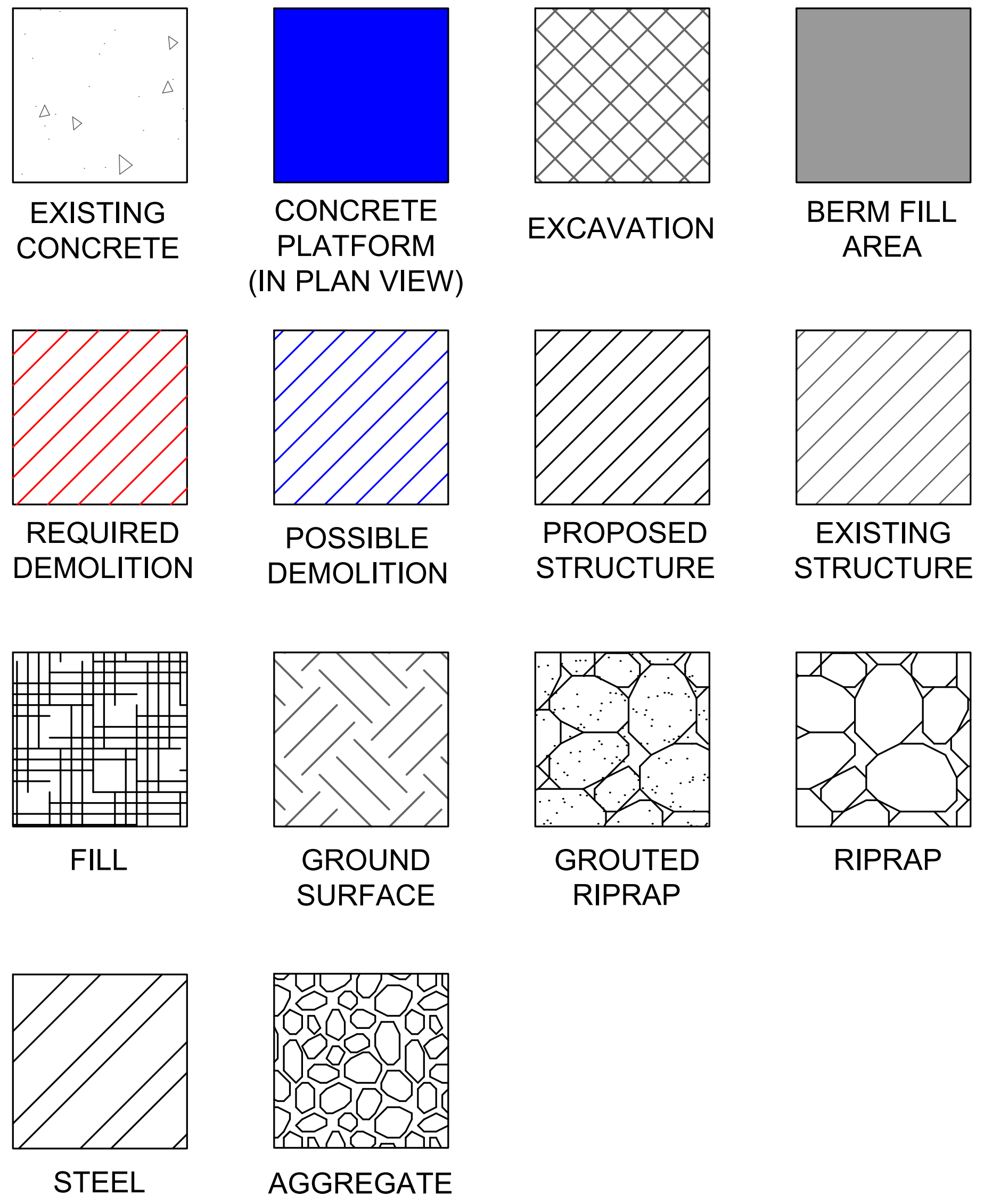
LINETYPE LEGEND



SYMBOLS LEGEND



HATCH LEGEND



Concept Plans

Attention:
0 1"
If this scale bar does not measure 1" then drawing is not original scale.

DRAFT

Designed: GK
Drawn: CH / JW
Checked: MC
Approved: *MC*
P.E. No: 6201054585
GEI Project 2403886

GEI Consultants
GEI CONSULTANTS OF MICHIGAN, P.C.
109 W. BARAGA AVENUE
MARQUETTE, MI 49855
(906)451-4021

VILLAGE OF HESPERIA
Welcome To Hesperia
EST. 1866

HESPERIA DAM REHABILITATION

WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

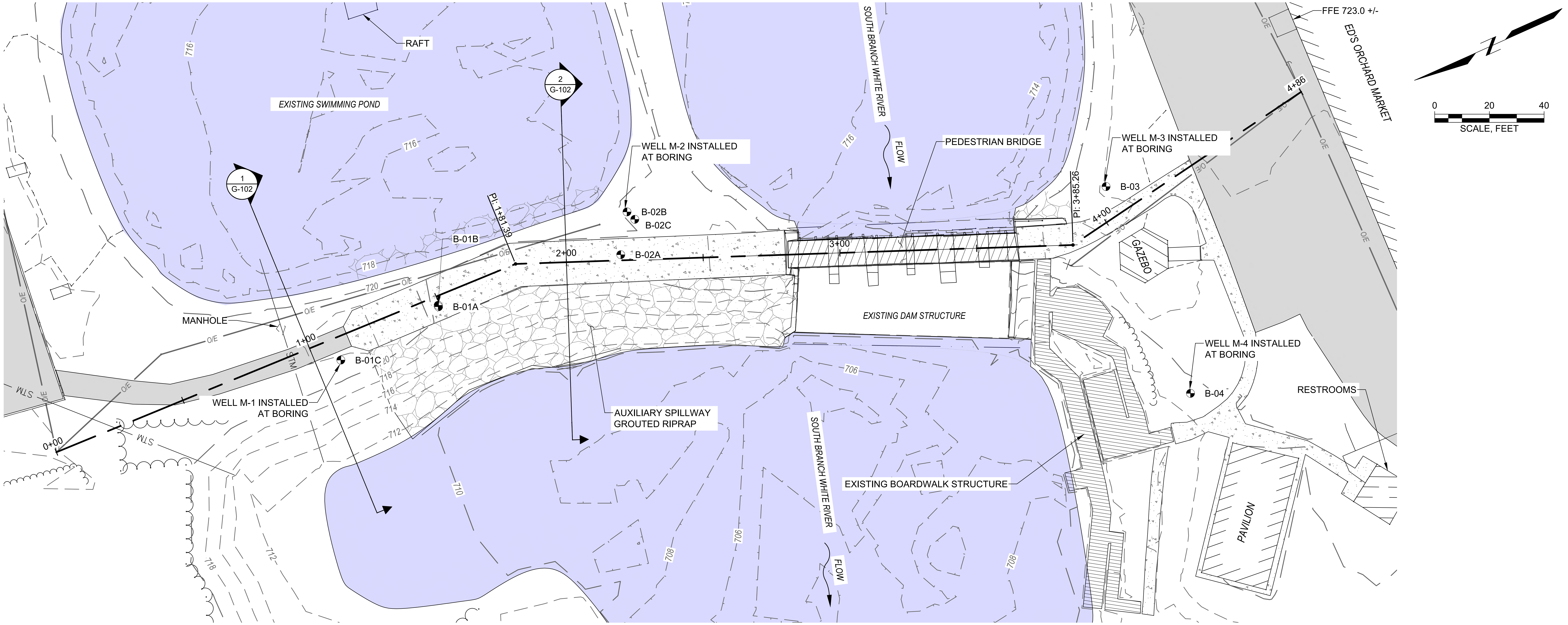
NO	DATE	ISSUE/REVISION	APP
0	6/3/2025	CONCEPTUAL PLANS	DD

SHEET NAME
GENERAL NOTES AND LEGEND

SHEET NO.
G-101

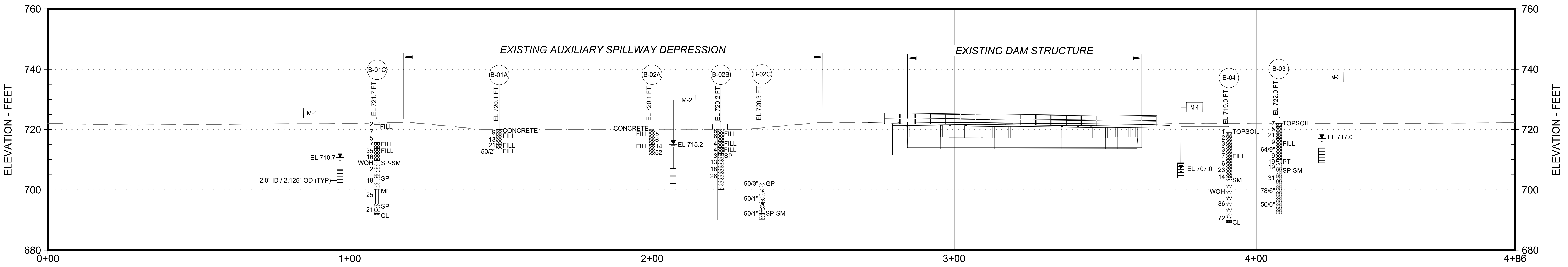
HELPPI, CHAD B:\Working\VILLAGE OF HESPERIA\2403886 Hesperia Dam Rehabilitation Feas. Study\00_CAD\Design\Sheets\C-101 GENERAL NOTES.dwg - 6/4/2025

HELPPI, CHAD B:\Working\VILLAGE OF HESPERIA\2403886 Hesperia Dam Rehabilitation Feas. Study\00_CAD\Design\Sheets\G-102 EXISTING PLAN AND PROFILE.dwg - 6/4/2025



EXISTING CONDITIONS PLAN

SCALE: 1" = 20'



EXISTING DAM PROFILE

SCALE: 1" = 20'

Concept Plans

Attention:

0 1"

If this scale bar does not measure 1" then drawing is not original scale.

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Approved:	MC
P.E. No:	6201054585
GEI Project	2403886

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VILLAGE OF HESPERIA
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HESPERIA DAM REHABILITATION

WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

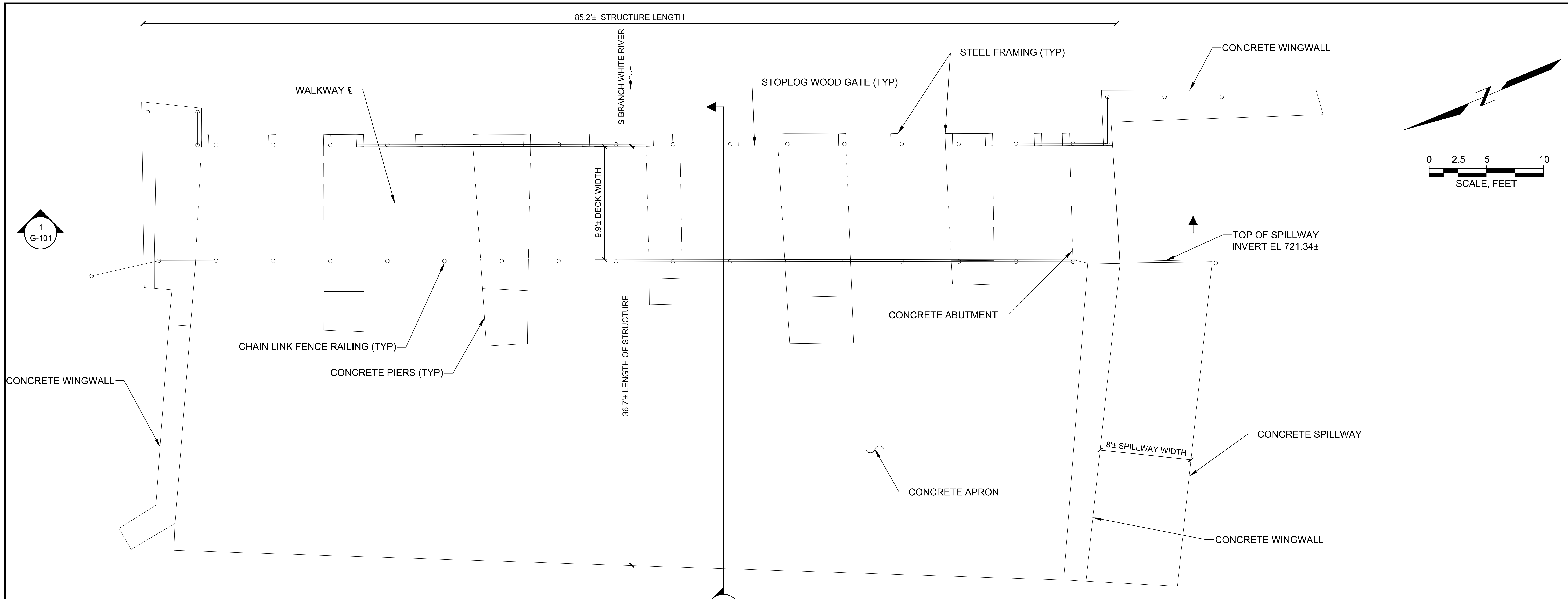
NO	DATE	ISSUE/REVISION	APP
0	06/06/2025	CONCEPTUAL PLANS	DD

SHEET NAME

EXISTING PLAN AND PROFILE

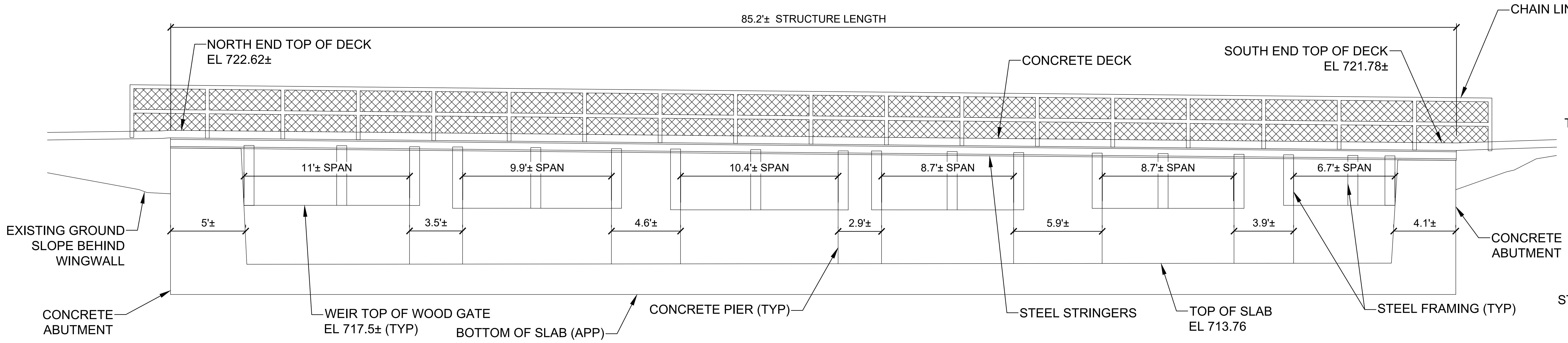
SHEET NO.

G-102



EXISTING DAM PLAN

SCALE: 1" = 5'

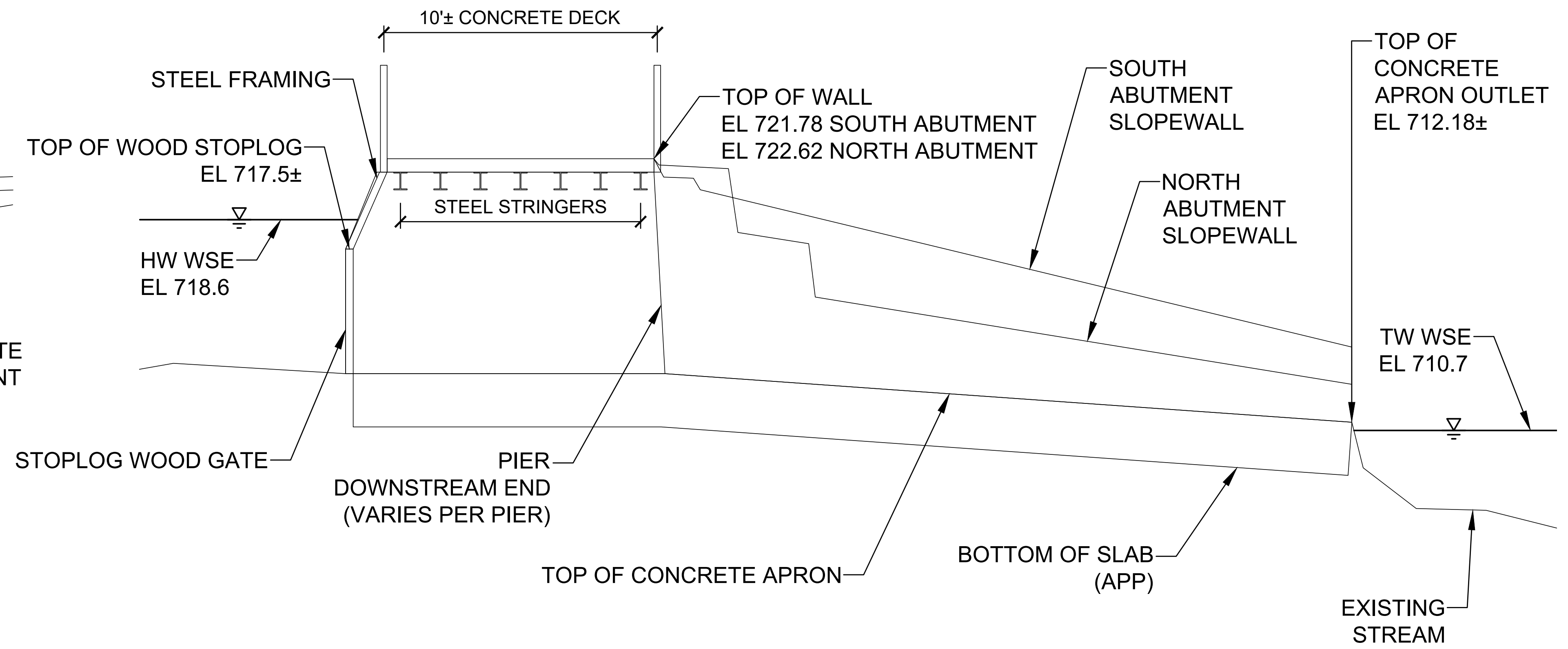


NOTES:

1. EXISTING DAM PLAN, ELEVATION, AND SECTION WAS DEVELOPED BY FLEIS & VANDENBRINK.
2. FOUNDATION CONDITION UNDER SPILLWAY SLAB IS UNKNOWN, BUT MAY CONSIST OF PORTIONS OF THE HISTORIC DAM AT THE SITE.

1 EXISTING DAM ELEVATION

SCALE: 1" = 5'



2 EXISTING DAM SECTION

SCALE: 1" = 5'

Concept Plans

Attention:
0 1"
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Checked:	MC
Approved:	*MC*
P.E. No:	6201054585
GEI Project	2403886

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VILLAGE OF HESPERIA
Welcome To Hesperia
EST. 1866

HESPERIA DAM
REHABILITATION

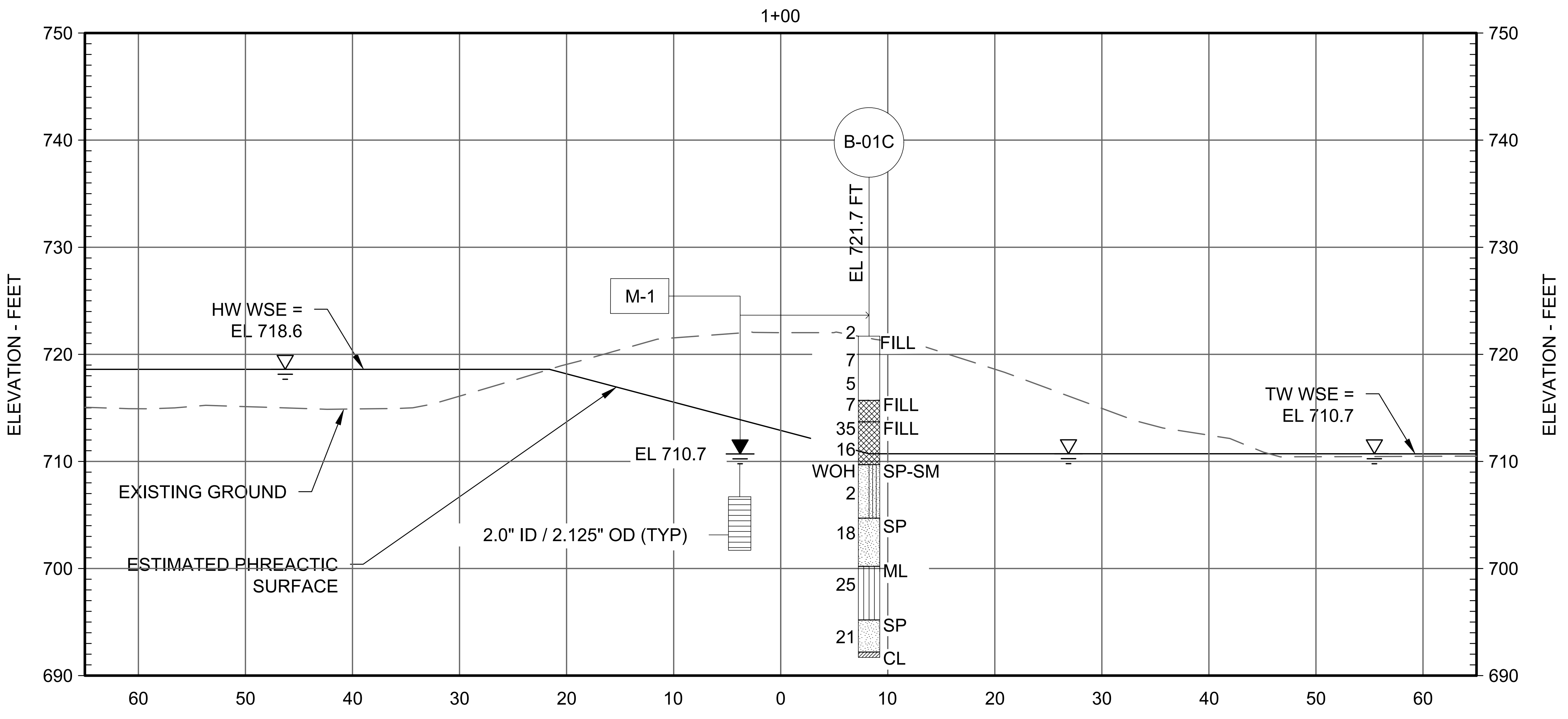
WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

NO	DATE	ISSUE/REVISION	APP
0	06/06/2025	CONCEPTUAL PLANS	DD

SHEET NAME
EXISTING SPILLWAY PLAN, ELEVATION, AND SECTION

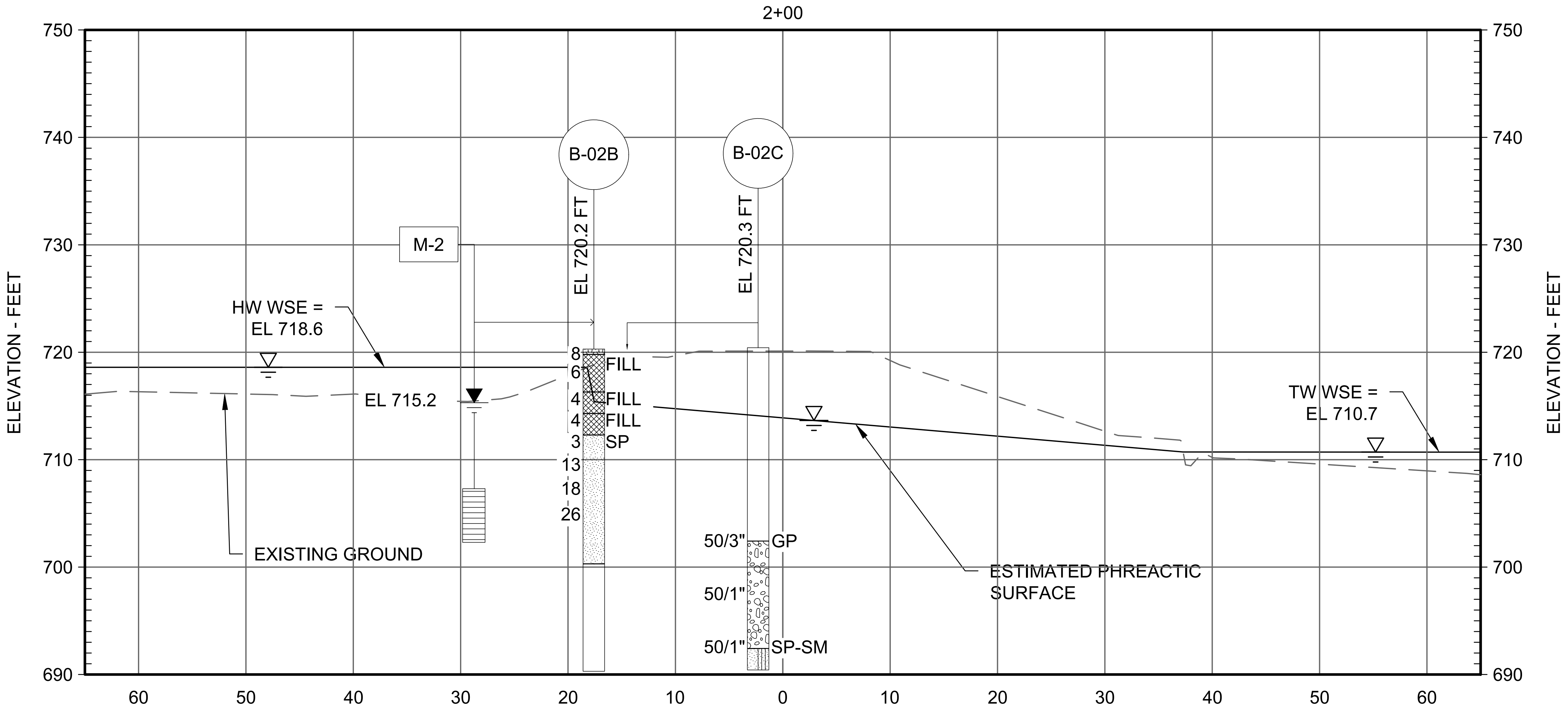
SHEET NO.
G-103

HELPPI, CHAD B:\Working\VILLAGE OF HESPERIA\2403886 Hesperia Dam Rehabilitation Feas. Study\00_CAD\Design\Sheets\G-103 EXISTING SPILLWAY PLAN, ELEVATION, AND SECTION.dwg - 6/4/2025



1 STA 1+00 SECTION VIEW

SCALE: 1"=10'



2 STA 2+00 SECTION VIEW

SCALE: 1"=10'

Concept Plans

Attention:

0 1"

If this scale bar
does not measure
1" then drawing is
not original scale.

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Designed:	GK
Drawn:	CH / JW
Checked:	MC
Approved:	*MC*
P.E. No:	6201054585
GEI Project	2403886

GEI Consultants
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VILLAGE OF HESPERIA
Welcome To Hesperia
EST. 1866

HESPERIA DAM
REHABILITATION

WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

0	06/06/2025	CONCEPTUAL PLANS	DD
NO	DATE	ISSUE/REVISION	APP

SHEET NAME

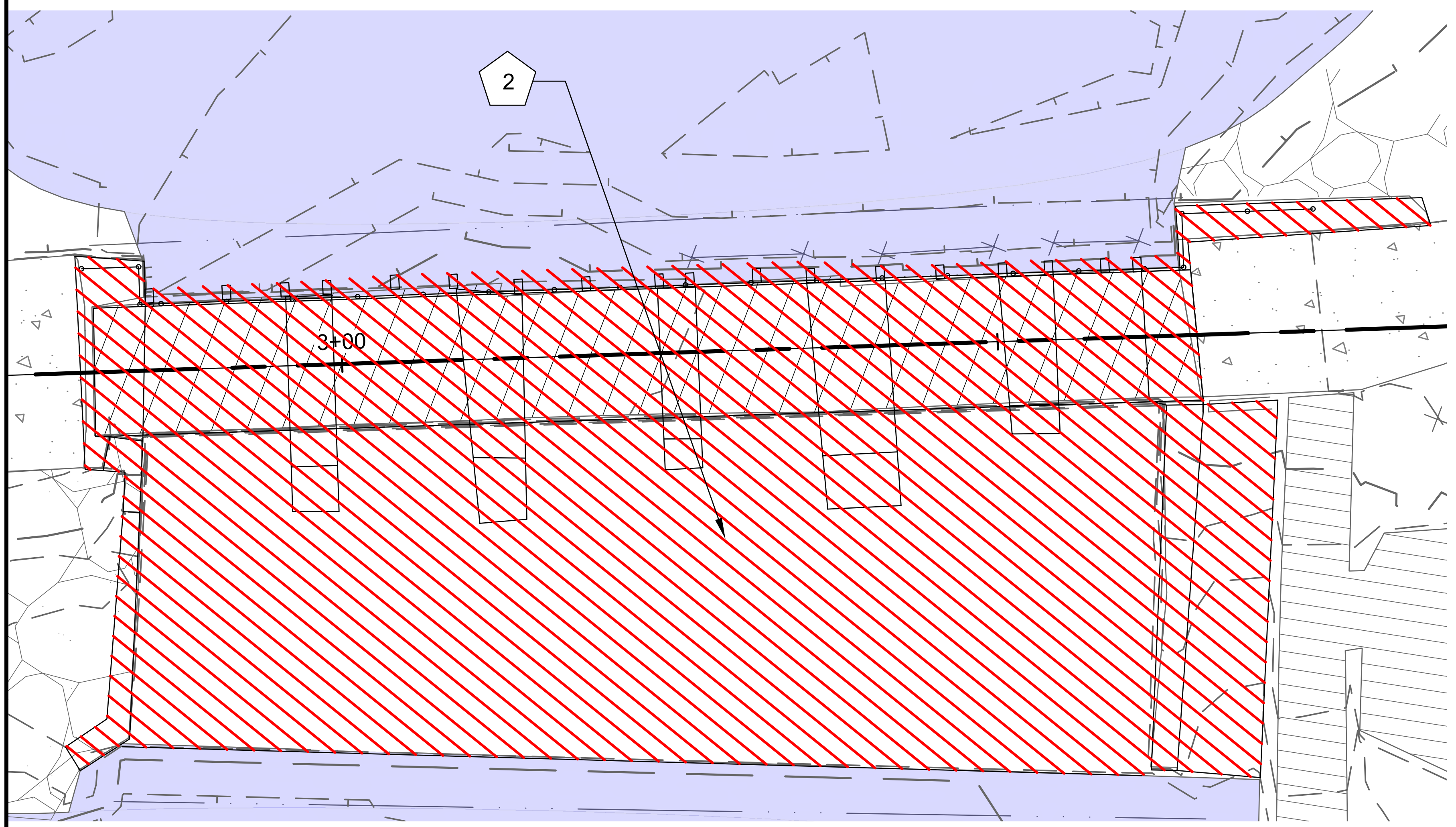
EXISTING EMBANKMENT SECTIONS

SHEET NO.

G-104

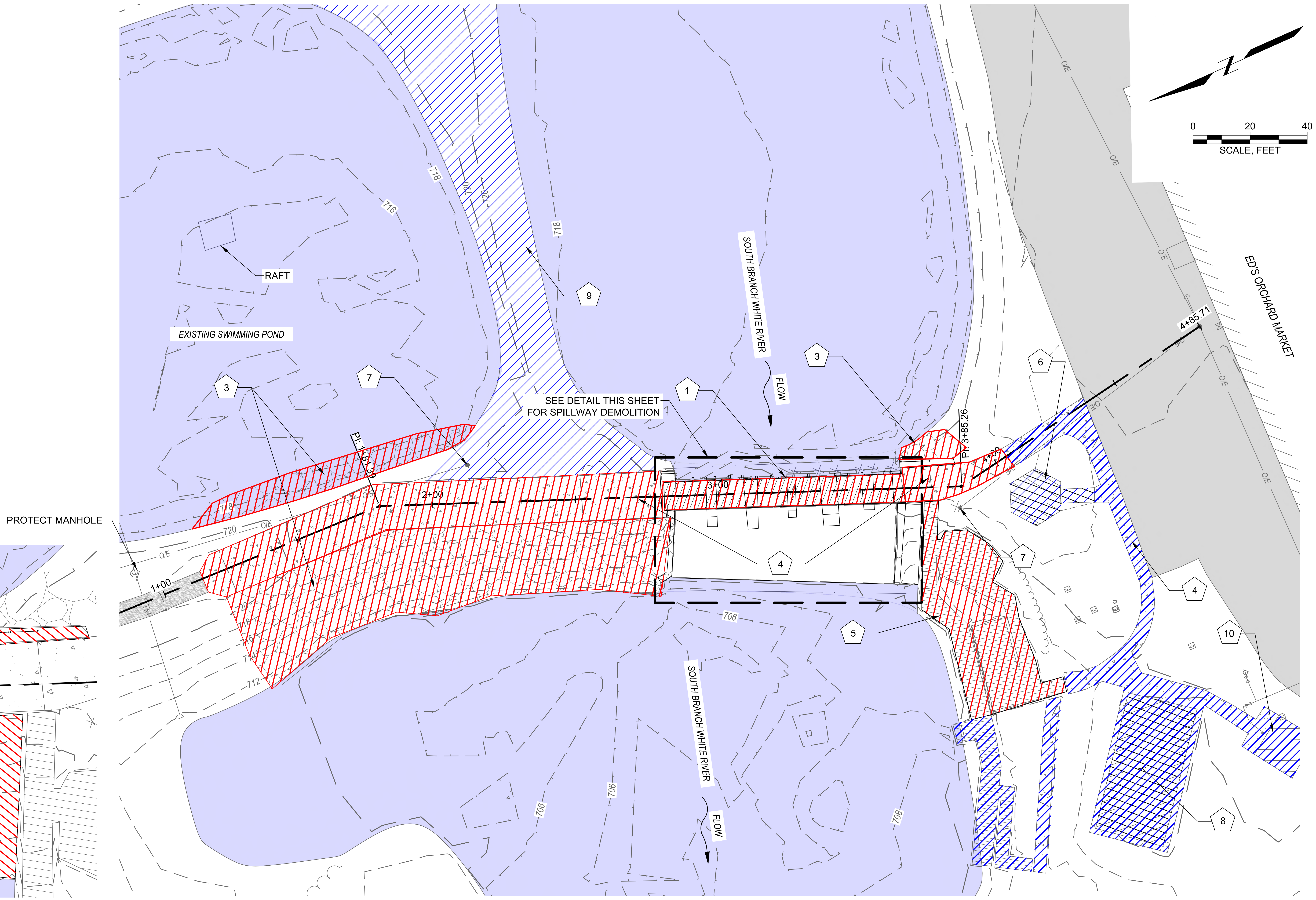
HELPPI, CHAD B:\Working\VILLAGE OF HESPERIA\2403886 Hesperia Dam Rehabilitation Feas. Study\00_CAD\Design\Sheets\C-101 EXISTING SECTIONS.dwg - 6/4/2025

DEMOLITION NOTES	
ID NO	FEATURE DESCRIPTION
1	WALKWAY
2	SPILLWAY
3	RIPRAP
4	SIDEWALK
5	BOARDWALK
6	GAZEBO
7	LIGHT POLES
8	PAVILION
9	EXISTING BERM
10	RESTROOM



DEMOLITION PLAN - SPILLWAY

SCALE: 1" = 10'



DEMOLITION PLAN

SCALE: 1" = 20'

Concept Plans

LEGEND:

- 🟥 REQUIRED DEMOLITION
- 🟦 POSSIBLE DEMOLITION

Attention:

0 1"

If this scale bar does not measure 1" then drawing is not original scale.

DRAFT

Designed:	GK
Drawn:	CH / JW
Checked:	MC
Approved:	*MC*
P.E. No:	6201054585
GEI Project	2403886

GEI Consultants

GEI CONSULTANTS OF MICHIGAN, P.C.
109 W. BARAGA AVENUE
MARQUETTE, MI 49855
(906)451-4021

VILLAGE OF HESPERIA
Welcome To Hesperia
EST. 1866

HESPERIA DAM REHABILITATION

WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

NO	DATE	ISSUE/REVISION	APP
0	06/06/2025	CONCEPTUAL PLANS	DD

SHEET NAME

DEMOLITION PLAN

SHEET NO.

D-100

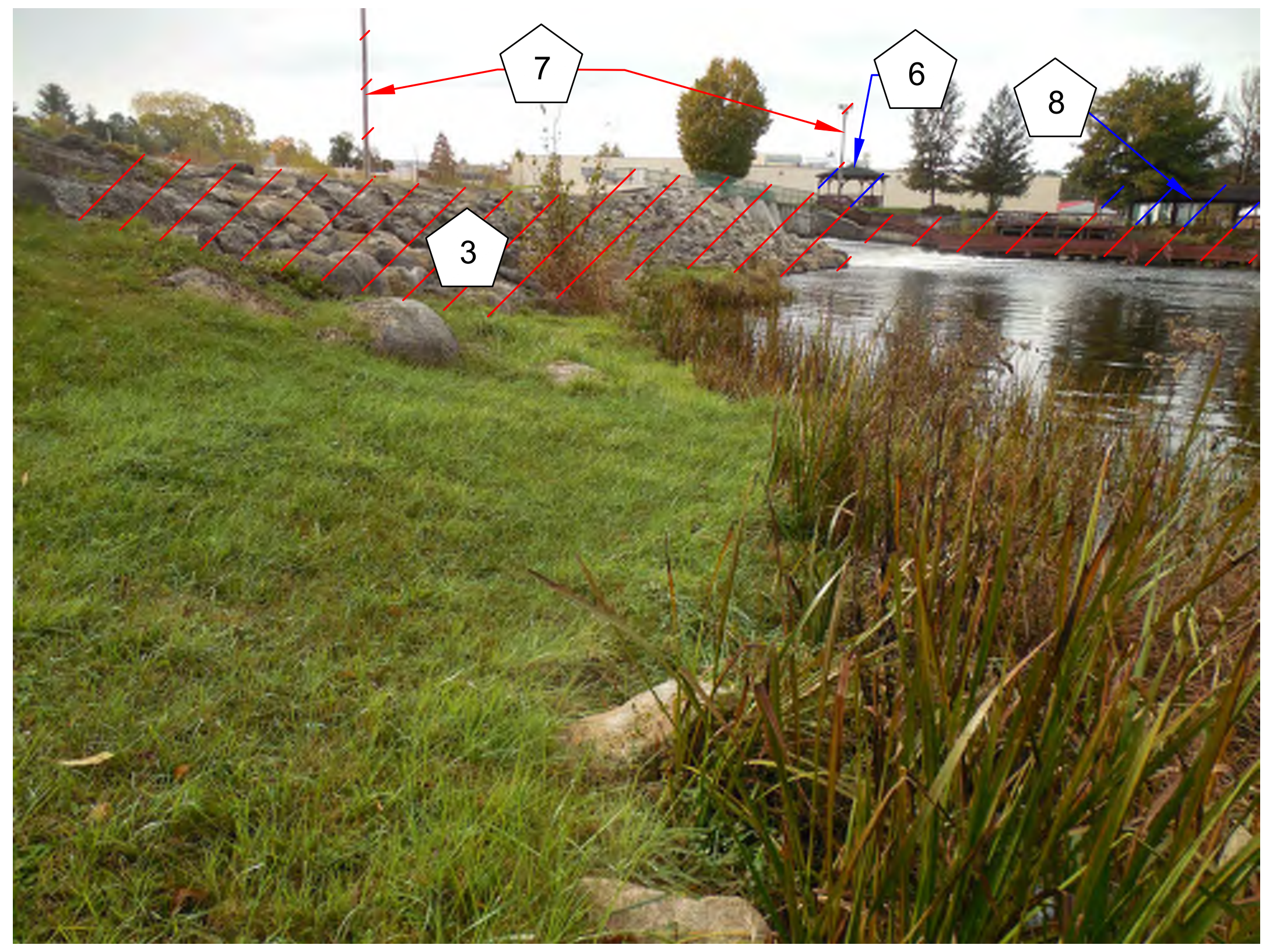
HELPPI, CHAD B:\Working\VILLAGE OF HESPERIA\2403886 Hesperia Dam Rehabilitation Feas. Study\00_CAD\Design\Sheets\D-100 DEMOLITION PLAN.dwg - 6/4/2025

1 PHOTO
HISTORIC MILL & DAM

2 PHOTO
DOWNSTREAM PRIMARY SPILLWAY

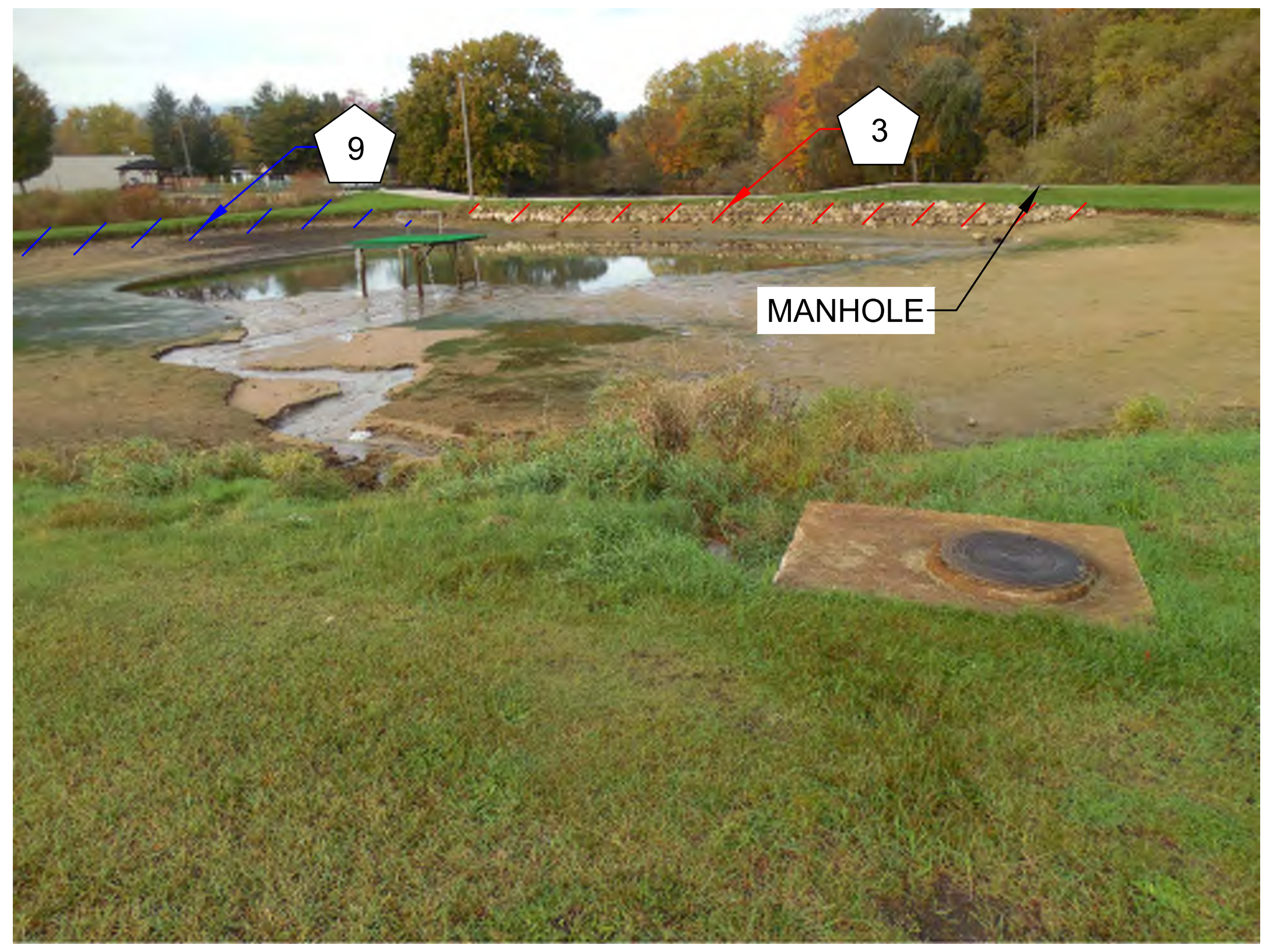
3 PHOTO
UPSTREAM PRIMARY SPILLWAY

4 PHOTO
RIGHT EMBANKMENT CREST



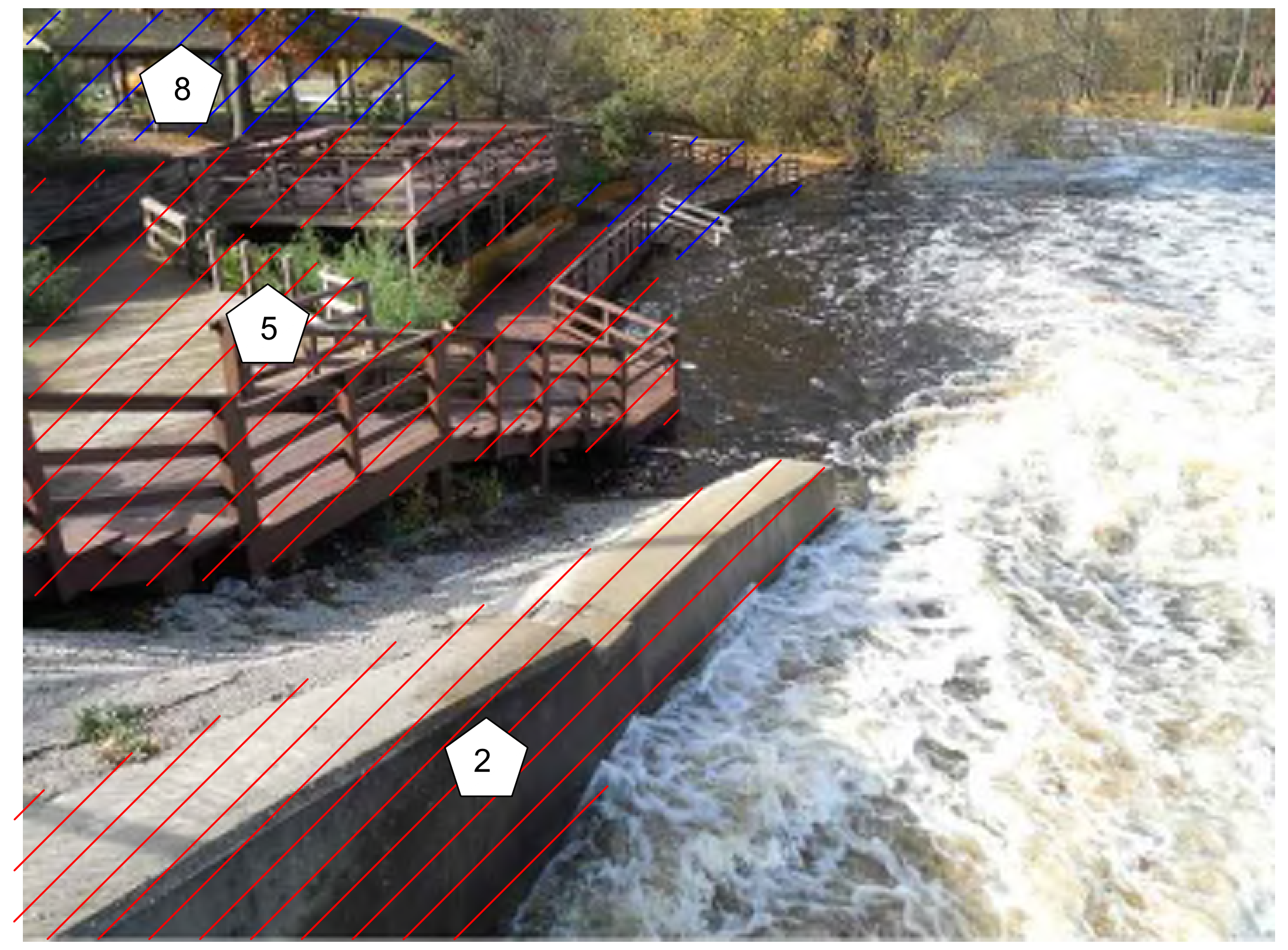
5 PHOTO
GROUTED RIPRAP AUXILIARY SPILLWAY

6 PHOTO
UPSTREAM RIPRAP RIGHT EMBANKMENT



7 PHOTO
SWIMMING POND

8 PHOTO
GAZEBO



9 PHOTO
DOWNSTREAM BOARDWALK

Concept Plans

Attention:
0 1"
If this scale bar does not measure 1" then drawing is not original scale.

DRAFT

Designed:	GK
Drawn:	CH / JW
Checked:	MC
Approved:	MC
P.E. No:	6201054585
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WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

NO	DATE	ISSUE/REVISION	APP
0	06/06/2025	CONCEPTUAL PLANS	DD

SHEET NAME
DEMOLITION PHOTOS

SHEET NO.
D-101

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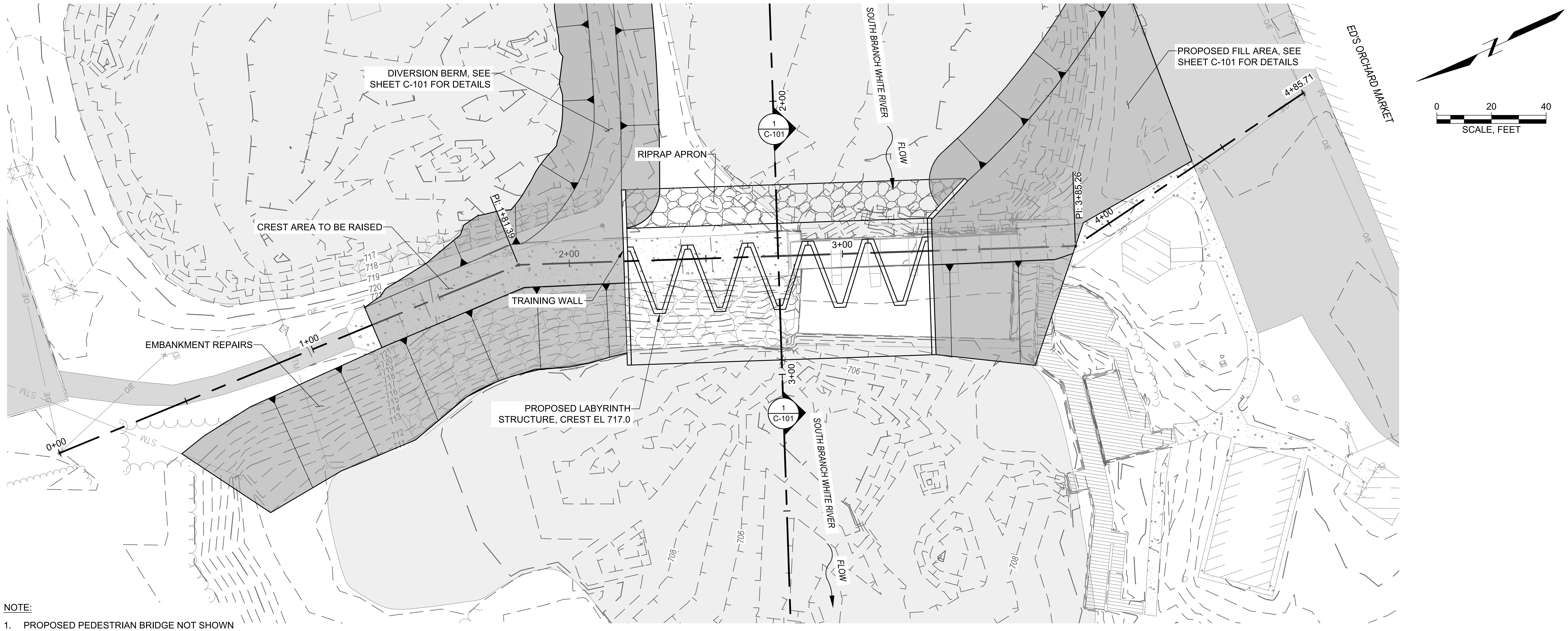
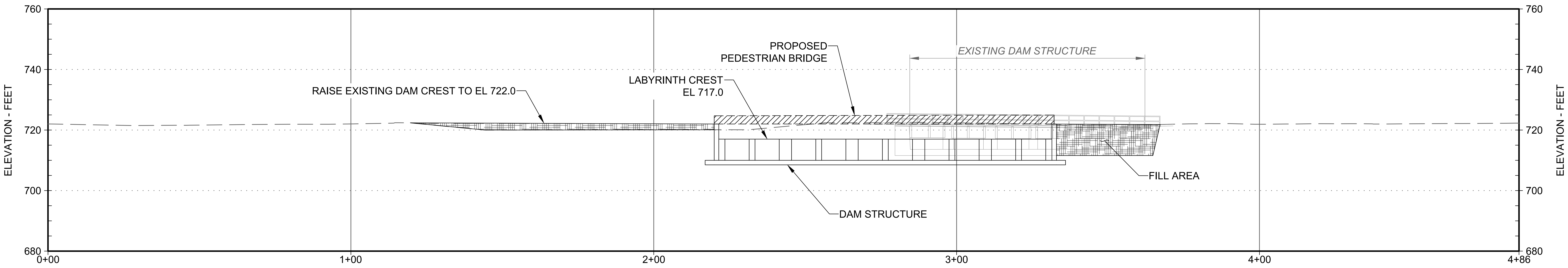


NOTE:

1. PROPOSED PEDESTRIAN BRIDGE NOT SHOWN IN PLAN VIEW FOR CLARITY PURPOSES.

PLAN

SCALE: 1" = 20'



PROFILE

SCALE: 1" = 20'

Concept Plans

Attention:
0 1"
If this scale bar does not measure 1" then drawing is not original scale.

DRAFT

Designed:	GK
Drawn:	CH / JW
Checked:	MC
Approved:	MC
P.E. No:	6201054585
GEI Project	2403886

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WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

NO	DATE	ISSUE/REVISION	APP
0	6/3/2025	CONCEPTUAL PLANS	DD

SHEET NAME

ALTERNATIVE 1 PLAN AND PROFILE

110 FT WIDE LABYRINTH SPILLWAY

SHEET NO.

C-100

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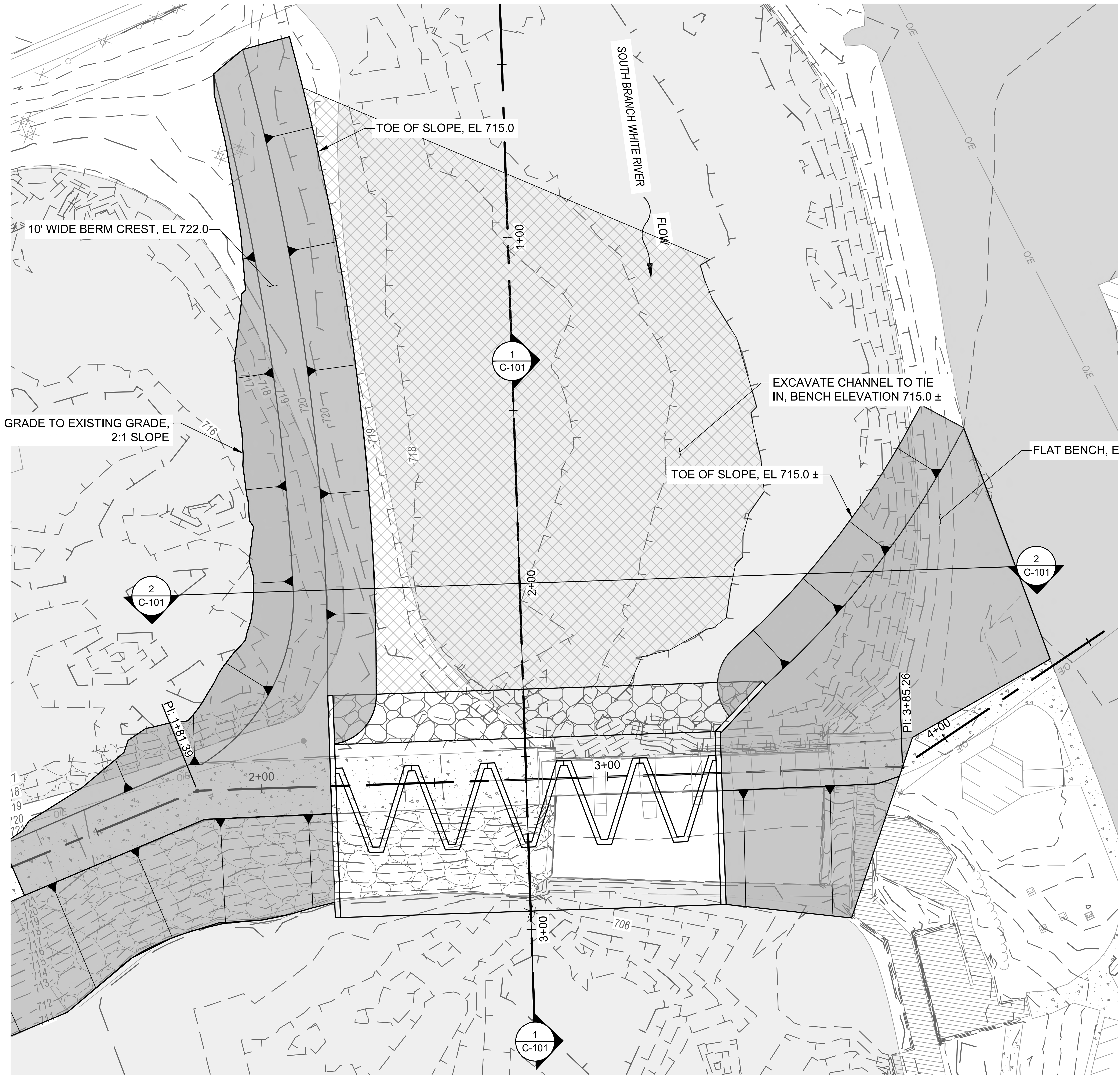
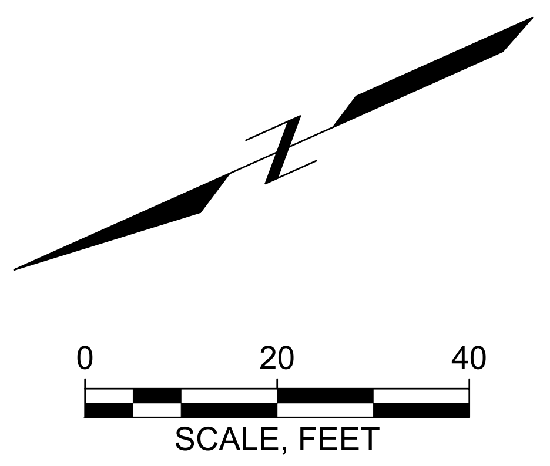


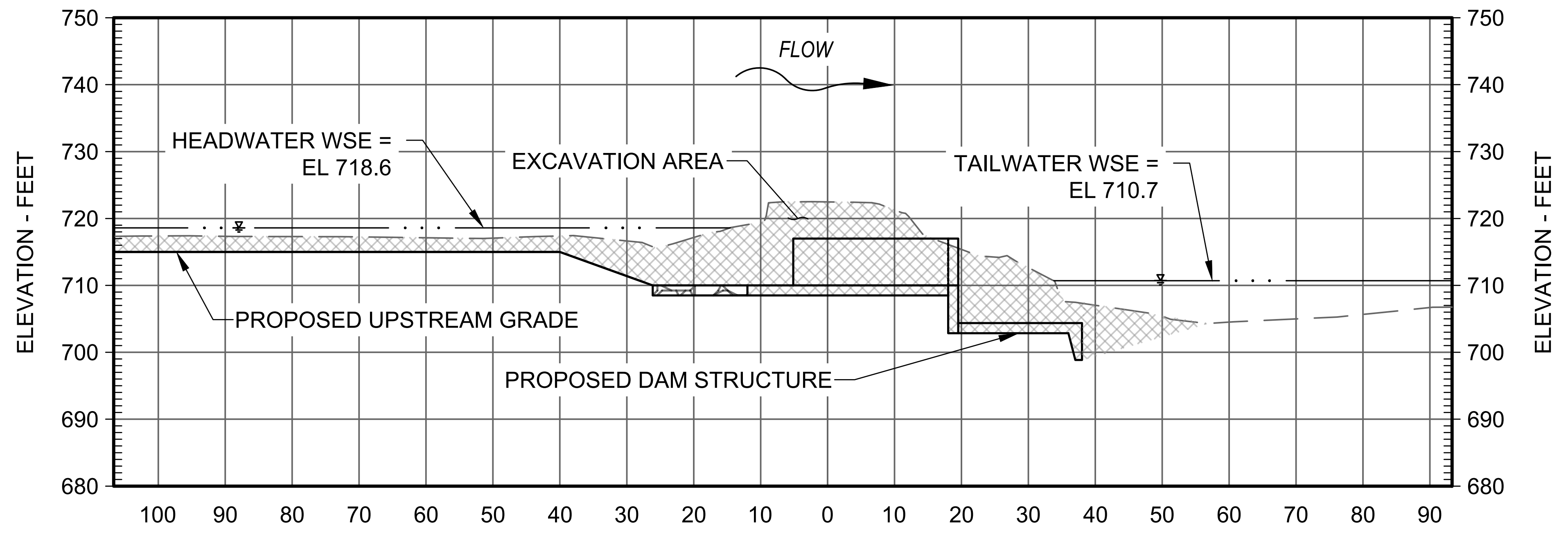


NOTE:

1. PROPOSED PEDESTRIAN BRIDGE NOT SHOWN IN PLAN VIEW FOR CLARITY PURPOSES.

PLAN

SCALE: 1" = 20'



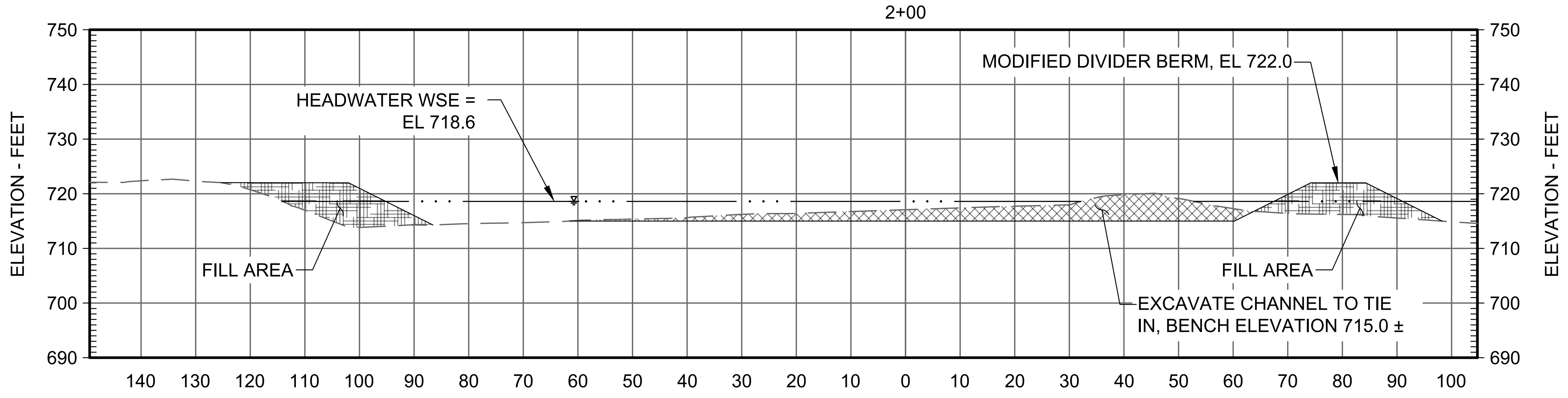
SECTION 1

DAM SECTION

SCALE: 1" = 20'

NOTE:

1. FOUNDATION PILING AND SEEPAGE CUTOFF WALLS NOT SHOWN.



SECTION 2

UPSTREAM CHANNEL

SCALE: 1" = 20'

Concept Plans

Attention:

0 1"

If this scale bar does not measure 1" then drawing is not original scale.

DRAFT

Designed:	GK
Drawn:	CH / JW
Checked:	MC
Approved:	MC
P.E. No:	6201054585
GEI Project	2403886

GEI Consultants

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WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

NO	DATE	ISSUE/REVISION	APP
0	6/3/2025	CONCEPTUAL PLANS	DD

SHEET NAME

**ALTERNATIVE 1
DIVERSION BERM
PLAN AND SECTIONS**

**110 FT WIDE LABYRINTH
SPILLWAY**

SHEET NO.

C-101

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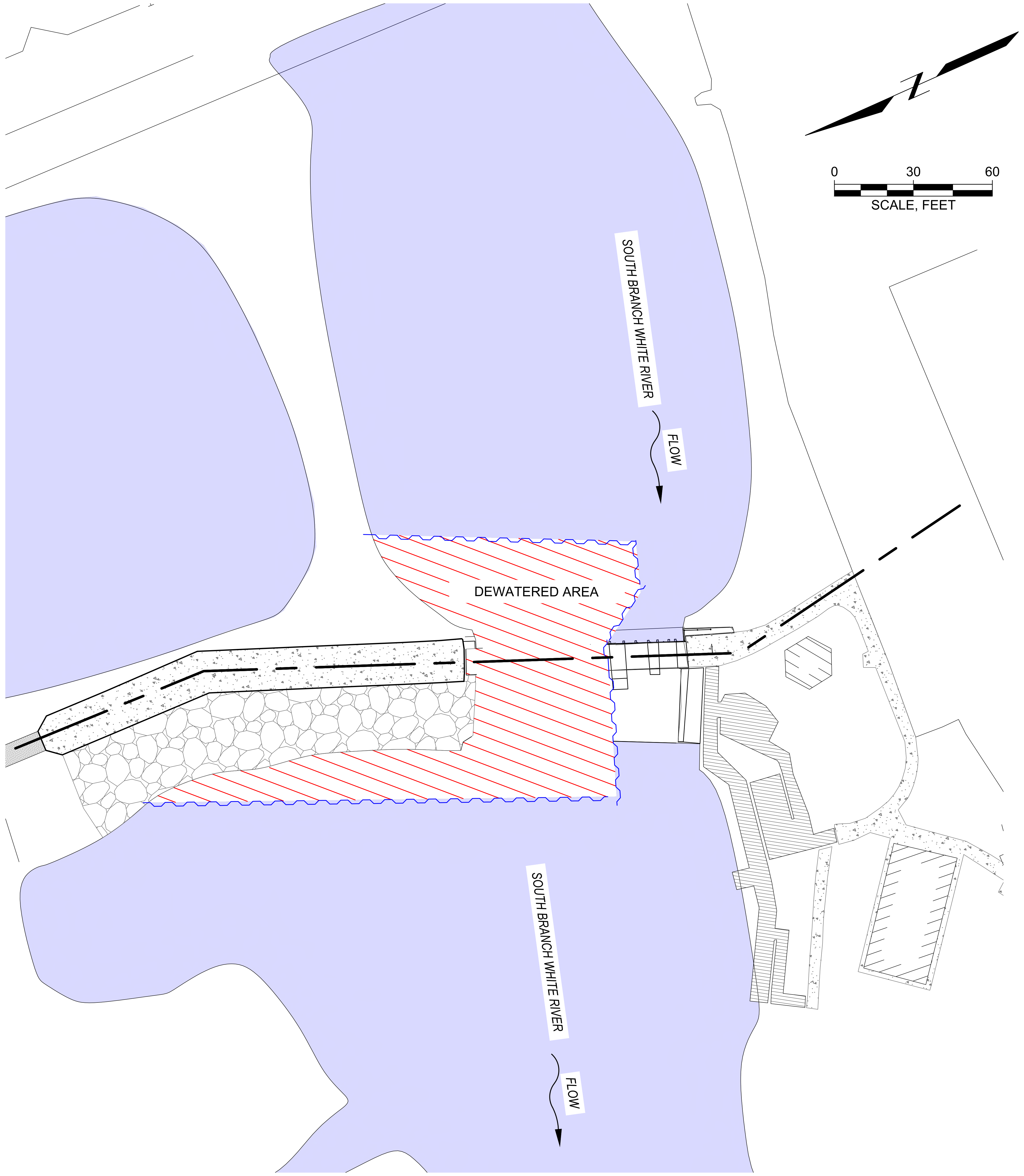
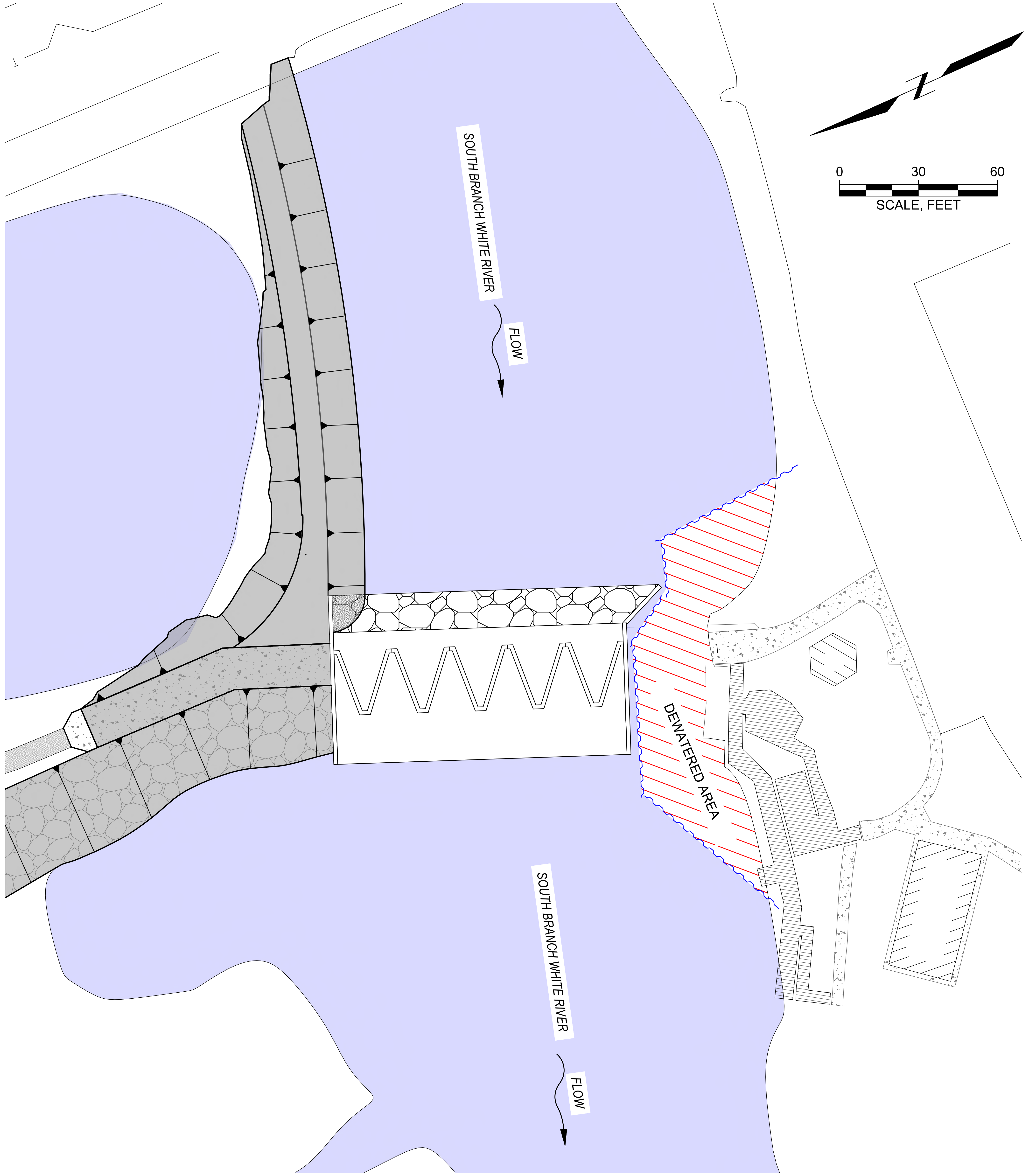


CONTROL OF WATER - PHASE 1

SCALE: 1" = 30'



CONTROL OF WATER - PHASE 2

SCALE: 1" = 30'

Concept Plans

Attention:
0 1"
If this scale bar does not measure 1" then drawing is not original scale.

DRAFT

Designed: GK
Drawn: CH / JW
Checked: MC
Approved: MC
P.E. No: 6201054585
GEI Project 2403886

GEI Consultants
GEI CONSULTANTS OF MICHIGAN, P.C.
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WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

NO	DATE	ISSUE/REVISION	APP
0	06/06/2025	CONCEPTUAL PLANS	DD

SHEET NAME

ALTERNATIVE 1
CONTROL OF WATER

110 FT WIDE LABYRINTH SPILLWAY

SHEET NO.

CW-102

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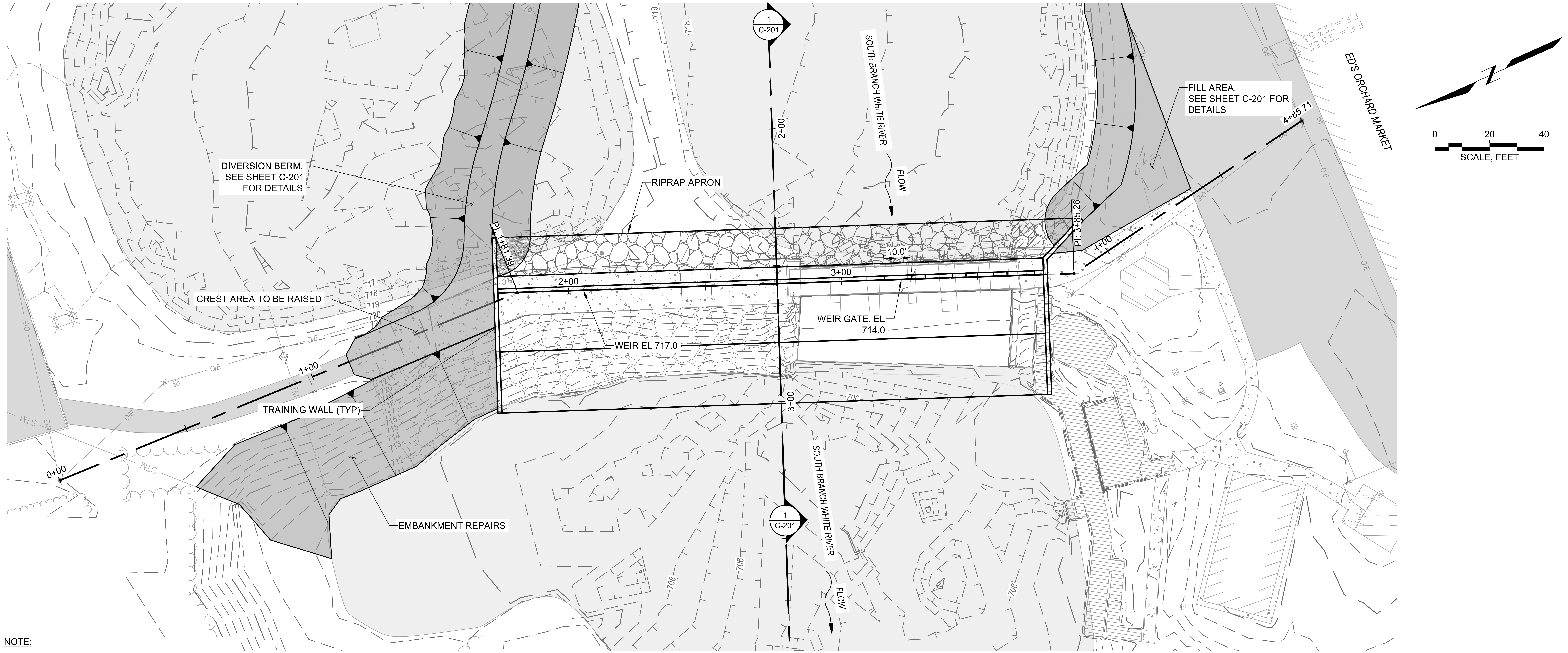
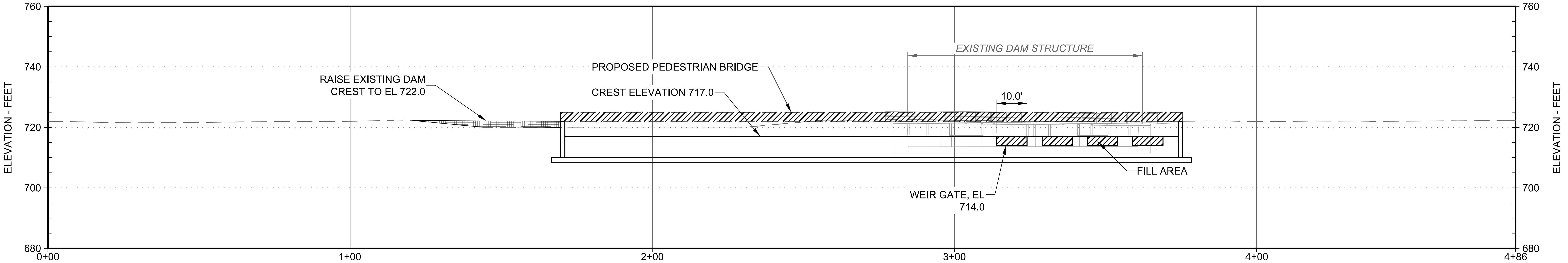


NOTE:

1. PROPOSED PEDESTRIAN BRIDGE NOT SHOWN IN PLAN VIEW FOR CLARITY PURPOSES.

PLAN

SCALE: 1" = 20'



PROFILE

SCALE: 1" = 20'

Concept Plans

Attention:
0 1"
If this scale bar does not measure 1" then drawing is not original scale.

DRAFT

Designed:	GK
Drawn:	CH / JW
Checked:	MC
Approved:	MC
P.E. No:	6201054585
GEI Project	2403886

GEI Consultants
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HESPERIA DAM REHABILITATION

WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

NO	DATE	ISSUE/REVISION	APP
0	06/06/2025	CONCEPTUAL PLANS	DD

SHEET NAME
ALTERNATIVE 2
PLAN AND PROFILE

200 FT WIDE GATE WEIR SPILLWAY

SHEET NO.
C-200

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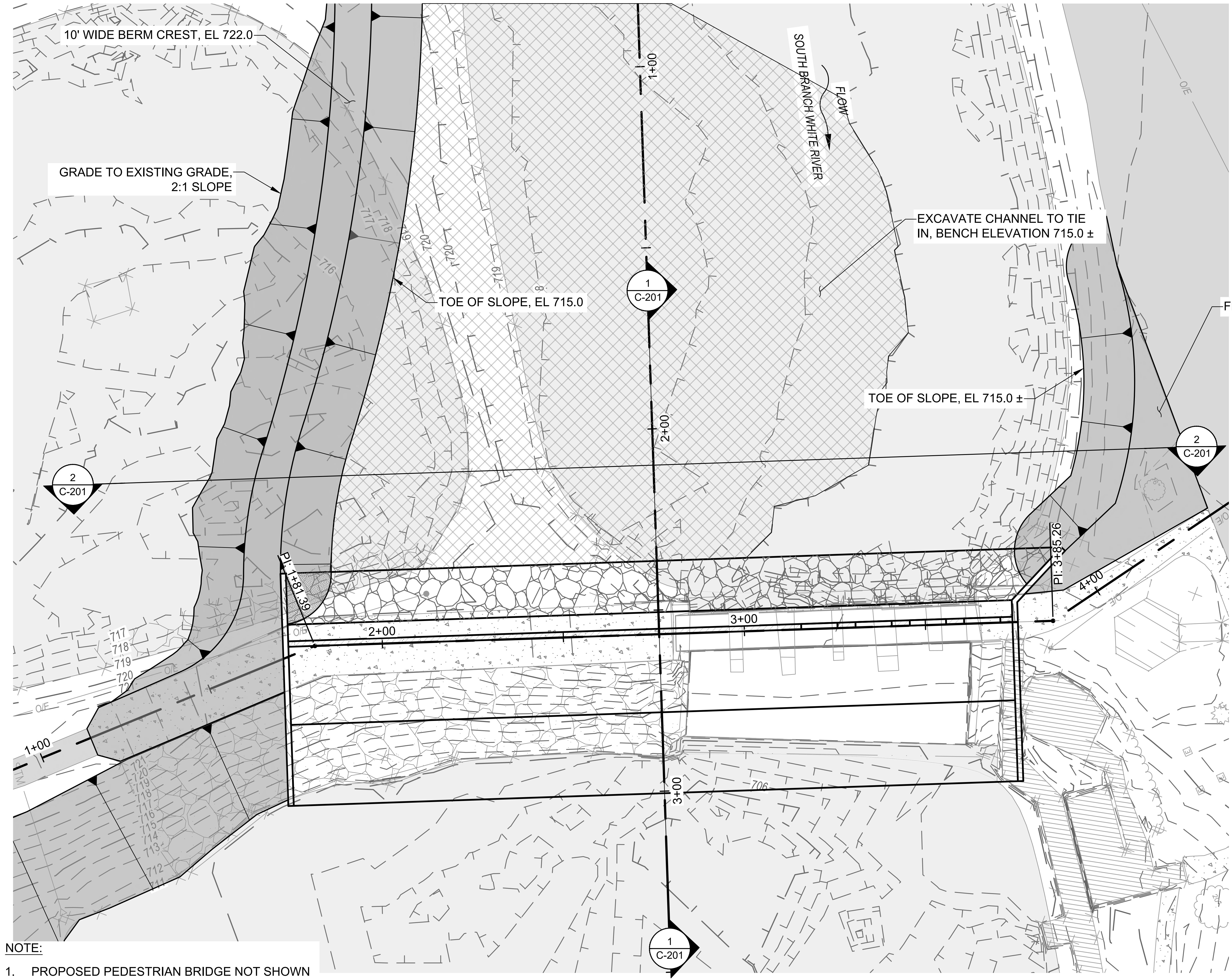
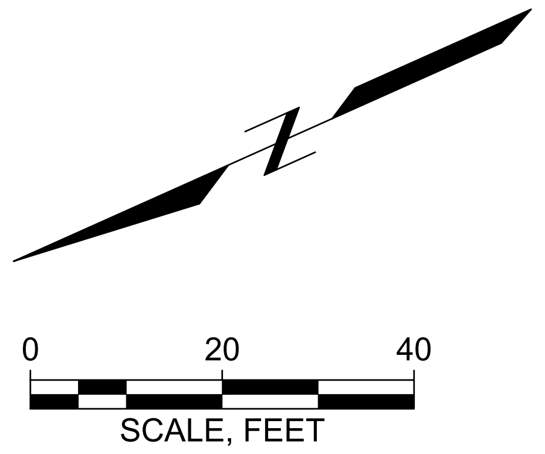


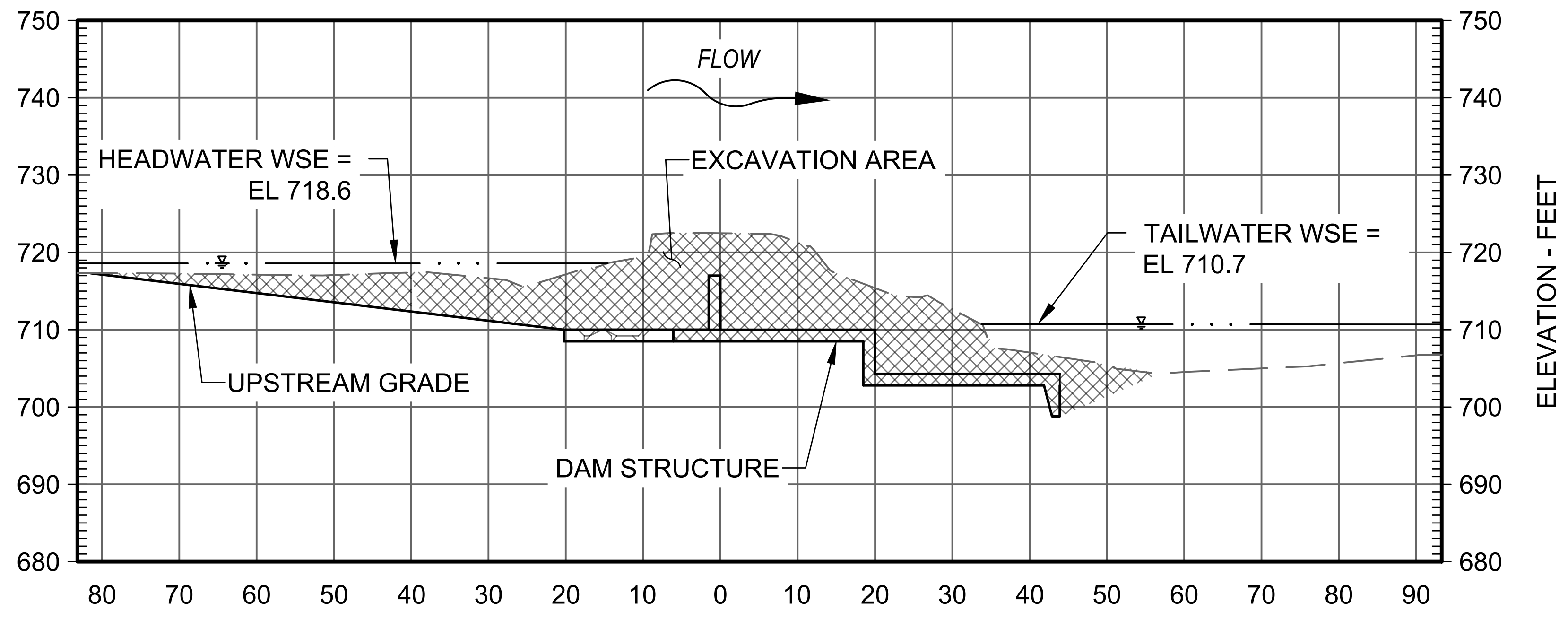


NOTE:

1. PROPOSED PEDESTRIAN BRIDGE NOT SHOWN IN PLAN VIEW FOR CLARITY PURPOSES.

PLAN

SCALE: 1" = 20'

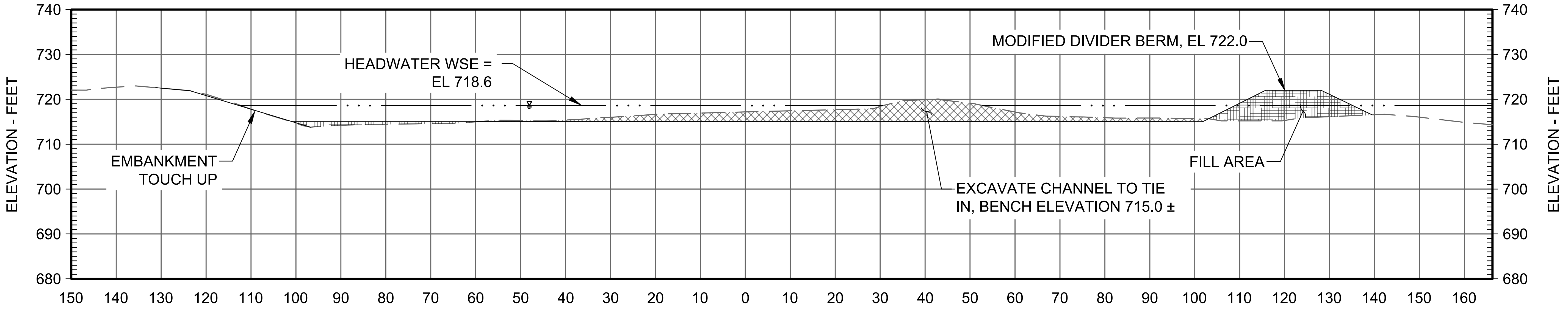


SECTION 1
DAM SECTION

SCALE: 1" = 20'

NOTE:

1. FOUNDATION PILING AND SEEPAGE CUTOFF WALLS NOT SHOWN.



SECTION 2
UPSTREAM CHANNEL

SCALE: 1" = 20'

Concept Plans

Attention:
0 1"
If this scale bar does not measure 1" then drawing is not original scale.

DRAFT

Designed: GK
Drawn: CH / JW
Checked: MC
Approved: MC
P.E. No: 6201054585
GEI Project 2403886

GEI Consultants
GEI CONSULTANTS OF MICHIGAN, P.C.
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(906)451-4021

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EST. 1866

HESPERIA DAM REHABILITATION

WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

NO	DATE	ISSUE/REVISION	APP
0	06/06/2025	CONCEPTUAL PLANS	DD

SHEET NAME

**ALTERNATIVE 2
DIVERSION BERM
PLAN AND SECTIONS**

200 FT WIDE GATE WEIR SPILLWAY

SHEET NO.

C-201

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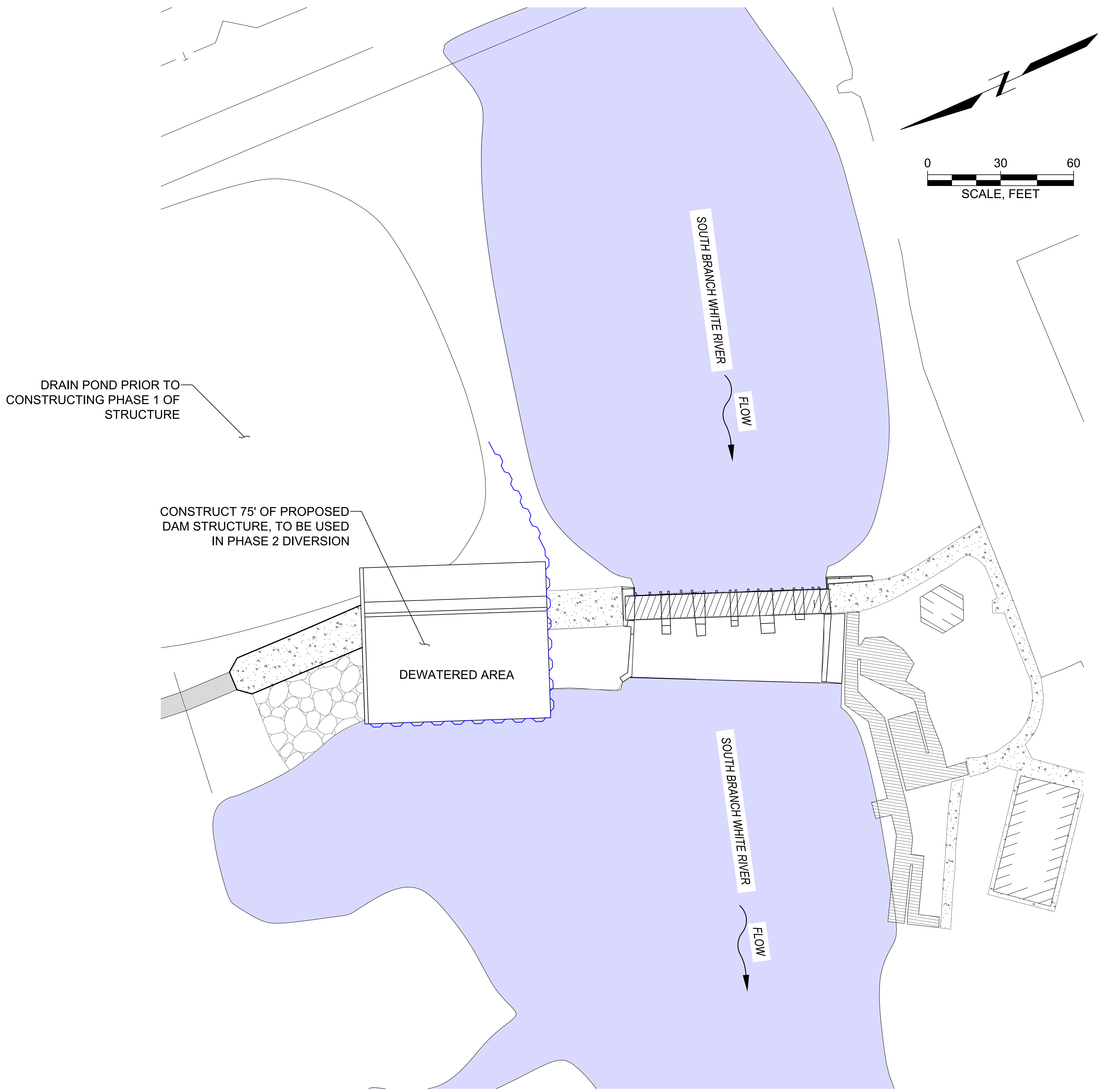
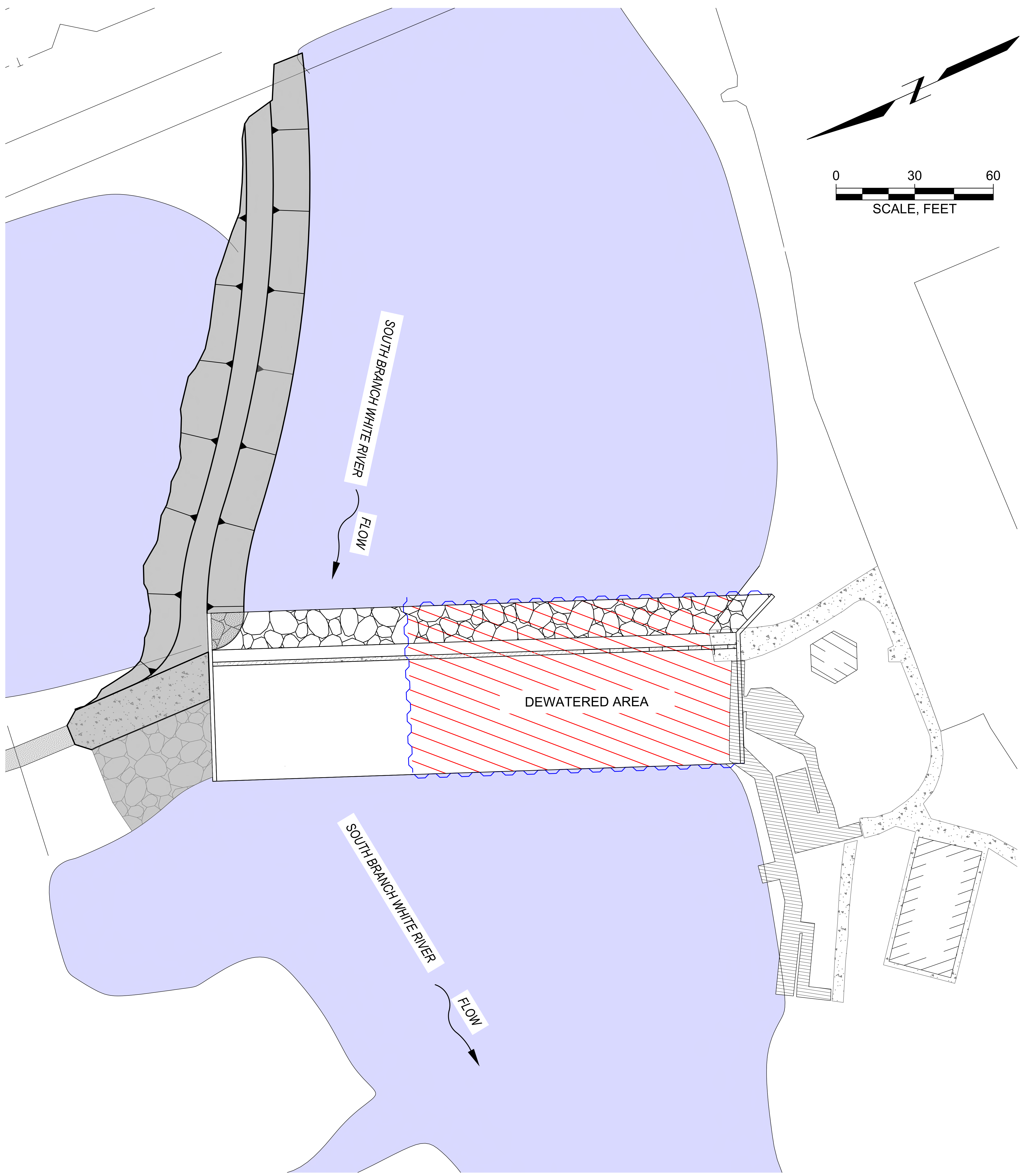


CONTROL OF WATER - PHASE 1
SCALE: 1" = 30'



CONTROL OF WATER - PHASE 2
SCALE: 1" = 30'

Concept Plans

Attention:
0 1"
If this scale bar does not measure 1" then drawing is not original scale.

DRAFT

Designed:	GK
Drawn:	CH / JW
Checked:	MC
Approved:	MC
P.E. No:	6201054585
GEI Project	2403886

GEI Consultants
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HESPERIA DAM REHABILITATION

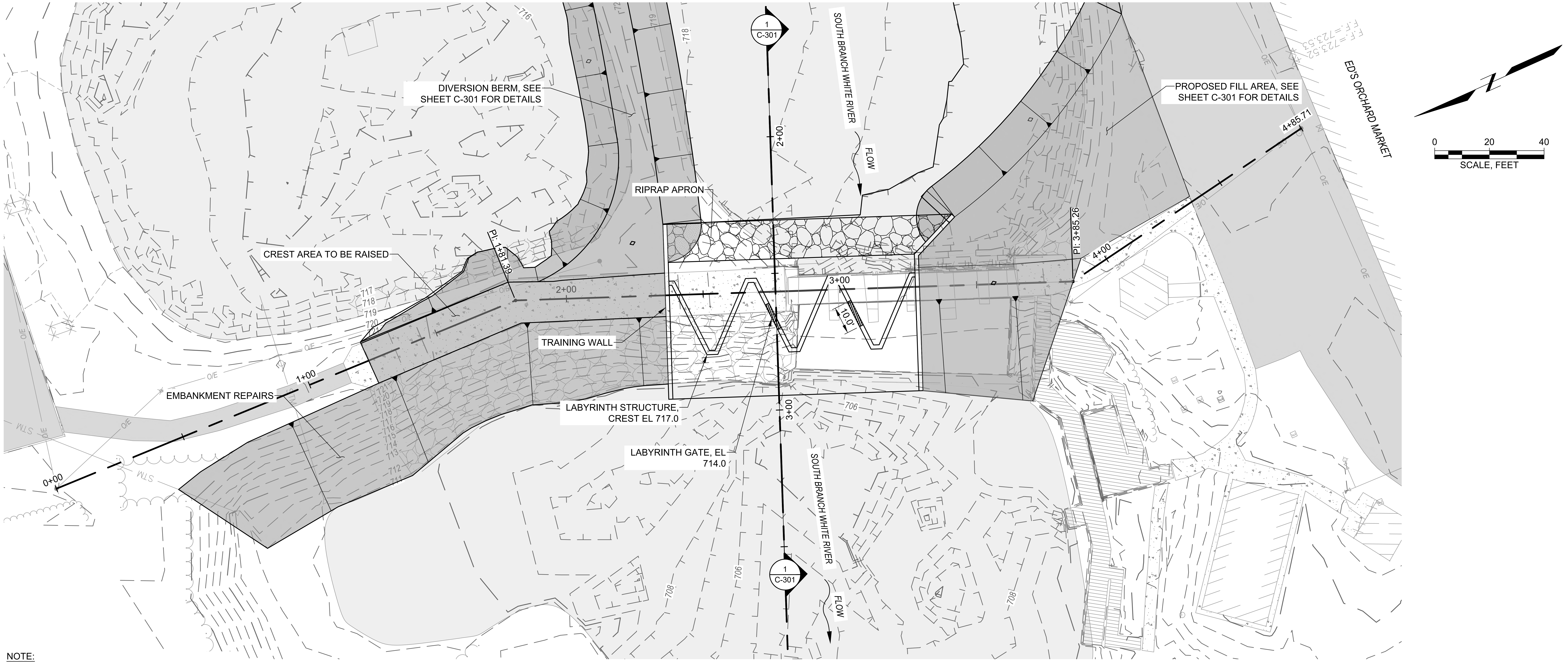
WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

NO	DATE	ISSUE/REVISION	APP
0	06/06/2025	CONCEPTUAL PLANS	DD

SHEET NAME
ALTERNATIVE 2 CONTROL OF WATER
200 FT WIDE GATE WEIR SPILLWAY

SHEET NO.
CW-202

HELPPI, CHAD B:\Working\VILLAGE OF HESPERIA\2403886 Hesperia Dam Rehabilitation Feas. Study\00_CAD\Design\Sheets\CW-202 OPTION 2 - CONTROL OF WATER.dwg - 6/4/2025

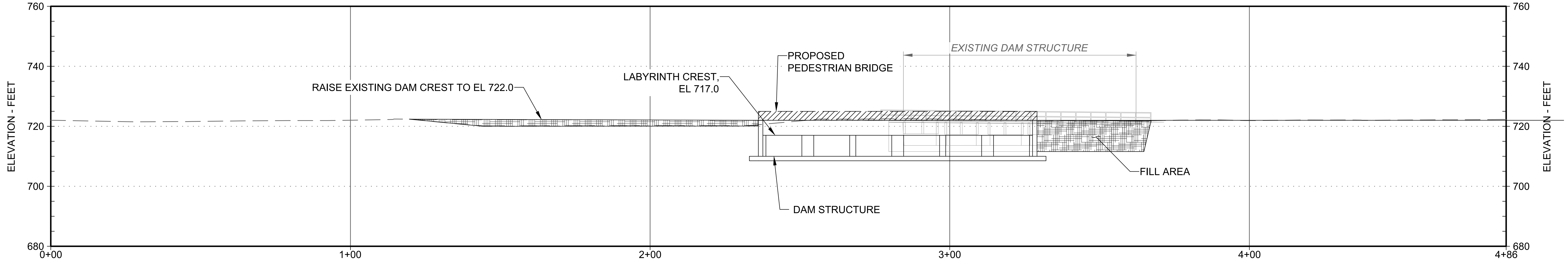


NOTE:

1. PROPOSED PEDESTRIAN BRIDGE NOT SHOWN IN PLAN VIEW FOR CLARITY PURPOSES.

PLAN

SCALE: 1" = 20'



PROFILE

SCALE: 1" = 20'

Concept Plans

Attention:

0 1"

If this scale bar does not measure 1" then drawing is not original scale.

DRAFT

Designed:	GK
Drawn:	CH / JW
Checked:	MC
Approved:	MC
P.E. No:	6201054585
GEI Project	2403886

GEI Consultants

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HESPERIA DAM REHABILITATION

WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

NO	DATE	ISSUE/REVISION	APP
0	6/3/2025	CONCEPTUAL PLANS	DD

SHEET NAME

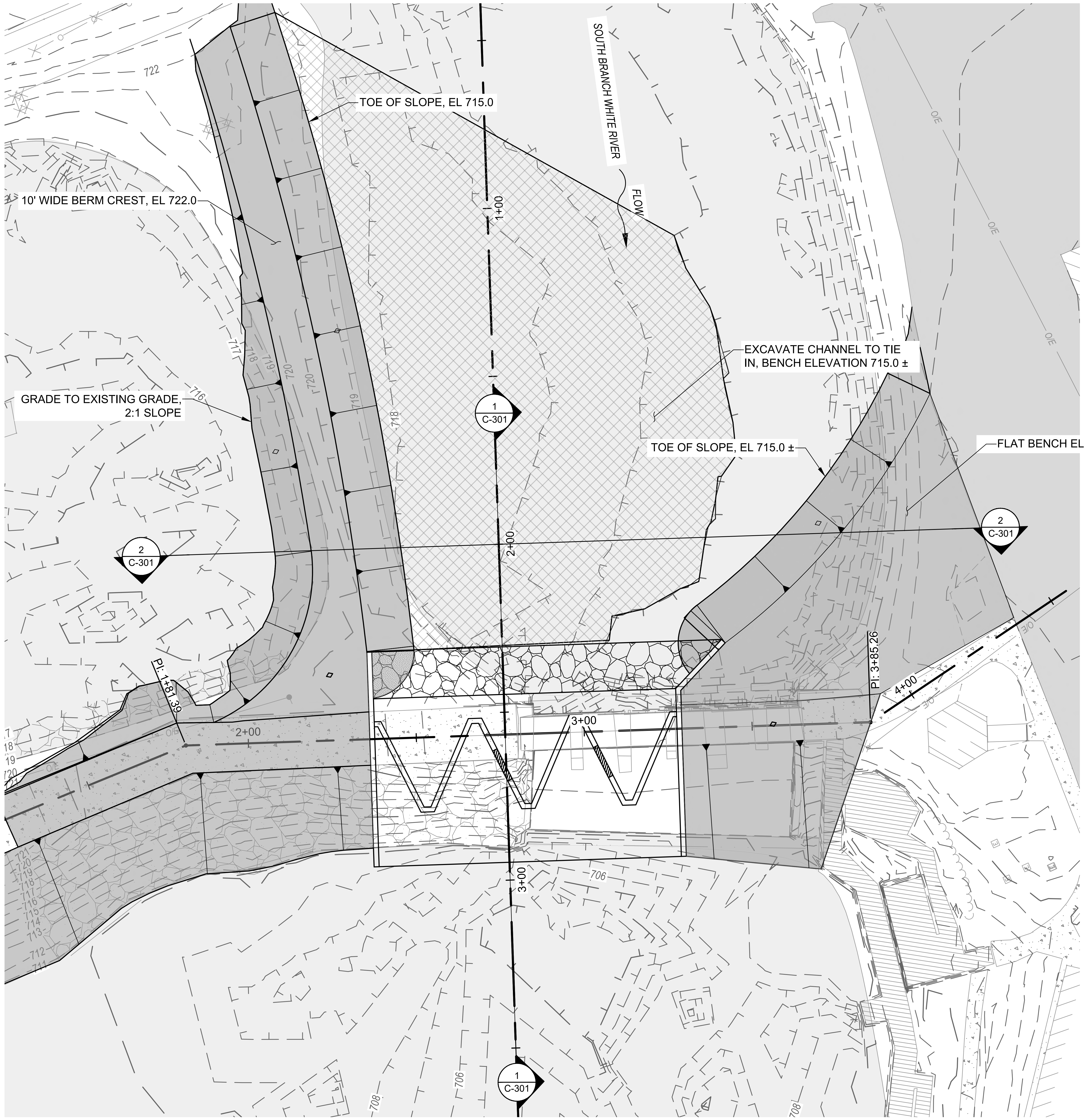
ALTERNATIVE 3 PLAN AND PROFILE

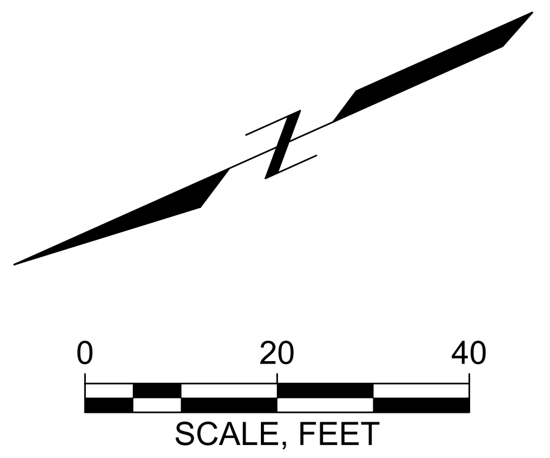
90 FT WIDE GATED LABYRINTH SPILLWAY

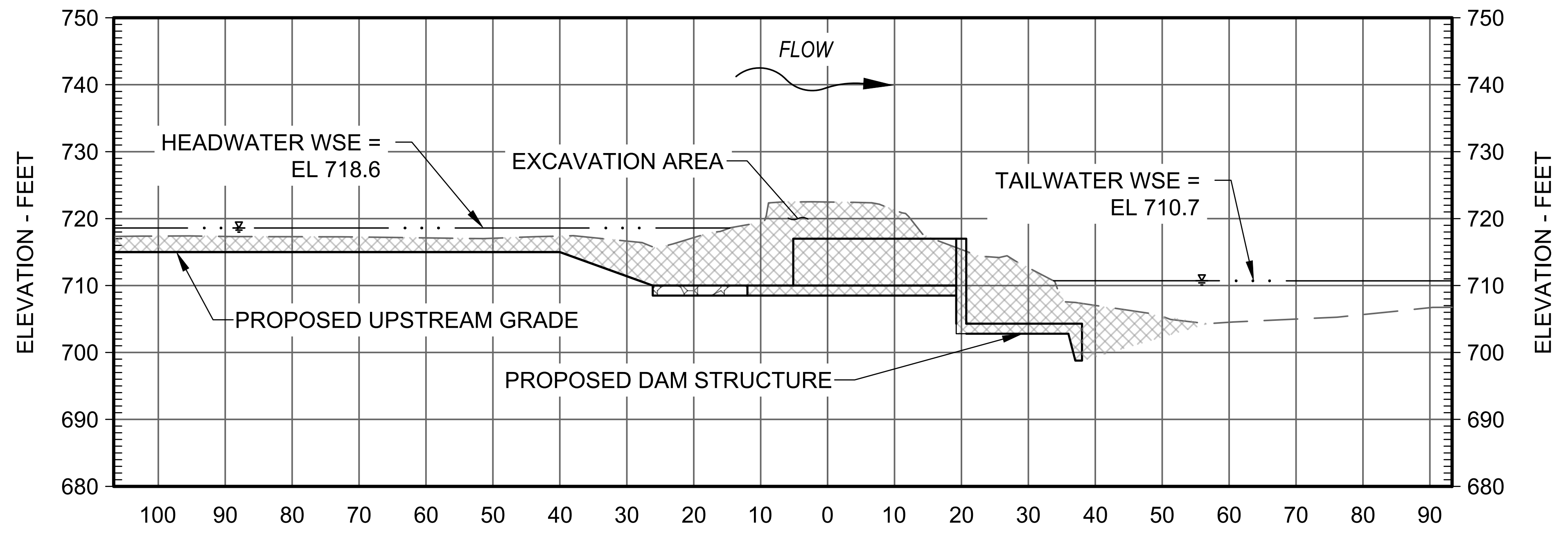
SHEET NO.

C-300

HELPPI, CHAD B:\Working\VILLAGE OF HESPERIA\2403886 Hesperia Dam Rehabilitation Feas. Study\00_CAD\Design\Sheets\C-301 OPTION 3 - DIVERSION BERM PLAN AND SECTIONS.dwg - 6/4/2025





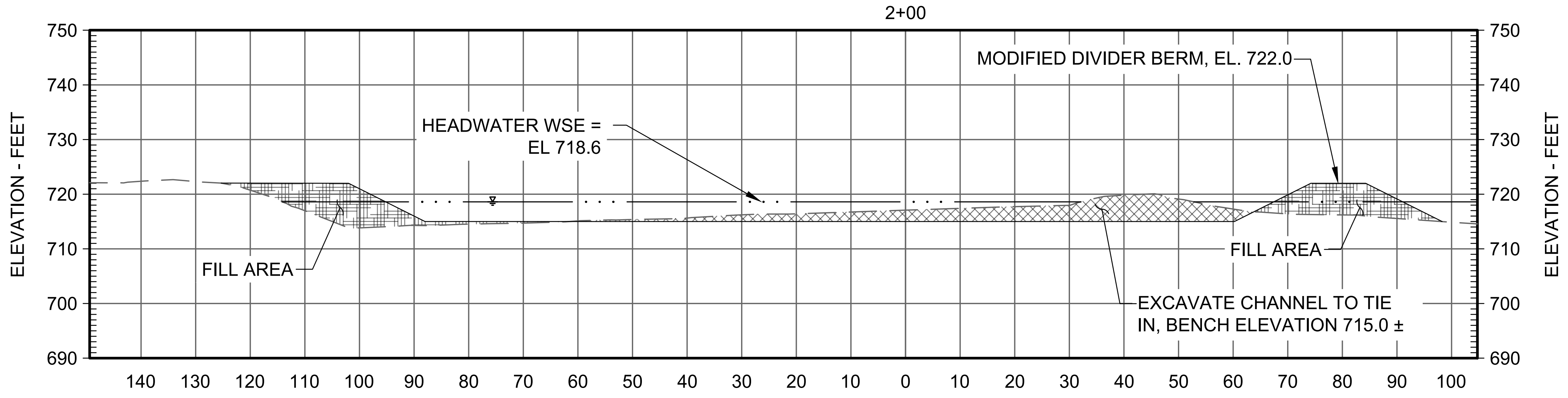


SECTION 1

PROPOSED DAM SECTION SCALE: 1" = 20'

NOTE:

1. FOUNDATION PILING AND SEEPAGE CUTOFF WALLS NOT SHOWN.



SECTION 2

UPSTREAM CHANNEL SCALE: 1" = 20'

NOTE:

1. PROPOSED PEDESTRIAN BRIDGE NOT SHOWN IN PLAN VIEW FOR CLARITY PURPOSES.

DIVERSION BERM MODIFICATION

SCALE: 1" = 20'

Concept Plans

Attention:
0 1"
If this scale bar does not measure 1" then drawing is not original scale.

DRAFT

Designed:	GK
Drawn:	CH / JW
Checked:	MC
Approved:	MC
P.E. No:	6201054585
GEI Project	2403886

GEI Consultants
GEI CONSULTANTS OF MICHIGAN, P.C.
109 W. BARAGA AVENUE
MARQUETTE, MI 49855
(906)451-4021

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EST. 1866

HESPERIA DAM REHABILITATION

WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

NO	DATE	ISSUE/REVISION	APP
0	6/3/2025	CONCEPTUAL PLANS	DD

SHEET NAME

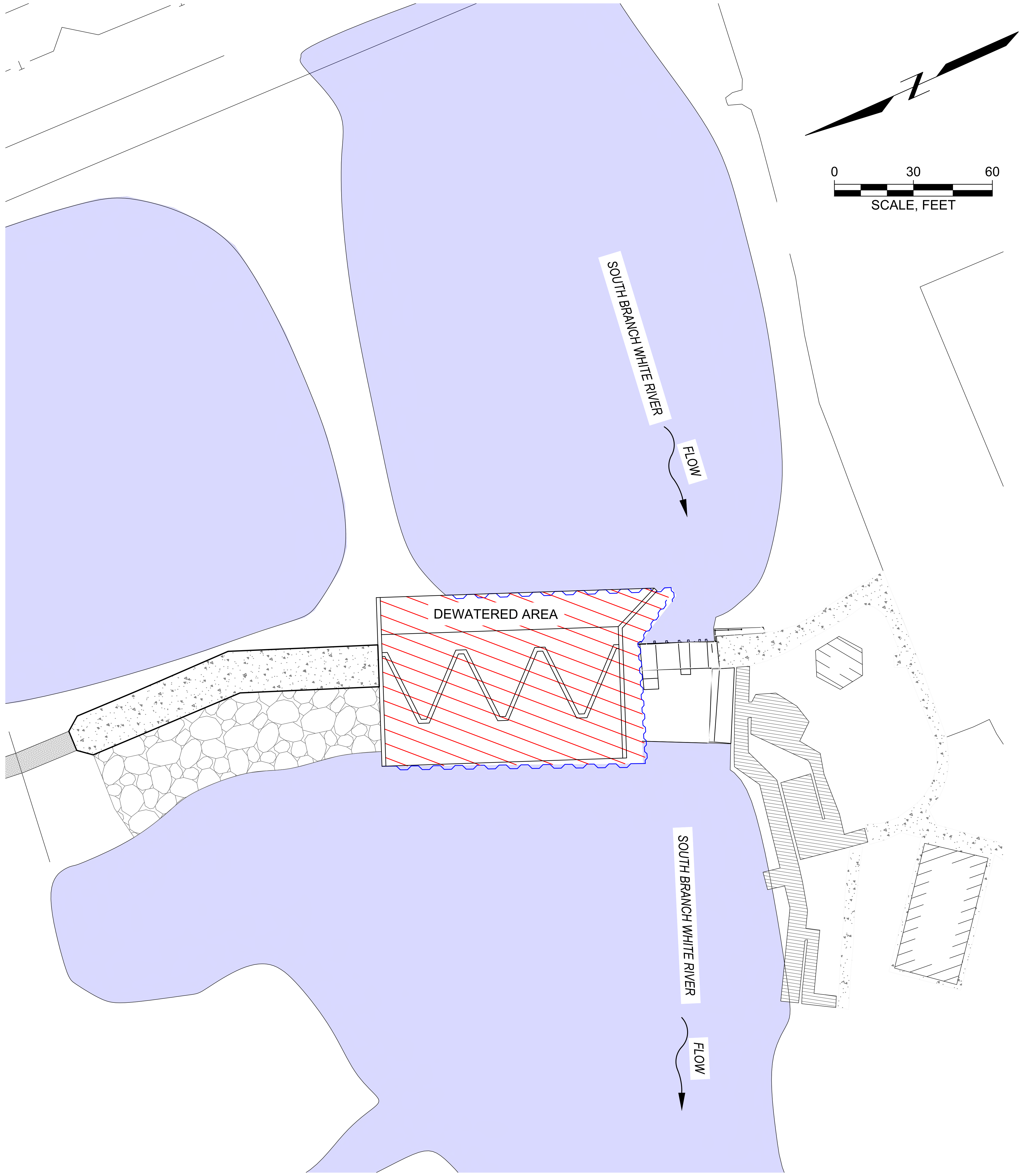
**ALTERNATIVE 3
DIVERSION BERM
PLAN AND SECTIONS**

**90 FT WIDE GATED
LABYRINTH SPILLWAY**

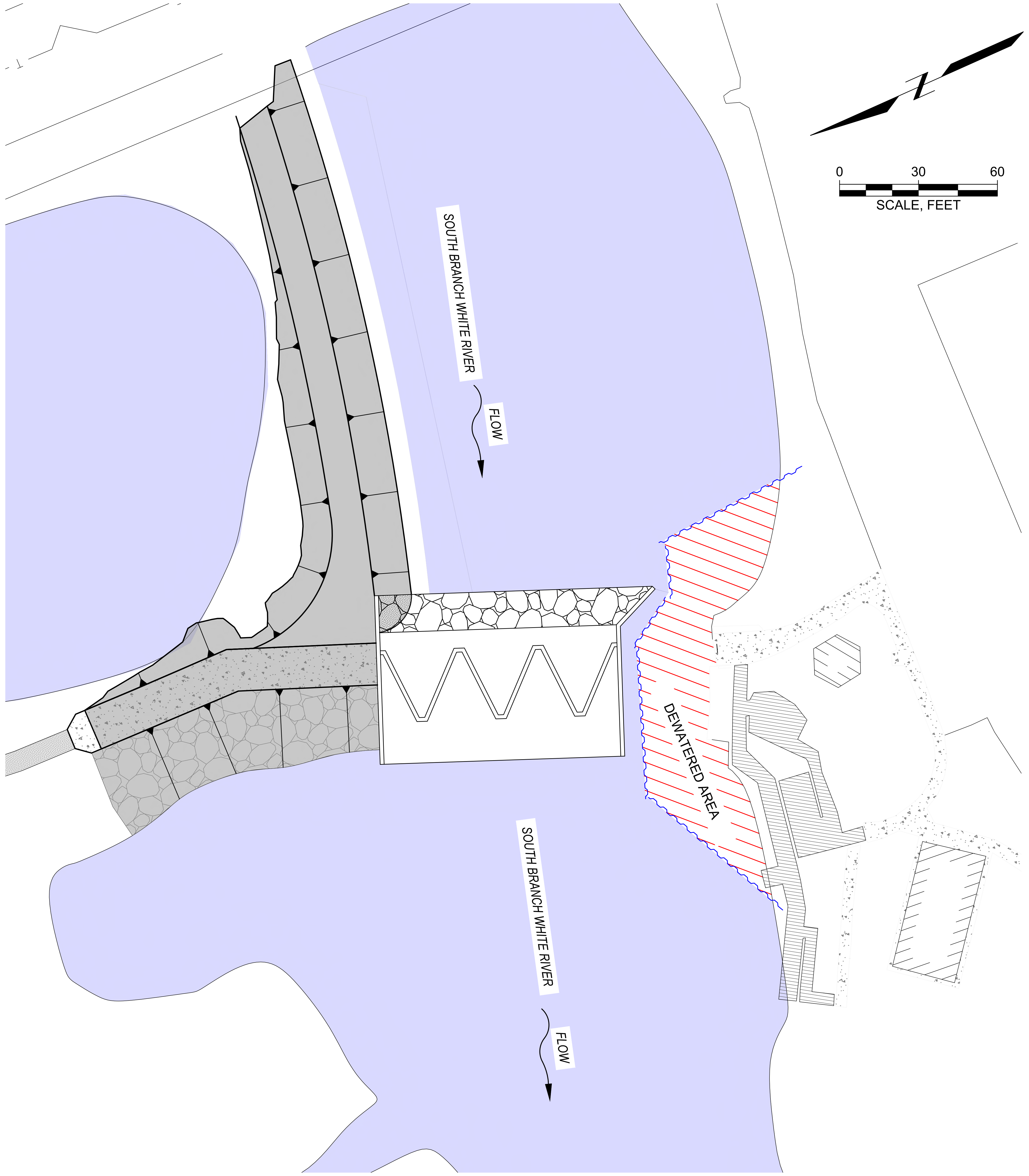
SHEET NO.

C-301

HELPPI, CHAD B:\Working\VILLAGE OF HESPERIA\2403886 Hesperia Dam Rehabilitation Feas. Study\00_CAD\Design\Sheets\C-301 OPTION 3 - DIVERSION BERM PLAN AND SECTIONS.dwg - 6/4/2025



CONTROL OF WATER - PHASE 1
SCALE: 1" = 30'



CONTROL OF WATER - PHASE 2
SCALE: 1" = 30'

Concept Plans

Attention:
0 1"
If this scale bar does not measure 1" then drawing is not original scale.

DRAFT

Designed:	GK
Drawn:	CH / JW
Checked:	MC
Approved:	*MC*
P.E. No:	6201054585
GEI Project	2403886

GEI Consultants
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HESPERIA DAM REHABILITATION

WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

NO	DATE	ISSUE/REVISION	APP
0	06/06/2025	CONCEPTUAL PLANS	DD

SHEET NAME

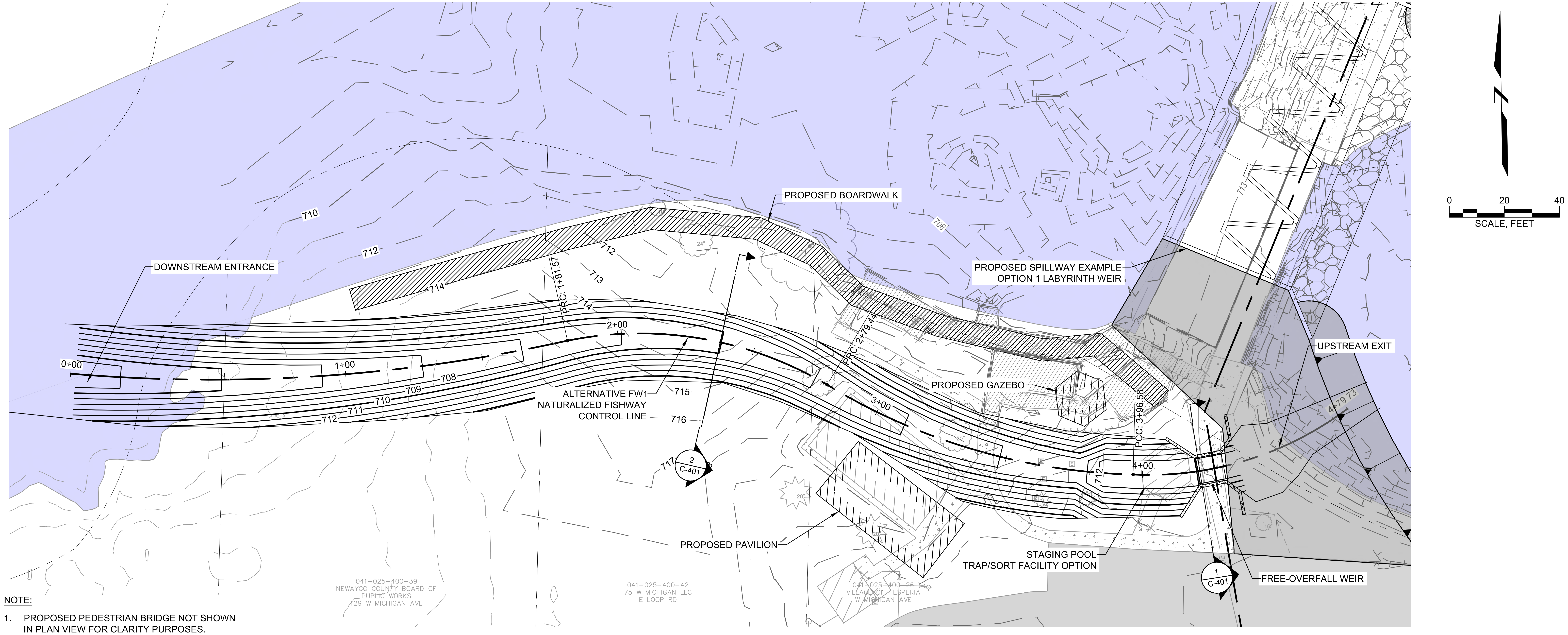
ALTERNATIVE 3
CONTROL OF WATER

90 FT WIDE GATED
LABYRINTH SPILLWAY

SHEET NO.

CW-302

HELPPI, CHAD B:\Working\VILLAGE OF HESPERIA\2403886 Hesperia Dam Rehabilitation Feas. Study\00_CAD\Design\Sheets\CW-102 OPTION 3 - CONTROL OF WATER.dwg - 6/4/2025

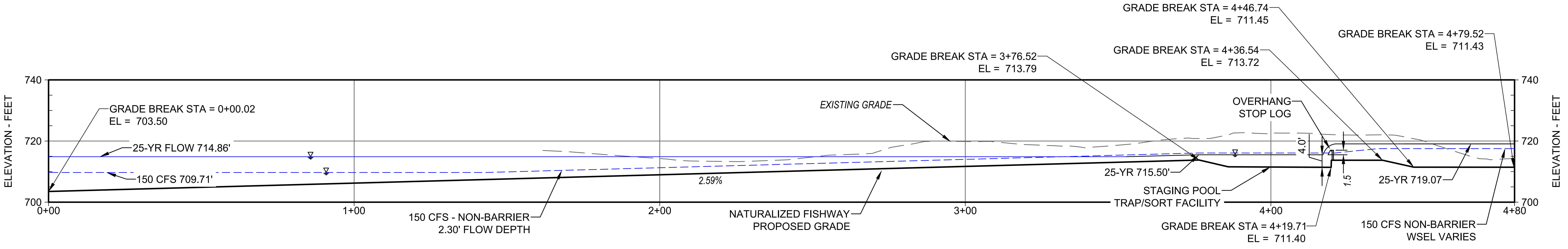


NOTE:

1. PROPOSED PEDESTRIAN BRIDGE NOT SHOWN IN PLAN VIEW FOR CLARITY PURPOSES.

PLAN VIEW

SCALE: 1" = 20'



PROFILE VIEW

SCALE: 1" = 20'

Concept Plans

Attention:

0 1"

If this scale bar does not measure 1" then drawing is not original scale.

DRAFT

Designed:	GK
Drawn:	CH / JW
Checked:	MC
Approved:	MC
P.E. No:	6201054585
GEI Project	2403886

GEI Consultants

GEI CONSULTANTS OF MICHIGAN, P.C.
109 W. BARAGA AVENUE
MARQUETTE, MI 49855
(906)451-4021

HESPERIA DAM REHABILITATION

WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

NO	DATE	ISSUE/REVISION	APP
0	06/06/2025	CONCEPTUAL PLANS	DD

SHEET NAME

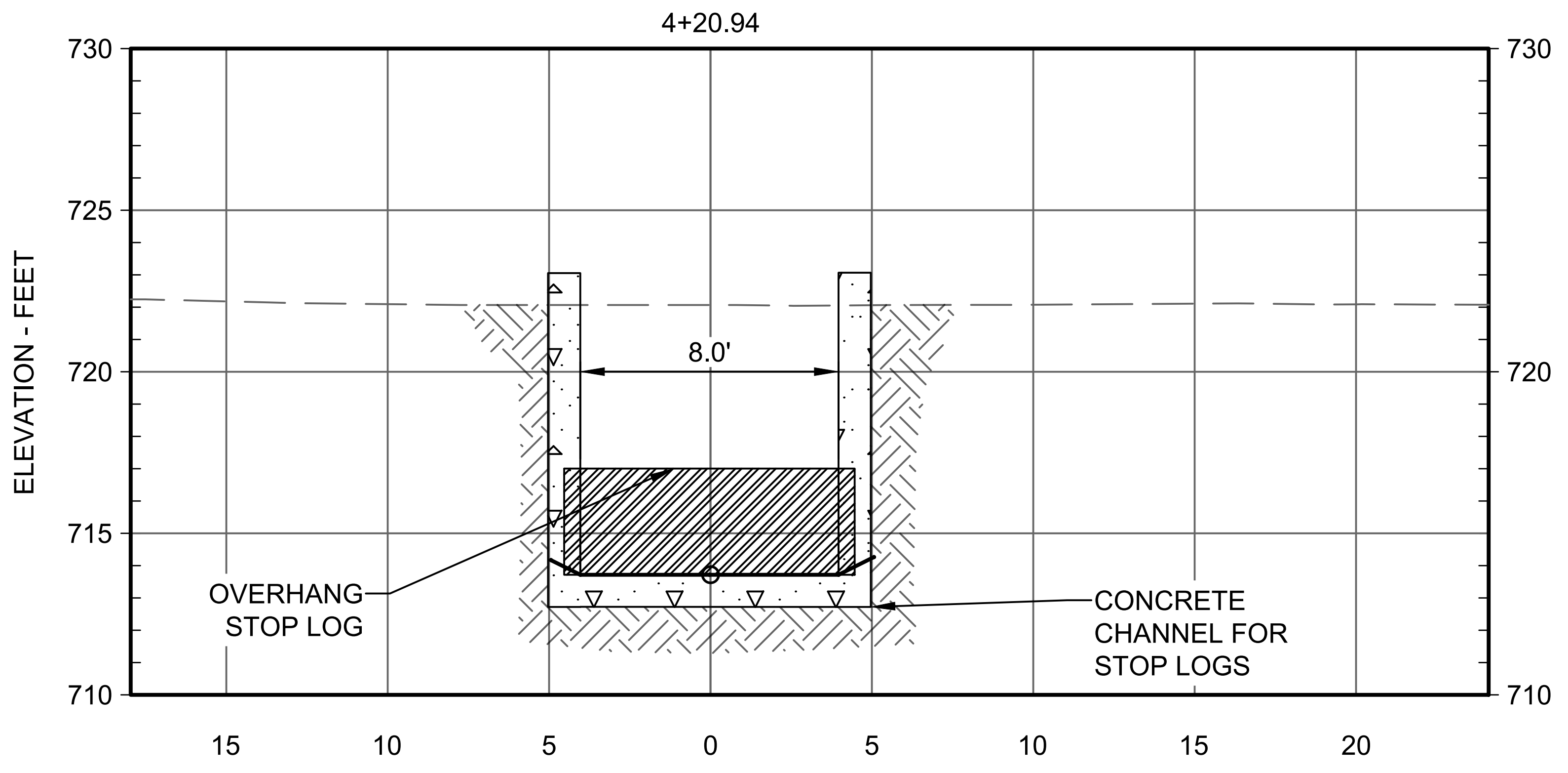
FW 1
PLAN AND PROFILE

NATURALIZED FISHWAY

SHEET NO.

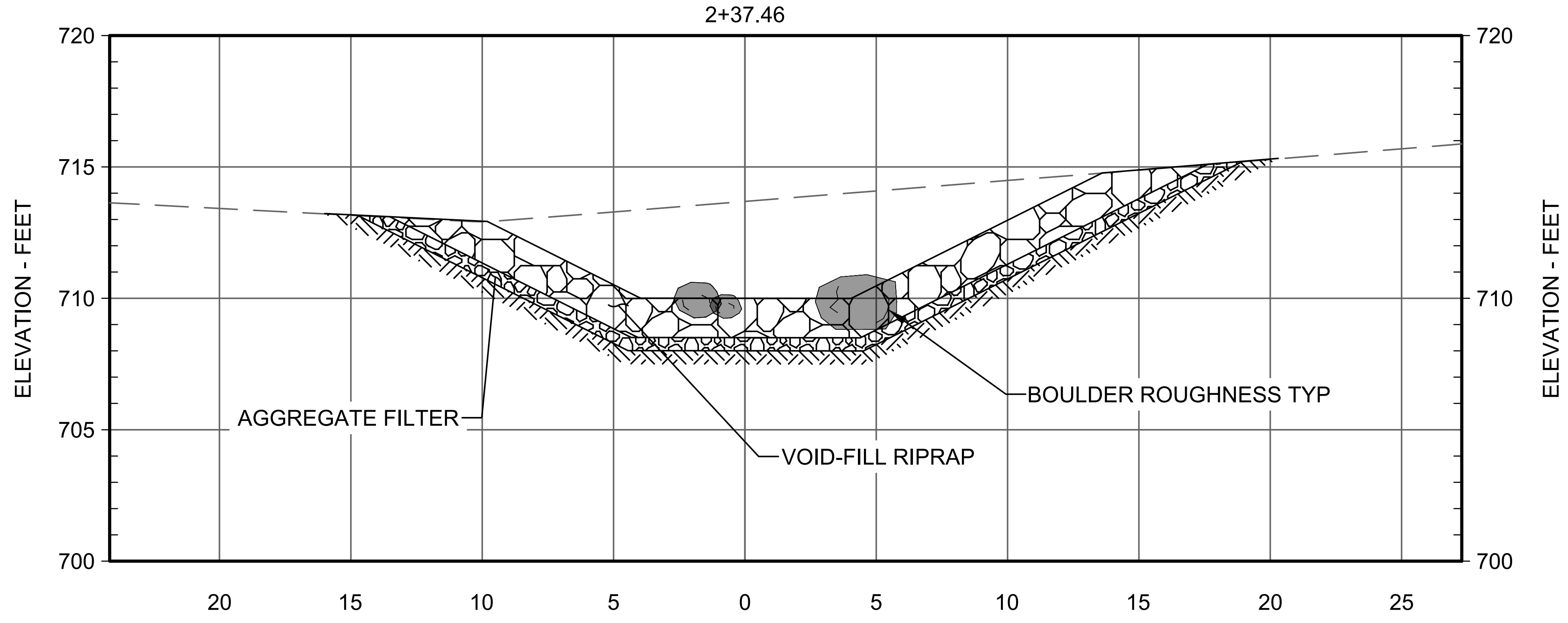
C-400

HELPPI, CHAD B:\Working\VILLAGE OF HESPERIA\2403886 Hesperia Dam Rehabilitation Feas. Study\00_CAD\Design\Sheets\C-401 ALTERNATIVE FW1 - SECTIONS.dwg - 6/4/2025



SECTION 1

OVERFALL WIER 1" = 5'



SECTION 2

NATURALIZED CHANNEL 1" = 5'

Concept Plans

Attention:
0 1"
If this scale bar does not measure 1" then drawing is not original scale.

DRAFT

Designed:	GK
Drawn:	CH / JW
Checked:	MC
Approved:	*MC*
P.E. No:	6201054585
GEI Project	2403886

GEI Consultants
GEI CONSULTANTS OF MICHIGAN, P.C.
109 W. BARAGA AVENUE
MARQUETTE, MI 49855
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HESPERIA DAM REHABILITATION

WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

NO	DATE	ISSUE/REVISION	APP
0	06/06/2025	CONCEPTUAL PLANS	DD

SHEET NAME

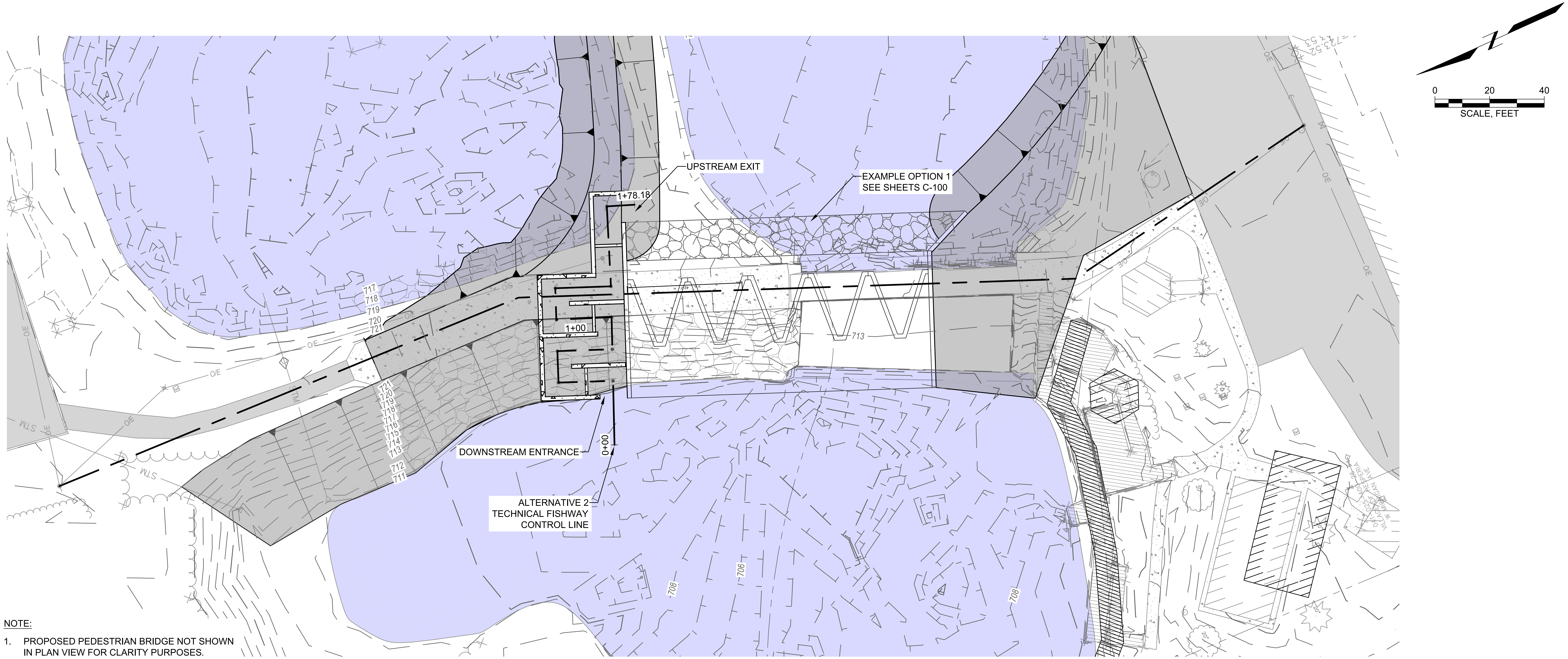
FW 1
SECTIONS

NATURALIZED FISHWAY

SHEET NO.

C-401

HELPPI, CHAD B:\Working\VILLAGE OF HESPERIA\2403886 Hesperia Dam Rehabilitation Feas. Study\00_CAD\Design\Sheets\C-401 ALTERNATIVE FW1 - SECTIONS.dwg - 6/4/2025

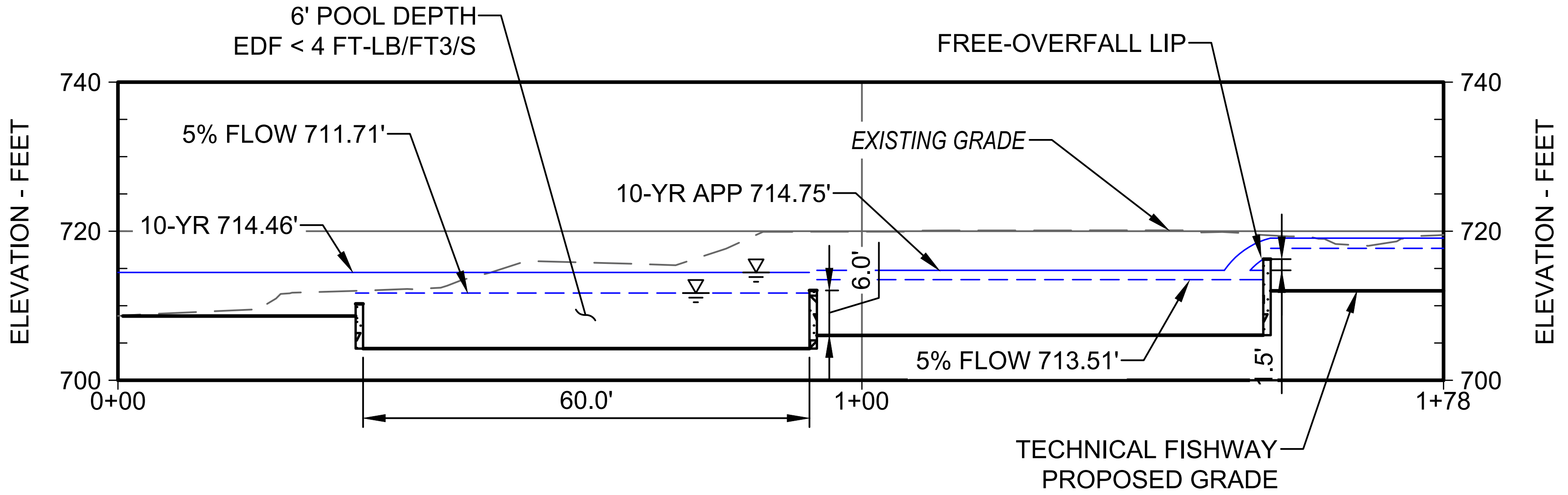


NOTE:

1. PROPOSED PEDESTRIAN BRIDGE NOT SHOWN IN PLAN VIEW FOR CLARITY PURPOSES.

PLAN VIEW

SCALE: 1"=20'



EXISTING PROFILE

SCALE: 1"=20'

Concept Plans

Attention:

0 1"

If this scale bar does not measure 1" then drawing is not original scale.

DRAFT

Designed:	GK
Drawn:	CH / JW
Checked:	MC
Approved:	MC
P.E. No:	6201054585
GEI Project	2403886

GEI Consultants
GEI CONSULTANTS OF MICHIGAN, P.C.
109 W. BARAGA AVENUE
MARQUETTE, MI 49855
(906)451-4021

VILLAGE OF HESPERIA
Welcome To Hesperia
EST. 1866

HESPERIA DAM REHABILITATION

WEST BRANCH OF THE WHITE RIVER
HESPERIA, MICHIGAN

NO	DATE	ISSUE/REVISION	APP
0	06/06/2025	CONCEPTUAL PLANS	DD

SHEET NAME

FW 2
PLAN AND PROFILE

TECHNICAL FISH LADDER

SHEET NO.

C-402

HELPPI, CHAD B:\Working\VILLAGE OF HESPERIA\2403886 Hesperia Dam Rehabilitation Feas. Study\00_CAD\Design\Sheets\C-401 ALTERNATIVE FW1 - SECTIONS.dwg - 6/4/2025

Appendix G Opinion of Probable Cost

OPINION OF PROBABLE COST - CONCEPTUAL DESIGN

Project: **Hesperia Dam Rehabilitation**
Client: **Village of Hesperia**

Project No.: **2403886**
Date: **5/5/2025**
Estimated by: **J. Wright, M. Scurlock**
Checked by: **M. Carden, C. Helppi**

SUMMARY:

Dam Name	Option Number	Total Estimated Cost*
Dam	Option 1: Standard Labryinth	$16,464,254
	Option 2: Weir Drop Structure	$17,483,771
	Option 3: Gated Labryinth	$14,792,150
Fish Passage	FW1: Natural Fish Passage	$1,688,257
	FW2: Technical Fish Passage	$1,582,264

* Includes 50% contingency.

OPINION OF PROBABLE COST - CONCEPTUAL DESIGN

Project: Hesperia Dam Rehabilitation
Client: Village of Hesperia
Scenario: Alternative 1 - Standard Labryinth

Project No.: 2403886
Date: 5/5/2025
Estimated by: J. Wright
Checked by: M. Carden, C. Helppi

Item	Description	Quantity	Units	Unit Price	Total Cost
0.00	**General Conditions**				
0.01	Contractor Mobilization / Demobilization	1	LS	$ 880,441	$ 880,441
	Includes: Bonds & Insurance, Permits, Easements, Project Management,				
	Temp Facilities, Project Survey/Layout, Indirect Costs				
				Subtotal	**$ 880,441**
1.00	**Site Preparation and Restoration**				
1.01	Erosion and Sediment Control	1	LS	$ 15,000	$ 15,000
1.02	Temporary Access Roads, Facilities and Laydown Areas	1	LS	$ 50,000	$ 50,000
1.03	Site Restoration	1	AC	$ 30,000	$ 30,000
1.04	SSP Cofferdams	19,400	SF	$ 120	$ 2,328,000
1.05	Construction Dewatering	2	LS	$ 25,000	$ 50,000
1.06	Site Clearing and Grubbing	1	LS	$ 25,000	$ 25,000
				Subtotal	**$ 2,498,000**
2.00	**Demolition**				
2.01	Embankment Excavation	3,700	CY	$ 35	$ 129,500
2.02	Grouted Riprap Exc.	350	SY	$ 60	$ 21,000
2.03	Fence Removal	-	LF	$ 15	$ -
2.04	Flatwork Concrete Removal	5,100	CY	$ 10	$ 51,000
2.05	Ancillary Strucutre Removal	1	LS	$ 50,000	$ 50,000
2.06	Mass Concrete Demo and Removal	500	CY	$ 75	$ 37,500
2.07	Structural Steel Demo	1	LS	$ 60,000	$ 60,000
				Subtotal	**$ 349,000**
3.00	**Concrete**				
3.01	Misc. Flatwork Concrete	2,900	SF	$ 20	$ 58,000
3.02	Labriynth Walls	185	CY	$ 4,000	$ 740,000
3.03	Wing walls/Training Walls/Earth Retaining Walls	95	CY	$ 2,000	$ 190,000
3.04	Weir	-	CY	$ 2,000	$ -
3.05	Spillway Slab/Apron	260	CY	$ 1,400	$ 364,000
3.06	US Apron	-	CY	$ 1,400	$ -
3.07	DS Apron	150	CY	$ 1,400	$ 210,000
3.08	Walkway Piers/Foundations	25	CY	$ 2,000	$ 50,000
				Subtotal	**$ 1,612,000**
4.00	**Steel**				
4.01	Structural Steel Gates	-	EA	$ 200,000	$ -
4.02	Railing	145	LFT	$ 200	$ 29,000
4.03	Fencing	-	LFT	$ 100	$ -
				Subtotal	**$ 29,000**
5.00	**Earth**				
5.01	Filter Sand	730	CY	$ 70	$ 51,100
5.02	Drainage Stone	440	CY	$ 125	$ 55,000
5.03	Coarse Drainage Stone	-	CY	$ 125	$ -
5.04	Embankment Fill	1,900	CY	$ 31	$ 58,900
5.05	Impervious fill	950	CY	$ 350	$ 332,500
5.06	Structural Fill/Bedding Stone	370	CY	$ 130	$ 48,148
5.07	Plain Riprap	45	TN	$ 160	$ 7,236
5.08	Heavy Riprap	430	TN	$ 240	$ 103,200
5.09	Topsoil	-	CY	$ 35	$ -
				Subtotal	**$ 656,084**
6.00	**Misc Site Works**				
6.01	RCP	-	LFT	$ 100	$ -
6.02	Perforated Drain pipe/tile	450	LFT	$ 70	$ 31,500
6.03	Cutoff SSP	13,500	SF	$ 65	$ 877,500
6.04	Grouting	-	CY	$ 1,500	$ -
6.05	HMA Repave	1	TN	$ 80	$ 80
6.06	Gate Seals	-	EA	$ -	$ -
6.07	Steel Stop Log (8 x 4)	-	LS	$ 53,000	$ -
6.08	Culvert/Strom Replacement	1	LS	$ 20,000	$ 20,000
6.09	Spillway Foundation Piles	1	LS	$ 1,000,000	$ 1,000,000
				Subtotal	**$ 1,929,080**
7.00	**Ammenities**				
7.01	Boardwalk Rebuild/Replace	150	LFT	$ 1,000	$ 150,000
7.02	Pavillion Rebuild/Replace	1	LS	$ 125,000	$ 125,000
7.03	Pedestrian Bridge	2	Span	$ 400,000	$ 800,000
7.04	Gazebo Rebuild/Replace	1	LS	$ 100,000	$ 100,000
7.05	Restroom Building	1	LS	$ 300,000	$ 300,000
7.06	River Overlook	1	LS	$ 50,000	$ 50,000
7.07	Timber Stairs	1	LS	$ 25,000	$ 25,000
7.08	Timber Deck	1,750	SF	$ 75	$ 131,250
7.09	Trees and Landscaping	1	LS	$ 50,000	$ 50,000
				Subtotal	**$ 1,731,250**
		0.00 to 7.00		**Total**	**$ 9,684,855**
8.00	Unknown Scope Items			50%	**$ 4,842,428**
9.00	Engineering Design and Permitting			10%	**$ 968,486**
10.00	Engineering and Construction Observation			10%	**$ 968,486**
	Total Estimated Cost				**$ 16,464,254**

Information presented on this sheet represents our opinion of probable costs in 2025 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 DESIGN

Project: Hesperia Dam Rehabilitation
Client: Village of Hesperia
/Scenario: Alternative 2 - Gated Straight Drop

Project No.: 2403886
Date: 5/5/2025
Estimated by: J. Wright
Checked by: M. Carden, C. Helppi

Item	Description	Quantity	Units	Unit Price	Total Cost
0.00	**General Conditions**				
0.01	Contractor Mobilization / Demobilization	1	LS	$ 934,961	$ 934,961
	Includes: Bonds & Insurance, Permits, Easements, Project Management, Temp Facilities, Project Survey/Layout, Indirect Costs				
				Subtotal	**$ 934,961**
1.00	**Site Preparation and Restoration**				
1.01	Erosion and Sediment Control	1	LS	$ 15,000	$ 15,000
1.02	Temporary Access Roads, Facilities and Laydown Areas	1	LS	$ 50,000	$ 50,000
1.03	Site Restoration	1.000	AC	$ 30,000	$ 30,000
1.04	SSP Cofferdams	17,700	SF	$ 120	$ 2,124,000
1.05	Construction Dewatering	2	LS	$ 25,000	$ 50,000
1.06	Site Clearing and Grubbing	1	LS	$ 25,000	$ 25,000
				Subtotal	**$ 2,294,000**
2.00	**Demolition**				
2.01	Embankment Excavation	6,500	CY	$ 35	$ 227,500
2.02	Grouted Riprap Exc.	350	SY	$ 60	$ 21,000
2.03	Fence Removal	-	LF	$ 15	$ -
2.04	Flatwork Concrete Removal	5,100	CY	$ 10	$ 51,000
2.05	Ancillary Strucutre Removal	1	LS	$ 50,000	$ 50,000
2.06	Mass Concrete Demo and Removal	500	CY	$ 75	$ 37,500
2.07	Structural Steel Demo	1	LS	$ 60,000	$ 60,000
				Subtotal	**$ 447,000**
3.00	**Concrete**				
3.01	Misc. Flatwork Concrete	1,580	SF	$ 20	$ 31,600
3.02	Labriynth Walls	-	CY	$ 4,000	$ -
3.03	Wing walls/Training Walls/Earth Retaining Walls	85	CY	$ 2,000	$ 170,000
3.04	Weir	135	CY	$ 2,000	$ 270,000
3.05	Spillway Slab/Apron	225	CY	$ 1,400	$ 315,000
3.06	US Apron	-	CY	$ 1,400	$ -
3.07	DS Apron	250	CY	$ 1,400	$ 350,000
3.08	Walkway Piers/Foundations	50	CY	$ 2,000	$ 100,000
				Subtotal	**$ 1,236,600**
4.00	**Steel**				
4.01	Structural Steel Gates	4	EA	$ 200,000	$ 800,000
4.02	Railing	140	LFT	$ 200	$ 28,000
4.03	Fencing	-	LFT	$ 100	$ -
				Subtotal	**$ 828,000**
5.00	**Earth**				
5.01	Filter Sand	380	CY	$ 70	$ 26,600
5.02	Drainage Stone	230	CY	$ 125	$ 28,750
5.03	Coarse Drainage Stone	-	CY	$ 125	$ -
5.04	Embankment Fill	900	CY	$ 31	$ 27,900
5.05	Impervious fill	450	CY	$ 350	$ 157,500
5.06	Structural Fill/Bedding Stone	745	CY	$ 130	$ 96,850
5.07	Plain Riprap	40	TN	$ 160	$ 6,400
5.08	Heavy Riprap	582	TN	$ 240	$ 139,680
5.09	Topsoil	-	CY	$ 35	$ -
				Subtotal	**$ 483,680**
6.00	**Misc Site Works**				
6.01	RCP	-	LFT	$ 100	$ -
6.02	Perforated Drain pipe/tile	450	LFT	$ 70	$ 31,500
6.03	Cutoff SSP	13,500	SF	$ 65	$ 877,500
6.04	Grouting	-	CY	$ 1,500	$ -
6.05	HMA Repave	1	TN	$ 80	$ 80
6.06	Gate Seals	4	EA	$ -	$ -
6.07	Steel Stop Log (8 x 4)	-	LS	$ 53,000	$ -
6.08	Culvert/Strom Replacement	1	LS	$ 20,000	$ 20,000
6.09	Spillway Foundation Piles	1	LS	$ 1,000,000	$ 1,000,000
				Subtotal	**$ 1,929,080**
7.00	**Ammenities**				
7.01	Boardwalk Rebuild/Replace	150	LFT	$ 1,000	$ 150,000
7.02	Pavillion Rebuild/Replace	1	LS	$ 125,000	$ 125,000
7.03	Pedestrian Bridge	3	Span	$ 400,000	$ 1,200,000
7.04	Gazebo Rebuild/Replace	1	LS	$ 100,000	$ 100,000
7.05	Restroom Building	1	LS	$ 300,000	$ 300,000
7.06	River Overlook	1	LS	$ 50,000	$ 50,000
7.07	Timber Stairs	1	LS	$ 25,000	$ 25,000
7.08	Timber Deck	1,750	SF	$ 75	$ 131,250
7.09	Trees and Landscaping	1	LS	$ 50,000	$ 50,000
				Subtotal	**$ 2,131,250**
			0.00 to 7.00	**Total**	**$ 10,284,571**
8.00	Unknown Scope Items			50%	**$ 5,142,286**
9.00	Engineering Design and Permitting			10%	**$ 1,028,457**
10.00	Engineering and Construction Observation			10%	**$ 1,028,457**
	Total Estimated Cost				**$ 17,483,771**

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OPINION OF PROBABLE COST - CONCEPTUAL DESIGN

Project: Hesperia Dam Rehabilitation
Client: Village of Hesperia
/Scenario: Alternative 3 - Gated Labryinth

Project No.: 2403886
Date: 5/5/2025
Estimated by: J. Wright
Checked by: M. Carden, C. Helppi

Item	Description	Quantity	Units	Unit Price	Total Cost
0.00	**General Conditions**				
0.01	Contractor Mobilization / Demobilization	1	LS	$ 791,024	$ 791,024
	Includes: Bonds & Insurance, Permits, Easements, Project Management,				
	Temp Facilities, Project Survey/Layout, Indirect Costs				
				Subtotal	**$ 791,024**
1.00	**Site Preparation and Restoration**				
1.01	Erosion and Sediment Control	1	LS	$ 15,000	$ 15,000
1.02	Temporary Access Roads, Facilities and Laydown Areas	1	LS	$ 50,000	$ 50,000
1.03	Site Restoration	1.000	AC	$ 30,000	$ 30,000
1.04	SSP Cofferdams	14,400	SF	$ 120	$ 1,728,000
1.05	Construction Dewatering	2	LS	$ 25,000	$ 50,000
1.06	Site Clearing and Grubbing	1	LS	$ 25,000	$ 25,000
				Subtotal	**$ 1,898,000**
2.00	**Demolition**				
2.01	Embankment Excavation	3,050	CY	$ 35	$ 106,750
2.02	Grouted Riprap Exc.	350	SY	$ 60	$ 21,000
2.03	Fence Removal	-	LF	$ 15	$ -
2.04	Flatwork Concrete Removal	5,100	CY	$ 10	$ 51,000
2.05	Ancillary Strucutre Removal	1	LS	$ 50,000	$ 50,000
2.06	Mass Concrete Demo and Removal	500	CY	$ 75	$ 37,500
2.07	Structural Steel Demo	1	LS	$ 60,000	$ 60,000
				Subtotal	**$ 326,250**
3.00	**Concrete**				
3.01	Misc. Flatwork Concrete	3,200	SF	$ 20	$ 64,000
3.02	Labriynth Walls	125	CY	$ 4,000	$ 500,000
3.03	Wing walls/Training Walls/Earth Retaining Walls	85	CY	$ 2,000	$ 170,000
3.04	Weir	-	CY	$ 2,000	$ -
3.05	Spillway Slab/Apron	240	CY	$ 1,400	$ 336,000
3.06	US Apron	-	CY	$ 1,400	$ -
3.07	DS Apron	115	CY	$ 1,400	$ 161,000
3.08	Walkway Piers/Foundations	40	CY	$ 2,000	$ 80,000
				Subtotal	**$ 1,311,000**
4.00	**Steel**				
4.01	Structural Steel Gates	2	EA	$ 200,000	$ 400,000
4.02	Railing	135	LFT	$ 200	$ 27,000
4.03	Fencing	-	LFT	$ 100	$ -
				Subtotal	**$ 427,000**
5.00	**Earth**				
5.01	Filter Sand	810	CY	$ 70	$ 56,700
5.02	Drainage Stone	485	CY	$ 125	$ 60,625
5.03	Coarse Drainage Stone	-	CY	$ 125	$ -
5.04	Embankment Fill	2,000	CY	$ 31	$ 62,000
5.05	Impervious fill	1,000	CY	$ 350	$ 350,000
5.06	Structural Fill/Bedding Stone	350	CY	$ 130	$ 45,500
5.07	Plain Riprap	45	TN	$ 160	$ 7,236
5.08	Heavy Riprap	440	TN	$ 240	$ 105,600
5.09	Topsoil	-	CY	$ 35	$ -
				Subtotal	**$ 687,661**
6.00	**Misc Site Works**				
6.01	RCP	-	LFT	$ 100	$ -
6.02	Perforated Drain pipe/tile	450	LFT	$ 70	$ 31,500
6.03	Cutoff SSP	13,500	SF	$ 65	$ 877,500
6.04	Grouting	-	CY	$ 1,500	$ -
6.05	HMA Repave	1	TN	$ 80	$ 80
6.06	Gate Seals	2	EA	$ -	$ -
6.07	Steel Stop Log (8 x 4)	-	LS	$ 53,000	$ -
6.08	Culvert/Strom Replacement	1	LS	$ 20,000	$ 20,000
6.09	Spillway Foundation Piles	1	LS	$ 1,000,000	$ 1,000,000
				Subtotal	**$ 1,929,080**
7.00	**Ammenities**				
7.01	Boardwalk Rebuild/Replace	150	LFT	$ 1,000	$ 150,000
7.02	Pavillion Rebuild/Replace	1	LS	$ 125,000	$ 125,000
7.03	Pedestrian Bridge	1	Span	$ 400,000	$ 400,000
7.04	Gazebo Rebuild/Replace	1	LS	$ 100,000	$ 100,000
7.05	Restroom Building	1	LS	$ 300,000	$ 300,000
7.06	River Overlook	1	LS	$ 50,000	$ 50,000
7.07	Timber Stairs	1	LS	$ 25,000	$ 25,000
7.08	Timber Deck	1,750	SF	$ 75	$ 131,250
7.09	Trees and Landscaping	1	LS	$ 50,000	$ 50,000
				Subtotal	**$ 1,331,250**
		0.00 to 7.00		**Total**	**$ 8,701,265**
8.00	Unknown Scope Items			50%	**$ 4,350,632**
9.00	Engineering Design and Permitting			10%	**$ 870,126**
10.00	Engineering and Construction Observation			10%	**$ 870,126**
	Total Estimated Cost				**$ 14,792,150**

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OPINION OF PROBABLE COST - CONCEPTUAL DESIGN

Project: **Hesperia Dam Rehabilitation**
Client: **Village of Hesperia**
Scenario: **Option FW1 - Natural Fish Passage**

Project No.: **2403886**
Date: **5/5/2025**
Estimated by: **M. Scurlock**
Checked by: **M. Carden, C. Helppi**

Item	Description	Quantity	Units	Unit Price	Total Cost
0.00	**General Conditions**				
0.01	Contractor Mobilization / Demobilization	1	LS	$ 90,281	$ 90,281
	Includes: Bonds & Insurance, Permits, Easements, Project Management,				
	Temp Facilities, Project Survey/Layout, Indirect Costs				
				Subtotal	**$ 90,281**
1.00	**Site Preparation and Restoration**				
1.01	Erosion and Sediment Control	1	LS	$ 15,000	$ 15,000
1.02	Temporary Access Roads, Facilities and Laydown Areas	1	LS	$ 50,000	$ 50,000
1.03	Site Restoration	1.000	AC	$ 30,000	$ 30,000
1.04	SSP Cofferdams	-	SF	$ 120	$ -
1.05	Construction Dewatering	1	LS	$ 25,000	$ 25,000
1.06	Site Clearing and Grubbing	1	LS	$ 25,000	$ 25,000
				Subtotal	**$ 145,000**
2.00	**Demolition**				
2.01	Embankment Excavation	2,000	CY	$ 35	$ 70,000
2.02	Grouted Riprap Exc.	-	SY	$ 60	$ -
2.03	Fence Removal	-	LF	$ 15	$ -
2.04	Flatwork Concrete Removal	-	CY	$ 10	$ -
2.05	Ancillary Strucutre Removal	-	LS	$ 50,000	$ -
2.06	Mass Concrete Demo and Removal	-	CY	$ 75	$ -
2.07	Structural Steel Demo	-	LS	$ 60,000	$ -
				Subtotal	**$ 70,000**
3.00	**Concrete**				
3.01	Misc. Flatwork Concrete	-	SF	$ 20	$ -
3.02	Labriynth Walls	-	CY	$ 4,000	$ -
3.03	Wing walls/Training Walls/Earth Retaining Walls	36	CY	$ 2,000	$ 71,111
3.04	Weir	-	CY	$ 2,000	$ -
3.05	Spillway Slab/Apron	4	CY	$ 1,400	$ 5,289
3.06	US Apron	-	CY	$ 1,400	$ -
3.07	DS Apron	-	CY	$ 1,400	$ -
3.08	Walkway Piers/Foundations	-	CY	$ 2,000	$ -
				Subtotal	**$ 76,400**
4.00	**Steel**				
4.01	Structural Steel Gates	-	EA	$ 200,000	$ -
4.02	Railing	-	LFT	$ 200	$ -
4.03	Fencing	-	LFT	$ 100	$ -
				Subtotal	**$ -**
5.00	**Earth**				
5.01	Filter Sand	-	CY	$ 70	$ -
5.02	Drainage Stone	73	CY	$ 125	$ 9,074
5.03	Coarse Drainage Stone	330	CY	$ 125	$ 41,250
5.04	Embankment Fill	218	CY	$ 31	$ 6,751
5.05	Impervious fill	-	CY	$ 350	$ -
5.06	Structural Fill/Bedding Stone	10	CY	$ 130	$ 1,336
5.07	Plain Riprap	-	TN	$ 160	$ -
5.08	Heavy Riprap	1,250	TN	$ 240	$ 300,000
5.09	Topsoil	-	CY	$ 35	$ -
				Subtotal	**$ 358,411**
6.00	**Misc Site Works**				
6.01	RCP	-	LFT	$ 100	$ -
6.02	Perforated Drain pipe/tile	-	LFT	$ 70	$ -
6.03	Cutoff SSP	-	SF	$ 65	$ -
6.04	Grouting	-	CY	$ 1,500	$ -
6.05	HMA Repave	-	TN	$ 80	$ -
6.06	Gate Seals	-	EA	$ -	$ -
6.07	Steel Stop Log (8 x 4)	1	LS	$ 53,000	$ 53,000
6.08	Culvert/Strom Replacement	-	LS	$ 20,000	$ -
				Subtotal	**$ 53,000**
7.00	**Ammenities**				
7.01	Boardwalk Rebuild/Replace	200	LFT	$ 1,000	$ 200,000
7.02	Pavillion Rebuild/Replace	-	LS	$ 125,000	$ -
7.03	Pedestrian Bridge	-	Span	$ 400,000	$ -
7.04	Gazebo Rebuild/Replace	-	LS	$ 100,000	$ -
7.05	Restroom Building	-	LS	$ 300,000	$ -
7.06	River Overlook	-	LS	$ 50,000	$ -
7.07	Timber Stairs	-	LS	$ 25,000	$ -
7.08	Timber Deck	-	SF	$ 75	$ -
7.09	Trees and Landscaping	-	LS	$ 50,000	$ -
				Subtotal	**$ 200,000**
			0.00 to 7.00	**Total**	**$ 993,092**
8.00	Unknown Scope Items			50%	**$ 496,546**
9.00	Engineering Design and Permitting			10%	**$ 99,309**
10.00	Engineering and Construction Observation			10%	**$ 99,309**
	Total Estimated Cost				**$ 1,688,257**

Information presented on this sheet represents our opinion of probable costs in 2025 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 DESIGN

Project: Hesperia Dam Rehabilitation
Client: Village of Hesperia
Scenario: Option FW2 - Technical Fish Passage

Project No.: 2403886
Date: 4/1/2025
Estimated by: M. Scurlock
Checked by: M. Carden, C. Helppi

Item	Description	Quantity	Units	Unit Price	Total Cost
0.00	**General Conditions**				
0.01	Contractor Mobilization / Demobilization	1	LS	$ 84,613	$ 84,613
	Includes: Bonds & Insurance, Permits, Easements, Project Management, Temp Facilities, Project Survey/Layout, Indirect Costs				
				Subtotal	**$ 84,613**
1.00	**Site Preparation and Restoration**				
1.01	Erosion and Sediment Control	1	LS	$ 15,000	$ 15,000
1.02	Temporary Access Roads, Facilities and Laydown Areas	1	LS	$ 50,000	$ 50,000
1.03	Site Restoration	1.000	AC	$ 30,000	$ 30,000
1.04	SSP Cofferdams	-	SF	$ 120	$ -
1.05	Construction Dewatering	1	LS	$ 25,000	$ 25,000
1.06	Site Clearing and Grubbing	1	LS	$ 25,000	$ 25,000
				Subtotal	**$ 145,000**
2.00	**Demolition**				
2.01	Embankment Excavation	1,381	CY	$ 35	$ 48,319
2.02	Grouted Riprap Exc.	-	SY	$ 60	$ -
2.03	Fence Removal	-	LF	$ 15	$ -
2.04	Flatwork Concrete Removal	-	CY	$ 10	$ -
2.05	Ancillary Strucutre Removal	-	LS	$ 50,000	$ -
2.06	Mass Concrete Demo and Removal	-	CY	$ 75	$ -
2.07	Structural Steel Demo	-	LS	$ 60,000	$ -
				Subtotal	**$ 48,319**
3.00	**Concrete**				
3.01	Misc. Flatwork Concrete	-	SF	$ 20	$ -
3.02	Labriynth Walls	-	CY	$ 4,000	$ -
3.03	Wing walls/Training Walls/Earth Retaining Walls	178	CY	$ 2,000	$ 356,667
3.04	Weir	-	CY	$ 2,000	$ -
3.05	Spillway Slab/Apron	34	CY	$ 1,400	$ 47,315
3.06	US Apron	-	CY	$ 1,400	$ -
3.07	DS Apron	-	CY	$ 1,400	$ -
3.08	Walkway Piers/Foundations	-	CY	$ 2,000	$ -
				Subtotal	**$ 403,981**
4.00	**Steel**				
4.01	Structural Steel Gates	-	EA	$ 200,000	$ -
4.02	Railing	-	LFT	$ 200	$ -
4.03	Fencing	-	LFT	$ 100	$ -
				Subtotal	**$ -**
5.00	**Earth**				
5.01	Filter Sand	-	CY	$ 70	$ -
5.02	Drainage Stone	200	CY	$ 125	$ 25,000
5.03	Coarse Drainage Stone	-	CY	$ 125	$ -
5.04	Embankment Fill	200	CY	$ 31	$ 6,200
5.05	Impervious fill	-	CY	$ 350	$ -
5.06	Structural Fill/Bedding Stone	74	CY	$ 130	$ 9,630
5.07	Plain Riprap	-	TN	$ 160	$ -
5.08	Heavy Riprap	33	TN	$ 240	$ 8,000
5.09	Topsoil	-	CY	$ 35	$ -
				Subtotal	**$ 48,830**
6.00	**Misc**				
6.01	RCP	-	LFT	$ 100	$ -
6.02	Perforated Drain pipe/tile	-	LFT	$ 70	$ -
6.03	Cutoff SSP	-	SF	$ 65	$ -
6.04	Grouting	-	CY	$ 1,500	$ -
6.05	HMA Repave	-	TN	$ 80	$ -
6.06	Gate Seals	-	EA	$ -	$ -
6.07	Steel Stop Log (8 x 4)	-	LS	$ 53,000	$ -
6.08	Culvert/Strom Replacement	-	LS	$ 20,000	$ -
				Subtotal	**$ -**
7.00	**Ammenities**				
7.01	Boardwalk Rebuild/Replace	-	LFT	$ 1,000	$ -
7.02	Pavillion Rebuild/Replace	-	LS	$ 125,000	$ -
7.03	Pedestrian Bridge	0.5	Span	$ 400,000	$ 200,000
7.04	Gazebo Rebuild/Replace	-	LS	$ 100,000	$ -
7.05	Restroom Building	-	LS	$ 300,000	$ -
7.06	River Overlook	-	LS	$ 50,000	$ -
7.07	Timber Stairs	-	LS	$ 25,000	$ -
7.08	Timber Deck	-	SF	$ 75	$ -
7.09	Trees and Landscaping	-	LS	$ 50,000	$ -
				Subtotal	**$ 200,000**
			0.00 to 7.00	**Total**	**$ 930,744**
8.00	Unknown Scope Items			50%	**$ 465,372**
9.00	Engineering Design and Permitting			10%	**$ 93,074**
10.00	Engineering and Construction Observation			10%	**$ 93,074**
	Total Estimated Cost				**$ 1,582,264**

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