1 Main Street SE ▪ Suite 300 ▪ Minneapolis, Minnesota ▪ 55414 ▪ p (612) 746-3660 ▪ d (248) 294-0026

September 9, 2021

To:

Brian Grennell, Cultural Resources Management Coordinator
State Historic Preservation Office
300 North Washington Square
Lansing, MI 48913

From:

Robb Roos, Project Manager and Senior Environmental Analyst
Mike Madson, Cultural Resources Specialist
Angela Julin, Cultural Resources Specialist

Subject:
Four Lakes Task Force: Smallwood Dam Rehabilitation
Smallwood Dam, Midland County, Michigan

Dear Mr. Grennell:

With this letter Four Lakes Task Force (FLTF) provides your office information on the efforts to stabilize the Smallwood Dam Midland County, Michigan. The Smallwood Dam is located on the Tittabawassee River, a tributary to the Saginaw River, and is approximately 35 river miles upstream of the City of Midland in Midland County, Michigan (see **Figures 1 and 2**). The facility is owned and operated by the FLTF which is the Part 307 delegated authority for Gladwin County. Construction of the dam was completed in 1925 to provide storage and headwater control for the purpose of hydroelectric power generation.

From left to right (looking downstream), the Project consists of an approximately 1,000-foot-long left embankment, an approximately 52-foot-wide gated spillway with two Tainter gates, an approximately 25-foot-wide powerhouse containing one turbine generating unit with a rated capacity of 1.2 MW with an operating head of 29.6 feet, and an approximately 125-foot-wide right embankment. The dam's normal headwater and tailwater elevations are approximately 704.3 and 674.7, respectively. All elevations presented are in the North American Vertical Datum of 1988 (NAVD88). The primary goal of the Smallwood Dam Rehabilitation Project is to construct improvements in accordance with the State of Michigan Department of Environment, Great Lakes and Energy (EGLE) requirements and restore the legal Smallwood Lake level.

Merjent, Inc. is a subcontractor to FLTF's consultant Spicer Group. In April 2021, Merjent archaeologists initiated an archaeological survey of the Smallwood Dam, and the results of that survey are pending. An architectural history review was not part of the initial scope; however, consideration of Smallwood Dam's structural components is now of interest to parties consulting with the FLTF, most notably the U.S. Department of Agriculture – Rural Development (USDA-RD). Recently, the USDA-RD advised FLTF to communicate with your office on the measures being taken to stabilize failed dams across the FLTF area of concern, including interim and long-term proposed rehabilitation measures at the Smallwood Dam. The proposed rehabilitation efforts for the Smallwood Dam are depicted on the Smallwood Dam Conceptual Design, which is provided as **Appendix A**. These plans depict the proposed work that is discussed within the narrative sections of this report.

Smallwood Spillway

The reinforced concrete spillway is a hollow reinforced concrete barrel arch and ogee-shaped rollway structure spanning to buttress piers and powerhouse wall and left spillway training wall with two Tainter gate bays (see Photo 1). Both the left and right Tainter gates are 25.4-feet-wide by 10-feet-high separated by a 1.5-foot-wide center pier. The spillway ogee crest sill is at El. 694.3 feet. A hydraulic hoist operates the gates with the operators located directly adjacent to the hoist above each gate on an elevated platform. The hydraulic gate chain and single cable hoist and reel system was installed in 2019, replacing the original electric hoist and trolley system. The gates are currently in the fully open position (10-feet) and dogged off to maintain a drawn-down impoundment per Federal Energy Regulatory Commission (FERC) and EGLE orders and to prevent accidental closure in the event of gate hoist or hoist cable failure.

Smallwood Dam Powerhouse

The powerhouse consists of a reinforced concrete substructure and brick superstructure with one vertical Francis shaft unit. A vertical trumpet-shaped draft tube is installed in the lower portion of the powerhouse allowing discharge of the outflow into the spillway stilling pool. The tailrace slab slopes up to the natural river bottom. Both spillway and powerhouse structures are constructed on dense glacial till. The base slabs for both contain shear keys and an upstream concrete cutoff into the till. The powerhouse measures 27 feet by 28 feet by 60 feet in height.

Photo 1. Smallwood Spillway and Powerhouse, October 2020.

Smallwood Dam Embankments

The left embankment is approximately 1,000-feet long, with a maximum structural height of 38 feet near the spillway. The embankment consists of an approximately 320-foot-long non-overflow section nearest the spillway and an approximately 680-foot-long emergency overflow section. The original embankment was reportedly constructed of native silt, sand, and clay from onsite sources. The non-overflow section contains a steel sheet pile (SSP) cutoff constructed in 1999 along the upstream edge of the embankment crest. The SSP was driven through the embankment and foundation overburden soils into the glacial till and extends above the crest to El. 715.2. In 2000, the upstream SSP line was extended downstream to form a training wall between the non-overflow and emergency overflow sections. The crest of the non-overflow section was narrowed, and the downstream slope regraded and flattened in 2001 to satisfy global stability criteria. The left embankment non-overflow section and SSP are illustrated Photo 2. The crest elevation of the 680-foot-long left embankment emergency overflow section generally ranges from El. 709.0 to 711.5 feet. This section is intended to overtop during an extreme flood event.

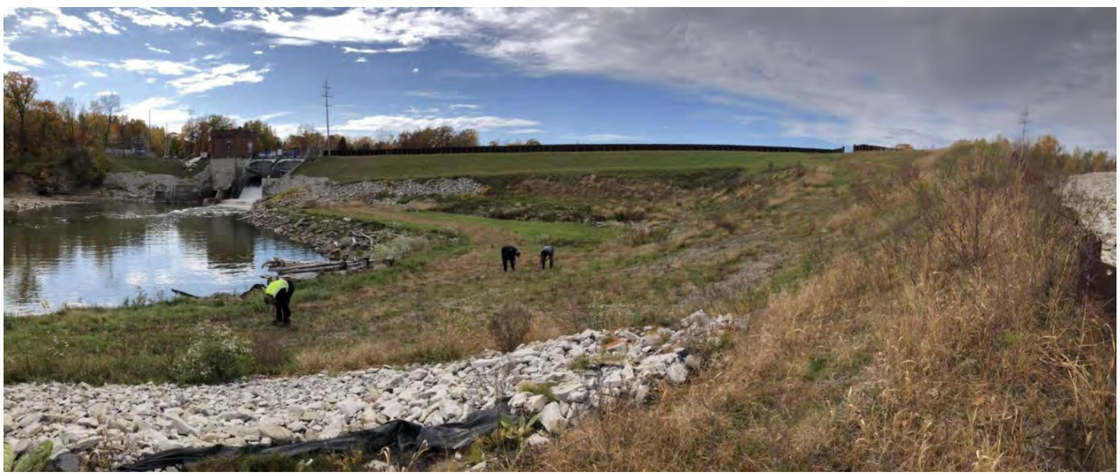


Photo 2. Smallwood Dam Left Embankment, December 2020.

The right embankment is 125-feet long, 38-feet tall and reportedly constructed of native silt, sand, and clay material. The right embankment also contains an upstream SSP seepage cutoff constructed in 1999 that extends approximately 250 feet beyond the end of the powerhouse abutment wall (see Photo 3).

Photo 3. Aerial Drone Imagery of Smallwood Dam, May 2020.

Smallwood Dam Stabilization
Following the May 19, 2020, storm event, significant downstream and embankment erosion damage occurred at the Smallwood Dam. In order to prevent similar dam failure events, most notably as seen at the Edenville Dam, the following rehabilitation measures are proposed:

- Partially demolish the existing Tainter gate spillway and replace with new hydraulically operated crest gates to increase spillway capacity.
- Raise the spillway training walls and extend the walls downstream to accommodate the increased outflows.
- Fill the hollow spillway rollways with mass concrete.
- Construct a new pin flashboard auxiliary spillway across the top of the left embankment to assist in passing the inflow design flood (IDF).
- Retrofit the existing powerhouse with a low-level outlet to pass base river flows during the winter. For Smallwood Dam, the current base river flow is a minimum of 80 cubic feet per second (cfs) in the winter months.
- Flatten the left and right embankment slopes to improve stability. The overflow section of the left embankment will be raised and extended east to “tie-in” to high ground at the left abutment.

SUMMARY OF DAM REPAIRS AND FLOOD CAPACITY UPGRADES

Primary Spillway Modifications
The existing Tainter gate spillway will be partially demolished and the two (2) Tainter gates will be replaced with hydraulically operated crest gates at approximate sill El. 688.3 to increase the spillway capacity. The left crest gate (Bay No. 2) and the right gate (Bay No. 1) will both be approximately 22.6-feet-wide by 16-feet-high. The new gates will be designed to open and close locally, using hydraulic controls (i.e., no remote or automatic operation capabilities) during both normal operation and during flood events. The hydraulic gate operators will be supported on a new, reinforced concrete center pier. The upstream portions of the barrel arches below approximate El. 688.3 will remain and the crest gates and their anchorage embedments will be founded on mass concrete over the original existing reinforced concrete slab. A reinforced concrete stepped chute will convey water that discharges over the crest gates down to a new reinforced concrete stilling basin. Both the left and right spillway walls and center pier will be widened, extended downstream, and side walls raised to provide adequate flow clearance, prevent overtopping, and accommodate downstream slope flattening of the flanking embankments.

Powerhouse Modifications
The FERC license was surrendered in May 2021 and flows through the powerhouse turbines ceased. The dam therefore has no means to pass base river flows other than over the spillway sill. For the long-term reconstruction, the existing powerhouse and its water passages will be retrofitted to pass base flows (estimated at 100 to 300 cfs) to reduce spilling over the crest gates during winter months and pass minimum monthly flows in accordance with the State of Michigan EGLE minimum flow requirements. This will also reduce the build-up of ice on the spillway walls due to spray kicked up from the rollway and stilling basin. This will be accomplished by removing the existing generator, turbine shaft, ancillary mechanical and electrical equipment, installing a

bulkhead over the runner pit and fixing the runner into place. The existing wicket gates and timber headgates will be repaired and upgraded. Upstream stop log slots and a new inclined trash rack will be installed to allow maintenance to the new intake and protect the gate and runner from flotsam and floating debris.

Auxiliary Spillway

A flashboard-type overflow spillway will be constructed across the top of the left embankment at approximate El. 705.5 to pass flows in excess of what the primary spillway and low-level outlet can pass. Stainless-steel pipe stanchions (pins) will be set into pockets embedded in the concrete base slab and will support corrosion-resistant, plate flashboards that extend up to approximate El. 709.5. The stainless-steel pin supports will be designed to fail during an extreme flood event that overtops the flashboards by controlled buckling failure to provide additional spillway capacity to pass flows up to the IDF. The overflow spillway will discharge into a concrete chute and U.S. Bureau of Reclamation (USBR) Type III stilling basin to dissipate energy and convey flow into the downstream discharge channel. Downstream of the stilling basin, the IDF design storm will be routed approximately 350 feet downstream to the confluence with the Tittabawassee River in a rock-lined spillway discharge channel.

EMBANKMENT MODIFICATIONS

The upstream and downstream embankment slopes will be flattened, and the crest widened to at least 15 feet to provide adequate stability in accordance with EGLE requirements under normal and flood pool loading criteria. The upstream slope will be graded to 2.5H:1V and new rip-rap over bedding will be placed to protect the dam during summer and winter pools and during flooding events. The overflow section of the left embankment will be raised to approximate El. 715.0 and extended approximately 700 feet to the east to “tie-in” to high ground at the approximate El. 715.0 topographic contour. The downstream slope will be flattened to 3H:1V to allow safe mowing and improve stability. The downstream overlay fill will include an internal filter and drainage layers will be installed to protect against seepage-induced internal erosion. The drainage systems will discharge to a weir to allow monitoring of seepage rates.

Embankment Fill

New embankment fill placed on maximum 2.5H:1V upstream slopes and 3H:1V downstream slopes will be used to reconstruct the embankment sections. The embankment fill will consist of material either salvaged from onsite excavations or imported from approved off-site sources, as required. All cobbles greater than 6 inches in diameter, or 2/3 the height of the allowable lift thickness, whichever is less, will be screened out. New embankment fill material will be comprised of semi-pervious granular material (Unified Soil Classification System [USCS] soil types: SP-SM, SM, and SC-SM) will be compatible with the remaining, existing embankment fill in terms of filter criteria. Embankment fill will be placed in loose horizontal lifts not exceeding 12 inches and compacted in a controlled manner to a minimum of 95 percent of maximum dry density determined by the standard Proctor (ASTM D698) with appropriate moisture control measures per ASTM D698.

Steel Sheet Pile

A sheet pile cutoff wall will be constructed in an approximately 125-foot-long section of the left embankment immediately to the left of the proposed auxiliary spillway along the upstream crest. The sheet pile is anticipated to be a hot rolled PZC 14 Grade 50 ksi or approved equal with WADIT

Interlock Sealant. No hydrophilic interlock sealants will be allowed as they are frost susceptible to break down and weathering.

Reverse Filter and Toe Drain

A reverse filter toe drain consisting of filter sand and drainage stone blanket will be constructed at the downstream slope and toe of the left and right embankments to mitigate against seepage and internal erosion of the embankment and foundation soils. The reverse filter and toe drain will generally consist of 18 inches of fine filter (MDOT 2NS natural riverbank or river bottom sand) and 24 inches of coarse filter (MDOT 29A stone). The MDOT 2NS shall not be a manufactured sand from carbonate bedrock. Depending upon their condition upon excavation, the existing finger drains will either be extended and conveyed downstream to daylight at the toe or be terminated with stainless-steel wire screened ends to pass flow, but no soil fines and seepage will be collected in the drainage stone layer. The seepage will be collected in a minimum 8-inch diameter slotted drainpipe surrounded by coarse filter material within an envelope of natural filter sand. The purposes are 1) to provide an outlet to convey seepage toward the outlet to keep the phreatic surface from rising within the reverse filter, and 2) to collect and direct seepage flow entering the reverse filter to the downstream weir box so the flow rate and potential fines movement can be collected and monitored.

Rip-rap and Bedding

Rip-rap placed on the upstream side of the auxiliary spillway approach apron, and upstream and downstream embankment slopes will consist of a hard, durable, non-weathered, angular stone in accordance with Michigan Department of Transportation (MDOT) standard specifications. The rip-rap design will follow Federal Emergency Management Agency's (FEMA) "Filters for Embankment Dams, Best Practices for Design and Construction," (FEMA, 2011) and will be sized in accordance with MDOT Standard Specifications for Construction. Bedding material will consist of imported granular material in accordance with MDOT specifications placed over MDOT 29A crushed stone or heavy non-woven geotextile (≥ 11 oz./sy). Geotextile will only be allowed under the upstream slope or under bedding located under the toe seepage collection ditch. Geotextile will not be permitted under the downstream slope.

SMALLWOOD DAM ARCHITECTURAL HISTORY

Frank Wixom founded the Tittabawassee Power Company in 1906 with a vision to dam the Tittabawassee and Tobacco River to provide cheap electricity to farmers and the local community, and to create a recreational area for the greater region. Although the initial plans were not financially feasible at the time for Wixom's power company, the Wolverine Power Company was formed in 1923, with Wixom as president. Sponsored by Wolverine Power Company, construction of the Smallwood Dam, designed by consulting engineers Holland, Ackerman & Holland, was completed in 1925 to provide storage and headwater control for the purpose of hydroelectric power generation.

FLTF maintains a collection of historic photos taken during the construction of the Smallwood Dam, as well as sheets of construction plans and improvements (1920s), as-builts (1930s), and common lifecycle modifications (into the 2000s). Original plans for the Smallwood Dam are provided as Figure 3.

Smallwood Dam as a Cultural Resource

To understand the eligibility of the Smallwood Dam as a cultural resource, all built components of the dam were considered. This includes the concrete spillways, water retaining, or water conveyance structures described in this report including the primary gated spillway (comprised of side walls, center piers, stepped rollway, stilling basin and crest gates), powerhouse (side walls, intake, scroll case, draft bay), and auxiliary spillway (including side walls). None of these elements have previously been evaluated for inclusion on the National Register of Historic Places (NRHP).

Spillway construction began in September 1923 (see Photo 4), followed by the powerhouse. Once the spillway structure was built, embankment dams were built using the native Michigan sand-clay materials for the fill, founded on the hardpan glacial till of the region. The powerhouse structure was built first and water diverted through it at which time the right half of the river was coffer-damned, and then the spillway structure was built. The lower portion of the powerhouse was used as the diversion structure. Once the concrete powerhouse and spillway structure were completed construction of the embankment dam was undertaken. Concrete work was completed in the summer and fall of 1924.

Prior to 2019, gate operations were handled by a human operator, due to the means of opening and closing a gate. The gate used a chain hoist on a trolley system, where the operator was required to set the chain on the hoist drum and be in attendance to push the start and stop buttons on the gate hoist.

According to historic documentation on file with the FLTF, modifications to the dam began in 1924 with changes to the bridge above the spillway. A fire in 1927 damaged the embankments, shown in Photo 5 below, however beyond historical photographs there is no record of the details of the impacts of the fire on the Smallwood Dam. In 1985 the spillway gates were repaired, and in 1998, the left embankment was cleared of vegetation, regraded, and flattened. In 1998 the spillway was upgraded. In 2001, the left embankment was modified, and sheet piling was added in 2013. In 2014, approximately 260 feet of the overflow section just left of the SSP training wall was raised to crest elevation 711.5 feet and a 20-foot-wide rip-rap channel was also constructed along the SSP training wall to prevent scour along the base of the wall during an extreme flood event that could overtop the embankment left of the SSP. There is no record of improvements or repairs made to the right embankment, other than installation of the SSP cutoff. In 2016 the plant facility was modified. Post-construction, modifications were performed on the Smallwood Dam embankment and Routine structural repairs included continual concrete repair on the structures, as well as gate repairs. All pre-disaster modifications were performed by Wolverine Power Company, followed by Boyce Hydro.

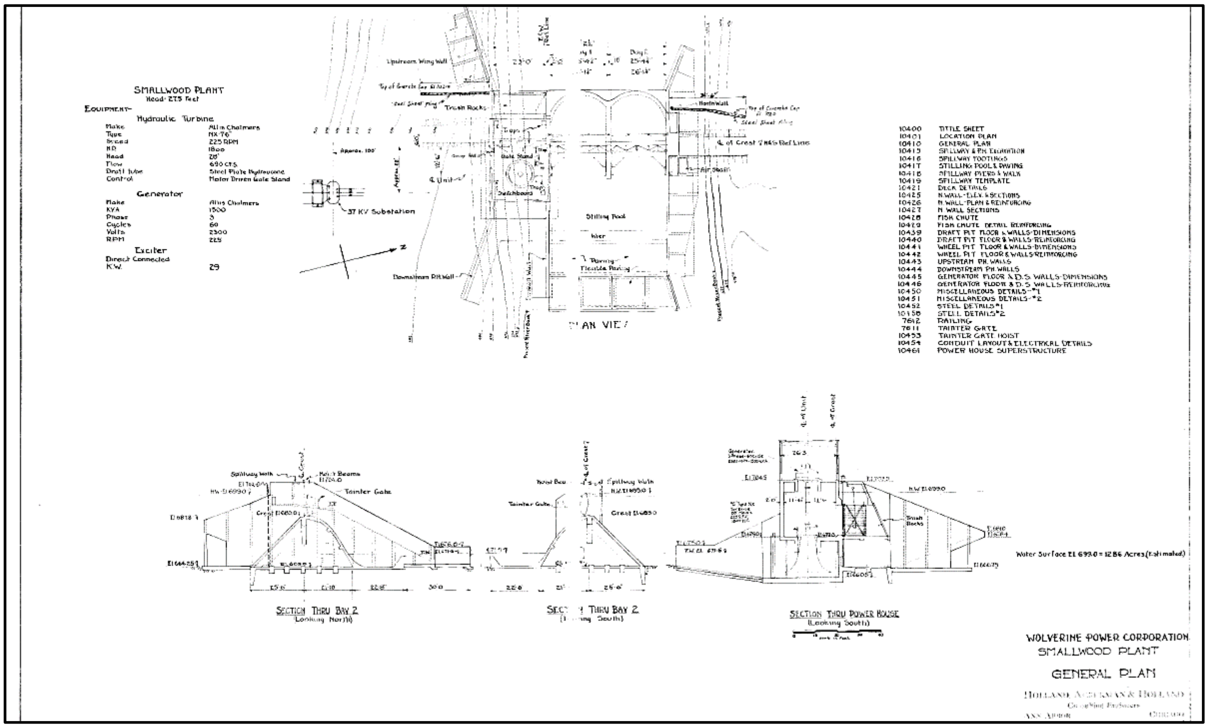


Figure 3. Original Plan Drawings of the Smallwood Dam, March 1924.

Photo 4. Smallwood Dam During Construction, 1924.

Photo 5. Smallwood Dam Post-Fire, 1927

There are 35 dams in Gladwin County, Michigan. There are more than 50 hydroelectric dams in Michigan, which provide approximately 1.5% of Michigan's energy. Four of these facilities are listed on the NRHP. Cooke Dam, constructed on the Au Sable River in 1911, is listed due to presence of associated outbuildings, including a powerhouse, substation, storage shed, and Classic-Revival style Attendant's House. The Croton Dam on the Muskegon River is listed on the NRHP as it attracted international attention in 1907 due to the 110,000-volt transmission line, which was the highest in use at that time. The Five Channels Dam, constructed in 1912, is listed on the NRHP as a District, which was known for its associated 45-acre worker's camp, which is also listed on the NRHP as an archaeological site. The Hardy Dam was constructed in 1931 and at the time was one of the largest earthen dams in the United States. Two additional dams are listed as Michigan State Historic Sites, including the Rugg Pond Dam constructed in 1904 on the Rapid River which was constructed with materials delivered via wagon and lists Ernest Hemingway as a notable guest. The other, the Mio Dam on the Au Sable River, was constructed in 1916 and is unique for its conduit spillways underneath the powerhouse foundation which paved the way for design innovations in icy rivers.

Of the hydroelectric dams in Michigan, most were constructed in the second quarter of the 20th century. To determine the presence of distinguishing features that might inform the significance of the Smallwood Dam, Merjent reviewed four other dams designed by Holland, Ackerman and Holland, all constructed between 1922 and 1927. These dams include the Chalk Hill Dam, the Victoria Dam, the Union City Dam, and the Quaker Mill Dam (see Table 2 below).

TABLE 2.

List of notable Holland, Ackerman and Holland Dams

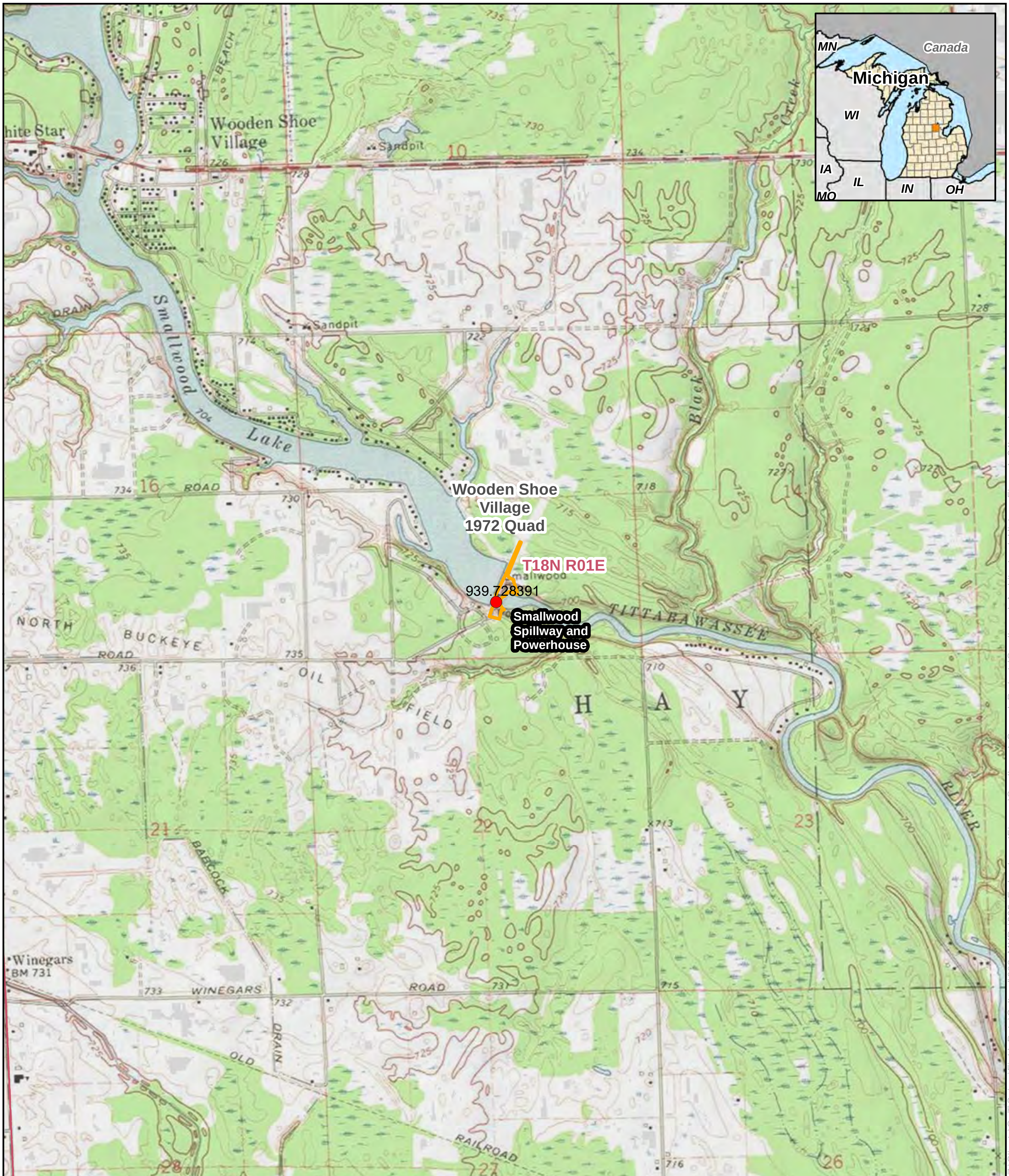
Dam Nam	State	Contractor	Power Company	Features
Union City Dam	Michigan	Benjamin Douglas Company	"municipality owned"	Tainter Gates (5)
Quaker Mill Dam	Iowa	Unknown	Iowa Electric Company	One Tainter Gate
Smallwood Dam	Michigan	Holland, Ackerman, and Holland	Wolverine Power Company	Tainter Gates (2)
Chalk Hill Dam	Wisconsin	Siems, Helmer, Shaffner, Inc.	Northern Electric Company	Tainter Gates (11)
Victoria Dam	Michigan	Price Brothers Company	Copper Range Company	No Tainter gates

Other properties designed by Holland, Ackerman and Holland, exhibit unique architectural elements such as stained glass within the powerhouse (Chalk Hill Dam) or sweeping arches (Victoria Dam). The Quaker Mill Dam, demolished in 2017, was previously listed on the NRHP due to a few unique characteristics, namely a monumental concrete fishway and a single Tainter gate with a manually operated hoist. While both the Chalk Hill Dam and the Tobacco River Spillway are hollow, the hollow nature of the Chalk Hill Dam was utilized to access the powerhouse, which is not present at the Smallwood Dam. The Chalk Hill Dam was also distinctive due to its large concrete fishway, its size (early 300 feet wide), and the decorative elements within the powerhouse (see Photo 6). Other than some being hollow and/or having multiple Tainter gates, unique architectural features and associated structures set these facilities apart from the Smallwood Dam.

Photo 6. Chalk Hill spillway (left) and powerhouse (right).

When considering the eligibility of the Smallwood Dam, the National Register Criteria for Evaluation were considered (36 C.F.R. § 60.4). It is of our opinion that the Smallwood Dam is not eligible for inclusion on the NRHP, either in and of itself or as a contributing property of a historic district. While the powerhouse and spillway remain intact, continual repairs have modified the original structures. Regardless of impacts to the structural characteristics, the Smallwood Dam lacks unique architectural elements present among other dam spillways, powerhouses, or embankments (particularly those listed on the NRHP with associated powerhouses or other notable engineering elements), it is our professional opinion that the Smallwood Dam does not meet the criteria established by the Secretary of the Interior as detailed in 36 C.F.R. § 60.4.

FIGURES



merjent

0 1,000 2,000 Feet

1:24,000

For Environmental Review Purposes Only

Figure 1: 24k Topo

Smallwood Dam
Gladwin County, Michigan

- Smallwood Spillway
- Embankment
- Quad Map Boundary
- Township Boundary
- County Boundary

Date: (8/27/2021)

0 87.5 175 Feet

1:2,100

N W E S

For Environmental Review Purposes Only

Figure 2: 2020 Aerial Map
Smallwood Dam
Gladwin County, Michigan

● Smallwood Spillway

Section Boundary

Embankment

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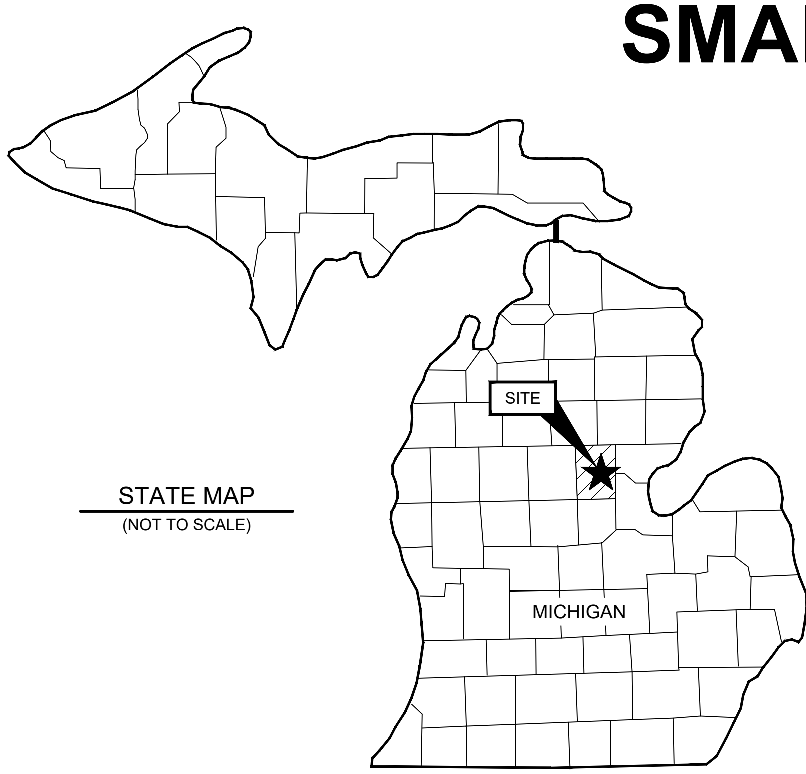
APPENDIX A

SMALLWOOD DAM CONCEPTUAL DESIGN

GLADWIN COUNTY, MICHIGAN
FOUR LAKES TASK FORCE
FERC PROJECT NO. 10810



STATE MAP
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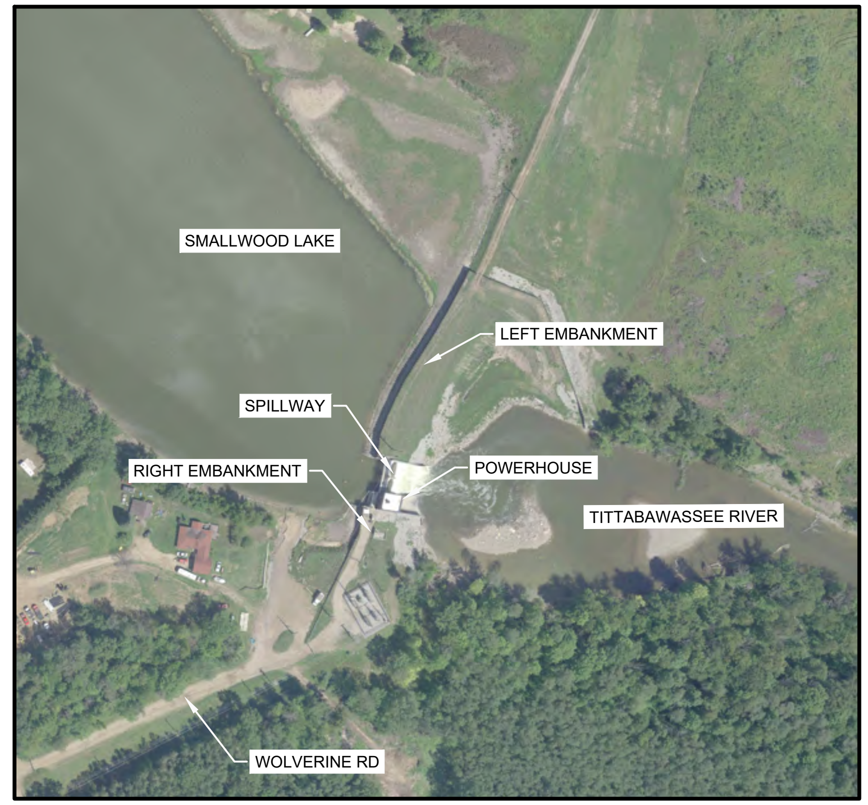
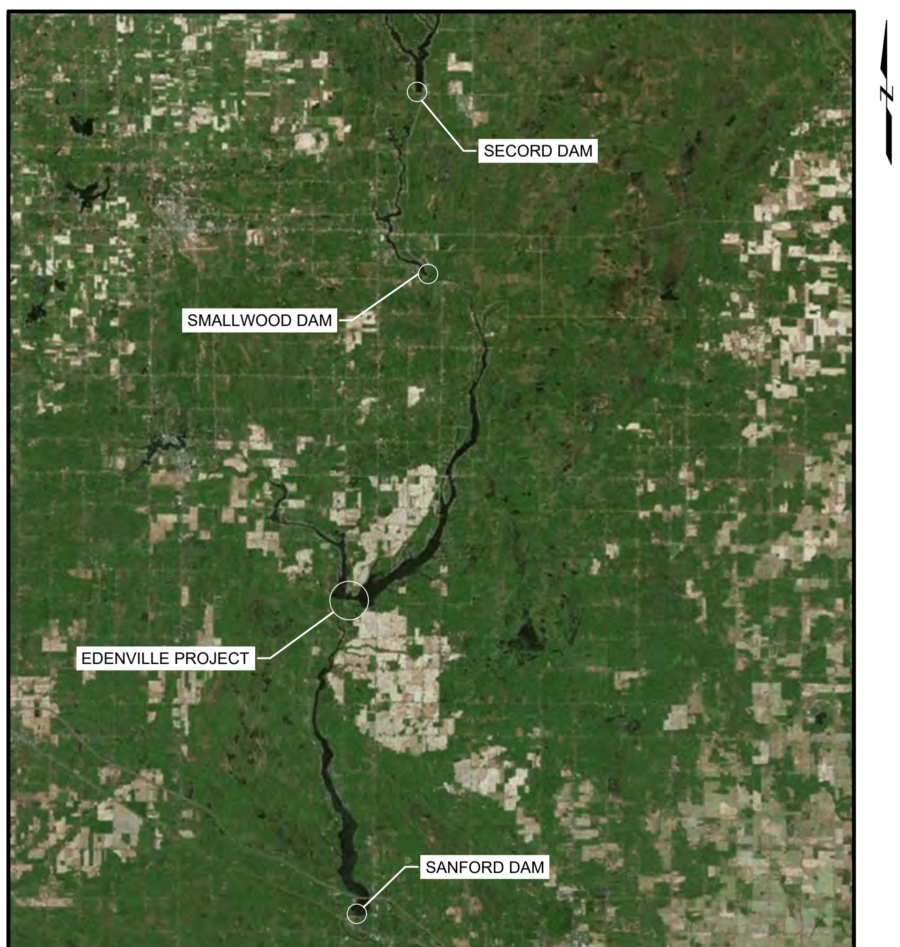


SITE AERIAL
(NOT TO SCALE)

SHEET INDEX

SHEET NO.	DRAWING NO.	TITLE
1	G-01	COVER SHEET AND SITE LOCATION
2	G-02	GENERAL NOTES AND LEGEND
3	C-01	SITE PLAN - EXISTING CONDITIONS
4	C-02	OUTLET WORKS - EXISTING CONDITIONS PLAN
5	C-03	OUTLET WORKS - TEMPORARY COFFERDAMS PLAN
6	S	OUTLET WORKS - DEMOLITION PLAN
7	C-05	OUTLET WORKS - DEMOLITION SECTION
8	C-06	SITE PLAN - PROPOSED MODIFICATIONS
9	C-07	OUTLET WORKS - MODIFICATION PLAN VIEW
10	C-08	PRIMARY SPILLWAY - MODIFICATIONS SECTION
11	C-09	PRIMARY SPILLWAY - CREST GATE DETAILS
12	C-10	NORTH TRAINING WALL - MODIFICATIONS SECTION
13	C-11	NORTH TRAINING WALL - MODIFICATIONS DETAILS
14	C-12	POWERHOUSE - MODIFICATIONS SECTION
15	C-13	EMBANKMENTS - MODIFICATIONS SECTIONS (SHEET 1 OF 2)
16	C-14	EMBANKMENTS - MODIFICATIONS SECTIONS (SHEET 2 OF 2)
17	C-15	AUXILIARY SPILLWAY - PROPOSED PLAN VIEW
18	C-16	AUXILIARY SPILLWAY - PROPOSED SPILLWAY & CHANNEL CROSS SECTIONS, SPILLWAY DETAILS



SOURCE:
AERIAL IMAGE TAKEN FROM GOOGLE EARTH

SITE LOCATION
(NOT TO SCALE)

PREPARED FOR:

FOUR LAKES TASK FORCE
233 E. LARKIN
MIDLAND, MI 48640

PREPARED BY:

GEI CONSULTANTS OF MICHIGAN, P.C.
10501 WEST RESEARCH DRIVE
G100
MILWAUKEE, WI 53226
(414) 930-7534

SPICER GROUP INC.
230 S. WASHINGTON AVE.
SAGINAW, MI 48607
TEL. (989) 754-4717
FAX. (989) 754-4440

GEI PROJECT NO. 2002879

NO.	DATE	ISSUE/REVISION	APP
0	XX/XX/XX	CONCEPTUAL DESIGN SUBMITTAL	XXX

DRAFT

DWG. NO. G-01

SHEET NO. 1

\\MSN1L-ASAMP C:\Users\asampson\OneDrive - GEI Consultants, Inc\Documents\Projects\FLTF\TASK 4 - CONCEPT DESIGN\Smallwood\CAD\Design\G-01_Cover Sheet and Site Location.dwg - 11/23/2020

1. GENERAL

SPACIAL DATUM INFORMATION

- VERTICAL: NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29).
- HORIZONTAL: NORTH AMERICAN DATUM OF 1983 (NAD83), MICHIGAN STATE PLANE, CENTRAL ZONE.
- A CONVERSION OF +5.8' IS REQUIRED WHEN CONVERTING VERTICAL DAM DATUM TO NGVD29 (E.G., HEADWATER ELEVATION AT DAM DATUM IS 699.0' AND AT NGVD29 DATUM IS 704.8').
- A CONVERSION OF -0.541' IS REQUIRED WHEN CONVERTING VERTICAL NGVD29 DATUM TO NAVD88 DATUM.
- CONTROL MONUMENTS ON-SITE SHALL BE REFERRED TO CONFIRM HORIZONTAL AND VERTICAL MEASUREMENTS.

BASEMAP DATA

- SITE TOPOGRAPHY AND AERIAL IMAGE OBTAINED DRONE FLIGHT PERFORMED BY SPICER GROUP IN 2020.
- COVER SHEET AERIAL IMAGES OBTAINED FROM GOOGLE EARTH REPRESENT CONDITIONS IN JUNE, 2018.
- OBTAINED FROM BOYCE HYDRO:
  - ORIGINAL CONSTRUCTION DRAWINGS
  - EXHIBIT F LICENSE DRAWINGS

DESIGN PARAMETERS

- NORMAL RESERVOIR ELEVATION 704.8' (+0.3' / -0.4')
- WINTER RESERVOIR OPERATIONS: MINIMUM 701.8'
- ORDINARY HIGH WATER MARK ELEVATION 675.2'

DESIGN REFERENCE STANDARDS

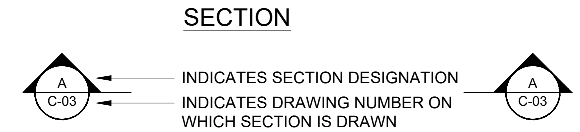
- (USBR, 1987) UNITED STATES DEPARTMENT OF THE INTERIORER, BUREAU OF RECLAMATION, "DESIGN OF SMALL DAMS", 1987.
- (USACE, 1995) UNITED STATES ARMY CORPS OF ENGINEERS, ENGINEERING AND DESIGN, "CONSTRUCTION CONTROL FOR EARTH AND ROCK-FILL DAMS", EM 1110-2-1911, 1995.
- (ACI, 2001) AMERICAN CONCRETE INSTITUTE, "CONTROL OF CRACKING IN CONCRETE STRUCTURES" (ACI 224), 2001.
- (USACE, 2004) UNITED STATES ARMY CORPS OF ENGINEERS, ENGINEERING AND DESIGN, "GENERAL DESIGN AND CONSTRUCTION CONSIDERATIONS FOR EARTH AND ROCK-FILL DAMS", EM 1110-2-2300, 2004.
- (ACI, 2006) AMERICAN CONCRETE INSTITUTE, "CODE REQUIREMENTS FOR ENVIRONMENTAL ENGINEERING CONCRETE STRUCTURES" (ACI 350), 2006.
- (ACI, 2011) AMERICAN CONCRETE INSTITUTE, "BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE" (ACI 318), 2011.
- (FERC, 2016) FEDERAL ENERGY REGULATORY COMMISSION, ENGINEERING GUIDELINES FOR EVALUATION OF HYDROPOWER PROJECTS (MOST RECENT VERSIONS)

ABBREVIATIONS

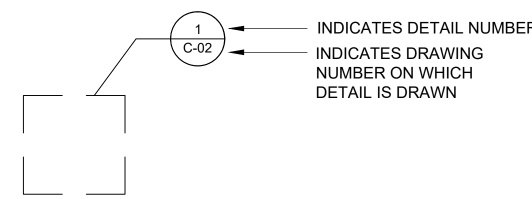
BO = BOTTOM OF
C = CENTER LINE
MM = MOVEMENT MONUMENT
CLSM = CONTROLLED LOW-STRENGTH MATERIAL
CONC = CONCRETE
CONT = CONTINUOUS
CTRD = CENTERED
D/S = DOWNSTREAM
EO = EDGE OF
EX = EXISTING
EF = EACH FACE
EL = ELEVATION (FEET)
HW = HEADWATER
MAX = MAXIMUM
OC = ON CENTER
OCEW = ON CENTER EACH WAY
OHWM = ORDINARY HIGH WATER MARK
PL = PLATE
PMF = PROBABLE MAXIMUM FLOOD
SDF = SPILLWAY DESIGN FLOOD
SSP = STEEL SHEET PILE
STD = STANDARD
STIFF = STIFFENER
TBD = TO BE DETERMINED
TO = TOP OF
TW = TAILWATER
TYP = TYPICAL
UON = UNLESS OTHERWISE NOTED
U/S = UPSTREAM
VIF = VERIFY IN FIELD
WL = WETLAND
W/ = WITH

SECTION AND DETAIL LEGEND

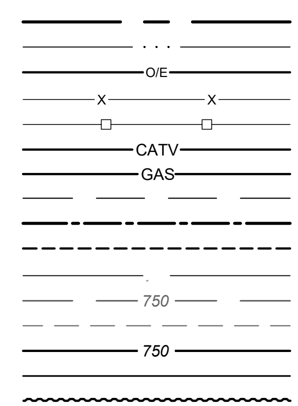
SECTION



DETAIL

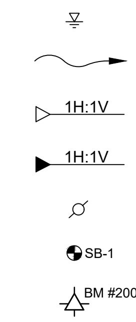


LINETYPE LEGEND



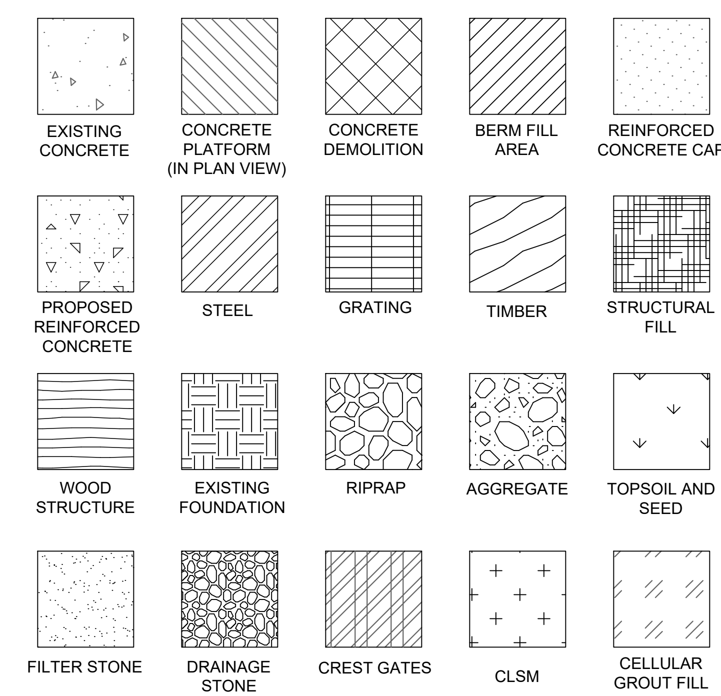
CENTERLINE
WATER ELEVATION
OVERHEAD ELECTRIC LINES
FENCE LINE (STEEL)
FENCE LINE (WOOD)
UNDERGROUND CABLE
GAS LINE
EDGE OF ROADWAY (UNPAVED)
ROADWAY CENTERLINE
BURIED PIPING
SILT FENCE
EXISTING MAJOR CONTOURS
EXISTING MINOR CONTOURS
DESIGN MAJOR CONTOURS
DESIGN MINOR CONTOURS
SHEETPILE

SYMBOLS LEGEND



WATER ELEVATION
FLOW DIRECTION
CUT SLOPE
FILL SLOPE
POWER POLE
SOIL BORING COMPLETED BY PROFESSIONAL SERVICE INDUSTRIES, 1997
SURVEY REFERENCE MONUMENT (CONTORL POINT / BENCHMARK)

HATCH LEGEND



0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	-	
NO.	DATE	ISSUE/REVISION	APP	

Attention:

0 1"

If this scale bar does not measure 1" then drawing is not original scale.

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Checked:	P. DREW
Drawn:	A. SAMPSON
Approved By:	B. WALTON

Four Lakes Task Force
FERC Project No. 10810

GEI Project 2002879

Smallwood Dam
Gladwin County, Michigan

GENERAL NOTES AND LEGEND

DWG. NO. G-02

SHEET NO. 2

LINETYPE LEGEND

- CENTERLINE
- WATER ELEVATION
- OVERHEAD ELECTRIC LINES (O/E)
- FENCE LINE (STEEL)
- FENCE LINE (WOOD)
- EDGE OF ROADWAY (UNPAVED)
- BURIED PIPING
- EXISTING MAJOR CONTOURS (750)
- EXISTING MINOR CONTOURS
- SHEETPILE

SYMBOLS LEGEND

- SB-3 — SOIL BORING COMPLETED BY PROFESSIONAL SERVICE INDUSTRIES, 1997
- FLOW DIRECTION
- BM #200 — SURVEY REFERENCE MONUMENT
- POWER POLE

EXISTING CONDITIONS SITE PLAN

0 30' 60'
SCALE, FT

SURVEY CONTROL MONUMENT LOCATIONS

ID	ELEVATION	NORTHING	EASTING
BM #200	710.61	234,396.048	19,693,143.919
CONTROL POINT	702.36	234,431.875	19,693,171.675

NOTES:

1. VERTICAL DATUM: NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29)
2. SPATIAL DATUM: NORTH AMERICAN DATUM OF 1983 (NAD83), MICHIGAN STATE PLANE, CENTRAL ZONE

Attention:
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NO.	DATE	ISSUE/REVISION	APP
0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	-

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Smallwood Dam
Gladwin County, Michigan

SITE PLAN - EXISTING CONDITIONS

DWG. NO. C-01

SHEET NO. 3

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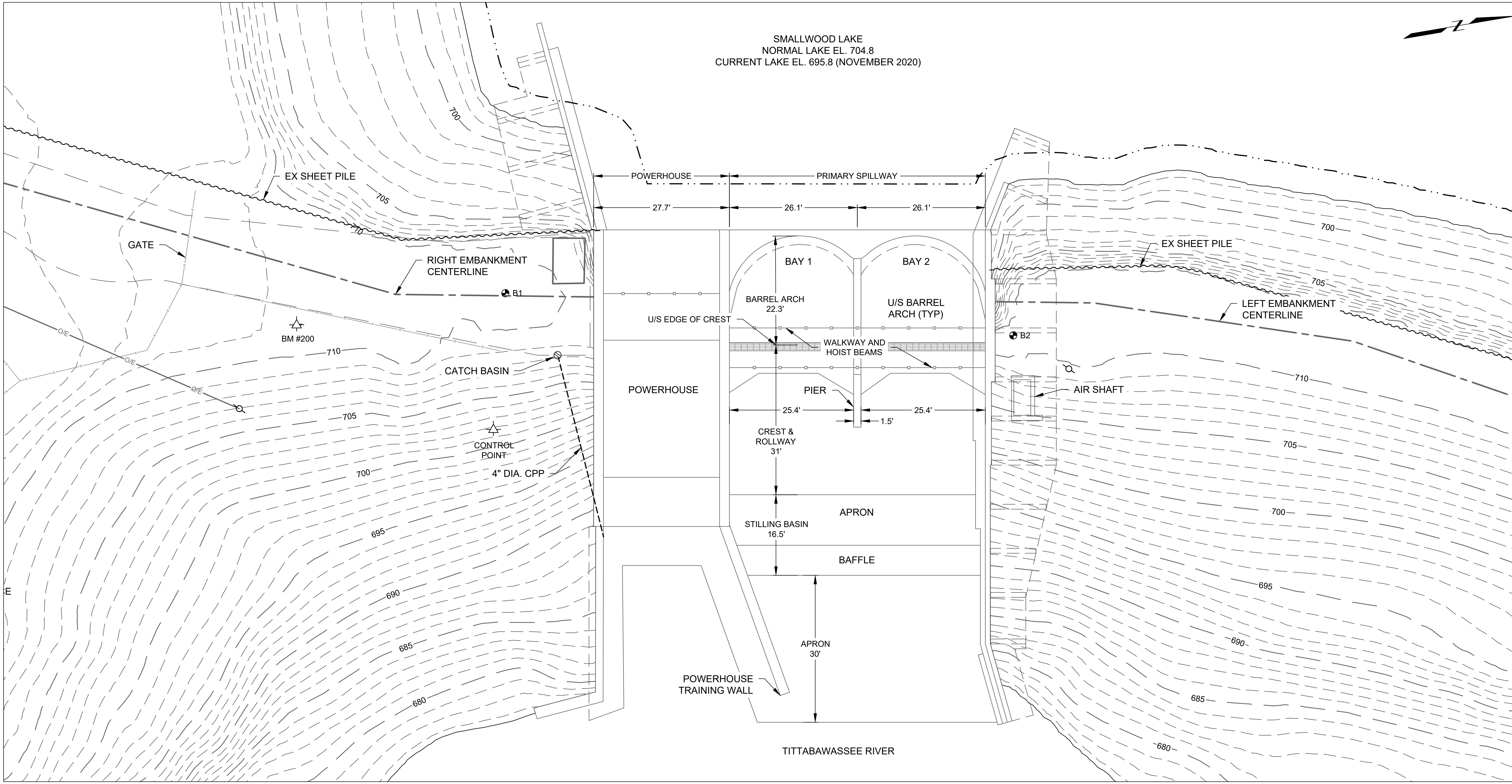

LINETYPE LEGEND

- CENTERLINE
- WATER ELEVATION
- OVERHEAD ELECTRIC LINES
- FENCE LINE (STEEL)
- FENCE LINE (WOOD)
- EDGE OF ROADWAY (UNPAVED)
- BURIED PIPING
- EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOURS
- SHEETPILE

SYMBOLS LEGEND

- SB-3 SOIL BORING COMPLETED BY PROFESSIONAL SERVICE INDUSTRIES, 1997
- FLOW DIRECTION
- BM #200 SURVEY REFERENCE MONUMENT
- POWER POLE

OUTLET WORKS - EXISTING PLAN VIEW

0 10' 20' SCALE, FT

Attention: 0 1" If this scale bar does not measure 1" then drawing is not original scale.

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Smallwood Dam
Gladwin County, Michigan

OUTLET WORKS - EXISTING CONDITIONS PLAN

DWG. NO. C-02
SHEET NO. 4

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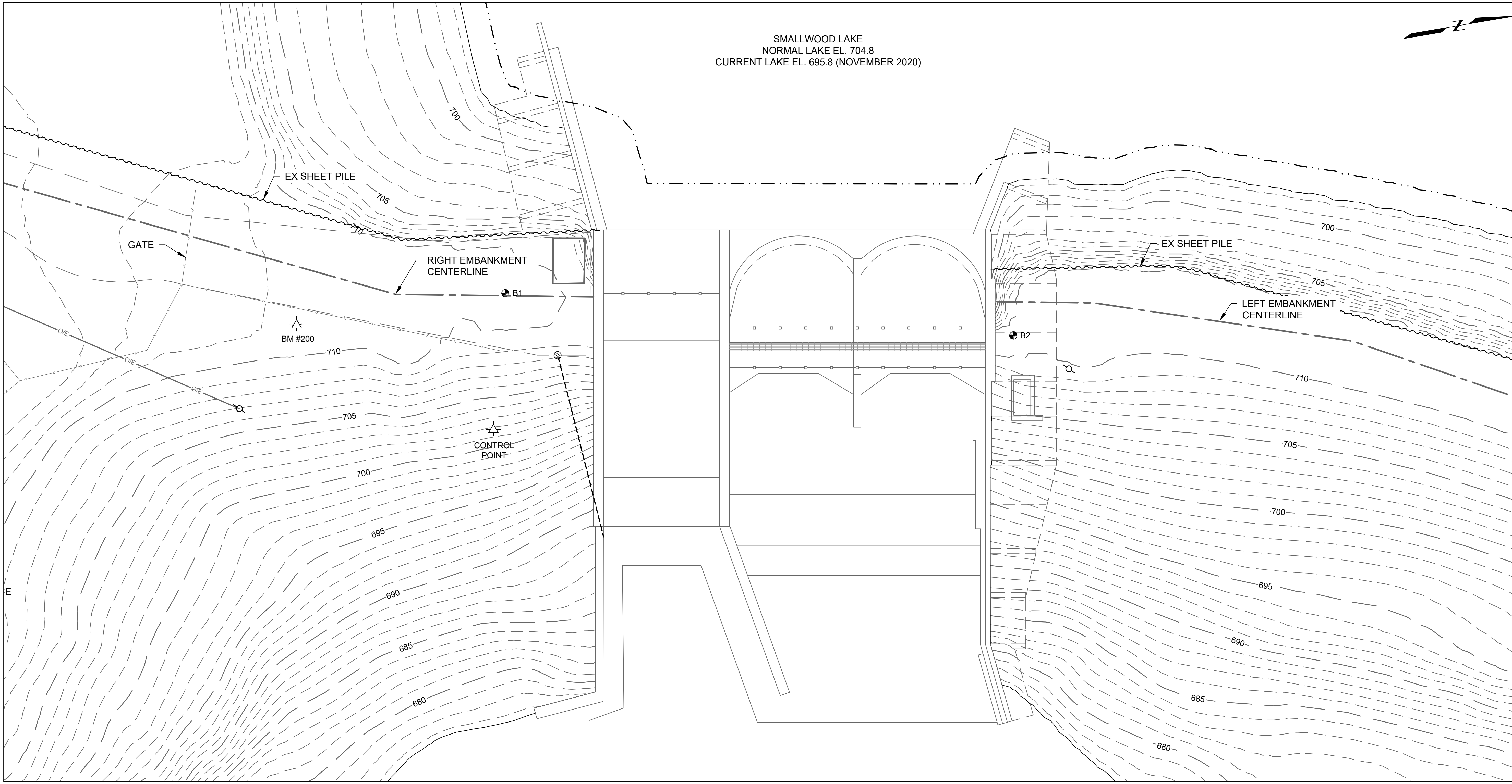

OUTLET WORKS - PLAN VIEW

0 10' 20'
SCALE, FT

LINETYPE LEGEND

— — —	CENTERLINE
- - · · · - -	WATER ELEVATION
—O/E—	OVERHEAD ELECTRIC LINES
—X—X—	FENCE LINE (STEEL)
—□—□—	FENCE LINE (WOOD)
— — —	EDGE OF ROADWAY (UNPAVED)
- - - -	BURIED PIPING
— 750 —	EXISTING MAJOR CONTOURS
- - - -	EXISTING MINOR CONTOURS
~~	SHEETPILE

SYMBOLS LEGEND

SB-3	SOIL BORING COMPLETED BY PROFESSIONAL SERVICE INDUSTRIES, 1997
	FLOW DIRECTION
BM #200	SURVEY REFERENCE MONUMENT
	POWER POLE

Attention:

0 1"

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Smallwood Dam
Gladwin County, Michigan

OUTLET WORKS - TEMPORARY COFFERDAMS PLAN

DWG. NO. C-03

SHEET NO. 5

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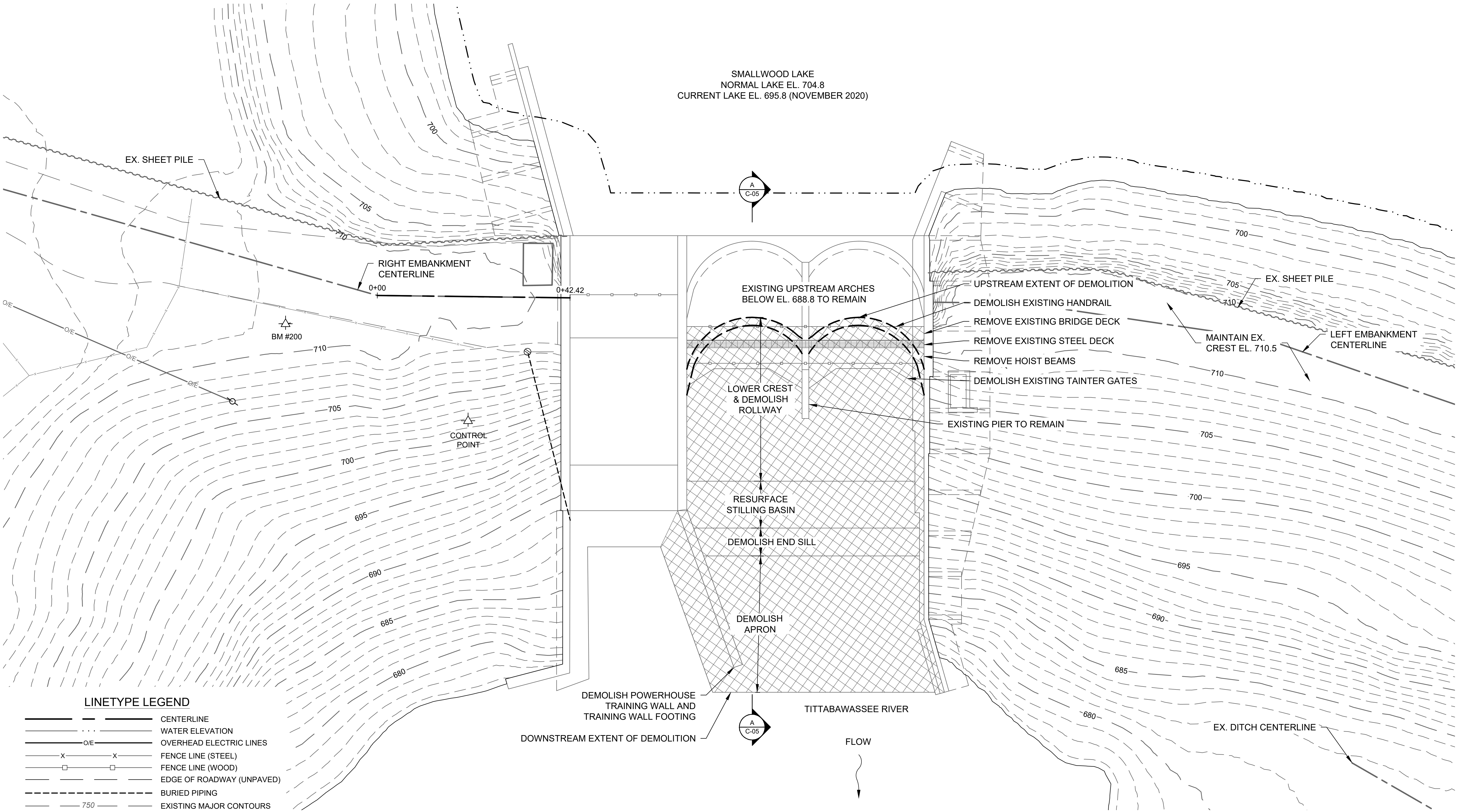

LINETYPE LEGEND

- CENTERLINE
- WATER ELEVATION
- OVERHEAD ELECTRIC LINES
- FENCE LINE (STEEL)
- FENCE LINE (WOOD)
- EDGE OF ROADWAY (UNPAVED)
- BURIED PIPING
- EXISTING MAJOR CONTOURS (750)
- EXISTING MINOR CONTOURS

HATCH LEGEND

- CONCRETE DEMOLITION
- GRATING

SYMBOLS LEGEND

- FLOW DIRECTION

OUTLET WORKS - DEMOLITION PLAN VIEW

0 10 20
SCALE, FT

Attention: 0 1" If this scale bar does not measure 1" then drawing is not original scale.

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Drawn:	A. SAMPSON
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Smallwood Dam
Gladwin County, Michigan

OUTLET WORKS - DEMOLITION PLAN

DWG. NO. C-04
SHEET NO. 6

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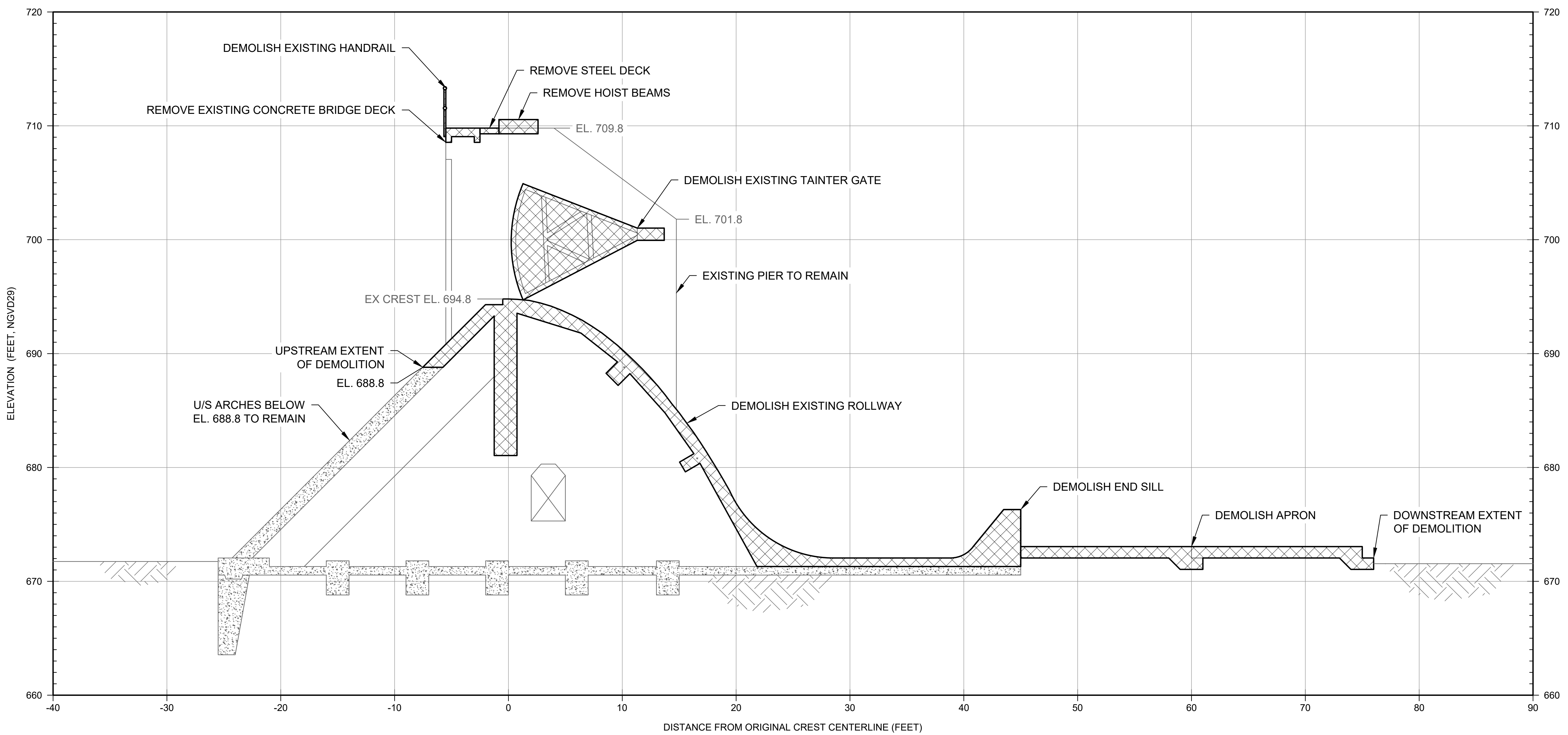

A
C-04

SECTION
SPILLWAY DEMOLITION

0 5 10
SCALE, FT

LINETYPE LEGEND

- WATER ELEVATION
- EXISTING FEATURE
- PROPOSED FEATURE

HATCH LEGEND

- CONCRETE DEMOLITION
- EXISTING CONCRETE
- EXISTING FOUNDATION

Attention:
0 1"
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Smallwood Dam
Gladwin County, Michigan

OUTLET WORKS - DEMOLITION SECTION

DWG. NO.
C-05

SHEET NO.
7

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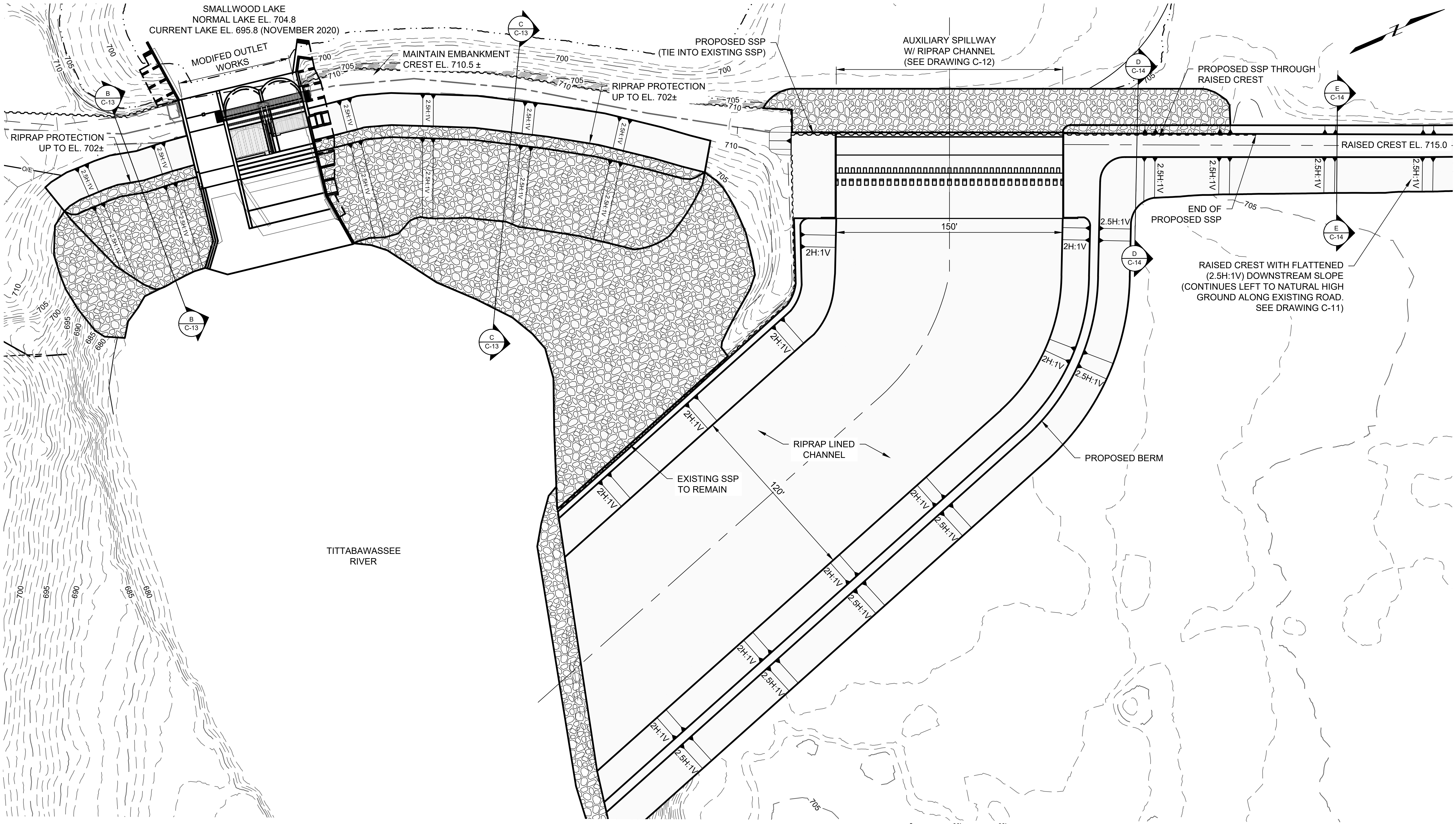

SITE PLAN - PROPOSED MODIFICATIONS

0 30' 60'
SCALE, FEET

Attention:				
0 1"				
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Approved By:	B. WALTON

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Smallwood Dam
Gladwin County, Michigan

SITE PLAN -
PROPOSED MODIFICATIONS

DWG. NO. C-06

SHEET NO. 8

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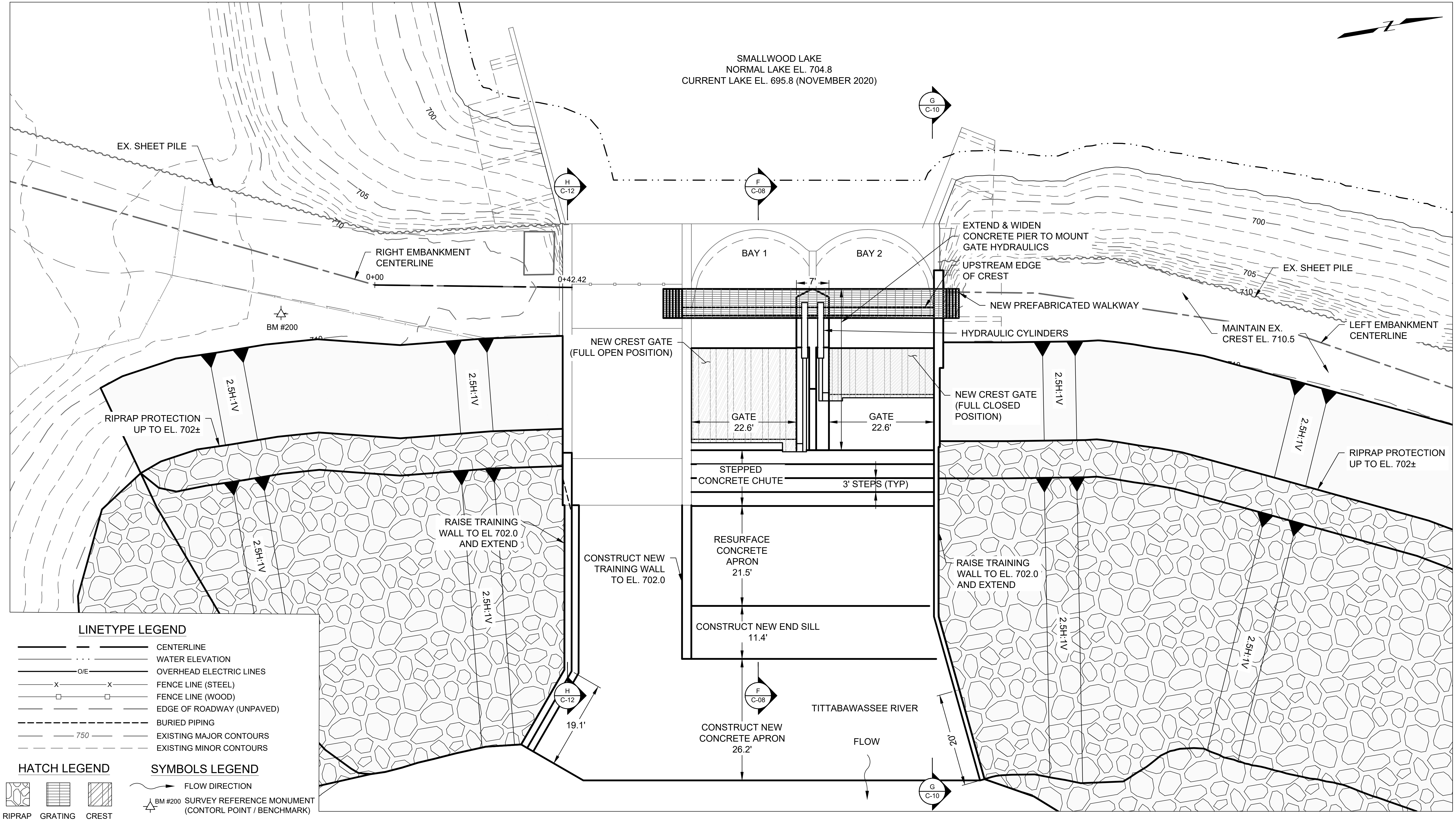

OUTLET WORKS - MODIFICATIONS PLAN VIEW

0 10 20
SCALE, FT

Attention:
0 1"
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Drawn:	A. SAMPSON
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Smallwood Dam
Gladwin County, Michigan

OUTLET WORKS - MODIFICATIONS PLAN VIEW

DWG. NO. C-07

SHEET NO. 9

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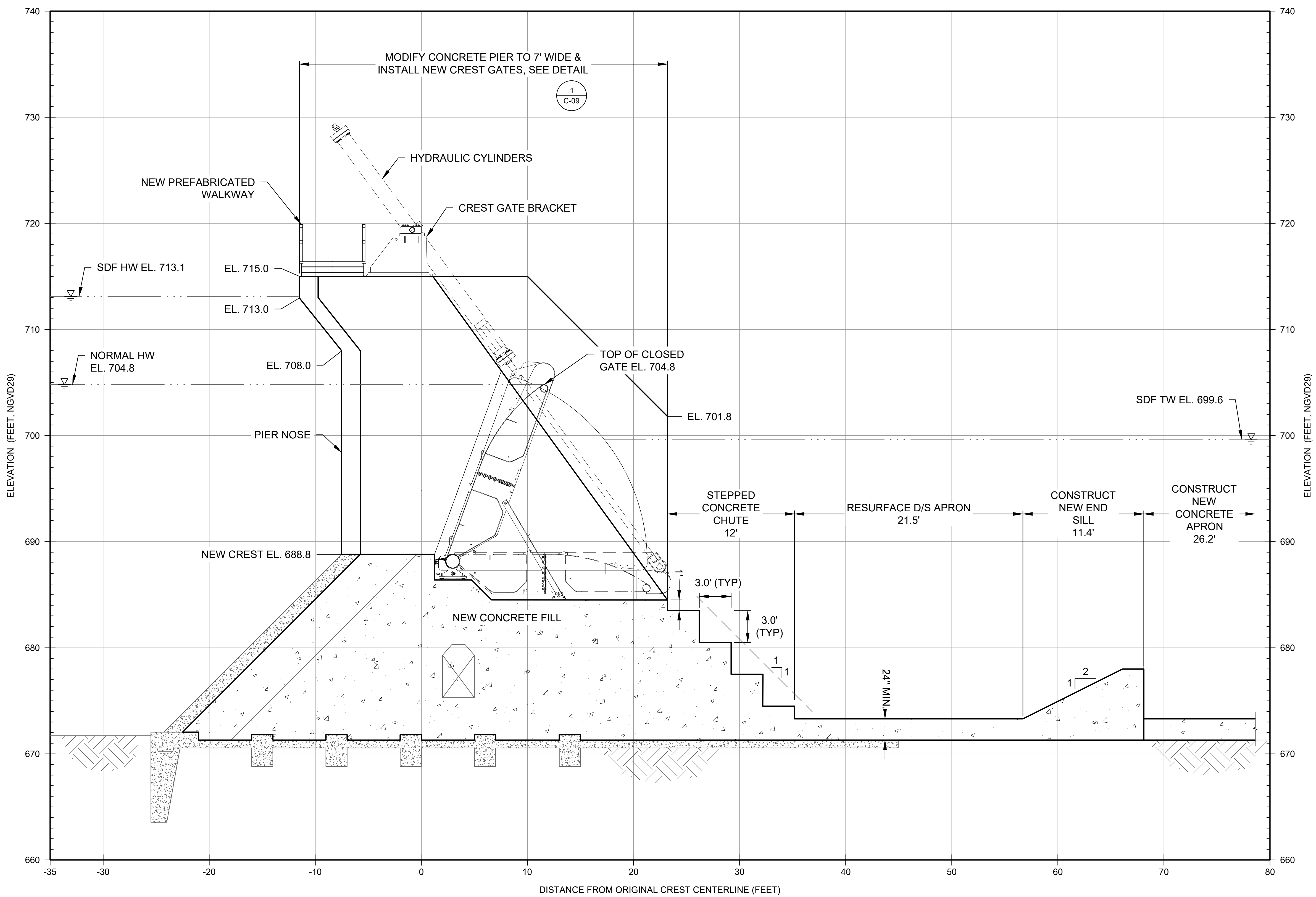

LINETYPE LEGEND

- WATER ELEVATION
- EXISTING FEATURE
- PROPOSED FEATURE

HATCH LEGEND

- PROPOSED REINFORCED CONCRETE
- EXISTING CONCRETE
- EXISTING FOUNDATION

F
C-07
SECTION
SPILLWAY BAY 1

0 5 10

Attention:				
0 1"				
If this scale bar does not measure 1" then drawing is not original scale.	0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	-
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Smallwood Dam
Gladwin County, Michigan

PRIMARY SPILLWAY - MODIFICATIONS SECTION

DWG. NO. C-08

SHEET NO. 10

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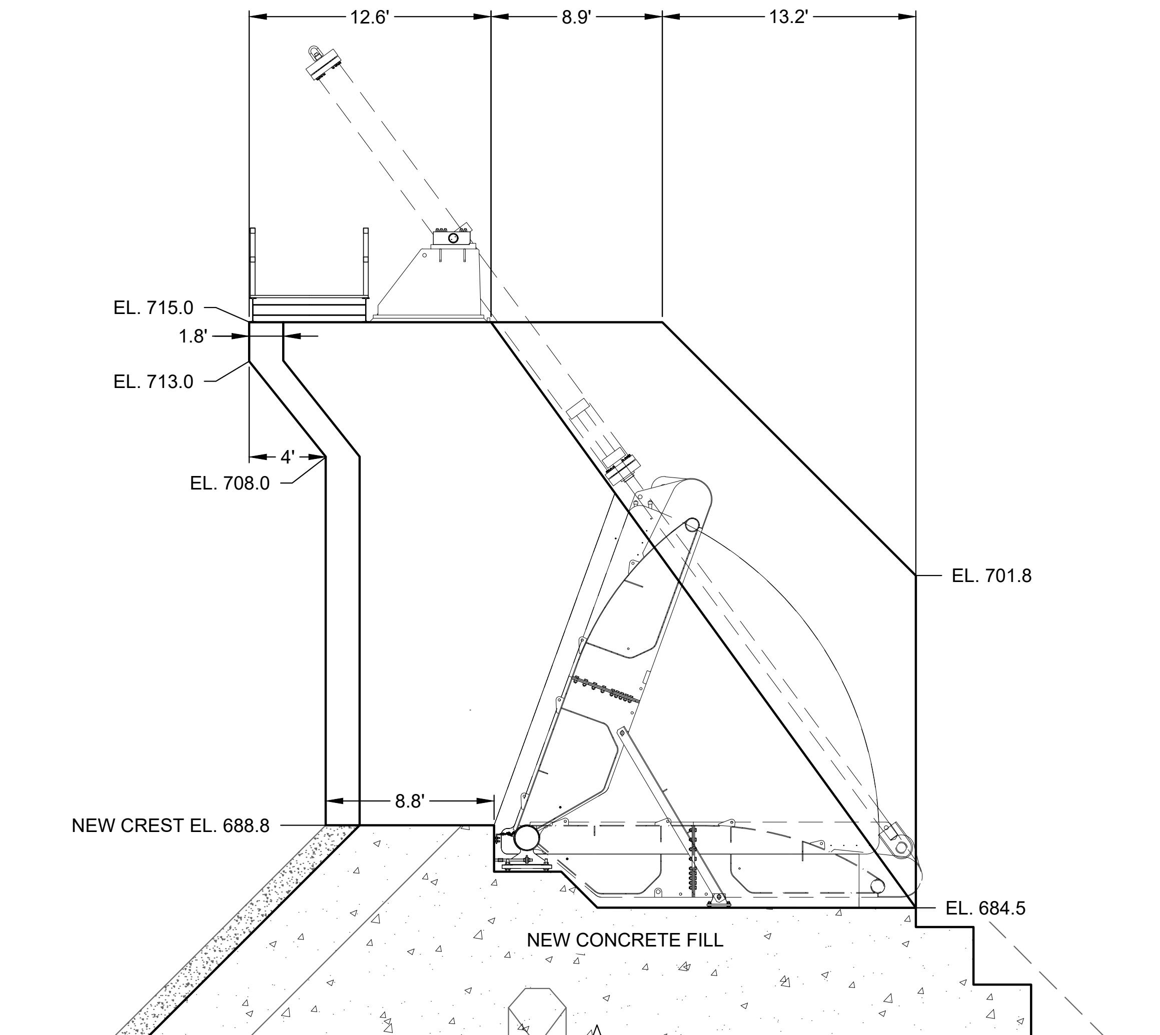

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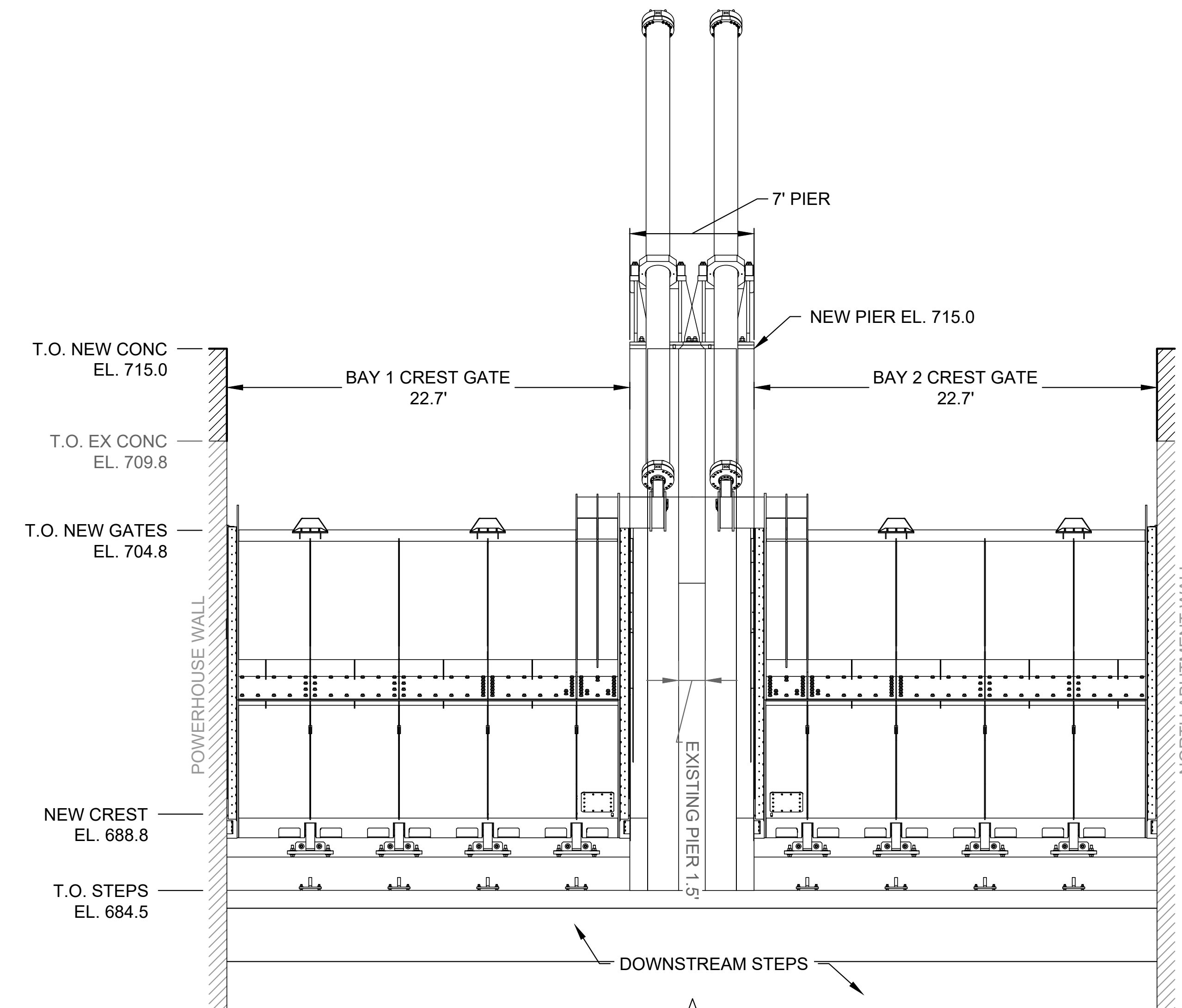

DOWNSTREAM ELEVATION
(LOOKING UPSTREAM)

1
C-08
DETAIL
PIER-MOUNTED CREST GATE

0 5 10

Attention:
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Smallwood Dam
Gladwin County, Michigan

PRIMARY SPILLWAY - CREST GATE DETAILS

DWG. NO.
C-09

SHEET NO.
11

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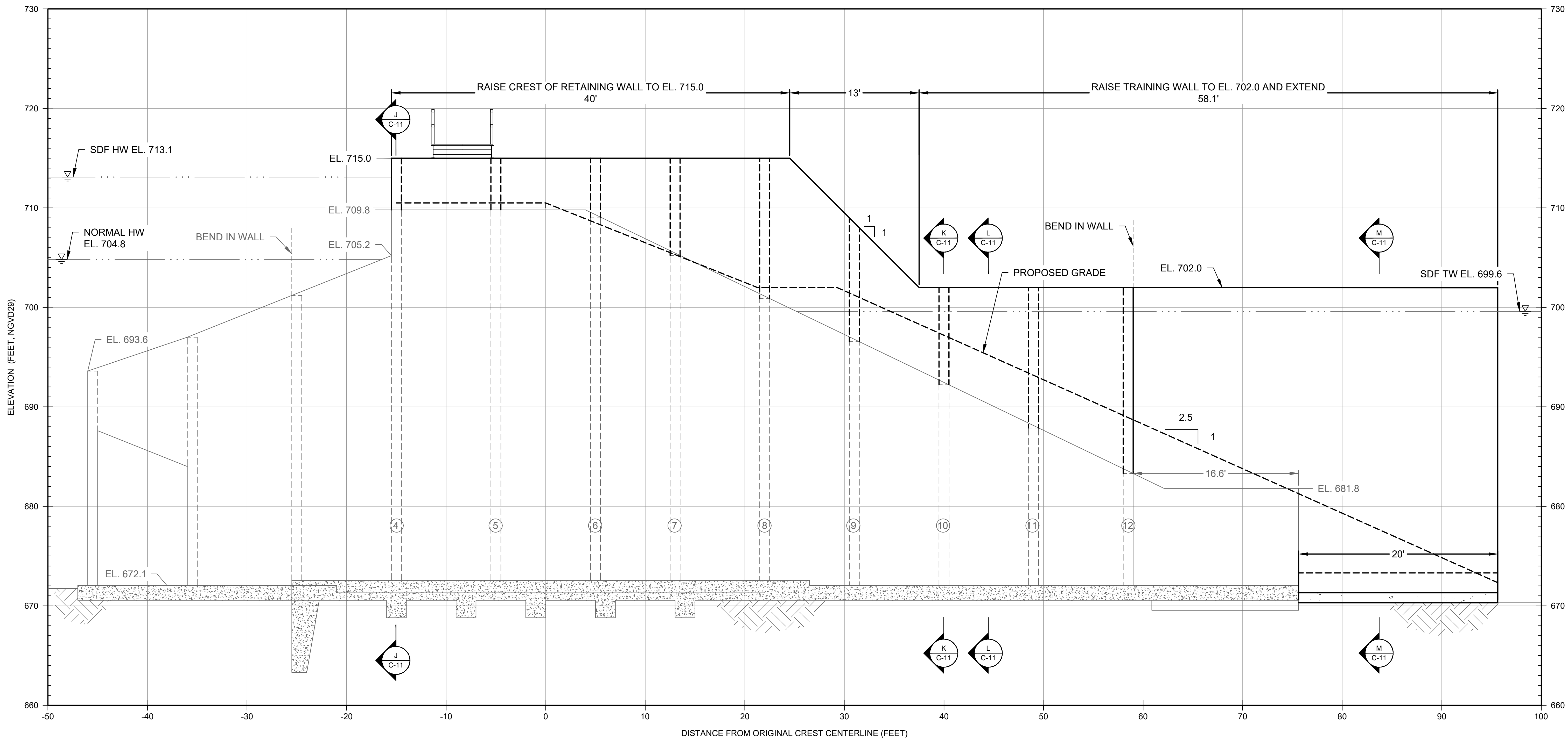

LINETYPE LEGEND

- WATER ELEVATION
- EXISTING FEATURE
- PROPOSED FEATURE

HATCH LEGEND

EXISTING CONCRETE — EXISTING FOUNDATION

SYMBOL LEGEND

(1) BUTTRESS NUMBER

G / C-07 SECTION
NORTH TRAINING WALL

Scale: 0 5 10

Attention: 0 1" — If this scale bar does not measure 1" then drawing is not original scale.

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Smallwood Dam
Gladwin County, Michigan

NORTH TRAINING WALL - MODIFICATIONS SECTION

DWG. NO. C-10

SHEET NO. 12

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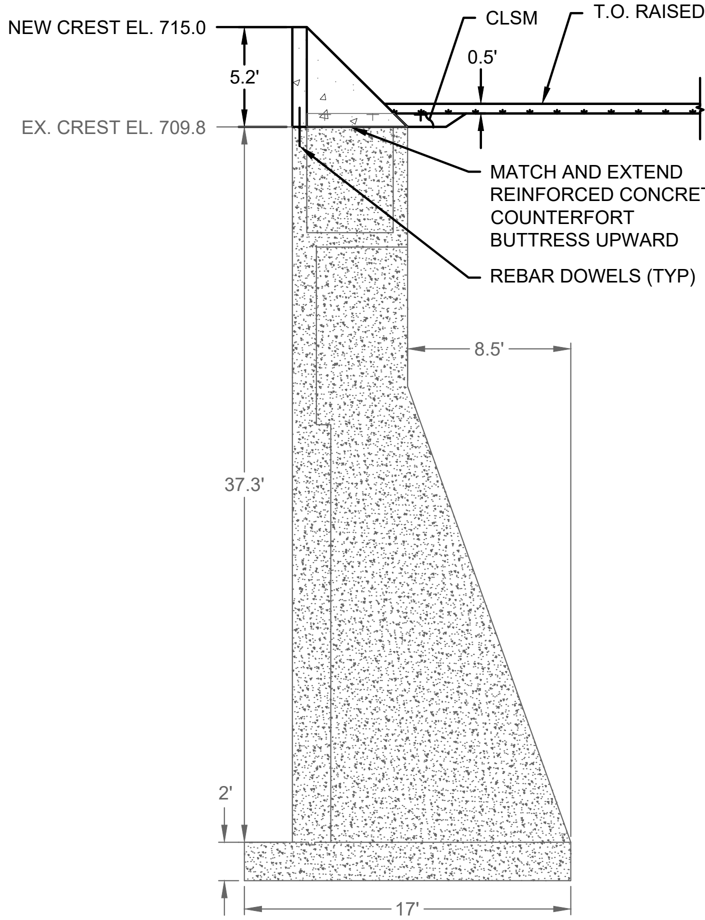
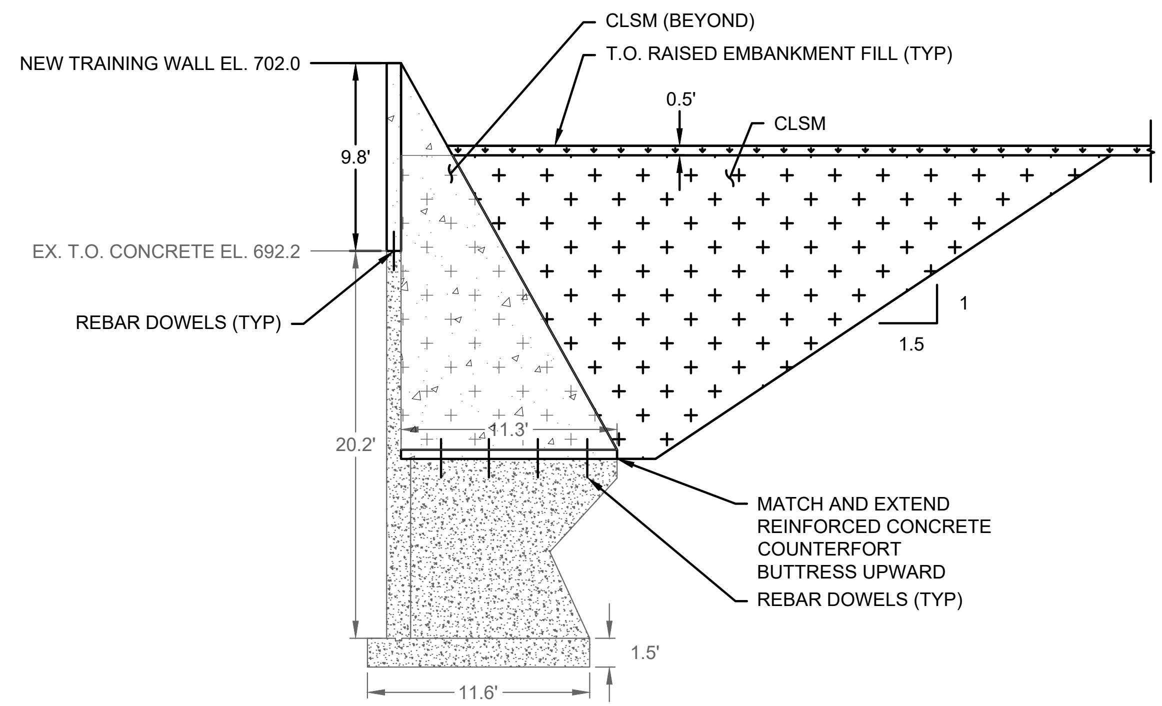
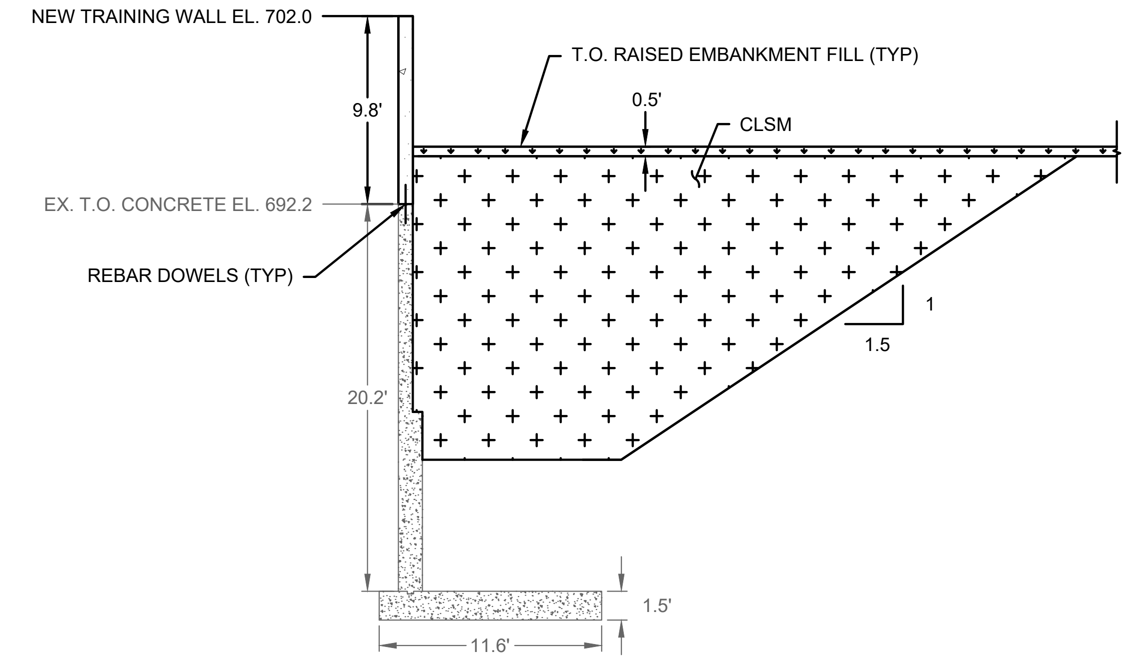


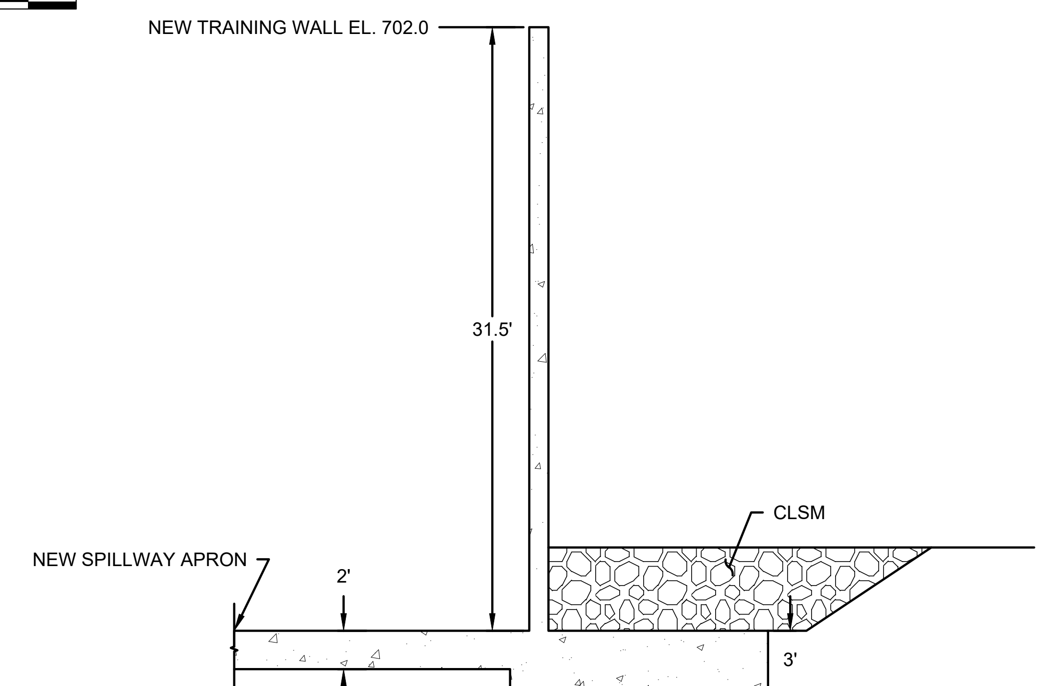
J
C-10
SECTION
BUTTRESS 4



K
C-10
SECTION
BUTTRESS 10



L
C-10
SECTION
BETWEEN BUTTRESSES 10 & 11

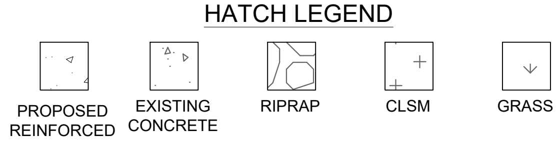


M
C-11
SECTION
NEW WALL EXTENSION

LINETYPE LEGEND

EXISTING FEATURE
PROPOSED FEATURE

HATCH LEGEND



Attention:
0 1"
If this scale bar does not measure 1" then drawing is not original scale.

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0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	-

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Approved By: B. WALTON

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Smallwood Dam
Gladwin County, Michigan

NORTH TRAINING WALL - MODIFICATIONS DETAILS

DWG. NO. C-11

SHEET NO. 13

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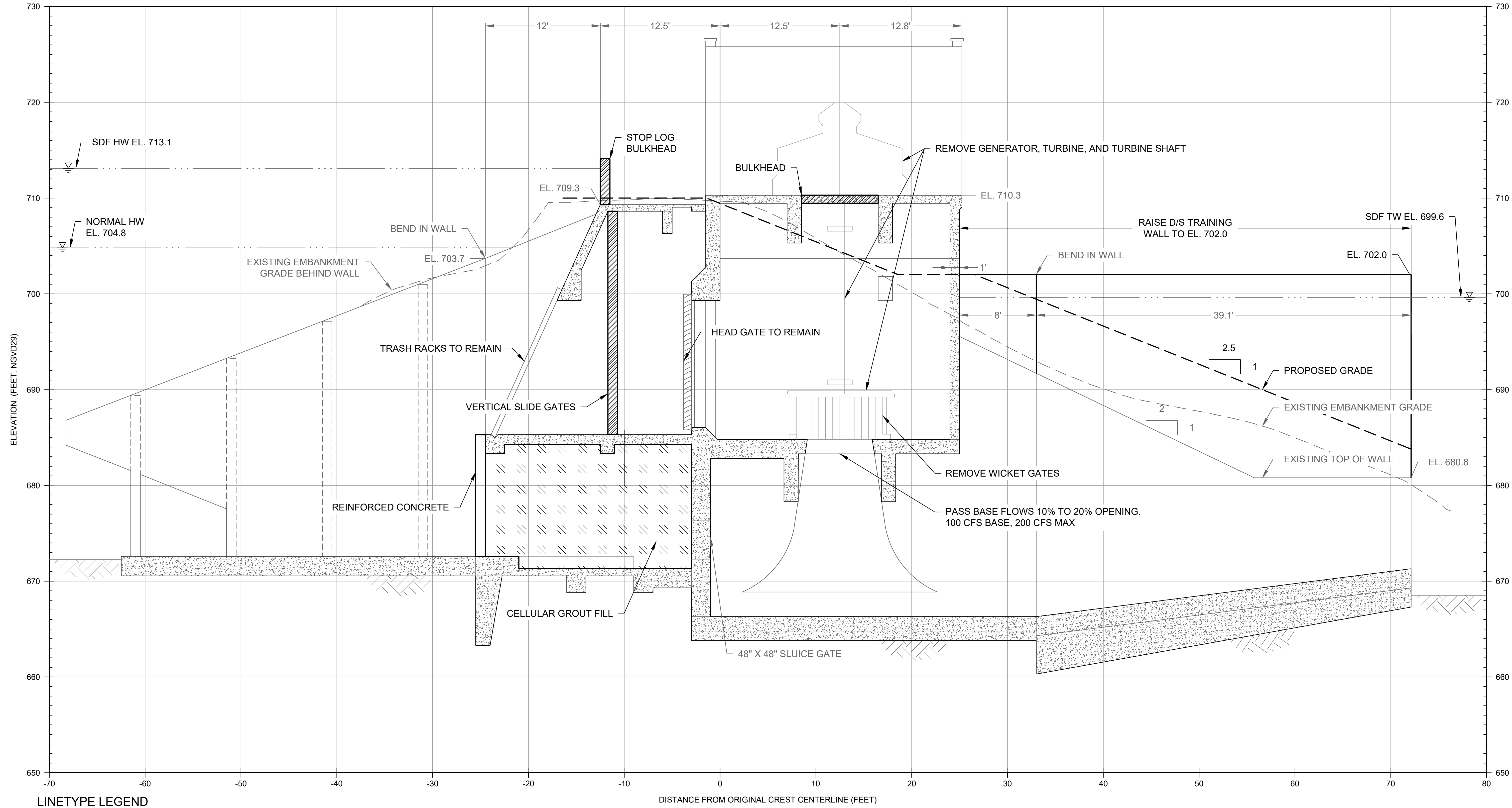

LINETYPE LEGEND

- WATER ELEVATION
- EXISTING FEATURE
- PROPOSED FEATURE

H / C-07 SECTION
POWERHOUSE

0 5 10

HATCH LEGEND

EXISTING CONCRETE | EXISTING FOUNDATION | REINFORCED CONCRETE CAP | CELLULAR GROUT FILL | TIMBER

Attention: 0 1" If this scale bar does not measure 1" then drawing is not original scale.

NO.	DATE	ISSUE/REVISION	APP
0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	-

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Checked:	P. DREW
Drawn:	A. SAMPSON
Approved By:	B. WALTON

Four Lakes Task Force
FERC Project No. 10810

GEI Project 2002879

Smallwood Dam
Gladwin County, Michigan

POWERHOUSE - MODIFICATIONS SECTION

DWG. NO. C-12

SHEET NO. 14

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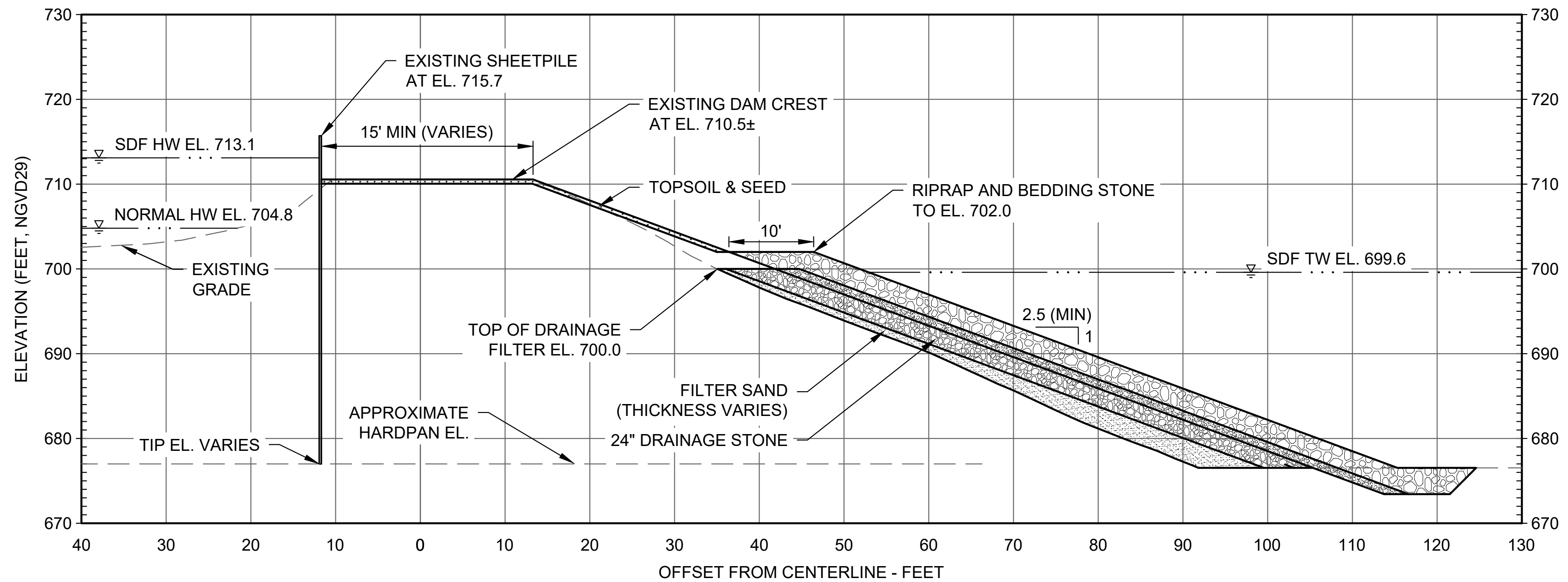
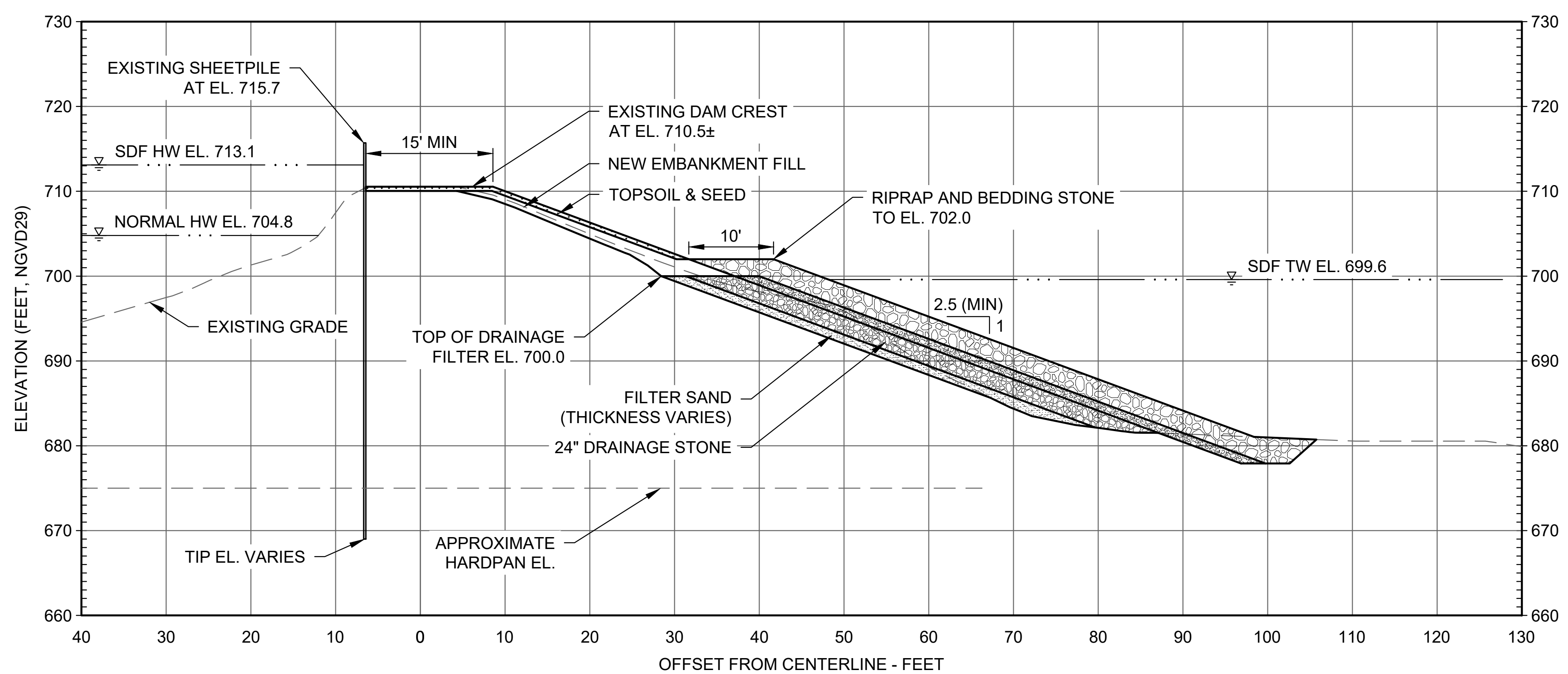


B
C-06
SECTION
RIGHT EMBANKMENT

HORIZONTAL SCALE, FEET
0 10 20
0 10 20
VERTICAL SCALE, FEET
NO VERTICAL EXAGGERATION



C
C-06
SECTION
LEFT EMBANKMENT

HORIZONTAL SCALE, FEET
0 10 20
0 10 20
VERTICAL SCALE, FEET
NO VERTICAL EXAGGERATION

Attention:
0 1"
If this scale bar does not measure 1" then drawing is not original scale.

NO.	DATE	ISSUE/REVISION	APP
0	xx/xx/xxxx	CONCEPTUAL DESIGN SUBMITTAL	-

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GEI Project 2002879

Smallwood Dam
Gladwin County, Michigan

EMBANKMENTS - MODIFICATIONS
SECTIONS (SHEET 1 OF 2)

DWG. NO.
C-13

SHEET NO.
15

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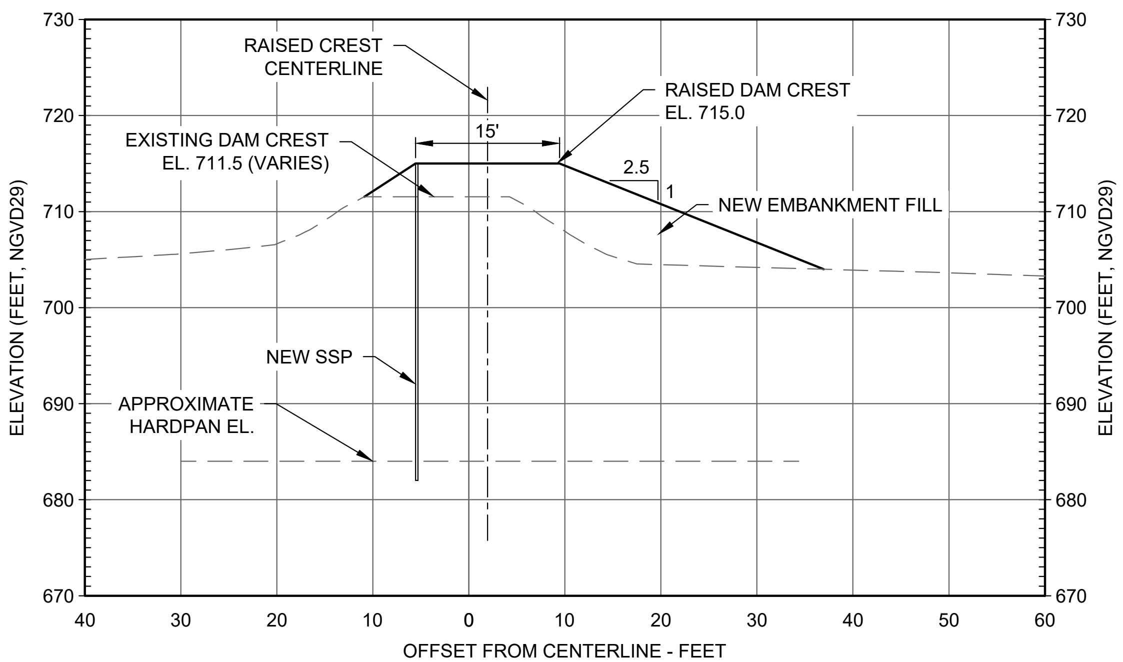
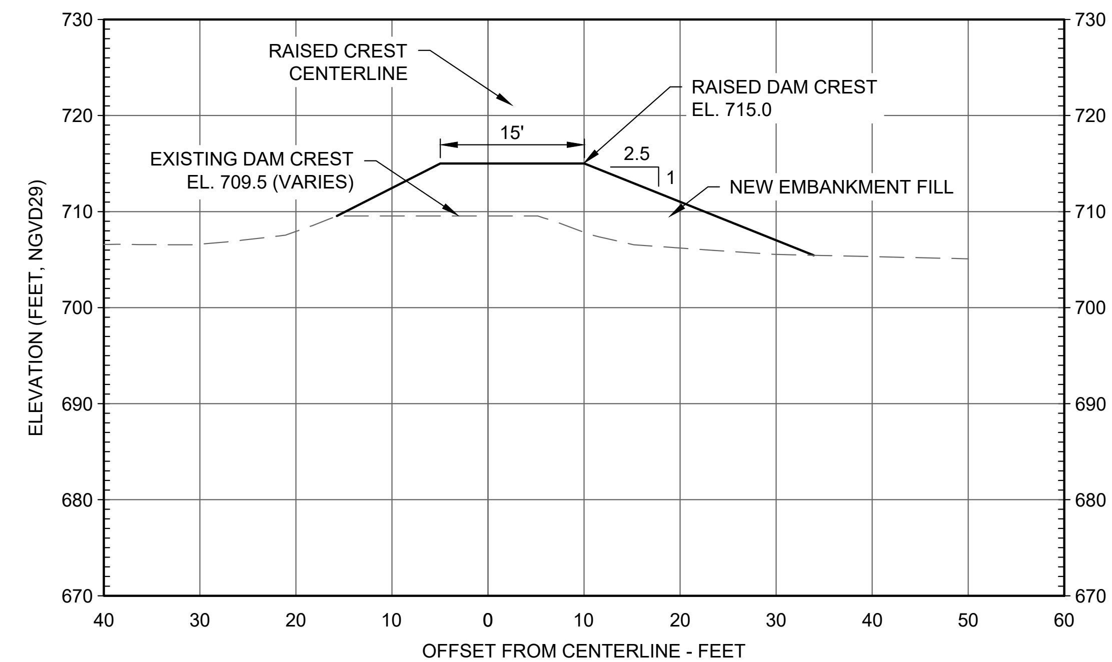


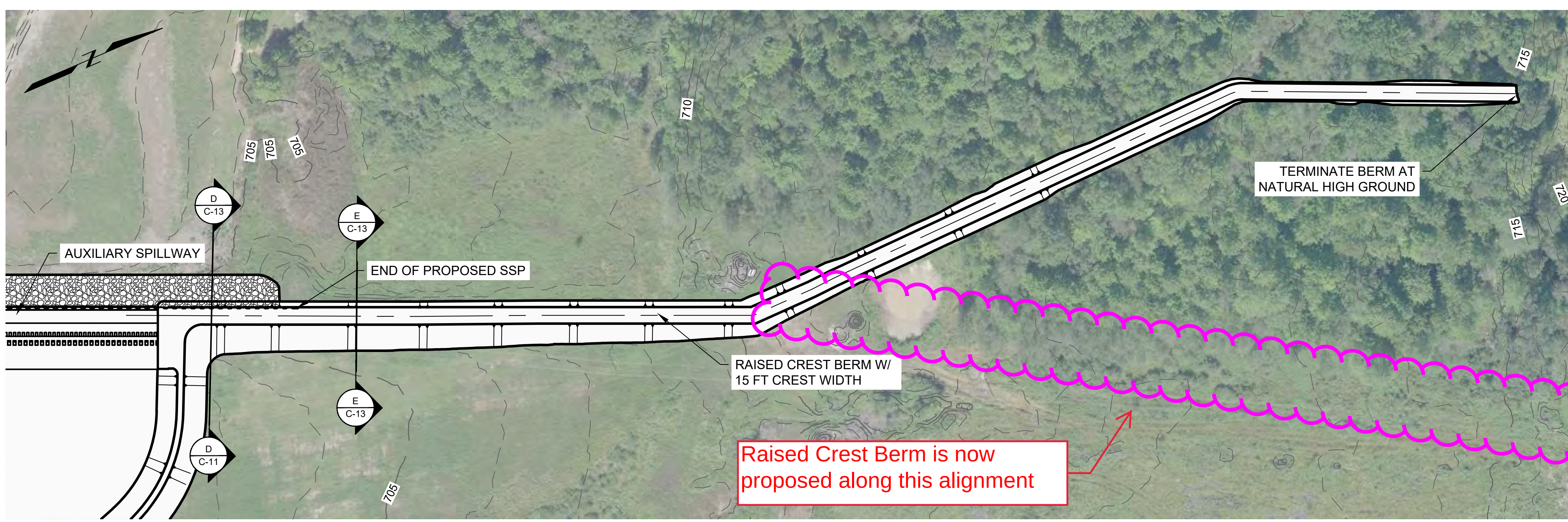
D SECTION
C-06 C-14
LEFT EMBANKMENT W/ SSP CUTOFF

HORIZONTAL SCALE, FEET 0 10 20
VERTICAL SCALE, FEET 0 10 20
NO VERTICAL EXAGGERATION



E SECTION
C-06 C-14
LEFT EMBANKMENT BERM DETAIL

HORIZONTAL SCALE, FEET 0 10 20
VERTICAL SCALE, FEET 0 10 20
NO VERTICAL EXAGGERATION



LEFT EMBANKMENT PLAN

SCALE, FEET 0 60' 120'

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Attention: 0 1" If this scale bar does not measure 1" then drawing is not original scale.

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FERC Project No. 10810

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Smallwood Dam
Gladwin County, Michigan

EMBANKMENTS - MODIFICATIONS SECTIONS (SHEET 2 OF 2)

DWG. NO. C-14

SHEET NO. 16

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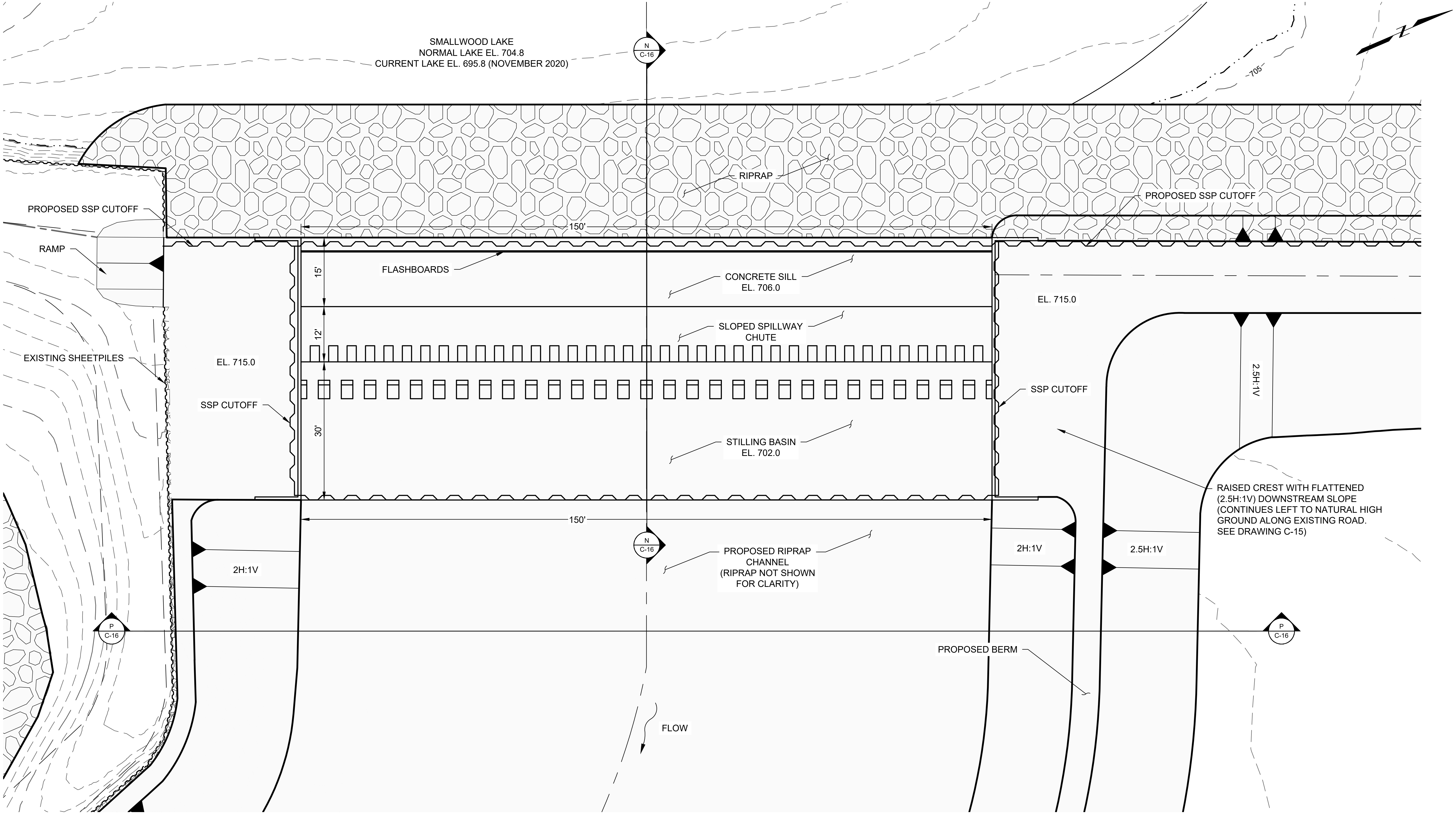

PLAN VIEW

PROPOSED AUXILIARY SPILLWAY

0 10' 20'

SCALE, FEET

Attention:

0 1"

If this scale bar does not measure 1" then drawing is not original scale.

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GEI Project 2002879

Smallwood Dam
Gladwin County, Michigan

AUXILIARY SPILLWAY -
PROPOSED PLAN VIEW

DWG. NO.
C-15

SHEET NO.
17

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