APPENDIX M: ENGINEERING REPORTS

Volume 3 of 4

Contents:

It should be noted that the Engineering Reports were provided by CPRA as standalone documents and in some cases the terminology within may not match the terminology used in the SEIS (e.g. MSP vs. MSA-2 for the selected alternative).

STATE OF LOUISIANA
COASTAL PROTECTION AND RESTORATION AUTHORITY

RIVER REINTRODUCTION INTO MAUREPAS SWAMP
AND WEST SHORE LAKE PONTCHARTRAIN FLOOD RISK
REDUCTION PROJECT PO-0029
STATE PROJECT No. PO-0062
LaGOV NO. 4400019214

BASIS OF DESIGN REPORT

15% DESIGN

APPENDIX C

PROJECT DESIGN CRITERIA

STATE OF LOUISIANA
COASTAL PROTECTION AND RESTORATION AUTHORITY

RIVER REINTRODUCTION INTO MAUREPAS SWAMP AND WEST SHORE LAKE PONTCHARTRAIN FLOOD RISK REDUCTION PROJECT PO-0029
LaGOV NO. 4400019214

PROJECT DESIGN CRITERIA

For

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Revision History

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Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AEP	Annual Exceedance Probability
AISC	American Institute of Steel Construction
AREMA	American Railway Engineering and Maintenance-of-Way Association
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
cfs	cubic feet per second
CIP	Cast-in-Place
CN	Canadian National
CPRA	Coastal Protection and Restoration Authority
dia	diameter
DOTD	Louisiana Department of Transportation and Development
EL	Elevation
EM	Engineering Manual
Gr	Grade
HSDRRS	Hurricane and Storm Damage Risk Reduction System
HSDRRS-DG	Hurricane and Storm Damage Risk Reduction System Design Guidelines
HSS	Hydraulic Structural Steel
Hwy	Highway
KCS	Kansas City Southern
ksi	kips per square inch
lb	Pound
LFPDG	Louisiana Flood Protection Design Guidelines
LRFD	Load and Resistance Factor Design
LWL	Low Water Level
Maint.	Maintenance

MDE	Maximum Design Earthquake
MOP	Method of Planes
MRL	Mississippi River Levee
NAVD	North American Vertical Datum
NWL	Normal Water Level
OBE	Operating Basis Earthquake
psf	pounds per square foot
psi	pounds per square inch
PVC	Polyvinyl chloride
SWL	Safe/Still Water Level
TBD	To Be Determined
T.O.	Top Of
USACE	United States Army Corps of Engineers
vpd	vehicles per day
WSE	Water Surface Elevation
WSLP	West Shore Lake Pontchartrian

1. INTRODUCTION

This document presents the criteria controlling all design disciplines for the combined River Reintroduction into Maurepas Swamp (herein the Maurepas Diversion) and West Shore Lake Pontchartrain Flood Risk Reduction Project (herein the WSLP Project). For additional details on all aspects of the Project, see the Basis of Design Report (BODR), of which this Project Design Criteria is an Appendix.

2. GEOTECHNICAL DESIGN

2.1 Codes, Standards, and Guidelines

The geotechnical exploration and geotechnical analyses for this project need to meet requirements for the 1% storm (AEP). Thus, all designs will need to be performed in accordance with the Interim Hurricane and Storm Damage Risk Reduction System Design Guidelines (HSDRRSDG) developed by the U.S. Army Corps of Engineers (USACE) New Orleans District. The project design criteria used in the geotechnical analyses are described in detail in the HSDRRSDG.

2.2 References

Additional design criteria prepared by the USACE and referenced for our analyses include:

- New Orleans District Engineering Division, *Hurricane and Storm Damage Risk Reduction System Design Guidelines* (HSDRRSDG), with all revisions and addendums, dated June 2012
- Engineering Manual (EM) 1110-2-1901, *Seepage Analysis and Control for Dams*, 30 Sept 1986, Including Change 1, 30 Apr 1993
- EM 1110-2-1902, *Slope Stability*, 31 Oct 2003
- EM 1110-1-1904, *Settlement Analysis*, 30 Sept 1990
- EM 1110-1-1905, *Bearing Capacity of Soils*, 30 Oct 1992
- EM 1110-2-1913, *Design and Construction of Levees*, 30 Apr 2000
- EM 1110-2-2906, *Pile Foundation Design*, 15 Jan 1991
- Engineering Technical Letter (ETL) 1110-2-569, *Design Guidance for Levee Underseepage*, 1 May 2005
- Division Regulation (DIVR) 1110-1-400, *Soil Mechanic Data*, Section 8, Groundwater and Seepage, 12 Dec 1998
- LPILE Method for Evaluating Bending Moments in Batter Piles Due to Ground Settlement for Pile-Supported Floodwalls in New Orleans and Vicinity, Final Contract Report, September 2012

2.3 Computer Programs

Global stability analyses will include evaluating an earthen levee without reinforcement. We assume the levee is constructed as an initial overbuild and then with two subsequent levee lifts to maintain target design grades at selected design periods. In accordance with HSDRRSDG, stability analyses will be performed using Spencer's Method and the Method of Planes (MOP) analyses will be used to verify the findings. For potential future lifts, Eustis Engineering will provide preliminary evaluations based only on Spencer's Method. Spencer's Method will be performed using the computer program SLOPE/W by GEO-SLOPE International, Ltd. The MOP analyses will be performed using the USACE's "Stability with Uplift" program.

For both analysis methods and design guidelines, stability analyses will be performed for multiple design water levels. We assume these water levels will be provided by AECOM and the CPRA. Water levels may include water at the Top of Levee, Top of Wall, or construction grade level; at the project grade level; at the Still Water Level (SWL); at the Normal Water Level (NWL); and the Low Water Level (LWL). Analyses for the NWL and LWL will be based on both short term drained soil design parameters (i.e., Q-case) and long term drained soil conditions (i.e., S-case). Additional analyses for the levees and floodwalls will include an evaluation of seepage and settlement.

2.4 Design Criteria

The geotechnical section of the HSDRRSDG is dated June 2012. Design of the project will also be in general accordance with the State of Louisiana, Coastal Protection and Restoration Authority's (CPRA) Louisiana Flood Protection Design Guidelines (LFPDG), dated 16 July 2015. The LFPDG is used when designing flood protection for less than a 100-year recurrent storm event (e.g., 2% storm, 4% storm). The CPRA's LFPDG generally follows the USACE's HSDRRSDG for design of I-walls and T-walls (floodgates) and earthen levees. One key difference allows for a reduced or phased exploration scope for an interim levee design per the LFPDG. Another difference is in the number and type of analyses to select the critical design template.

The HSDRRS design guidelines shall supersede all applicable EM and ETL criteria. A summary of the geotechnical criteria and required factors of safety are presented in **Table 2-1.**

Table 2-1. Geotechnical Design Criteria

ITEM	LOADING CONDITIONS		FACTOR OF SAFETY	CONDITION
	WATER LEVEL(1)	SHEAR STRENGTH PARAMETER(2)		
Pile Capacity (Axial)	N/A	Q	2.0	With Load Test
	N/A	Q	3.0	Without Load Test
	N/A	Q	2.5	With Dynamic Pile Test
	N/A	S	1.5	With or Without Load Test
Deep-Seated Stability of Pile Supported Structures Using Spencer's Method (and Optimization Search Routine)	SWL	Q	1.5	If Target Factor of Safety is not Achieved, Determine Required Unbalanced Force to Achieve This Target Factor of Safety
	EWL	Q	1.4	
	LWL	Q	1.4	
	LWL	S	1.4	

ITEM	LOADING CONDITIONS		FACTOR OF SAFETY	CONDITION
	WATER LEVEL(1)	SHEAR STRENGTH PARAMETER(2)		
Deep-Seated Stability of Pile Supported Structures Using Janbu's Method(3)	SWL	Q	1.3	
	EWL	Q	1.2	
	LWL	Q	1.3	
Tie-In Levee Stability Using Spencer's Method	LWL	Q	1.4	-
	LWL	S	1.4	-
Tie-In Levee Stability Using Janbu's Method	LWL	Q	1.3	-
	LWL	S	1.3	-
	SWL	Q	1.3	With and Without Partial Gap(4)
Stability of Soil Disposal Spencer's Method with Optimization Search Routine	LWL	Q	1.4	-
	LWL	Q	1.2	Rapid Drawdown Case
	LWL	S	1.4	Represents Long Term (Steady State Seepage)

3. STRUCTURAL DESIGN

3.1 Introduction

This document presents the criteria controlling structural design for the combined River Reintroduction into Maurepas Swamp (herein the Maurepas Diversion) and West Shore Lake Pontchartrain Flood Risk Reduction Project (herein the WSLP Project). This document applies to the Maurepas Headworks, Maurepas Conveyance Channel features at road and railroad crossings, WSLP crossings at roads and railroads, WSLP floodwalls and I-walls, and any other required hardened structures.

Within this criteria there are three general structure types:

- West Shore Lake Pontchartrain flood protection structures
- Maurepas Headworks (Mississippi River Levee flood protection) structures
- Maurepas Internal Conveyance structures

The primary differences between the groups is in load conditions. WSLP has a specific hydraulic criterion to follow regarding water and wave loads and shall adhere to the HSDRRS Design Guidelines. The Headworks portion of the Maurepas Diversion must follow MRL hydraulic criteria and regulations. The Maurepas Internal Conveyance system does not require flood control analyses and is focused on significant traffic and rail live loads. All structures are designed using the same concrete, steel, and foundation codes and guides (primarily USACE documents).

3.2 Maurepas Project Structures

A brief summary of the required structures is presented here. For additional detail refer to the Basis of Design Report (BODR) and the Design Drawings.

3.2.1 Mississippi River Intake System

The Intake System is the group of structures that control flow of Mississippi River water into the Conveyance Channel. It is comprised of the following:

- Inflow Structures: three (3) U-frame Monoliths, U-1, U-2 and U-3
- Headworks Structure, C-1 (also referred to as the “Gated Intake Structure”)
- Five (5) box culverts, C-2 through C-6
- Outflow Structures: three (3) U-frame Monoliths, U-4, U-5 and U-6

All structures are normal-weight reinforced concrete construction on pile foundations.

3.2.2 Canadian National Railroad Crossing

Concrete multi-barrel box culvert running beneath four (4) rail lines. The BODR contains discussion regarding the status of the number of tracks that will be incorporated into the design.

3.2.3 Kansas City Southern Railroad Crossing

Previously designed as a standard KCS Rail bridge in the 2013 Design, this item may be changing to a concrete multi-barrel culvert crossing similar to CN Railroad. The BODR contains discussion regarding the status of this change.

3.2.4 Airline Highway Crossing

Concrete multi-barrel box culvert running beneath a newly placed levee embankment with roadway on top. At this time, this is the chosen Alternative from the 15% Design phase. Adjustments will be made as necessary if this Alternative is superseded by another.

3.2.5 Interstate 10 Crossing

No structures are required at this crossing.

3.3 WSLP Project Structures

A brief summary of the required structures is presented here. For additional detail refer to the Basis of Design (BOD) Report and the Design Drawings.

3.3.1 MRL Tie-In

A small section of concrete capped I-wall may be required to span the distance between the River Road crossing and the MRL.

3.3.2 River Road Crossing

Two alternatives are being explored during feasibility-level planning: raising the elevation of River Road to meet the design flood elevation or building a gated closure structure. The gated closure structure appears to be the favored Alternative and has been designed to a 15% level.

3.3.3 Canadian National Railroad Crossing

Roller gate closure structure flanked by tie-in T-wall monoliths. All are inverted T-wall style reinforced concrete structures on pile foundations; the center monolith contains the rolling floodgate. As stated previously, the BODR contains discussion regarding the status of the number of tracks that will be incorporated into the design

3.3.4 Kansas City Southern Railroad Crossing

Swing gate closure structure flanked by tie-in T-wall monoliths. All are inverted T-wall style reinforced concrete structures on pile foundations; the center monolith contains the swing floodgate.

3.3.5 Airline Highway Crossing

Two viable alternatives are being explored during feasibility-level planning: raising the elevation of Airline Highway to meet the design flood elevation or an elevated bridge that provides space for WSLP flood protection features underneath.

3.4 References and Publications

The following is a list of US Army Corps of Engineers (USACE) references and industry codes and standards that are applicable to structural design of the Maurepas/WSLP Project. Local codes shall govern in case of conflicting requirements. All of the general codes and standards listed below apply to all design elements, but are not necessarily limited to, the following:

3.4.1 Industry Codes and Standards.

- AA, Aluminum Association, *Aluminum Design Manual*, 2020
- AASHTO, American Association of State Highway and Transportation Officials, *LRFD Bridge Design Specifications,* 8th Edition
- ACI 318-14, American Concrete Institute, Building Code Requirements for Structural Concrete
- ACI 350-06, American Concrete Institute, Code Requirements for Environmental Engineering Concrete Structures and Commentary
- AISC, American Institute of Steel Construction, Inc., *Manual of Steel Construction*,15th Edition (ASD only)
- AREMA, American Railway Engineering and Maintenance-of-Way Association, *Manual for Railway Engineering,* 2019
- ASCE 7-16, American Society of Civil Engineers, Minimum Design Loads and Associated Criteria for Buildings and Other Structures
- ASTM, American Society for Testing and Materials
- AWS D1.1, American Welding Society, *Structural Welding Code*, 2015
- AWS D1.4, Structural Welding Code, Reinforcing Steel, 2011
- AWS D 1.5, Bridge Welding Code, 2015
- LaDOTD, Louisiana Department of Transportation and Development, *Louisiana Standard Specifications for Roads and Bridges,* 2016

3.4.2 USACE Engineering Manuals and Guidance

- New Orleans District Engineering Division, *Hurricane and Storm Damage Risk Reduction System Design Guidelines* (HSDRRSDG), with all revisions and addendums, dated June 2012
- EM 1110-2-1913, Design and Construction of Levees, 30 Apr 2000

- EM 1110-2-2000, Standard Practice for Concrete for Civil Works Structures, 31 March 2001
- EM 1110-2-2007, Structural Design of Concrete Lined Flood Control Channels, 30 Apr 1995
- EM 1110-2-2100, Stability Analysis of Concrete Structures, 1 Dec 2005
- EM 1110-2-2102, Waterstops and Other Preformed Joint Material for Civil Works Structures, 30 Sep 1995
- EM 1110-2-2104, Strength Design for Reinforced Concrete Hydraulic Structures, 30 Nov 2016
- EM 1110-2-2400, Structural Design and Evaluation of Outlet Works, 02 Jun 2003
- EM 1110-2-2502, *Retaining and Flood Walls*, 29 Sep 1989
- EM 1110-2-2503, Design of Sheet Pile Cellular Structures Cofferdams and Retaining Structures, 11 June 1990
- EM 1110-2-2504, *Design of Sheet Pile Walls*, 31 Mar 1994
- EM 1110-2-2902, *Conduits, Culverts and Pipes*, 31 Mar 1998
- EM 1110-2-2906, *Design of Pile Foundations*, 15 Jan 1991
- EM 1110-2-6053, Earthquake Design and Evaluation of Concrete Hydraulic Structures, 01 May 2007
- ETL 1110-2-584/EM 1110-2-2107 (Pending), *Design of Hydraulic Steel Structures*, 30 Jun 2014
- ETL 1110-2-575, *Evaluation of I-Walls*, 1 Sep 2011

3.4.3 Computer Programs

The following is a general list of computer programs that will be used in the structural analysis of the project features, but are not necessarily limited to, the following:

- SAP 2000 Version 20.1
- Microsoft 2019 Excel
- Microsoft 2019 Word
- AutoCAD Version 2020
- CPGA
- Ensoft, Group Pile Design
- SP Column

3.5 Concrete Design Criteria

Concrete design is based on EM 1110-2-2104 and uses the strength design methods of ACI 318-14. Loads and Load Cases, which also follow the HSDRRSDG guidelines, are presented in Section 6.

3.5.1 Minimum Design Values

Minimum design values are as follows unless otherwise noted:

- Superstructure Structural Concrete: 4,000psi compressive strength at 28 days
- Pre-stressed precast concrete piles: 6,000psi compressive strength at 28 days
- Concrete for paving, sidewalks, and other flatwork: 3,500 psi compressive strength at 28 days
- Steel reinforcement: 60,000 psi (ASTM A615)
- Welded wire fabric: ASTM A185
- Prestressing strands: 270 ksi low relaxation, tensile strength, uncoated 7-wire strand

Reinforcement cover distances, maximum flexural reinforcement, shear requirements, and temperature and shrinkage requirements shall all comply with EM 1110-2-2104. Strength reduction factors (ϕ) conform to ACI 318 and are 0.9 for flexure and 0.75 for shear.

3.5.2 Joints and Waterstops

Water-retaining structures shall be designed with joints spaced and detailed as per EM 1110-2-2102. Monoliths shall be designed independent of adjacent monoliths (i.e. no load transfer). Joint gaps shall be designed for thermal expansion and shall be protected from debris contamination.

If they provide flood protection or act as a Conveyance Channel feature, all walls, slabs and foundations shall be fitted with waterstops at all construction, control (contraction), and expansion joints. The only exceptions are the inflow and outflow U-frames, where watertight joints are not required because channel water is able to flow to the backside of these walls.

Joints and waterstops shall be designed in accordance with the more applicable of EM 1110-2-2102 and ACE 350. Polyvinyl chloride (PVC) or strip-type (hydrophilic, non-bentonite type) waterstops should be used in construction joints, and PVC waterstops should be used in expansion and control joints. Waterstops in joints at the bases of walls and similar applications should be detailed and installed to remain in their intended position during the construction process. In the case of PVC waterstops, emphasis would be placed on using prefabricated T, cross, and L-sections at corners and intersections.

3.6 Steel Design Criteria

Hydraulic Steel Structure (HSS) design shall be performed in accordance with ETL 1110-2-584 and the AISC Steel Construction Manual, 15th edition. Load and Resistance Factor Design (LRFD) is the preferred design method except that pile foundations shall be designed using the Allowable Stress Design (ASD) procedure presented in EM 1110-2-2906.

3.6.1 LRFD Design Basis

All HSS members and connections shall satisfy the following equation:

$\Sigma\gamma_i Q_{ni} \leq \alpha\phi R_n$ (ETL 1110-2-584 Eq. 3-1)

Where, γ_i = load factors that account for variability in loads to which they are assigned

Q_{ni} = nominal (code-specified) load effects

α = performance factor, 0.9 for all structures

ϕ = resistance factor taken from AISC (i.e. 0.90 for flexural loading)

R_n = nominal resistance

3.6.2 Structural Shapes

Steel shapes conform to the following ASTM designations unless otherwise noted:

– H-piles	A572, Grade 50
– Steel Sheet Piling	Hot Rolled, ASTM A 572 Grade 50
– Structural steel rolled W-shapes	A992, Grade 50
– Other rolled sections and plates	ASTM A36 or ASTM A572, Grade 50
– HSS (Rect, Square, Round)	ASTM A500, Grade C
– Pipe	ASTM A53, Types E or S, Grade B, or ASTM A501
– Bolts	F3125, min. 3/4“ dia.
– Nuts	A563
– Washers	F436
– Anchor Bolts or rods	ASTM A449, (3/4“ dia. or greater); F1554, Grades 36, 55, and 105 ksi; A354; or A449
– Sheet Piles	ASTM A572, Grade 50
– Stainless Steel Embed Anchors	ASTM A276 or UNS S21800

Stainless steel, if used, shall conform to the following:

– Bars, shapes	ASTM A276, Type 316
– Tubing and pipes	ASTM A269, A312, or A554, Type 316
– Strip, plate, and flat bar	ASTM 666, Type 316, Grade A
– Bolts, nuts, expansion/adhesive anchors	ASTM F593, Type 316
– Minimum yield strength:	25 ksi
– Material for welded connections	Type 316 L

– Welding Electrodes shall be in accordance with AWS for alloy being welded

3.6.3 Corrosion Protection of Steel Components

Components that will be exposed to the environment shall be primed, painted and sealed with coats of an applicable epoxy painting system (20 mils min.). Sluice gates and bulkhead gates shall be painted with the painting system recommended by the manufacturer.

The top 8-inch length of steel sheet piling and steel H-piling shall not be painted. 10’-0” of the upper portion of the sheet piling and H-pile, beginning 8” down from the top of the pile, shall be painted with coal tar epoxy. In addition, steel sheet piling and steel H-piling conforming to ASTM A572 Gr 50 shall be used.

As an alternate, a “sacrificial thickness” steel sheet piling and H-piling with a material thickness of at least 1/8-inch greater than the shape required by design may be used in lieu of painting.

3.6.4 Steel H-Piles

Steel piles shall be designed structurally per AISC ASD, 15th Edition, and as modified by EM 1110-2-2906. 2013 Geotechnical analysis is available to the team and is used in the 15% Design. Data includes H-pile capacity curves, lateral force vs. deflection data and moment vs. deflection data. Geotechnical information collected during this Design Phase shall be incorporated into all future design work.

Final pile designs for large structures shall be based on a soil-structure interactive analysis using structural finite-element software (SAP2000) to account for the stiffness of the base. Pile supports shall be input as pile head springs in accordance with EM 1110-2-2906. Lateral springs shall be developed from pile head lateral load versus displacement curves generated by a P-Y analysis. Axial springs shall be developed using the spring constant derived by the CPGA program:

$b_{33} = c_{33} * (A * E) / L$

Where, b_{33} = axial pile stiffness spring (k/in)

c_{33} = axial stiffness modifier coefficient (supplied by geotechnical analysis for various pile types)

A = cross-sectional area of the pile

E = modulus of elasticity of the pile

L = length of the pile

Group effects shall be applied as required.

All pile foundations are designed under the assumption that pile load tests will be performed before construction. A Factor of Safety of 2.0 is used for the undrained pile strength curves and 1.5 is used for the drained pile strength curves. If a pile load test will not be performed, or if one will only be performed for certain portions of the project (e.g. the Headworks area), the piles on all structures not included in a pile load test zone shall need to be lengthened to accommodate a Factor of Safety of 3.0 for the undrained curves (1.5 safety factor stays the same). If not specifically designed as a moment connection, pile foundations shall be analyzed as both fixed and pinned connections to the monolith base and designed for the resulting envelope.

Piles are not lengthened to accommodate higher reactions produced by the settlement forces. The piles are checked structurally for all settlement load cases and no Combined Bending Factor (as defined in the CPGA Manual, Paragraph 37) is allowed to surpass 1.0. Allowable Stress Design (ASD) is permitted in the design of piles, allowable stresses shall not exceed those specified in EM 1110-2-2906.

3.7 Aluminum Design Criteria

General criteria for aluminum shall be in accordance with the Aluminum Design Manual. Aluminum Alloy 6061-T6 is used for the basic design of aluminum structures and members.

3.8 General Design Parameters

Structures, both concrete and steel, shall be designed using the LRFD method. Capacity shall equal or exceed the effects of the factored load combinations as prescribed in the concrete and steel criteria sections. Service loads shall be calculated to determine serviceability, deflections and foundation designs. Load Combination Tables are provided for all Maurepas and WSLP Project Structures in Section 3.8.3. Load abbreviations and descriptions are described below.

3.8.1 Loads

3.8.1.1 Load Abbreviations

Table 3-1. Load Abbreviations

Load	Description
D	Dead
L	Live Load (vertical)
Lr	Roof Load
Q	Operating Equipment
V	Vehicle Live Loads
Vr	Railroad Live Loads
Ls	Temporary Construction (Live Load) Surcharge
EV	Vertical Earth
EH	Lateral Earth
Hs	Hydrostatic Static Load
Hw	Wave
Hu	Uplift
EQ	Seismic Loads
Ld	Vibration Loads
I	Debris Impact
IM	Barge/Boat Impact
W	Wind
ST	Settlement

3.8.1.2 Dead Loads (D)

Dead loads are in accordance with applicable USACE EMs and ASCE 7-16 and include the self-weight of all permanent construction components including foundations, slabs, walls, roofs, actual weights of permanent equipment, overburden pressures, and all permanent non-removable stationary construction.

Table 3-2. Unit Material Weights

Item	Weight (pcf)
Water (Fresh)	62.4
Saltwater	64.0
Reinforced Concrete (Normal weight)	150
Steel	490
Semi-compacted Granular Fill	110
Fully Compacted Granular Fill, wet	120
Fully Compacted Granular Fill, Effective	58
90% Compacted Clay Fill, wet	115
90% Compacted Clay Fill, Effective	52.6
Riprap	132
Silt	110
Ballast	120

Railway dead loads shall be in accordance with AREMA MRE Chapter 8 Sections 2.2.3b and 16.4.2. Track rails are assumed to be 200 lb per linear foot of track as per the AREMA code.

Equipment weight provided below is based on the best available information from the manufacturer:

- Weight 120” x 120” cast iron sluice gate assembly: 26,100 lbs

3.8.1.3 Live Loads (L, Lr)

Live Loads are as defined in the table below. Other transient loads, except for Environmental loadings, are specified in Chapter 4 of ASCE 7-16.

Table 3-3. Live Loads (L, Lr)

Item	Weight (PSF)	Alternate Weight, Concentrated Load (lb)
Roof Live Loads	60	--
Roof Load Hydraulic Structure	100	--
Railing Loads (Pr)	See para 5.4.2.7	
Floor Live Loads:		
Minimum unless noted otherwise	100	--
Grating Floors, Landings and Stairs	100	300
Operating Floor	300	--
Equipment and Control Room	200	--
Service Bridge	300	50 ton crane or AASHTO HS-20

Pedestrian railings shall be designed to carry the following loads:

- 50 lb/ft transverse and vertical simultaneously on all longitudinal members (rails).
- 50 lb/ft per post spacing at height to center of top rail at each post.
- 200 lb concentrated on top rail.

3.8.1.4 Equipment (Q)

The sluice gate equipment force provided below is based on the best available information from the manufacturer.

- The maximum force of gate movement for any water elevation: 99,743 lbs

3.8.1.5 Vehicle (V)

Vehicular live loads shall be applied to all gate structures; design truck load, lane load, vehicular collision loads, dynamic load allowances, and multiple presence factors shall be in accordance with AASHTO Standard Specifications for Highway Bridges. The HS20-44 design truck used is shown in *Figure 6.1*. The design lane load shall be a 640 lb/ft uniform line load running in the longitudinal direction and distributed over an assumed lane width of 10 feet, as per AASHTO Specifications section 3.6.1.2.4. HS20 truck and lane loads shall be combined to create the HL-93 design load as required by section 3.6.1.3 of the AASHTO Specification. Dynamic Load Allowance, IM, shall be 75% for joints and 33% for all other structural components and shall be applied by multiplying the static design load by (1 + IM/100).

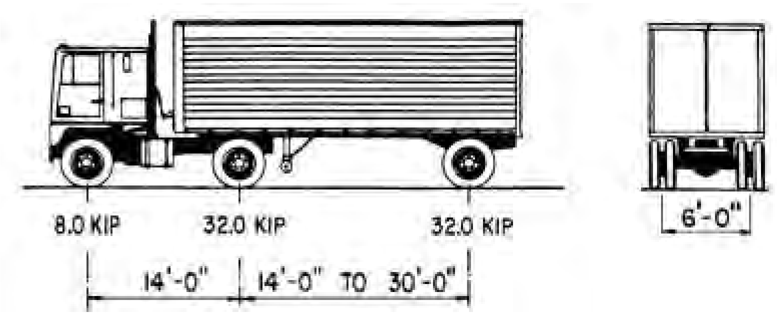

Figure 3.1. Design Truck Load

Multiple presence factor, *m*, shall be applied to all vehicular loads per AASHTO Specifications Section 3.6.1.1.2; values of *m* used are shown in **Table 3.3** below.

Table 3-4. Vehicular Multiple Presence Factors

Number of Loaded Lanes	Multiple Presence Factor, *m*
1	1.2
2	1.0
3	0.85
>3	0.65

3.8.1.6 Railroad (Vr)

Cooper E80 rail live loads are applied to all crossing structures. Loading follows AREMA MRE Chapter 8 Sections 2.2.3c and 16.4.3 of the AREMA *Manual for Railway Engineering*; axle loads are to be distributed and adjusted for simultaneous loading as described in this section. The axle spacing is shown in the figure below.

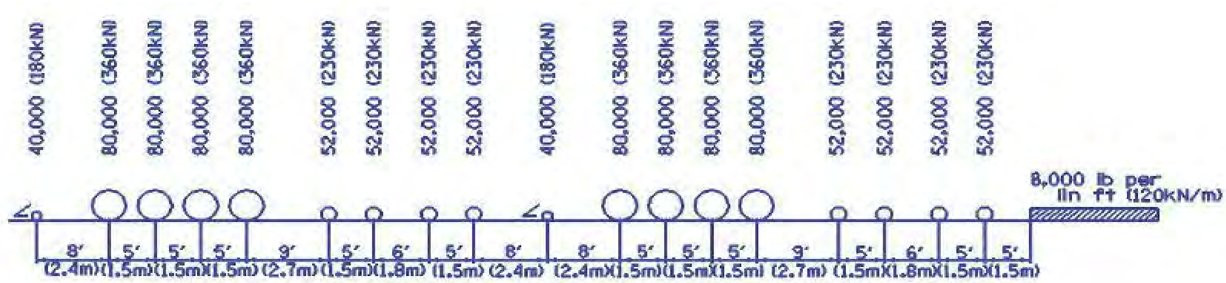

Figure 3.2. Design Train Load

Other applicable railroad loads such as impact, longitudinal forces, and lateral surcharge shall also be applied.

3.8.1.7 Temporary Construction Surcharge (Ls)

A minimum vertical live load surcharge of 250 psf is applied to the top slab during construction for soil and earth moving loads on the culvert.

A minimum horizontal live load surcharge of 300 psf is applied to all abutment walls and wing walls of hydraulic structures in addition to other live loads that may be applicable in accordance with AASHTO.

3.8.1.8 Soil Pressures (EV, EH)

Structures are designed for lateral (EH) and vertical (EV) soil pressures. Vertical pressures are calculated using unit weight of clay, which is based on soil boring data from the site. Lateral pressures are determined using the at-rest coefficients, $K_{0,}$ obtained from the Geotechnical Report. In 15% Design calculations a value of 0.95 is used because this was recommended in the 2013 Geotechnical Report with regard to the Headworks. This value will be verified and updated as needed based on new geotechnical data and may vary between features if soil conditions differ significantly.

3.8.1.9 Hydrostatic Loads (Hs)

Hydrostatic loads are the vertical and horizontal loads induced by a static water head and buoyant pressures, excluding uplift pressures. Vertical and horizontal hydrostatic pressures are calculated using the unit weight of water and height of the water column in question.

3.8.1.10 Wave and Dynamic Hydrostatic Loads (Hw)

Wave pressures shall be applied to applicable structures within the WSLP levee system. These loads are provided by the USACE for each WSLP Reach within this project. Pressure diagrams use the Goda formulation for computed wave forces.

Dynamic wave load will not be applied to any Maurepas Project structures. The Headworks is set back from and perpendicular to the Mississippi River, resulting in little to no expected dynamic hydraulic forces; the remainder of the Maurepas features are not exposed to wave action.

3.8.1.11 Uplift (Hu)

Uplift loads are defined by two uplift conditions:

- Impervious Uplift condition assumes the sheet pile cutoff wall is fully effective, and
- Pervious Uplift condition assumes the sheet pile cutoff wall is ineffective (pressure assumed to vary linearly across the base).

3.8.1.12 Seismic (EQ)

Earthquake ground motions for the design and evaluation of the structure are the Operating Basis Earthquake (OBE) and the Maximum Design Earthquake (MDE) ground motions as defined by EM 1110-2-6053 and ASCE 7-16. Seismic forces associated with the OBE are considered unusual loads and those of the MDE are considered extreme loads. When applicable, seismic (earthquake) loads are combined with other loads that are expected to be present during routine operations. Earthquake loadings are not combined with hurricane and riverine flood events.

Typically, earthquake ground motion does not govern design of hydraulic structures in this region of Louisiana; flood and other environmental loads tend to govern. However, this assumption shall be validated during the design process.

3.8.1.13 Vibration Loads (Ld)

Vibration loadings are considered negligible and are not included.

3.8.1.14 Impact Loads (I, IM)

No Maurepas Project features are subject to debris, barge, or ship impact loads. The existing Marathon Petroleum dock structures will shelter the Inflow and Gated Structures from large debris or errant ships. If debris does pass through and around the existing docks it will not be able to accelerate to a velocity required to impart significant impact loads. Structures within the Conveyance Channel are sheltered and will not see significant debris loads.

3.8.1.14.1 Debris Impact

WSLP flood-control features will be subject to a debris loading equal to 500 lbs/ft applied at the TOW as described in the HSDRRS Design Guidelines. If a vessel impact is required for WSLP features, this load will govern by inspection over a debris impact case.

3.8.1.14.2 Barge Impact

If WSLP Reaches fall within a requirement for pleasure craft or barge impact loads, these shall be applied to all hardened structures.

3.8.1.15 Wind (W)

Wind forces shall be determined in accordance with ASCE 7-16, which provides a minimum wind velocity of 130 mph for a 3-second gust. Hydraulic concrete structures shall be designed for a wind load no less than 50 psf. Closure gates shall be analyzed for two wind loads, an extreme load of 50psf and an operational load of 15psf, as per ETL 1110-2-584

3.8.1.16 Settlement (ST)

All Maurepas Headworks structures shall be designed for forces generated by settlement in coordination with the U.S. Army Corps of Engineer's previous designs of diversion structures. As per the design criteria from the Davis Pond and Canarvan Diversion Structures, a 600psf adhesion force (downdrag) shall be applied to all wall areas subject to clay backfill. To account for additional vertical forces due to settlement, a contributory area of soil extending at a 45° angle from the top corners of all buried structures shall be added to the column of fill directly over it.

For all WSLP Structures, downdrag on pile foundations shall be included when settlement of soils within the footprint of the foundation induces axial and flexural stresses in a battered pile. Assessment of locations where downdrag may take place and computation of loads shall be provided by the Geotechnical Engineer.

3.8.2 Controlling Elevations

3.8.2.1 Maurepas Headworks

Important design, hydraulic, and groundwater elevations are described below for all structures that make up the Headworks.

Table 3-5. Maurepas Headworks Structural Elevations

Item	Elevation (ft-NAVD88)
Top of Levee/Top of Protection*	31.50
Top of Gate Structure (C-1)**	33.50
Top of LA 44 (River Rd.)	10.49 (previously 10.73)
Top of culvert, exterior	5.75
Top of culvert, interior	3.00
Inflow U-frame Starting Invert	-4.00
Culvert & Gate Structure Invert	-7.00
Outflow U-frame Ending Invert	-1.91

*Mississippi River Flow line at this location, El. 27.1, plus estimated freeboard of 4.4 feet. Levee is at El. 33.50 near Gate Structure to accommodate embedded capped I-wall.

**Top of Required Protection + 2 feet slab thickness.

Table 3-6. Hydraulic Stages and Design Water Surface Elevations – Normal Operation

Operational Cases	Head Water (ft-NAVD88)	Tail Water (ft-NAVD88)
Minimum River Stage	1.00**	1.00
~500 cfs Operation	3.80	3.80
~1000 cfs Operation	4.90	4.60
~1500 cfs Operation - Low Stage	6.70	5.80
~2000 cfs Operatin - Low Stage	9.10	7.60
~1500 cfs Operation - Medium Stage	9.90	5.80
~2000 cfs Operatin - Medium Stage	9.90	7.60
Maximum River Stage	24.35*	1.00
~1500 cfs Operatin - High Stage	24.35*	5.80
~2000 cfs Operation - High Stage	24.35*	7.60
Hurricane Condition	1.00**	9.00

* Based on Mississippi River Stages at Reserve, LA. See Figures 1, page 12 for hydraulic data. Elevations include geodetic adjustments.

** Minimum River Stage is as per river data is 1.19ft NAVD88. This number has been rounded down slightly for design.

Table 3-7. Design Ground Water Surface Elevations

Item	Elevation (ft-NAVD88)
Average Ground Water El.	5.2
Maximum Ground Water El.	8.10

Table 3-8. Tail Water at Headworks (USACE - August 7, 2011)

Stage Condition	100-yr (ft-NAVD88)	500-yr (ft-NAVD88)	1000-yr (ft-NAVD88)
Existing	5.2	7.3	8.1
Low (SLR 1)	10.7	13.3	14.3
Intermediate (SLR 2)	11.5	14.2	15.1
High (SLR 3)	13.8	16.5	17.4

1. The stages are shown for hurricane events ranging from the 100-year to the 500-year chance of occurrence.
2. The “Low”, “Intermediate” and “High” are future conditions stages for Year 2060. They are the low, intermediate and high Sea Level Rise (SLR) conditions, as projected using the USACE latest design guidance for considering sea level rise.

3.8.2.2 Maurepas CN Crossing

Elevations that control the Canadian National Railroad crossing culvert design are as follows.

Table 3-9. Maurepas CN Design Elevations

Item	Elevation (ft-NAVD88)
Top of rail	11.98
Top of culvert, exterior	2.75
Top of culvert, interior	0.75
Culvert Invert	-7.25
Bottom of culvert, exterior	-9.75
Conveyance Channel Water surface	8.0

3.8.2.3 Maurepas KCS Crossing

Elevations that control the Kansas City Southern Railroad crossing bridge design are as follows.

Table 3-10. Maurepas KCS Design Elevations

Item	Elevation (ft-NAVD88)
Top of rail	8.74 (previously 9.85)
Low chord elevation	6.35
Channel Invert	-6.5 (approx.)
Conveyance Channel Water surface	5.35

3.8.2.4 Airline Hwy Crossing

Elevations that control the Airline Highway crossing culvert design are as follows.

Table 3-11. Maurepas Airline Structural Elevations

Item	Elevation (ft-NAVD88)
Top of road	16.125
Top of culvert, exterior	1.29
Top of culvert, interior	-0.50
Culvert Invert	-9.50
Bottom of culvert, exterior	-12.0
Conveyance Channel Water surface	5.30

3.8.2.5 Interstate-10 Crossing

Elevations that control the Interstate-10 crossing bridge design are as follows.

Table 3-12. Maurepas Interstate-10 Design Elevations

Item	Elevation (ft-NAVD88)
Top of road	13.00
Low chord elevation	11.75
Channel Invert	-8.0
Conveyance Channel Water surface	0.5 (approx.)

3.8.2.6 WSLP Reach 1 Design Elevations

The USACE New Orleans District has provided design elevations for Reach 1, which encompasses all WSLP structures within this project. Their provided tables are shown below. All WSLP features shall be designed to meet the 2070 Design Grade.

Table 3-13. WSLP Reach 1 Water Surface Elevations (USACE)

Intermediate Sea Level Rise

1% Water Surface Elevations		1% Levee Design Elevations		
Year	90% WSE ft NAVD88(2004.65)	Year	Levee with 1:3 Slope ft NAVD88(2004.65)	
2020	6.98	2023	8.95	
2070	12.74	2070	16.00	
Stability Analyses Elevations			F.S. requirements	
Water Grade	Flood Side Canal	Land Side Canal	Spencers Method	MOP Method
Low Water Level	-2.79	-2.79	1.4	1.3
Still Water Level	N/A	-1	1.5	1.3
Water at Project	N/A	-1	1.4	1.2
Water at Contruction	N/A	-1	1.2	N/A

Table 3-14. WSLP Reach 1 Design Elevations (USACE)

Project Feature	Construction Type	Existing Grade	2020 Design Elevations		2070 Design Elevations	
			SWL	Design Grade	SWL	Design Grade
MRL Tie-In	Levee	+7.0	+7.0	+8.5	+12.7	+16.0
River Road	Gate	+7.0	+7.0	+8.5	+12.7	+16.0
T-Wall Reach	Structure	+6.0	+7.0	+8.5	+12.7	+16.0
CN Railroad	Gate	+11.0 (Top of Rail)	+7.0	+8.5	+12.7	+16.0
KCS Railroad	Gate	+9.85 (Top of Rail)	+7.0	+8.5	+12.7	+16.0
Airline Hwy	Ramp	+6.0 EB, +7.0 WB	+7.0	+8.5	+12.7	+16.0

3.8.3 Load Combinations

Load Combinations analyzed are based on EM 11110-2-2104 for concrete structures and ETL 1110-2-584 for steel. Conditions differ a great deal between Maurepas and WSLP Projects and between features within the same Project. For this reason, there is no one project-wide master list of load combinations. Instead, every major structure location (e.g. WSLP KCS crossing, Maurepas airline crossing) has its own combination list. In the case of the Maurepas Headworks, multiple combination lists are presented for the range of different load types present.

3.8.3.1 Maurepas Headworks

Table 3-15. Load Combinations for Concrete Design, Monoliths U-1, U-2 & U-3

	DESIGN LOAD CASES		River Water Elevations (ft NAVD88)	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
LC No.	**Load Case Name**	**Description/Applicable Loads**				
1a	**Construction**	Dead load Vertical surcharge Horizontal surcharge Lateral load from dry backfill	-10.5	Unusual	1.6(D+EH+EV+LS)	16.67%
1b	**Uneven Construction**	Dead load Vertical surcharge Horizontal surcharge Lateral load from uneven dry backfill (5ft differential)	-10.5	Unusual	1.6(D+EH+EV+LS)	16.67%
1c	**Construction with Wind**	Dead Load Wind on walls before backfilling	-10.5	Unusual	1.6(D+W)	33.33%
2	**Design Flood Condition**	Dead Load Water to T.O. Protection Lateral Load from Saturated Soil	31.5	Usual	2.2(D+Hs+EH+EV)	0%

1. *For Design Flood Load Case, the design water elevation = flowline water level + freeboard (EM 1110-2-2007, Struct. Design of Concrete Lined Flood Channels). This case is designed to mimic TOW Design Check Case A from the HSDRRS Guidelines for T-wall design.*
2. *Settlement Loading: A copy of each load case is created and the forces due to settlement of fill are added. These load cases are denoted with "-ST" in the name (ex: OP1a-ST is Operational Case 1a plus the addition of settlement forces).*
3. *Construction Load cases assume a piezometer dewatering system is in place during construction and that the ground water is drawn to below the bottom of the stablization slab which is currently is El. -10.5.*

Table 3-16. Load Combinations for Concrete Design, Monoliths U-4, U-5 & U-6

	DESIGN LOAD CASES		Channel Water Elevations (ft NAVD88)	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
LC No.	**Load Case Name**	**Description/Applicable Loads**				
1a	**Construction**	Dead load Vertical surcharge Horizontal surcharge Lateral load from dry backfill	-10.5	Unusual	1.6(D+EH+EV+LS)	16.67%
1b	**Uneven Construction**	Dead load Vertical surcharge Horizontal surcharge Lateral load from uneven dry backfill (5ft differential)	-10.5	Unusual	1.6(D+EH+EV+LS)	16.67%
1c	**Construction with Wind**	Dead Load Wind on walls before backfilling	-10.5	Unusual	1.6(D+W)	33.33%
2	**High Water Condition**	Dead Load Water to T.O. Protection Lateral load from saturated soil	9.0	Usual	2.2(D+Hs+EH+EV)	0%
3	**Low Water Condition**	Dead Load Water to T.O. Protection Lateral load from saturated and dry backfill	2.0	Usual	2.2(D+Hs+EH+EV)	0%

1. *Settlement Loading: A copy of each load case is created and the forces due to settlement of fill are added. These load cases are denoted with "-ST" in the name (ex: OP1a-ST is Operational Case 1a plus the addition of settlement forces).*
2. *Construction Load cases assume a piezometer dewatering system is in place during construction and that the ground water is drawn to below the bottom of the stablization slab which is currently is El. -10.5.*

Table 3-17. Load Combinations for Concrete Design, Monolith C-1

	DESIGN LOAD CASES		Water Elevations				
LC No.	**Load Case Name**	**Description/Applicable Loads**	**Head water** (NAVD88)	**Tail water** (NAVD88)	**Load Category**	**Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)**	**Allowable Overstress for Pile Design (EM-1110-2-2906)**
1a	**Construction**	Dead Load (Concrete & Gate) Vertical surcharge Lateral load from dry backfill to T.O. Culvert	-10.5	-10.5	Unusual	1.6(D+EH+EV+LS)	16.67%
1b	**Construction + Top Soil**	Dead Load (Concrete & Gate) Vertical surcharge Lateral load from final backfill placement to T.O. Levee	-10.5	-10.5	Unusual	1.6(D+EH+EV+LS)	16.67%
1c	**Construction + Uneven Fill**	Dead Load (Concrete & Gate) Vertical surcharge Lateral load from uneven dry backfill (5ft differential)	-10.5	-10.5	Unusual	1.6(D+EH+EV+LS)	16.67%
OP1	**Minimum River Stage** **(Gates Closed)**	Dead Load (Concrete & Gate) Vertical load from topsoil & Lateral load from backfill Impervious Uplift (OP1a) & Pervious Uplift (OP1b)	1	1	Usual	2.2(D+EH+EV+Hs+Hu)	0.00%
OP2	**~500cfs Operation** **(Gates Operating)**	Dead Load (Concrete) Load from gate operation Vertical load from topsoil & Lateral load from backfill Impervious Uplift (OP2a) & Pervious Uplift (OP2b)	3.8	3.8	Usual	2.2(D+EH+EV+Hs+Hu+Q)	0.00%

	DESIGN LOAD CASES		Water Elevations				
LC No.	**Load Case Name**	**Description/Applicable Loads**	**Head water** (NAVD88)	**Tail water** (NAVD88)	**Load Category**	**Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)**	**Allowable Overstress for Pile Design (EM-1110-2-2906)**
OP3	**~1000cfs Operation** **(Gates Operating)**	Dead Load (Concrete) Load from gate operation Vertical load from topsoil & Lateral load from backfill Impervious Uplift (OP3a) & Pervious Uplift (OP3b)	4.9	4.6	Usual	2.2(D+EH+EV+Hs+Hu+Q)	0.00%
OP4	**~1500cfs Operation - Low Stage** **(Gates Operating)**	Dead Load (Concrete) Load from gate operation Vertical load from topsoil & Lateral load from backfill Impervious Uplift (OP4a) & Pervious Uplift (OP4b)	6.7	5.8	Usual	2.2(D+EH+EV+Hs+Hu+Q)	0.00%
OP5	**~2000cfs Operation - Low Stage** **(Gates Operating)**	Dead Load (Concrete) Load from gate operation Vertical load from topsoil & Lateral load from backfill Impervious Uplift (OP5a) & Pervious Uplift (OP5b)	9.1	7.6	Usual	2.2(D+EH+EV+Hs+Hu+Q)	0.00%
OP6	**~1500cfs Operation - Medium Stage** **(Gates Operating)**	Dead Load (Concrete) Load from gate operation Vertical load from topsoil & Lateral load from backfill Impervious Uplift (OP6a) & Pervious Uplift (OP6b)	9.9	5.8	Usual	2.2(D+EH+EV+Hs+Hu+Q)	0.00%

LC No.	DESIGN LOAD CASES: Load Case Name	DESIGN LOAD CASES: Description/Applicable Loads	Water Elevations: Head water (NAVD88)	Water Elevations: Tail water (NAVD88)	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
OP7	**~2000cfs Operation - Medium Stage** **(Gates Operating)**	Dead Load (Concrete) Load from gate operation Vertical load from topsoil & Lateral load from backfill Impervious Uplift (OP7a) & Pervious Uplift (OP7b)	9.9	7.6	Usual	2.2(D+EH+EV+Hs+Hu+Q)	0.00%
OP8	**Maximum River Stage** **(Gates Closed)**	Dead Load (Concrete & Gate) Vertical load from topsoil & Lateral load from backfill Impervious Uplift (OP8a) & Pervious Uplift (OP8b)	23.73	1	Usual	2.2(D+EH+EV+Hs+Hu)	0.00%
OP9	**~1500cfs Operation - High Stage** **(Gates Operating)**	Dead Load (Concrete) Load from gate operation Vertical load from topsoil & Lateral load from backfill Impervious Uplift (OP9a) & Pervious Uplift (OP9b)	23.73	5.8	Usual	2.2(D+EH+EV+Hs+Hu+Q)	0.00%
OP10	**~2000cfs Operation - High Stage** **(Gates Operating)**	Dead Load (Concrete) Load from gate operation Vertical load from topsoil & Lateral load from backfill Impervious Uplift (OP10a) & Pervious Uplift (OP10b)	23.73	7.6	Usual	2.2(D+EH+EV+Hs+Hu+Q)	0.00%
OP11	**Hurricane/ Reverse Head Condition [4]** **(Gates Closed)**	Dead Load (Concrete & Gate) Vertical load from topsoil & Lateral load from backfill Impervious Uplift (OP11a) & Pervious Uplift (OP11b)	1	9	Usual	2.2(D+EH+EV+Hs+Hu)	0.00%

	DESIGN LOAD CASES		Water Elevations				
LC No.	**Load Case Name**	**Description/Applicable Loads**	**Head water** (NAVD88)	**Tail water** (NAVD88)	**Load Category**	**Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)**	**Allowable Overstress for Pile Design (EM-1110-2-2906)**
DC A	**Design Flood Load Case (Gates Closed) Max Flood Elevation [1]**	Dead Load (Concrete & Gate) Water to T.O. MRL Protection Impervious Uplift (DC Aa) & Pervious Uplift (DC Ab) Levee soil submerged on Flood Side of cutoff, Levee soil dry on Protected Side, Lateral load from dry backfill	31.5	1	Unusual	1.6(D+EH+EV+Hs+Hu)	33.33%
D1	**Maintenance Dewatering Type 1** **(Center Culvert Dewatered)**	Dead Load (Concrete & Gate) Internal water pressure in two exterior culverts from Maximum River Stage Vertical load from topsoil & Lateral load from backfill Impervious Uplift (D1a) & Pervious Uplift (D1b)	23.73	23.73	Unusual	1.6(D+EH+EV+Hs+Hu)	33.33%
D2	**Maintenance Dewatering Type 2** **(One Edge Culvert in Operation)**	Dead Load (Concrete & Gate) Internal water pressure in one exterior culvert from Maximum River Stage Vertical load from topsoil & Lateral load from backfill Impervious Uplift (D2a) & Pervious Uplift (D2b)	23.73	23.73	Unusual	1.6(D+EH+EV+Hs+Hu)	33.33%

1. *For Design Flood Load Case, the design water elevation = flowline water level + freeboard (EM 1110-2-2007, Struct. Design of Concrete Lined Flood Channels). This case is designed to mimic TOW Design Check Case A from the HSDRRS Guidelines for T-wall design.*
2. *Settlement Loading: A copy of each load case is created and the forces due to settlement of fill are added. These load cases are denoted with "-ST" in the name (ex: OP1a-ST is Operational Case 1a plus the addition of settlement forces).*
3. *Hurricane Case (OP11): tailwater expected as per USACE analysis for existing river stages is EL 8.10. EL 9.0 is used because this is the top of the channel levees in the outflow canal, and therefore is the highest possible tailwater level. This creates a more conservative reverse head condition.*

4. *Maximum and Minimum River Levels taken from Mississippi River Hydrographs at Reserve, LA.*
5. *Construction Load cases assume a piezometer dewatering system is in place during construction and that the ground water is drawn to below the bottom of the stablization slab which is currently is El. -10.5.*

Table 3-18. Load Combinations for Concrete Design, Monoliths C-2, C-3 & C-4

	DESIGN LOAD CASES		River Water Elevations (ft NAVD88)	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
LC No.	**Load Case Name**	**Description/Applicable Loads**				
1a	**Construction**	Dead load Vertical surcharge Lateral load from dry backfill to T.O. Levee	-10.5	Unusual	1.6(D+EH+EV+Ls)	16.67%
1b	**Uneven Construction**	Dead load Vertical surcharge Lateral load from uneven dry backfill (5ft differential)	-10.5	Unusual	1.6(D+EH+EV+Ls)	33.33%
2a	Maximum River Stage with Uplift	Dead Load Culverts empty Uplift from Maximum River Stage Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill	23.73	Usual	2.2(D+EH+EV+Hs+Hu)	0.00%
2b	Maximum River Stage, no Uplift	Dead Load Culverts flowing full Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill	23.73	Usual	2.2(D+EH+EV+Hs)	0.00%

	DESIGN LOAD CASES		River Water Elevations (ft NAVD88)	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
LC No.	Load Case Name	Description/Applicable Loads				
3a	Minimum River Stage with Uplift	Dead Load Culverts empty Uplift from Minimum River Stage Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill	1	Usual	2.2(D+EH+EV+Hs+Hu)	0.00%
3b	Minimum River Stage without Uplift	Dead Load Culverts flowing at Mininmum River Stage water level Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill	1	Usual	2.2(D+EH+EV+Hs)	0.00%
D1a	Maintenance Dewatering Type 1 (Center Culvert Dewatered) with Uplift	Dead Load Two exterior culverts flowing full Uplift from Maximum River Stage Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill	23.73	Unusual	1.6(D+EH+EV+Hs+Hu)	33.33%
D1b	Maintenance Dewatering Type 1 (Center Culvert Dewatered) without Uplift	Dead Load Two exterior culverts flowing full Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill	23.73	Unusual	1.6(D+EH+EV+Hs)	33.33%

	DESIGN LOAD CASES		River Water Elevations (ft NAVD88)	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
LC No.	**Load Case Name**	**Description/Applicable Loads**				
D2a	Maintenance Dewatering Type 2 (One Edge Culvert Operational) with Uplift	Dead Load One exterior culvert flowing full Uplift from Maximum River Stage Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill	23.73	Unusual	1.6(D+EH+EV+Hs+Hu)	33.33%
D2b	Maintenance Dewatering Type 2 (One Edge Culvert Operational) without Uplift	Dead Load One exterior culvert flowing full Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill	23.73	Unusual	1.6(D+EH+EV+Hs)	33.33%

1. *Average Groundwater Table is EL 5.2 NAVD88.*
2. *Settlement Loading: A copy of each load case is created and the forces due to settlement of fill are added. These load cases are denoted with "-ST" in the name (ex: OP1a-ST is Operational Case 1a plus the addition of settlement forces).*
3. *Maximum and Minimum River Levels taken from Mississippi River Hydrographs at Reserve, LA.*
4. *Construction Load cases assume a piezometer dewatering system is in place during construction and that the ground water is drawn to below the bottom of the stabilization slab which is currently is El. -10.5.*

Table 3-19. Load Combinations for Concrete Design, Monoliths C-5 & C-6

	DESIGN LOAD CASES		**River Water Elevations**	**Load Category**	**Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)**	**Allowable Overstress for Pile Design (EM-1110-2-2906)**
LC No.	**Load Case Name**	**Description/Applicable Loads**	(ft NAVD88)			
1a	**Construction Under Roadway**	Dead load Vertical surcharge Lateral load from dry backfill to T.O. Road	-10.5	Unusual	1.6(D+EH+EV+Ls)	16.67%
1b	**Uneven Construction**	Dead load Vertical surcharge Lateral load from uneven dry backfill (5ft differential)	-10.5	Unusual	1.6(D+EH+EV+Ls)	33.33%
2a	Maximum River Stage with Uplift, Roadway	Dead load Culverts empty Uplift from Maximum River Stage Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill to T. O. Road	23.73	Usual	2.2(D+EH+EV+Hs+Hu+V)	0.00%
2a_6	Maximum River Stage with Uplift, C-6 Soil Cover	Dead load Culverts empty Uplift from Maximum River Stage Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill to EL +8.0	23.73	Usual	2.2(D+EH+EV+Hs+Hu)	0.00%

LC No.	DESIGN LOAD CASES Load Case Name	 Description/Applicable Loads	River Water Elevations (ft NAVD88)	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
2b	Maximum River Stage without Uplift, Roadway	Dead load Culverts flowing full Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill to T. O. Road	23.73	Usual	2.2(D+EH+EV+Hs+V)	0.00%
3a	Minimum River Stage with Uplift, Roadway	Dead load Culverts empty Uplift from Minimum River Stage Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill to T. O. Road	1	Usual	2.2(D+EH+EV+Hs+Hu+V)	0.00%
3a_6	Minimum River Stage with Uplift, C-6 Soil Cover	Dead load Culverts empty Uplift from Maximum River Stage Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill to EL +8.0	1	Usual	2.2(D+EH+EV+Hs+Hu)	0.00%
3b	Minimum River Stage without Uplift, Roadway	Dead load Culverts flowing at Minimum River Stage water level Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill to T. O. Road	1	Usual	2.2(D+EH+EV+Hs+V)	0.00%

	DESIGN LOAD CASES		River Water Elevations (ft NAVD88)	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
LC No.	**Load Case Name**	**Description/Applicable Loads**				
D1a	Maint. Dewatering Type 1 (Center Culvert Dewatered) with Uplift, Roadway	Dead load Two exterior culverts flowing full Uplift from Maximum River Stage Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill to T. O. Road	23.73	Unusual	1.6(D+EH+EV+Hs+Hu+V)	33.33%
D1a_6	Maint. Dewatering Type 1 (Center Culvert Dewatered) with Uplift, C-6 Soil Cover	Dead load Two exterior culverts flowing full Uplift from Maximum River Stage Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill to EL +8.0	23.73	Unusual	1.6(D+EH+EV+Hs+Hu)	33.33%
D1b	Maint. Dewatering Type 1 (Center Culvert Dewatered) without Uplift, Roadway	Dead load Two exterior culverts flowing full Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill to T. O. Road	23.73	Usual	1.6(D+EH+EV+Hs+V)	33.33%
D2a	Maint. Dewatering Type 2 (One Edge Culvert Full) with Uplift, Roadway	Dead load One exterior culvert flowing full Uplift from Minimum River Stage Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill to T. O. Road	1	Usual	1.6(D+EH+EV+Hs+Hu+V)	33.33%

	DESIGN LOAD CASES		River Water Elevations (ft NAVD88)	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
LC No.	**Load Case Name**	**Description/Applicable Loads**				
D2a_6	Maint. Dewatering Type 2 (One Edge Culvert Full) with Uplift, C-6 Soil Cover	Dead load One exterior culvert flowing full Uplift from Minimum River Stage Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill to EL +8.0	1	Usual	1.6(D+EH+EV+Hs+Hu)	33.33%
D2b	Maint. Dewatering Type 2 (One Edge Culvert Full) without Uplift, Roadway	Dead load One exterior culvert flowing full Average groundwater table outside culvert Vertical & Lateral load from semi-saturated backfill to T. O. Road	1	Usual	1.6(D+EH+EV+Hs+V)	33.33%

1. *Average Groundwater Table is EL 5.2 NAVD88.*
2. *Construction Load cases assume a piezometer dewatering system is in place during construction and that the ground water is drawn to below the bottom of the stablization slab which is currently is El. -10.5.*
3. *Maximum and Minimum River Levels taken from Mississippi River Hydrographs at Reserve, LA.*
4. *Settlement Loading: A copy of each load case is created and the forces due to settlement of fill are added. These load cases are denoted with "-ST" in the name (ex: OP1a-ST is Operational Case 1a plus the addition of settlement forces).*
5. *Traffic Loading: Four worst-case traffic conditions were developed. Each load case with the “Roadway” fill condition is copied and one of the four traffic conditions is added. These cases are denoted with "_T1", "_T2","_T3" or "_T4" in the name (ex: 1a_T1 would be load case 1a with the addition of traffic condition 1).*

3.8.3.2 Canadian National Railroad Culvert

Note, if KCS chooses to construct a concrete culvert instead of a bridge, load combinations for the KCS crossing will be the same as what follows.

Table 3-20. Load Combinations for Concrete Design, CN Railroad Culverts

	DESIGN LOAD CASES		Channel Water Elevation (ft NAVD88)	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
LC No.	Load Case Name	Description/Applicable Loads				
1a	Construction	Dead Load Vertical Surcharge Loads Vertical & Lateral load from dry backfill	-9.75	Unusual	1.6(D+EH+EV+LS)	16.67%
1b	Uneven Construction	Dead Load Vertical Surcharge Loads Lateral load from uneven dry backfill (5ft differential)	-9.75	Unusual	1.6(D+L+EH+EV+LS)	33.33%
2a	Maximum Water Table with Uplift (Full Flow)	Dead Load (Concrete and Rail) Culverts flowing full Maximum groundwater table outside culvert (including uplift) Vertical & Lateral load from semi-saturated backfill	8.0	Usual	2.2(D+EH+EV+Hs+Hu)	0.00%
2a_t	Maximum Water Table with Uplift (Full Flow) + Cooper E-80	Dead Load (Concrete and Rail) Culverts flowing full Maximum groundwater table outside culvert (including uplift) Vertical & Lateral load from semi-saturated backfill Cooper E-80	8.0	Usual	2.2(D+EH+EV+Hs+Hu+V)	0.00%

LC No.	DESIGN LOAD CASES Load Case Name	Description/Applicable Loads	Channel Water Elevation (ft NAVD88)	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
2b	Minimum Water Table (Full Flow)	Dead Load (Concrete and Rail) Culverts flowing full Groundwater below culvert Vertical & Lateral load from dry backfill	8.0	Usual	2.2(D+EH+EV+Hs)	0.00%
2b_t	Minimum Water Table (Full Flow) + Cooper E-80	Dead Load (Concrete and Rail) Culverts flowing full Groundwater below culvert Vertical & Lateral load from dry backfill Cooper E-80	8.0	Usual	2.2(D+EH+EV+Hs+V)	0.00%
3a	Maximum Water Table with Uplift (Empty)	Dead Load (Concrete and Rail) Culverts empty Maximum groundwater table outside culvert (including uplift) Vertical & Lateral load from semi-saturated backfill	-9.75	Usual	2.2(D+EH+EV+Hs+Hu)	0.00%
3a_t	Maximum Water Table with Uplift (Empty) + Cooper E-80	Dead Load (Concrete and Rail) Culverts empty Maximum groundwater table outside culvert (including uplift) Vertical & Lateral load from semi-saturated backfill Cooper E-80	-9.75	Usual	2.2(D+EH+EV+Hs+Hu+V)	0.00%

LC No.	DESIGN LOAD CASES: Load Case Name	DESIGN LOAD CASES: Description/Applicable Loads	Channel Water Elevation (ft NAVD88)	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
3b	Minimum Water Table (Empty)	Dead Load (Concrete and Rail) Culverts empty Groundwater below culvert Vertical & Lateral load from dry backfill	-9.75	Usual	2.2(D+EH+EV)	0.00%
3b_t	Minimum Water Table (Empty) + Cooper E-80	Dead Load (Concrete and Rail) Culverts empty Groundwater below culvert Vertical & Lateral load from dry backfill Cooper E-80	-9.75	Usual	2.2(D+EH+EV+V)	0.00%

1. *Maximum groundwater and maximum water level in channel are EL 8.0. Minimum groundwater and minimum water level in channel are assumed to be below the structure.*
2. *Construction Load cases assume a piezometer dewatering system is in place during construction and that the ground water is drawn to below the bottom of the structure, which is currently is El. -9.75.*

3.8.3.3 Airline Highway Culvert

Table 3-21. Load Combinations for Concrete Design, Airline Highway Culverts

	DESIGN LOAD CASES		Channel Water Elevations (ft NAVD88)	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
LC No.	**Load Case Name**	**Description/Applicable Loads**				
1a	**Construction Under Roadway**	Dead load Vertical surcharge Vertical & Lateral load from dry backfill to T.O. Road	-12.0	Unusual	1.6(D+EH+EV+Ls)	16.67%
1b	**Uneven Construction**	Dead load Vertical surcharge Lateral load from uneven dry backfill (5ft differential)	-12.0	Unusual	1.6(D+EH+EV+Ls)	33.33%
2a	Maximum Water Table with Uplift (Full Flow)	Dead load Culverts flowing full Maximum groundwater table outside culvert (including uplift) Vertical & Lateral load from semi-saturated backfill	5.3	Usual	2.2(D+EH+EV+Hs+Hu)	0.00%
2a_t	Maximum Water Table with Uplift (Full Flow) + Traffic Loads	Dead load Culverts flowing full Maximum groundwater table outside culvert (including uplift) Vertical & Lateral load from semi-saturated backfill Traffic	5.3	Usual	2.2(D+EH+EV+Hs+Hu+V)	0.00%

	DESIGN LOAD CASES		Channel Water Elevations (ft NAVD88)	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
LC No.	**Load Case Name**	**Description/Applicable Loads**				
2b	Minimum Water Table (Full Flow)	Dead load Culverts flowing full Groundwater below culvert Vertical & Lateral load from dry backfill	-12.0	Usual	2.2(D+EH+EV+Hs+V)	0.00%
2b_t	Minimum Water Table (Full Flow) + Traffic Loads	Dead load Culverts flowing full Groundwater below culvert Vertical & Lateral load from dry backfill Traffic	-12.0	Usual	2.2(D+EH+EV+Hs+V)	0.00%
3a	Maximum Water Table with Uplift (Empty)	Dead load Culverts empty Maximum groundwater table outside culvert (including uplift) Vertical & Lateral load from semi-saturated backfill	5.3	Usual	2.2(D+EH+EV+Hs+Hu)	0.00%
3a_t	Maximum Water Table with Uplift (Empty) + Traffic	Dead load Culverts empty Maximum groundwater table outside culvert (including uplift) Vertical & Lateral load from semi-saturated backfill Traffic	5.3	Usual	2.2(D+EH+EV+Hs+Hu+V)	0.00%

	DESIGN LOAD CASES		Channel Water Elevations (ft NAVD88)	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
LC No.	**Load Case Name**	**Description/Applicable Loads**				
3b	Minimum Water Table (Empty)	Dead load Culverts empty Groundwater below culvert Vertical & Lateral load from dry backfill	-12.0	Usual	2.2(D+EH+EV)	0.00%
3b_t	Minimum Water Table (Empty) + Traffic Loads	Dead load Culverts empty Groundwater below culvert Vertical & Lateral load from dry backfill Traffic	-12.0	Usual	2.2(D+EH+EV+V)	0.00%

1. *Maximum groundwater and maximum water level in channel are EL 5.3. Minimum groundwater and minimum water level in channel are assumed to be below the structure.*
2. *Construction Load cases assume a piezometer dewatering system is in place during construction and that the ground water is drawn to below the bottom of the structure, which is currently is El. -12.0.*

3.8.3.4 WSLP River Road, CN Railroad & KCS Railroad Crossings

Table 3-22. Load Combinations for Concrete Design, WSLP Gated Crossings

	DESIGN LOAD CASES		Flood Side Water Elevation (ft NAVD88)	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
LC No.	**Load Case Name**	**Description/Applicable Loads**				
1a	**Construction**	Dead Load Construction surcharge loads Soil backfill in place	B.O. Slab	Unusual	1.6(D+EH+EV+Ls)	16.67%
1b	**Construction + Wind**	Dead Load No soil placed Wind from Protected Side	B.O. Slab	Unusual	1.6(D+W)	33.33%
2a	**Water to SWL (Impervious)**	Dead Load SWL Flood hydrostatic load Impervious Uplift Vertical & Lateral load from backfill	12.7	Usual	2.2(D+EH+EV+Hs+Hu)	0.00%
2b	**Water to SWL (Pervious)**	Dead Load SWL Flood hydrostatic load Pervious Uplift Vertical & Lateral load from backfill	12.7	Usual	2.2(D+EH+EV+Hs+Hu)	0.00%
2c	**Water to SWL + Wind (Impervious)**	Dead Load SWL Flood hydrostatic load Impervious Uplift Vertical & Lateral load from backfill Wind from Flood Side above SWL	12.7	Unusual	1.6(D+EH+EV+Hs+Hu+W)	33.33%

	DESIGN LOAD CASES		Flood Side Water Elevation	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
LC No.	**Load Case Name**	**Description/Applicable Loads**	(ft NAVD88)			
2d	**Water to SWL + Wind (Pervious)**	Dead Load SWL Flood hydrostatic load Pervious Uplift Vertical & Lateral load from backfill Wind from Flood Side above SWL	12.7	Unusual	1.6(D+EH+EV+Hs+Hu+W)	33.33%
3a	**Water to SWL + Wave (Impervious)**	Dead Load SWL Flood hydrostatic load Impervious Uplift Vertical & Lateral load from backfill SWL Wave load	12.7	Unusual	1.6(D+EH+EV+Hs+Hu+Hw)	33.33%
3b	**Water to SWL + Wave (Pervious)**	Dead Load SWL Flood hydrostatic load Pervious Uplift Vertical & Lateral load from backfill SWL Wave load	12.7	Unusual	1.6(D+EH+EV+Hs+Hu+Hw)	33.33%
4a	**Water to SWL + Wind + Impact (Impervious)**	Dead Load SWL Flood hydrostatic load Impervious Uplift Vertical & Lateral load from backfill Wind from Flood Side above SWL Boat/Debris Impact Load	12.7	Extreme	0.9D+(1.35/0.9)EH+1.0EV+ 1.3Hs+1.3Hu+1.6W+I1.0)	33.33%
4b		Dead Load	12.7	Extreme		33.33%

	DESIGN LOAD CASES		Flood Side Water Elevation	Load Category	Factored Load Combinations for Hydraulic Concrete Design (EM-1110-2-2104)	Allowable Overstress for Pile Design (EM-1110-2-2906)
LC No.	**Load Case Name**	**Description/Applicable Loads**	(ft NAVD88)			
	Water to SWL plus Wind + Impact (Pervious)	SWL Flood hydrostatic load Pervious Uplift Vertical & Lateral load from backfill Wind from Flood Side above SWL Boat/Debris Impact Load			0.9D+(1.35/0.9)EH+1.0EV+ 1.3Hs+1.3Hu+1.6W+I1.0)	
5a	**Water to Reverse Head (Impervious/Pervious)**	Dead Load Reverse Head hydrostatic load Impervious/Pervious Uplift Vertical & Lateral load from backfill	B.O. Slab	Usual	2.2(D+EH+EV+Hs+Hu)	0.00%
5b	**Water to Reverse Head (Impervious/Pervious)**	Dead Load Reverse Head hydrostatic load Impervious/Pervious Uplift Vertical & Lateral load from backfill Wind from Protected Side above water	B.O. Slab	Unusual	1.6(D+EH+EV+Hs+Hu+W)	33.33%
A	**Water to TOW (Impervious/Pervious)**	Dead Load TOW Flood hydrostatic load Impervious/Pervious Uplift from TOW Elev	16	Unusual	1.6(D+EH+EV+Hs+Hu)	33.33%

1. *If unbalanced loads are found with subsequent geotechnical stability analysis these loads will be added to the above load combinations in agreement with the HSDRRS Design Guidelines.*

Table 3-23. Load Combinations for Steel Design, WSLP Gated Crossings

	DESIGN LOAD CASES		Flood Side Water Elevation (ft NAVD88)	Factored Load Combinations for Hydraulic Steel Design (ETL 1110-2-584)
LC No.	**Load Case Name**	**Description/Applicable Loads**		
1	**Strength I, TOW Hydrostatic**	Gate Closed TOW Flood hydrostatic load	16	0D + 1.4Hs2
2	**Strength I, Wind**	Gate Closed Dead Load Wind Load (extreme)	N/A	1.2D + 1.3W
3	**Strength II, Operating + Wind (Hinged Gate)**	Gate being operated (opened/closed) Dead Lead Wind Load (operation)	N/A	1.2D + 1.3W
4	**Strength II, Operating (Roller Gate)**	Gate being operated (opened/closed) Operating Machinery (winch load)	N/A	0D + 1.3Q

1. *Load abbreviations differ slightly from Table 6-1. These abbreviations match ETL 1110-2-584 Appendix F Design Loads.*

4. CIVIL DESIGN

4.1 Codes, Standards, and Guidelines

4.1.1 Industry Codes, Standards and References

- DOTD Roadway Design Procedures and Details (often referred to as the Roadway Design Manual), latest edition
- DOTD Minimum Design Guidelines dated March 6, 2017
- AASHTO A Policy on Geometric Design of Highways and Streets, 2011 Edition
- AASHTO Roadside Design Guide, 4th Edition
- AASHTO Highway Safety Manual, 2012 Edition
- DOTD Guidelines for Conducting a Safety Analysis for Transportation Management Plans and Other Work Zone Activities
- DOTD Traffic Management Plan
- DOTD Construction Plans Quality Control/Quality Assurance Manual v2013
- DOTD Office of Highways Roadway Plan Preparation Manual
- DOTD Erosion Control Guidelines
- DOTD Louisiana Standard Specifications for Roads and Bridges
- American Railway Engineering and Maintenance-of-Way Association (AREMA).
- American Welding Society (AWS) – AWS D1.5.
- Louisiana State Plumbing Code, 2013
- Code of Ordinances St. John the Baptist Parish, 2016
- Louisiana Department of Environmental Quality Codes and Regulations, 2018
- ADA Standards for Accessible Design, 2010 (including 28 CFR 35.151 and 2004 ADAAG at 36 CFR part 1191, Appendices B and D)
- ANSI, American National Standards Institute
- ASTM, American Society for Testing and Materials
- Code of Federal Regulations, Title 29-Labor, Chapter XVII, Occupational Safety and Health Administration (OSHA), 1976
- Engineering Directives and Standards Manual (EDSMs)

4.1.2 USACE Engineering Manuals and Guidelines

- EM 1110-2-1601, *Hydraulic Design of Flood Control Channels*, 1 July 1991
- EM 1110-2-1913, *Design & Construction of Levees*, 30 April 2000

- New Orleans District Engineering Division, *Hurricane and Storm Damage Risk Reduction System Design Guidelines* (HSDRRS-DG), with all revisions and addendums, dated June 2012

4.1.3 Computer Programs

- AutoCad Civil3D (version 2020)
- Microstation In-Roads (version 2018)
- ESRI ArcGIS
- HYDRWIN (LADOTD hydraulics Program)
- STADD Pro for the railroad bridge
- PG Super for prestressed concrete beams.
- LPILE for lateral analysis of the prestressed concrete piles.
- SP Column for the design of the prestressed concrete piles.
- CAP 18 and Excel spreadsheets for design and analysis for the cap.

4.2 Design Criteria

4.2.1 Site Civil Design

Levee design grade elevations are as follows:

- Mississippi River Levee (MRL): EL 16.4 or EL 20.1
- Guide Levees on protected side of MRL: EL 13.6
- Guide Levees at back structure/outfall: EL 11.6
- Hurricane Levee (current): EL 12.1
- Hurricane Levee (future): EL 15.6
- See Tables 2-2 and 2-3 for related design stages

4.2.1.1 Conveyance Channel Bottom

Based on the available soils investigation data collected, the Conveyance Channel bottom is comprised of dispersive clays which are subject to erosion. Under normal operating conditions, the depth-averaged velocity in the center of the channel is 7.21 ft/s. Based on the USACE EM 1110-2-1601 design guidance the required revetment to prevent erosion at that velocity equates to a DOTD Class 10-lb stone. Using the Factor of Safety design approach put forth in the National Concrete Masonry Association's Design Manual for ACB Revetment Systems indicates that a 4-inch thick Articulated Concrete Block mat system is sufficient to protect the channel bottom. The decision between using riprap or ACBs has not been made yet; however, either are capable of providing the required erosion control.

During storm surge/hurricane conditions there will be significant wind-driven wave action at the surface of the channel, these forces will be the governing ones determining the revetment protection required on the channel slopes and stability berms. However, the significant depth of the channel bottom prevents those forces from being translated down to EL -25. Therefore, the design of the channel bottom revetment is the same for both the normal operation and storm/hurricane condition, which would be either the DOTD Class 10 lb Stone or the 4-inch thick ACB mat system.

4.2.1.2 Civil Sitework

The site layout will be designed to allow for ease of access during levee, structure and channel maintenance activities. The site layout for the camp reservation will be designed as a 12-inch thick limestone roadway/parking surface with a 12-inch thick sand subbase and will allow for ease of construction during levee, structure and channel maintenance activities; includes subsurface drainage, utility service such as sewer treatment, water, power, telephone/cable etc. with security fencing, lighting, parking facilities, and sidewalks. The radii, turning movements and curb design assumption are using a WB-40 tractor trailer design vehicle and a 40 foot turning radius. Reservation access roads will be surfaced with 12-inch thick limestone, or 2-inch thick asphalt, and sand subbase with swale drainage. The levee surface roads design will be asphalt with stone base course and sand subbase and turning movements for WB-40 tractor trailer design vehicle. Minimum width for one-way haul/access roads will be 15 feet; for two-way, minimum width will be 24 feet.

4.2.1.3 Security Fencing

Security Fencing will be a minimum of 10-feet high with a barbed-wire apron with extension arms. Fencing will be per typical USACE details.

4.2.1.4 Erosion and Sedimentation Control

Erosion and sedimentation control will be provided to prevent violations of water quality standards. Controls will be installed per LDEQ requirements.

4.2.1.5 Signs

Where required, signs will be in accordance with applicable codes and standards (e.g. – MUTCD, NFPA, ADA, etc.). See Section 10 for applicable guidelines and criteria.

4.2.2 Roadway Design Criteria

There are two roadway crossings in the subject Project: 1) LA 44 (River Road), and 2) US 61 (Airline Highway). A bypass roadway will be constructed to reroute River Road during construction of the Project to facilitate installation of the culverts under the road and the attached U-frame channels on each side. The proposed alternative selected for Airline Highway is to raise the road to the 2070 flood protection elevation. The design of the re-routed and raised roadways will be performed according to the criteria outlined in the DOTD and AASHTO references listed above. The following sections outline the specific design criteria for each roadway.

4.2.2.1 LA 44 (River Road)

River Road is classified as a Rural Minor Arterial, the appropriate guidelines in the Roadway Design Manual would be followed and are included below. Refer to Table 1.1 below for design criteria.

Table 4-1. Basic Design Criteria for LA 44 (River Road)

Detour Posted Speed (mph)		35	
Lane Width (ft)		12	
Shoulder Width (ft) (Inside)		Preferred	8
		Acceptable	2
Shoulder Width (ft) (Outside)		Preferred	8
		Acceptable	2
Min. Lateral Offset (ft)		4	
Clear Zone (ft)		Foreslope	16
		Backslope	16
Max. Longitudinal Grade (%)		Preferred	-
		Acceptable	5
Fore Slopes		Acceptable	4:1
Back Slopes		Acceptable	3:1
Vertical Curve Criteria	**Crest**	LVC_{MIN} (ft)	105
		SSD_{CREST} (ft)	250
		K_{MIN}	29
	SAG	LVC_{MIN} (ft)	105
		SSD_{SAG} (ft)	250
		K_{MIN}	49
Lane Width Taper Length (ft)		120	
ADT (vpd) (2017)		5,502	
Horizontal Curve Data		E_{max}	4%
		Design Speed	35
		Min. $Radius_{NC}$ (ft)	527

4.2.2.2 US 61 (Airline Highway)

Airline Highway is federal roadway classified as an Urban Principal Arterial. It is a 4-lane divided highway with a 30-ft wide median. The Maurepas Diversion elements, the WSLP flood protection features, and the culverts of the re-routed drainage ditches all cross the roadway. Table 1.1 lists the applicable specific design criteria.

Table 4-2. Basic Design Criteria for US 61 (Airline Highway)

<table>
<tr><td colspan="2">Posted Speed (mph)</td><td colspan="2">65</td></tr>
<tr><td colspan="2">Lane Width (ft)</td><td colspan="2">12</td></tr>
<tr><td colspan="2">Shoulder Width (ft) (Inside)</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Shoulder Width (ft) (Outside)</td><td colspan="2">8</td></tr>
<tr><td colspan="2">Min. Lateral Offset (ft)</td><td colspan="2">4</td></tr>
<tr><td colspan="2" rowspan="2">Max. Longitudinal Grade (%)</td><td>Preferred</td><td>3</td></tr>
<tr><td>Acceptable</td><td>5</td></tr>
<tr><td colspan="2" rowspan="2">Fore Slopes</td><td>Preferred</td><td>6:1</td></tr>
<tr><td>Acceptable</td><td>4:1</td></tr>
<tr><td colspan="2" rowspan="2">Back Slopes</td><td>Preferred</td><td>4:1</td></tr>
<tr><td>Acceptable</td><td>3:1</td></tr>
<tr><td rowspan="6">Vertical Curve Criteria</td><td rowspan="3">Crest</td><td>LVC_{MIN} (ft)</td><td>1056</td></tr>
<tr><td>SSD_{CREST} (ft)</td><td>645</td></tr>
<tr><td>K_{MIN}</td><td>193</td></tr>
<tr><td rowspan="3">SAG</td><td>LVC_{MIN} (ft)</td><td>477</td></tr>
<tr><td>SSD_{SAG} (ft)</td><td>645</td></tr>
<tr><td>K_{MIN}</td><td>157</td></tr>
<tr><td colspan="2">Lane Width Taper Length (ft)</td><td colspan="2">780</td></tr>
<tr><td colspan="2">ADT (vpd) (2017)</td><td colspan="2">20,755</td></tr>
</table>

4.2.3 Railroad Design Criteria

The following will be the Design Criteria for the proposed work on the CN and KCS railroads. Railroad track and bridge design shall comply with the requirements of 2016 American Railway Engineering and Maintenance-of-Way Association (AREMA) *Manual for Railway Engineering* and the pertinent requirements of the CN RR and KCS RR.

4.2.3.1 Track Work

Track operating speed for the CN RR shall be 60 mph for the main spur track and the interchange and facility site. Adjacent parallel tracks should have minimum track centers of at least 9 feet.

4.2.3.1.1 Track Embankment Design

All permanent side slopes are to be no steeper than 3:1. Staged construction side slopes may be as steep as 2:1. The top width of the subgrade should be 13 feet from the track centerline to the outside shoulder. The top of the subgrade should be crowned for drainage at a minimum slope of 2 percent. A minimum of 12 inches of sub-ballast should be used. Ballast beneath the ties will be a minimum thickness of 8 inches. Track should be constructed with 7-in x 9-in x 9-ft hardwood timber crossties spaced at 19-ft 6-in on center. The rail material shall be new 115# CWR.

4.2.3.1.2 Horizontal Alignment

Curves shall be designed using the chord definition. Maximum degree of curvature for the spur track should be 10°. Superelevation and spirals shall be added to curves that have 1-in or greater unbalance, in accordance with the CN RR and KCS RR standards. Where superelevation and spirals are required, minimum spiral length is 25-ft. Maximum superelevation is 3-in. Turnouts should be No. 20 to support operations to or from the main line at 15 mph. Minimum tangent distance between curves should be 300-ft for the main spur tracks and 150-ft at the interchanges and the Marathon facility site.

4.2.3.1.3 Vertical Alignment

Maximum grade shall be 1.5%. Maximum rate of change for sag curves should be 0.12 (ft/ft) with a desirable value of 0.06 (ft/ft). Maximum rate of change for summit (crest) curves should be 0.20 (ft/ft) with a desirable value of 0.10 (ft/ft).

4.2.3.1.4 Drainage

Drainage design shall be in accordance with CN RR, KCS RR, and LADOTD requirements. Design of drainage features for significant waterbody crossings shall use a 50-yr design storm return interval. Minor culverts shall use a 25-yr design frequency.

4.2.3.2 Railroad Bridge

Structural design of bridges and wingwalls shall be in accordance with the 2016 American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering, plus pertinent requirements of CN and KCS Railroads. Welding would be in accordance with the AWS Bridge Welding Code D1.5, as amended and complemented by the 2012 AREMA Manual for Railway Engineering specifications.

4.2.3.2.1 Track Clearances

There are no overhead clearance restrictions in the Project. Vertical clearances shall comply with CN RR and KCS RR criteria. Low Chord requirements over waterways shall comply with KCS RR standards. Horizontal clearances of 9'-0" from centerline of railroad bridges to the face of the bridge handrail would be provided. Handrails would be provided on each side of the bridge. Minimum horizontal clearance to a proposed bridge substructure is 25'-0" without crash walls to protect the proposed substructure.

4.2.3.2.2 Design Loads

Train Live loads will be Cooper E-80. Deck plate girders and diaphragms would be checked for an alternative loading condition of 4 axles at 1.25 times the maximum Cooper axle load (100 kips) at 5-ft, 6-ft, and 7-ft axis spacing. A minimum 200 psf live load shall be applied where rail and road loadings are not applied. Wind loads would be applied in accordance with 2016 AREMA Manual for Railway Engineering Chapters 8 and 15. Other loads, as applicable, would be considered in accordance with 2012 AREMA Manual for Railway Engineering specifications.

4.2.3.2.3 Materials

Painted steel conforming to requirements of ASTM A709 Grade 50 would be used. All steel shall be coated or galvanized. Structural concrete would have a minimum 28-day strength of 4,000 psi or higher, as required by design. Reinforcing steel will be deformed billet steel bars conforming to requirements of ASTM A615 Grade 60.

Table 4-3. Railroad Design Criteria Summary

Design Aspect	Design Parameter	Criterion
General	Track operating speed (main spur track)	20 mph
	Track operating speed (interchange and facility site)	20 mph
	Double track spacing	20 feet
Trackbed	Subgrade width from centerline to edge of trackbed	13 feet
	Subgrade width increase per inch of superelevation	6 inches
	Minimum cross slope	1% - 2% utilized
	Min. depth of longitudinal ditches below top of subgrade	3 feet
	Minimum grades of ditches	0.20%
	Maximum fore slope	3:1
	Maximum back slope	2:1 (3:1 desired)
	Minimum width of ditches (flat bottom)	10 feet
	Sub-ballast depth (minimum)	12 inches
	Ballast depth (minimum)	8 inches
	Wood ties	7 in x 9 in x 9 ft
	Track (continuous welded rail)	115 CWR
Horizontal Geometry	Maximum curvature – chord definition (main spur track/Industry Track)	7° 00’
	Superelevation and spiral length	E = S (0.0007 SD) - 1"
	Minimum tangent distance between curves (main spur track)	300 feet
	Minimum tangent distance between curves (interchange and facility site)	150 feet
	Minimum distance between switch points (main spur track)	125 feet
	Minimum distance between switch points (plant site)	100 feet
	Main line turnout	No. 11
	Interchange and facility site turnout	No. 11
Vertical Geometry	Minimum grade	0.00%
	Maximum grade	1.50% (1.00% desired)
	Maximum rate of change – sag curve	0.12-(0.06 desired)
	Maximum rate of change – summit curve	0.20-(0.10 desired)
	Vertical curve should not fall within the limits of horizontal curves or turnouts (general rule)	—

5. HYDRAULIC DESIGN

5.1 Introduction

There are several aspects to the Hydrologic and Hydraulic (H&H) design of the Project:

- Hydrologic analyses to estimate the stormwater runoff at various points throughout the project area.
- Hydraulic analyses to calculate the flow capacities and water surface elevations in the existing and proposed drainage ditches.
- Hydraulic analyses to calculate the flow capacities and water surface elevations in the Conveyance Channel.
- The modeling of the dispersion into the southern portion of the Maurepas Swamp from the proposed drainage routing. and
- The modeling of the dispersion of the water and nutrients into the northern portion of the swamp from the Maurepas Diversion discharge.

5.2 Codes, Guidelines, and References

- DOTD, *Hydraulics Manual*, 2011
- Natural Resources Conservation Service TR-55 methodology - Urban Hydrology for Small Watersheds, USDA, NRCS, Technical Release 55, June 1986
- SCS Unit Hydrograph Method
- Muskingum-Cunge Routing
- Rainfall Distribution SCS Type III
- Rainfall depth comes from the NOAA Atlas 14 Volume 9 Version 2PDS Estimates for Garyville LA, Table 3.4-2 Louisiana Rainfall Depths (inches for 100 Year Return Period Duration (Hour) 24.,
- LiDAR data 2017,
- USGS Quad Maps and Aerial Photography,
- National Hydrographic Dataset,
- Historical SWMM modeling (performed in the St. John the Baptist Parish area)
- USACE Report “West Shore Lake Pontchartrain Hydraulic Design of Pump Stations and Drainage Structures Draft Repot April 2019”
- USACE Report “West Shore Lake Pontchartrain Hydraulic Design of Pump Stations and Drainage Structures Addendum to Main H&H Report September 2019”
- Fenstermaker Survey and LiDAR collected specifically for this project

5.3 Computer Programs

The following computer programs were used as tools to perform the various H&H calculations:

- HEC-HMS 4.6.1 – for determining the peak values of existing and proposed conditions for the sub basins flowing into Hope Canal and Marathon Ditch

- Hydraulic Toolbox- for checking ditch sizing using peak values form HEC-HMS
- HEC-RAS 1D converted to version 5.0.7- the original 2007 Diversion modeling was done in 1D.
- HEC-RAS 2D version 5.0.7- The USACE model was adjusted and limited to the proposed site from the MS River to Airline Highway for the purposes of developing the existing and proposed conditions. The existing conditions are those as of Fall 2020, compared to the proposed conditions of a diversion channel and West Shore Lake Pontchartrain (WSLP) levee system. Also included in the proposed conditions are the proposed east and west ditches to convey water that would have otherwise flowed past the diversion or into Angelina canal.
- ESRI ArcMap 10.8. GIS software was used to process LiDAR raster data, develop exhibits, process the proposed channel and existing survey shapefiles, and view land coverage raster files.

5.4 Design Criteria

The following limitations and constraints were applied to the data analysis and design of the proposed features:

- Maintain the increase in WSE in the CN RR ditch < 0.1-ft,
- Maintain the increase in WSE in the Marathon detention pond < 0.1-ft,
- Minimize the required acquisition of land to the east of the project (by keeping width of west ditch as small as possible)
- Minimize impacts to the existing portions of St. John the Baptist Parish.

6. MECHANICAL DESIGN

6.1 Codes, Standards, and Guidelines

There are numerous Codes, Standards, and Guidelines that will apply to the design of the Mechanical, Plumbing, and Fire Protection Systems. Key documents include, but are not limited to, the following:

- IBC, International Building Code, *2015*.
- NFPA 101, Life Safety Code, *2015*.
- NFPA 30, Flammable and Combustible Liquids Code, *2015*.
- International Plumbing Code, *2012 with amendments*.
- International Fuel Gas Code, *2012*.
- International Mechanical Code, *2012*.
- ASHRAE 90.1, Energy Code, *2007*.
- NFPA 13, Standard for the Installation of Sprinkler Systems, *2016*.
- NFPA 37, Stnd for Installation & Use of Stationary Combustion Engines & Gas Turbines, *2015*.

- NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems, *2015*.
- NFPA 110, Standard for Emergency and Standby Power Systems, *2013*.
- Hurricane Storm Reduction List Design Guidelines, Chapter 6, *04 October 2007*.
- 40 CFR 112, EPA Spill Prevention, Control and Countermeasure (SPCC) Regulation.
- UFC 1-200-01, DOD Building Code (General Building Requirements), *Change 2, 01 Nov 2018*.
- UFC 3-401-01, Mechanical Engineering, *Change 1, October 2015*.
- UFC 3-410-01, Heating, Ventilating, and Air Conditioning Systems, Change 4, 01 November 2017.
- UFC 3-410-02, Direct Digital Control for HVAC and Other Building Control Systems, *18 July 2018*.
- UFC 3-410-04N, Industrial Ventilation, *25 October 2004.*
- UFC 3-420-01, Plumbing Systems, *Change 10, October 26, 2015*.
- UFC 3-420-02FA, Compressed Air, *Change 1, December 2007*.
- UFC 3-600-01 Fire Protection Engineering for Facilities, *Change 2, 25 March 2018*.
- UFC 4-023-10, Safe Havens, *1 June 2016*.
- UFC 4-610-01, Administrative Facilities, *Change 2, 21 May 2014*.

6.2 References

There are numerous standards that will be referenced by the design specifications. Key organizations with standards referenced will include, but are not limited to, the following:

- ABMA, American Bearing Manufacturers Association.
- AGMA, American Gear Manufacturers Association
- ASTM, American Society for Testing and Materials
- AHRI, Air-Conditioning, Heating and Refrigeration Institute.
- AISC, American Institute of Steel Construction
- AISI, American Iron and Steel Institute.
- AMCA, Air Movement and Control Association International.
- ANSI, American National Standards Institute.
- ASHRAE, American Society of Heating, Refrigerating and Air-Conditioning Engineers.
- ASME, American Society of Mechanical Engineers.
- ASSE, American Society of Sanitary Engineering.
- ASTM, American Society for Testing and Materials.
- AWS, American Welding Society.
- AWWA, American Water Works Association.

- CAGI, Compressed Air and Gas Institute.
- CGA, Compressed Gas Association.
- ISA, International Society of Automation.
- ISO, International Organization for Standardization.
- MSS, Manufacturers Standardization Society of the Valve and Fittings Industry.
- NEMA, National Electrical Manufacturer's Association.
- NSF, National Sanitation Foundation.
- PPFA, Plastic Pipe and Fittings Association.
- PDI, Plumbing and Drainage Institute.
- SAE, Society of Automotive Engineers International.
- SMACNA, Sheet Metal and Air Conditioning Contractors' National Association.
- UL, Underwriters Laboratories.

Key specific standards referenced will include, but not be limited to, the following:

- Code of Federal Regulations, Title 29-Labor, Chapter XVII, Occupational Safety and Health Administration (OSHA).
- AGMA, American Gear Manufacturers Association. 6010 (1997f) Standard for Spur, Helical,
- Herringbone, and Bevel Enclosed Drives
- ASTM INTERNATIONAL (ASTM) A126 (2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
- ASTM A269 (2010) Standard Specification for Seamless and Welded Austenitic Stainless Steel
- Tubing for General Service
- ASTM B21 (2001e1) Standard Specification for Naval Brass Rod, Bar, and Shapes
- ASTM B584 (2012a) Standard Specification for Copper Alloy Sand Castings for General Applications

6.3 Computer Programs

Design of Mechanical and Plumbing Systems will utilize the following programs:

- Carrier HAP.
- COMCheck for Energy Code Compliance.
- AutoCAD Civil3D
- Specs-In-Tact for development of specifications.

6.4 Design Criteria

6.4.1 Sluice Gates & Actuators

The sluice gates within the Headworks Structure are hydraulically actuated. They will be specified as complete units, consisting of gate frames and guides; gate slides; and wall thimbles. A central hydraulic power unit will provide the energy to operate the gates via linear piston actuators coupled to gate valves for control of the hydraulic fluid.

6.4.1.1 Guidelines:

The following latest revision of the US Army Corps of Engineers Engineering documents will be used for designing the mechanical components:

- ETL 1110-2-584, *Design of Hydraulic Steel Structures*, 30 June 2014
- EM 1110-2-2610, *Mechanical and Electrical Design for Lock and Dam Operating Equipment*, 30 June 2013
- EM 1110-2-3200, *Wire Rope Selection Criteria for Gate-Operating Devices*, 30 November 2016
- AWWA C501-87, *Standard for Cast-Iron Sluice Gates*

The AWWA standard covers wall-thimble, vertically mounted, cast-iron sluice gates designed for either seating head or unseating head, or both. The cast-iron sluice gates have machined metal faces and machined adjustable wedging devices, and can be used for square, rectangular, or round openings. They may be of the conventional-closure or the flush-bottom-closure type. The standard also covers manual sluice gate actuator mechanisms together with standard accessories.

6.4.2 Fire Protection

No assumptions will be made regarding available water pressure and flow from the City. Pressure and flow tests will need to be performed as near to the site as possible to determine available city water capacity, which in turn will be used for pipe sizing calculations. While it is not anticipated that a fire pump will be necessary, information will also be used to size the fire pump, if needed.

6.4.3 Plumbing

No assumptions will be made regarding available water pressure and flow from the City. Pressure and flow tests will need to be performed as near to the site as possible to determine available city water capacity, which in turn will be used for pipe sizing calculations. While it is not anticipated that domestic water booster pumps will be necessary, information will also be used to size domestic water booster pumps, if needed.

6.4.4 Fuel Storage and Distribution

Fuel tank(s) will be sized for operating on-site generating equipment at full load for 3 days.

6.4.5 Heating and Ventilation

HVAC Systems for conditioned spaces within the Control House will be designed to maintain a temperature of 75-degrees Fahrenheit. Actual R-values of designed building insulation materials will be utilized for calculations. Outside air temperature will be assumed to be between 32-degrees Fahrenheit and 95-degrees Fahrenheit; outside air relative humidity will be assumed to be between 50% RH and 100% RH.

Ventilation Systems for non-conditioned spaces will be designed for a minimum of 6 air-changes per hour at a static pressure of 0.25-inches water, and with velocity limited to a maximum of 750 CFM.

The PLC cabinet will be conditioned with an enclosure-mounted air conditioner. Sizing will be based on the heat release information of the Basis of Design PLC equipment and associated power supplies. System will be designed to maintain an internal cabinet temperature between 40-degrees Fahrenheit and 90-degrees Fahrenheit. Cabinet humidity will be maintained below 80% RH.

Ventilation Systems for non-conditioned spaces within the Safe House will be designed for a minimum of 12 air changes per hour at a static pressure of 0.25-inches water, and with velocity limited to a maximum of 500 CFM to limit water intrusion.

The Control House, if separate from the Safe House, will be ventilated, not conditioned, with the system designed for a minimum of 12 air changes per hour at a static pressure of 0.25-inches water, and with velocity limited to a maximum of 500 CFM to limit water intrusion.

7. ELECTRICAL & INSTRUMENTATION DESIGN

7.1 Codes, Standards and Guidelines

There are numerous Codes, Standards, and Guidelines that will apply to the design of the Electrical, Fire Alarm, and Control/Instrumentation Systems. Key documents include, but are not limited to, the following:

- NFPA 70, National Electrical Code, *2014*.
- NFPA 72, National Fire Alarm and Signaling Code, *2013*.
- NFPA 101, Life Safety Code, *2015*.
- IBC, International Building Code, *2015*.
- ASHRAE 90.1, Energy Code, *2007*.
- NFPA 110, Standard for Emergency and Standby Power Systems, *2013*.
- NFPA 780, Standard for the Installation of Lightning Protection Systems, *2014*
- IESNA Lighting Handbook, *Nineth Edition*
- Entergy Customer Installation Standards for Electric Service, *September 4, 2018*.
- Hurricane Storm Reduction List Design Guidelines, Chapter 6, *04 October 2007*.
- EM 1110-2-2610, Mechanical and Electrical Design for Lock and Dam Operating Equipment, 30 June 2013.
- UFC 1-200-01, DOD Building Code (General Building Requirements), Change 2, 01 November 2018.
- UFC 3-501-01, Electrical Engineering, October 6, 2015.
- UFC 3-520-01, Interior Electrical Systems, October 6, 2015.
- UFC 3-530-01, Interior and Exterior Lighting Systems and Controls, Change 3, 01 June 2016.

- UFC 3-540-01, Engine-Driven Generator Systems for Prime and Standby Power Applications,
- Change 1, 24 October 2017.
- UFC 3-575-01, Lightning and Static Electricity Protection Systems, July 1, 2012.
- UFC 3-580-01, Telecommunications Interior Infrastructure Planning and Design, Change 1, 01 June 2016.
- UFC 3-600-01 Fire Protection Engineering for Facilities, Change 2, 25 March 2018.
- UFC 4-021-02, Electronic Security Systems, 1 October 2013.
- UFC 4-023-10, Safe Havens, 1 June 2016.
- UFC 4-610-01, Administrative Facilities, *Change 2, 21 May 2014*.

7.2 References

There are numerous standards that will be referenced by the design specifications. Key organizations with standards referenced will include, but are not limited to, the following:

- ANSI, American National Standards Institute.
- ASME, American Society of Mechanical Engineers.
- ASTM, American Society for Testing and Materials.
- NEMA, National Electrical Manufacturer’s Association.
- NETA, International Electrical Testing Association
- ICEA, Insulated Cable Engineers Association.
- IEEE, Institute of Electrical and Electronics Engineers.
- IES, Illuminating Engineering Society.
- ISA, International Society of Automation.
- ISO, International Organization for Standardization.
- TIA, Telecommunications Industry Association.
- UL, Underwriters Laboratories.

Key specific standards referenced will include, but not be limited to, the following:

- Code of Federal Regulations, Title 29-Labor, Chapter XVII, Occupational Safety and Health Administration (OSHA).
- NFPA 70E, Standard for Electrical Safety in the Workplace.

7.3 Computer Programs

Design of electrical and Instrumentation Systems will utilize the following programs:

- Microsoft Excel for load calculations, conduit fill calculations, and voltage drop calculations.
- Litepro for simple interior and exterior lighting calculations.

- AGI32 for complex interior and exterior lighting calculations and for roadway lighting calculations.
- ElumTools for Revit-based lighting calculations.
- Cummins PowerSuite for generator sizing calculations
- COMCheck for Energy Code compliance.
- AutoCAD for drawing development.
- Specs-In-Tact for development of specifications.

7.4 Design Criteria

7.4.1 Power Distribution

Feeders will be sized to limit voltage drop to a maximum of 2%. Branch circuits will be sized to limit voltage dip to a maximum of 3%. Total voltage drop from source to load will be limited to 5%.

Distribution equipment will be sized to allow for future load increases of 25%, minimum.

7.4.2 Back-up Power Systems

Generating equipment will be sized per the following:

- Max Step Voltage Dip: 20%
- Max Step Voltage Recovery Time: 3 seconds. Max Step Frequency Dip: 5%
- Max Step Frequency Recovery Time: 3 seconds. Peak Voltage Dip (Cyclic Loads): 15%
- Peak Frequency Dip (Cyclic Loads): 3%
- Steady State Operational Bandwidth (Voltage): +/- 0.5% Steady State Operational Bandwidth (Frequency): +/- 0.25%
- Min Connected Load: 30% of generator set rating.
- Max Connected Load: 80% of generator set rating.

7.4.3 Lighting

IES standard building reflectances of 80%/50%/20% (Ceiling/Wall/Floor) will be used for preliminary interior lighting calculations (conditioned spaces). Final calculations will utilize actual material and finish reflectances to the greatest extent possible.

Lighting calculations for mechanical and electrical spaces will utilize industrial reflectances.

Roadway lighting calculations will utilize IES-recommended design criteria for roadway reflectance based on concrete/asphalt construction.

Light Levels: Minimum average horizontal foot-candle light levels for interior spaces will be designed to meet IES recommended average levels. In mechanical and electrical spaces, levels will be designed to an average of 50 foot-candles average, measured 30-inches AFF.

Uniformity: Max-to-Min foot-candle levels within any single interior space will be limited to 4:1 to be considered “acceptable”; however, design will strive to limit uniformity to below 3:1.

Emergency Lighting: Per NFPA requirements, emergency lighting will be designed for a minimum of 1 foot-candle average and a max-to-min no greater than 40:1 for paths of egress. Per NFPA 110, design will include emergency lighting in Generator Rooms. As an additional measure of safety, we also intend to specify emergency lighting in mechanical and electrical spaces.

7.4.4 Grounding and Lightning Protection

Grounding electrode system will be site-wide and consist of multiple ground rods connected together with underground electrode conductors (ground loops). Ground loops will be specified around each building, pad-mounted transformers, generating equipment, and fuel tanks. All ground loops will be connected together.

Ground rods will be copper-bonded steel or stainless steel.

Separately derived systems will be grounded to the grounding electrode system in accordance with NEC requirements.

An equipment grounding conductor will be specified for each branch circuit and feeder. Where conductor sizes are increased to limit voltage drop or for other reasons, equipment grounding conductor sizes will be increased proportionally.

Lightning Protection Systems will tie into the site-wide grounding electrode system.

7.4.5 Gate Controls

Gate controls will be designed to limit single points of failure. Multiple control schemes (Local/Remote, PLC/Manual) will be implemented.

Backup power for PLC-based instrumentation and controls will be provided by a UPS capable of operating PLC-based equipment and instrumentation for a minimum of 4-hours.

7.4.6 Network Communication

Network equipment ports and media that connect to the utility or to other network equipment (network backbone) will be designed for Giga-bit speeds. Backbone media will be fiber, unless otherwise required for connection to the utility. Connections to user terminals and surveillance cameras will be designed for 100 Mega-bit speeds. Copper media will be used within buildings for connections to workstations; fiber media will be used for connections to exterior surveillance cameras.

Network equipment, including that associated with surveillance cameras, PLC Ethernet communications, and connection to the Metro Ethernet, will be powered by UPS equipment sized to keep the equipment operating for a minimum of 4-hours when neither utility nor standby generator power are available.

7.4.7 Security Systems

Access Control System door strikes for perimeter doors will be fail-secure, with door hardware configured to allow egress, but not entrance, upon loss of power. For interior, double-egress doors, a fail-safe strike or mag lock will be specified so that a loss of power will not prevent egress in either direction.

Backup DC power for the Access Control System will be provided by batteries sized to provide a minimum of 4-hours of backup power when neither utility nor standby generator power are available.

7.4.8 Fire Alarm Systems

Backup DC power will be provided by batteries sized to provide a minimum of 24-hours of backup power when neither utility nor standby generator power are available.

HYDROLOGIC AND HYRAULIC DESIGN REPORT

RIVER REINTRODUCTION INTO MAUREPAS SWAMP AND WEST SHORE LAKE PONTCHARTRAIN FLOOD RISK REDUCTION PROJECT PO-0029

Prepared for:
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November 2020

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LIMITATIONS AND DISCLAIMERS

Background information, design bases, and other data have been furnished to AECOM by third parties, which AECOM has used in preparing this Hydrologic and Hydraulic Design Report. AECOM has relied on this information as furnished and is neither responsible for nor has confirmed the accuracy of the information.

This report has been prepared based on certain key assumptions made by AECOM which substantially affect the conclusions and recommendations herein. These assumptions, although thought to be reasonable and appropriate, may not prove to be true in the future. The conclusions and recommendations of AECOM are conditioned upon these assumptions.

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EXECUTIVE SUMMARY
RIVER REINTRODUCTION INTO MAUREPAS SWAMP AND WEST SHORE LAKE PONTCHARTRAIN FLOOD RISK REDUCTION PROJECT PO-0029
BASIS OF DESIGN REPORT

Introduction

This Hydrologic and Hydraulic Design Report has been prepared for the Coastal Protection and Restoration Agency (CPRA) and analyses contained in this document pertain to the construction of the *River Reintroduction Into Maurepas Swamp And West Shore Lake Pontchartrain Flood Risk Reduction Project Po-0029* in St. John the Baptist Parish, near Garyville, Louisiana.

Existing Site Drainage Characteristics

Most of the site drains into Angelina Canal and Bourgeois Canal, which flow northward into Hope Canal and ultimately the Maurepas Swamp. The Marathon property is self-contained for storm water with onsite retention ponds that flow under the railroad into Marathon Ditch (old Sugar Mill Ditch) and under Airline Highway into Hope Canal. There are also large offsite areas located on the west side of the Marathon property that are self-contained and flow across Airline Highway in independent channels. The existing area of focus is considered to extend from State Route 3213 to the west, State Route 54 to the east, the MS river levees to the south and Airline Highway to the north.

Proposed Conditions Analysis

With construction of the Maurepas River Diversion, the existing drainage patterns will be split into two areas - an east side and west side. Areas on the west side that currently flow into Angelina Canal will be carried under the railroad and into a new West Ditch along the eastern boundary of the Marathon property, under the KCS railroad, and under Airline Highway. The West Ditch will join with the Marathon Ditch downstream of Airline Highway and its flow will be dispersed into the Maurepas Swamp. The Marathon property will not be impacted and all internal drainage that currently flow into the Marathon Ditch will continue to do so under the proposed conditions. The areas that flow into Angelina Canal from the east side will be carried in a new East Ditch along the edge of the diversion right of way adjacent to the current Angeline Canal. This East Ditch will follow the path of the Maurepas Diversion\WSLP Project until Airline Highway where it will connect with the USACE's rerouted Hope Canal from which it will be dispersed into Maurepas Swamp.

Summary and Conclusion

All design storm peak water surface elevations and peak discharges will be at or below existing site conditions levels. From this analysis, it is concluded that the designed East and West Ditches will not cause adverse drainage or flooding effects to any surrounding properties or areas.

1 Section 1 - Introduction

1.1 Purpose

AECOM is submitting this Hydrologic and Hydraulic Design Report to the Coastal Protection and Restoration Authority (CPRA). This analysis is being submitted as part of the 15% Design process for the proposed “River Reintroduction into Maurepas Swamp and West Shore Lake Pontchartrain Flood Risk Reduction Project PO-0029” in St. John the Baptist Parish, near Garyville, Louisiana. The analyses and results presented in this report are intended as proof to CPRA, USACE and St. John the Baptist Parish, and Marathon Petroleum that the proposed diversion and flood protection features, with the herein proposed local drainage improvements, will not cause adverse drainage impacts to any surrounding properties or areas.

1.2 Proposed Design

The Maurepas Diversion is a proposed 2,000 cubic foot per second (cfs) freshwater diversion from the Mississippi River into the Maurepas Swamp. The intake to the diversion is located at approximately River Mile 144 and the inland features will be in St. John the Baptist Parish, Louisiana. The basic components are an intake channel in the batture; a gated structure in the Mississippi River levee; a sedimentation basin; a 5½ mile long open conveyance channel; crossings at the Canadian National (CN) and Kansas City Southern (KCS) railroads; crossings at River Road, Airline Highway, and Interstate 10; submerged weirs in Bayou Secret and Bourgeois Canal; embankment cuts in the existing ridge of an old cypress logging trail; and check valves on the northern side of culverts underneath I-10.

AECOM submitted the latest plans and specifications for the Maurepas Diversion to CPRA in September of 2013. Since that time, major changes to both the existing conditions as well as the overall Scope of Work have been made. The primary changes in conditions have been: 1) the development of the Marathon Petroleum Mt. Airy Terminal facilities on land adjacent to the proposed Maurepas Diversion alignment, and 2) the construction of a Marathon Petroleum marine docking facility upstream of the diversion intake. The permitting of a second marine dock facility, which will include a pipe-bridge across the intake, is currently in progress. The primary change to the Scope of Work is the addition of the design of those components of the USACE WSLP flood protection project that parallel the Maurepas Diversion project from the south side of River Road to the north side of Airline Highway, which includes levees, floodwalls, and gates.

The West Shore Lake Pontchartrain (WSLP) project will provide hurricane and storm-damage risk reduction in St. Charles and St. John the Baptist Parishes. The recommended plan includes the construction of a levee system around the communities of Montz, Laplace, Reserve, and Garyville. The system will consist of approximately 18 miles of earthen levees and floodwalls, 4 floodgates, a drainage canal running parallel to the levee, 2 drainage structures, and 4 pump stations along the alignment. The flood protection features of the final three reaches of the WSLP project (WSLP-111, WSLP-112, and WSLP-113) are to be constructed parallel to and immediately adjacent to the Maurepas Diversion. The main design features of these reaches include an earthen tie-in to the Mississippi River levee, a gated crossing at River Road, a combination of levees and structural walls throughout the alignment, gated crossings at both the CN and KCS railroads, a raised crossing of Airline Highway, and a tie-in to the flood protection levee at Reach WSLP-110.

The purpose of this report is to document the viability of the construction features proposed to facilitate drainage in the area surrounding the Maurepas Diversion\WSLP Project. Construction of the project will require clearing and grading of the project area for both the diversion and flood protection features and the associated drainage infrastructure. The projects, once constructed, will enable water to be diverted from the Mississippi River into the Maurepas Swamp and provide flood protection to the majority of the developed areas of St. John the Baptist and St. Charles Parishes. In addition, the location of the various project elements minimizes impacts to potential jurisdictional wetlands, sensitive habitats, cultural resources, and populated areas to the extent practicable.

1.2.1 Location and Watershed

The proposed project is located near Garyville, Louisiana, in St. John the Baptist Parish. The overall site for this analysis is bounded by a point 2,500-ft beyond Airline Highway to the north, the Mississippi River to the south, LA-3213 to the west, and LA-54 to the east. Figure 1-1 shows a map of the project area.

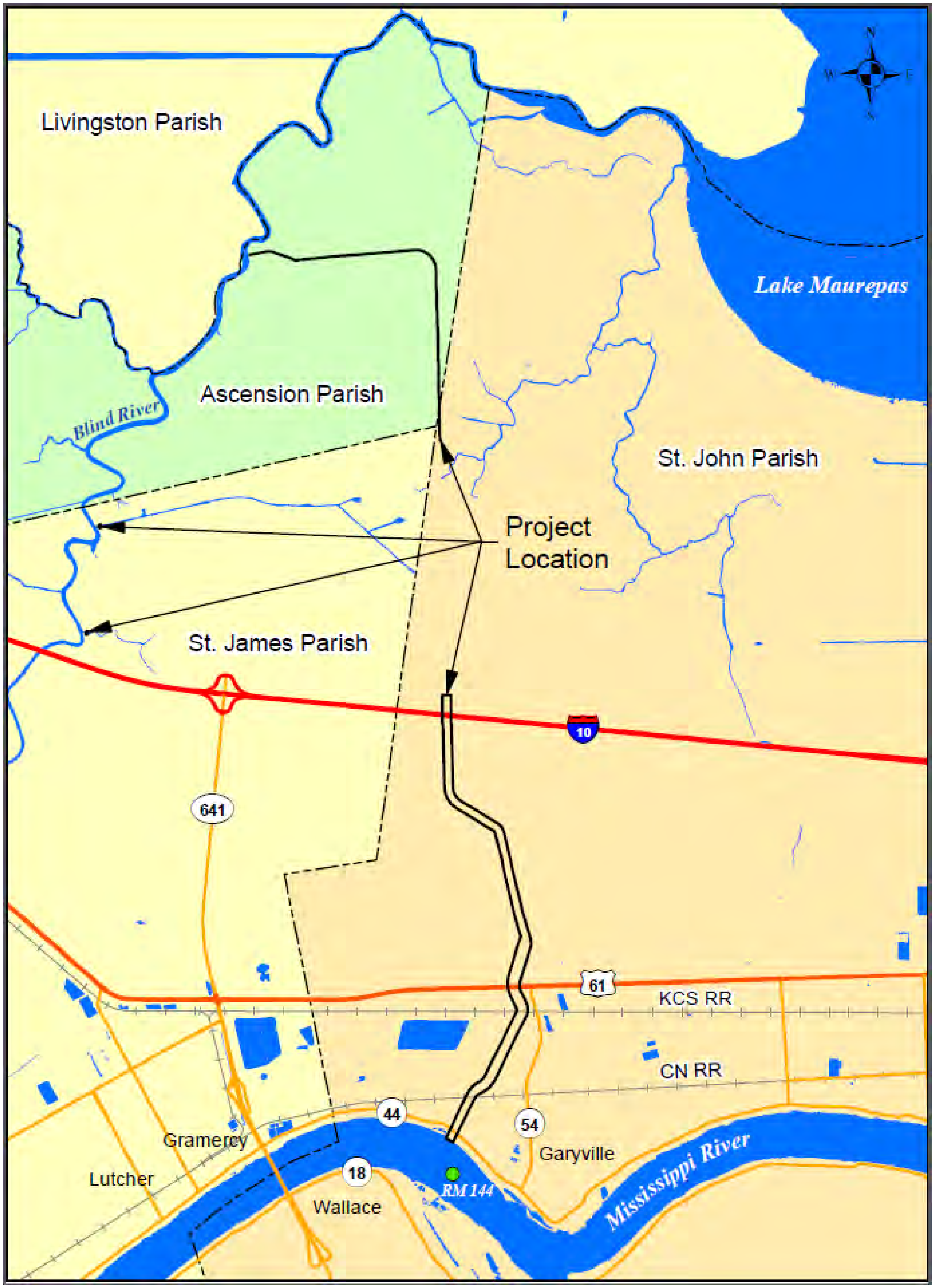


Figure 1-1: Vicinity Map

The overall watershed map can be found on Figure 1 in Appendix E. The watershed area for the project site spans 1162 acres.

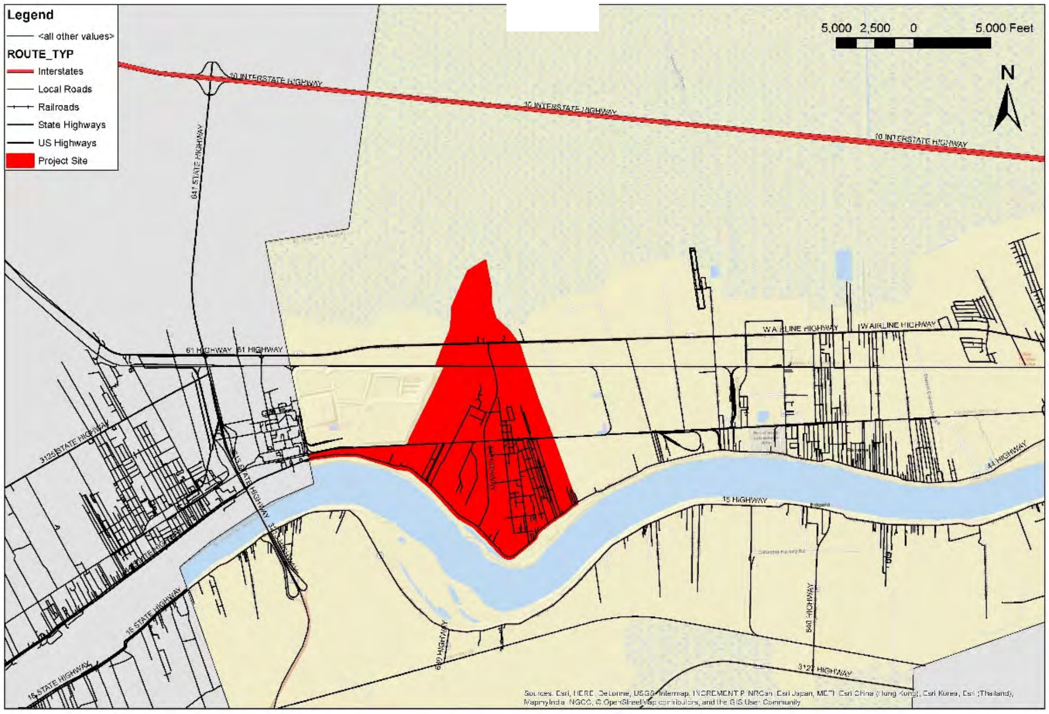


Figure 1-2: Watershed Map

2 Section 2 – Existing Conditions Hydrological Analysis

2.1 **Introduction**

The U.S. Army Corps of Engineer's Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) software version 4.6.1 was used to model the rainfall effects and hydrology of the project area and watershed. HEC-HMS models consist of three main components: a basin manager which includes the physical characteristics of the watershed; a meteorological model containing the rainfall data; and a control specification defining the computational simulation period and calculation interval for the desired simulation. Each of these is described in subsequent subsections.

2.2 Existing Conditions Drainage Areas

Using a combination of LiDAR data; USGS Quad Maps and Aerial Photography; National Hydrographic Dataset; and historical SWMM modeling, the project watershed was divided into subbasins. These subbasins comprise the entire project area, including all -areas beyond the

Project boundaries that drain to the project site. The subbasins are shown in Figure 1: Existing Conditions Drainage Area Map in Appendix E.

2.3 Loss Method – SCS Curve Number

During rainfall events, a portion of the rainwater seeps into the ground and does not contribute to runoff. To account for this in HEC-HMS, the loss function is used. There are several different methods of estimating the rainfall loss amount. In this analysis, the development of hydrologic characteristics was based on the SCS Curve Number Method (Natural Resources Conservation Service TR-55 methodology - Urban Hydrology for Small Watersheds, USDA, NRCS, Technical Release 55, June 1986) for drainage areas ranging from 200 to 2000 acres. This method is widely used to model rainfall runoff.

In the SCS curve number method, a curve number (CN) is assigned to each area based on that area's hydrologic soil group, land cover, and hydrologic condition. Table 2-1 shows typical CN values for a range of rural land uses.

For each subbasin, a weighted average CN was computed using a combination of aerial photography, site photos, and USGS maps. Each assigned CN represents a weighted CN for each subbasin based on land-use, land cover, and percent impervious area.

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2/]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3/]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4/]	48	65	73
Woods—grass combination (orchard or tree farm). [5/]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6/]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4/]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

Table 2-1: Typical Curve Numbers for Rural Areas

Source: NRCS TR-55: Urban Hydrology for Small Watersheds

Table 2-2 shows the weighted CNs that were assigned to each subbasin in this analysis.

Table 2-2: Existing Conditions Curve Numbers

Subbasin	CN
1	85.84
2	80.0
3a	91.81
3b	79.56
4	79
5	78.94
6	80
7	83.94
8	76.74
9	81.58
10	82.86

A detailed breakdown of the CNs can be found in Appendix A: Curve Numbers Analysis.

2.4 Transform Method – SCS Unit Hydrograph

In HEC-HMS, each subbasin element represents a combination of infiltration, surface runoff, and subsurface processes interacting together; however, the actual runoff calculations are performed by what is called a transform method within each subbasin. There are several transform methods in HEC-HMS. For this study, the SCS Unit Hydrograph Method was used. In the SCS Method, the time of concentration (Tc) is used to define the shape of the hydrograph. It is defined as the travel time for a flow path in a subbasin from the most hydraulically remote point within the subbasin. The SCS unit hydrograph method is based on lag time, which is the travel time from the centroid of precipitation mass to the peak flow of the resulting hydrograph. Lag time is roughly equivalent to 60 percent of the Tc. This relationship was used to calculate a lag time for each subbasin in this analysis.

Tc is calculated as the summation of travel times within a basin. Travel reaches were selected where there are significant changes in either slope or flow. Flow paths in predominantly undeveloped subbasins will typically include the following components:

- overland flow – fields, maximum 300 feet
- small gullies
- channels

There can be more than one small gully reach and more than one channel reach if there are significant changes in either slope or flow. Flow paths in developed areas will typically include the following components:

- overland flow – lawns (backyard to front curb or ditch) or parking lots (actual distance of parking lot swale)
- gutters (distance to nearest inlet or ditch) or roadside ditches
- storm drains
- channels

Table 2-3 shows a summary of the times of concentration and lag times calculated for each subbasin. Detailed calculations can be found in Appendix B: Times of Concentration and Lag Times.

Table 2-3 Existing Conditions Times of Concentration and Lag Times

Subbasin	Time of Concentration (hours)	Lag Time (minutes)
1	4.208	151.502
2	4.412	158.827
3a	10.371	373.37
3b	1.338	48.16
4	2.192	78.914
5	4.218	151.855
6	1.411	50.809
7	1.525	54.894
8	0.58	20.898
9	2.209	79.537
10	12.616	454.172

Note:

Once these parameters had been determined and calculated, the subbasin model schematics were put together. The subbasin network was laid out in a fashion representative of real-world flow conditions.

2.5 Muskingum-Cunge Routing

Routing reaches are used to move subbasin runoff hydrographs downstream. Upstream subbasins typically discharge into a drainage ditch or bayou at the upper end of the next downstream subbasin. The flow then combines with the flow from this downstream subbasin at its discharge location at the lower end. It takes time for the upstream hydrograph to move through the downstream subbasin. In addition, there will be some attenuation (flattening out of the hydrograph) as it moves downstream. This is all accomplished by an element in HEC-HMS known as the routing reach. There are several methods for flow routing available in HMS. The selected routing method for this analysis is Muskingum-Cunge flow routing. This method is a widely accepted physically-based method that uses an approximation of channel characteristics and dimensions to provide an efficient approach to flow routing.

HEC-HMS input parameters for the Muskingum-Cunge routing method include the following:

- Cross sectional shape - One of five different options must be selected to describe the cross sectional shape of the reach. These include circle, eight point, rectangle, trapezoid and triangle. For our analysis, an eight point cross section was measured for each reach. Each eight-point cross section measured represents an average cross section for the reach, which includes the main channel and the overbank areas on both sides.

- Reach Length, represents the total length of the reach.

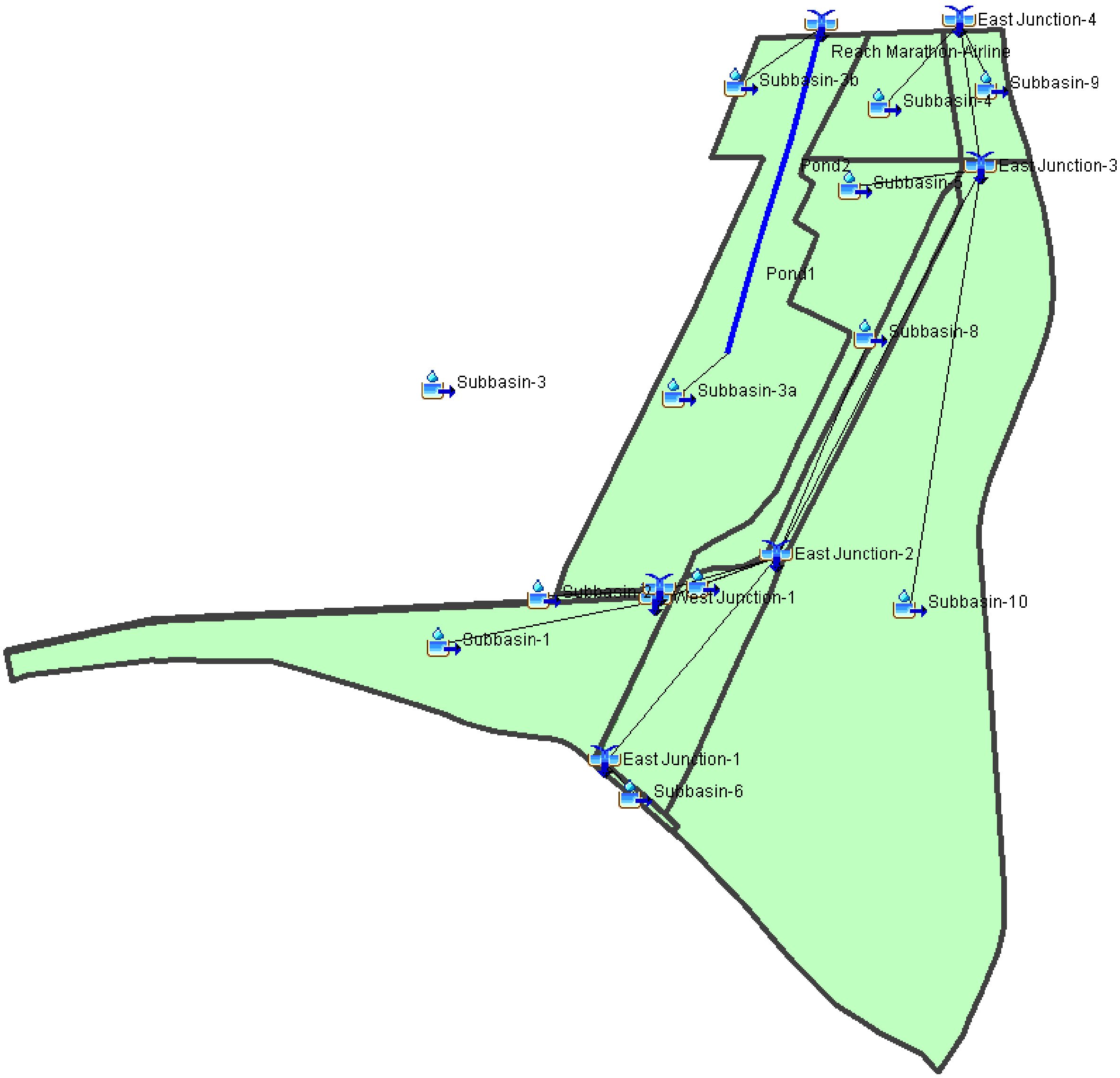
- Slope, represents the average slope for the entire reach. Slope values were measured from LiDAR data.

- Manning's n roughness coefficient – a value that represents an average for the entire reach was used.

- Invert – invert elevation of the channel. This value is used to compute the water stages. This value was derived from topographic survey data or proposed elevations.

Figure 2-1 shows the schematic of the existing conditions watershed area from HEC-HMS. This schematic shows the network of subbasins and routing reaches as it is shown in the model. More information on parameters used in each routing reach can be found in Appendix C: Muskingum-Cunge Routing Parameters.

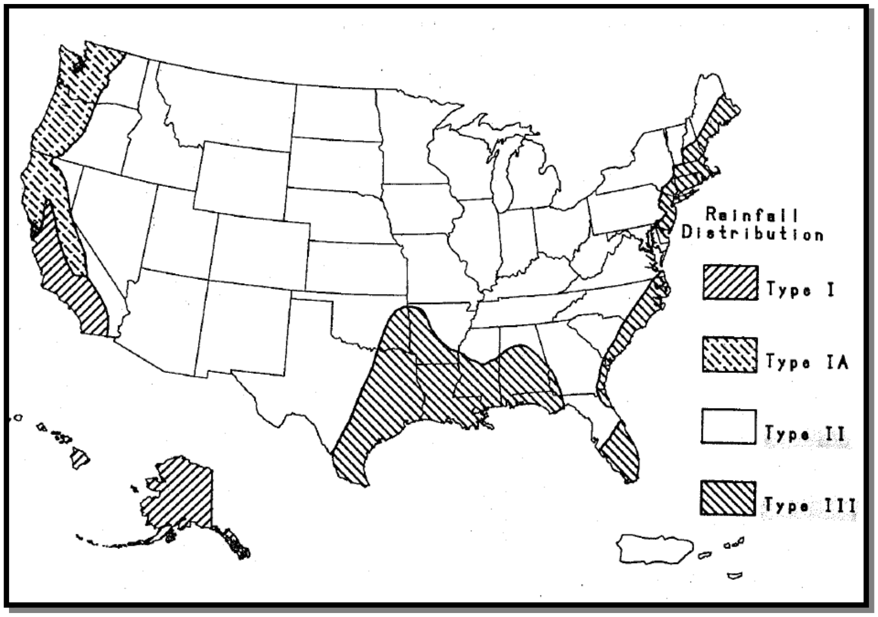
Figure 2-1: Existing Conditions HEC-HMS Schematic



2.6 Rainfall Data

The next step in creating a HEC-HMS model is defining the rainfall data, which is known in HEC-HMS as the meteorological model. There are several methods for defining rainfall, but for this analysis, the SCS storm was used. The SCS storm was developed by the Soil Conservation Service, which is currently known as the Natural Resources Conservation Service. This method used the same data for all subbasins in the model. Each storm has a single distribution type, depending on its location: Type 1, Type 1A, Type 2 or Type 3. Figure 2-2 shows a map of the different types throughout the United States.

Figure 2-2: SCS Storm Types Map



Source: Hydraulics and Hydrology for Stormwater Management: Gribbin, John R. 1996

As shown, all of Louisiana has a Type III rainfall distribution. Each storm in the SCS storm method has a duration of 24 hours. The following table shows the data input into the HEC-HMS model of the project area for the 10-year and100-year rainfall events.

Table 2-4: HEC-HMS Rainfall

Rainfall Event	Rainfall Depth (inches)
10-year	7.68
100-year	12.60

Note: Rainfall depth comes from the NOAA Atlas 14 Volume 9 Version 2PDS Estimates for Garyville LA, Table 3.4-2 Louisiana Rainfall Depths (inches for 100 Year Return Period Duration (Hour) 24.

2.7 Design Storm Peak Flows

Table 2-5 shows a summary of the 10-year and 100-year results of the HEC-HMS output for each element in the model. These values represent the peak flows used in the hydraulic model of Maurepas Swamp to analyze the 10-year and 100-year peak water surface elevations, as described in Section 3 of this report.

Table 2-5: Existing Conditions HEC-HMS Peak Flows

Element	10-year Peak Runoff (cfs)	100-year Peak Runoff (cfs)
Subbasin-10	252.6	475.5
Subbasin-2	6.6	12.7
Subbasin-1	166.9	303.2
West Junction-1	**166.9**	**303.2**
West Junction-2	**6.6**	**12.7**
Subbasin-7	138.9	254
Subbasin-8	76.6	148.9
Subbasin-6	5.5	10.5
East Junction-1	**5.5**	**10.5**
East Junction-2	**251.6**	**469.5**
Subbasin-5	78.7	152.4
East Junction-3	**372**	**706.3**
Subbasin-4	68.2	131
Subbasin-9	39.5	74.1
East Junction-4	**441.7**	**844.4**
Subbasin-3	153.4	272.5
Subbasin-3a	109	190.8
Pond1	108.7	190.4
Pond2	108.7	190.4
Reach Marathon-Airline	108.6	190.3
Subbasin-3b	83.1	158.4
Junction-Airline HWY	**113.5**	**199.1**

3 Section 3 – Existing Conditions Hydraulic Analysis

3.1 Methodology

To ensure that the proposed development will not cause any increase in water surface elevations to the local drainage network, a hydraulic model of Maurepas Swamp was created using the U.S. Army Corps of Engineer's River Analysis System (HEC-RAS) version 5.0.7. HEC-RAS is a widely accepted modeling software designed to perform hydraulic modeling of open channels under a variety of conditions.

The following subsections further describe the components and steps included in this analysis.

3.2 Geometry

The geometry file is where the channel system being modeled is described to the software. It contains the physical characteristics of the channel system, including its streamlines, cross sections, roughness coefficients, bridges, culverts, blocked obstructions, and ineffective flow areas.

Using a combination of LiDAR data and aerial photography, the local drainage for the existing conditions into Hope Canal was established and imported into the HEC-RAS model. Survey collected by C. H. Fenstermaker, LLC was used to update the geometry to obtain inverts and channel profiles where the LiDAR could not penetrate the standing water. It was also used to capture those areas that have newer construction development than the published data.

The USACE model was provided for the WSLP Interior Drainage Hydraulic Design Analysis. The model included separate 2D meshes for the polder interior and exterior, developed using HEC-RAS 5.0.6. The exterior portion of the mesh includes all of Lake Maurepas, Pass Manchac and the western end of Lake Pontchartrain. The interior portion is bounded by the Mississippi River levees to the south and the WSLP project alignment to the north. The interior and exterior are separate 2D areas connected with a storage area connection. The weir profile of the storage area connection for existing conditions is set to the existing terrain. In RAS2D, "terrain" includes the topography and bathymetry. For the with-project conditions, the weir profile elevations of the storage area connection were set to non-overtopping conditions. This ensured that the mesh was exactly the same for both the with and with-out project conditions (aside from elevations of the storage area connection weir profile). This set-up allowed a better comparison between the with and without-project conditions.

Breaklines were drawn along all raised features in the model domain. The breaklines ensured that the raised features such as roadways were captured in the hydraulic calculations.

The 2011 National Land Cover Database was used for the USACE modeling effort. More information on this dataset is provided at http://www.mrlc.gov/. Manning's n values were assigned to the various land coverage types in a manner consistent with other MVN H&H analyses.

The USACE model was opened and confirmed to have referenced geometry and flow files. The model from the pre-project conditions was appropriated and truncated to the subject project area. The terrain was updated with additional breaklines and features to reflect any changes since the USACE model was developed, including the work done on the Marathon property.

Figure 3-1 shows a map of the mesh, existing culverts, and boundary lines used in HEC-RAS. Additional detail can be found in the work maps for this project in Appendix E.

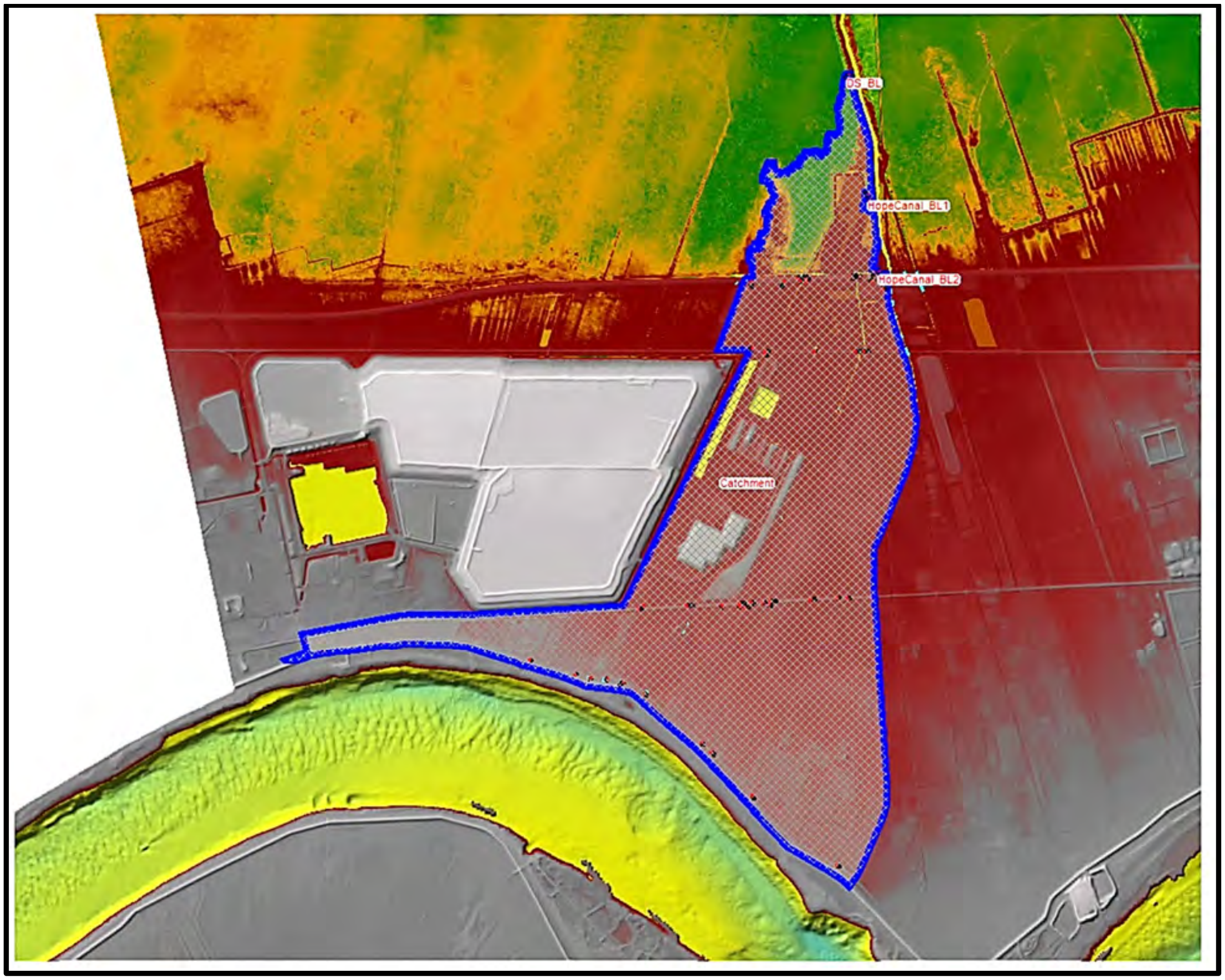


Figure 3-1 Existing Conditions HEC-RAS Geometry

3.4 Flow Files

The final element of the HEC-RAS models is the flow files. With unsteady state 2D models, flows are entered into their applicable boundary condition locations. The flow values used were generated from the HEC-HMS models and the original USACE modeling provided. They were entered at locations throughout the study reach of Maurepas Swamp to accurately simulate real-world design storm conditions along the reach. The USACE provided a tailwater of elevation 1.5-ft NAVD88 and the normal depth, which were used as the downstream boundary conditions in the flow files.

3.5 HEC-RAS Results

Figure 3-1 shows a map of the cross-section and 2D feature locations within the HEC-RAS model. Table 3-1 shows the 10-year peak water surface elevations at the outfall of the Marathon Ditch into the Swamp downstream of Airline Highway.

Table 3-1: Summary of Existing Conditions HEC-RAS Results

Time Step at Cross Section	10-year Peak Water Surface Elevation
01Sep2008 0000	1.5000
01Sep2008 0020	1.1093
01Sep2008 0040	1.1060
01Sep2008 0100	1.1040
01Sep2008 0120	1.1028
01Sep2008 0140	1.1029
01Sep2008 0200	1.1045
01Sep2008 0220	1.1102
01Sep2008 0240	1.1233
01Sep2008 0300	1.1910
01Sep2008 0320	1.2378
01Sep2008 0340	1.2843
01Sep2008 0400	1.3104
01Sep2008 0420	1.3294
01Sep2008 0440	1.3468
01Sep2008 0500	1.3574
01Sep2008 0520	1.3679
01Sep2008 0540	1.3782
01Sep2008 0600	1.3880
01Sep2008 0620	1.3954

Time Step at Cross Section	10-year Peak Water Surface Elevation
01Sep2008 0640	1.4031
01Sep2008 0700	1.4110
01Sep2008 0720	1.4188
01Sep2008 0740	1.4264
01Sep2008 0800	1.4342
01Sep2008 0820	1.4475
01Sep2008 0840	1.4600
01Sep2008 0900	1.4704
01Sep2008 0920	1.4790
01Sep2008 0940	1.4871
01Sep2008 1000	1.4946
01Sep2008 1020	1.5016
01Sep2008 1040	1.5081
01Sep2008 1100	1.5142
01Sep2008 1120	1.5198
01Sep2008 1140	1.5249
01Sep2008 1200	1.5295
01Sep2008 1220	1.5322
01Sep2008 1240	1.5341
01Sep2008 1300	1.5357
01Sep2008 1320	1.5371
01Sep2008 1340	1.5382
01Sep2008 1400	1.5392
01Sep2008 1420	1.5399
01Sep2008 1440	1.5404
01Sep2008 1500	1.5408
01Sep2008 1520	1.5409
01Sep2008 1540	1.5408
01Sep2008 1600	1.5406
01Sep2008 1620	1.5402
01Sep2008 1640	1.5396
01Sep2008 1700	1.5389
01Sep2008 1720	1.5381
01Sep2008 1740	1.5372
01Sep2008 1800	1.5361
01Sep2008 1820	1.5349
01Sep2008 1840	1.5336

Time Step at Cross Section	10-year Peak Water Surface Elevation
01Sep2008 1900	1.5322
01Sep2008 1920	1.5307
01Sep2008 1940	1.5291
01Sep2008 2000	1.5274
01Sep2008 2020	1.5256
01Sep2008 2040	1.5238
01Sep2008 2100	1.5218
01Sep2008 2120	1.5198
01Sep2008 2140	1.5177
01Sep2008 2200	1.5155
01Sep2008 2220	1.5132
01Sep2008 2240	1.5109
01Sep2008 2300	1.5084
01Sep2008 2320	1.5059
01Sep2008 2340	1.5034
02Sep2008 0000	1.5008

Notes:

1. Locations refer to stationing shown on Figure 3-1: Existing Conditions HEC-RAS Locations Map

2. Water Surface Elevations are referenced to the North American Datum of 1983 (NAD 83), Louisiana South Zone (1702), US Survey Feet; and The North American Vertical Datum of 1988 (NAVD 88), Epoch 2012.0293, Feet, as per O.P.U.S. solution at the MSI Network Base Station.

4 Section 4 – Proposed Conditions Hydrologic Analysis

4.1 Introduction

Hydrologic and hydraulic analyses were performed to ensure that the Proposed Conditions would not cause adverse drainage impacts to surrounding properties or areas.

For the subject site the Proposed Conditions include the completed Maurepas Diversion, the finished construction of the WSLP flood protection features, along with new drainage ditches along either side to convey local flow.

4.2 Proposed Conditions Drainage Areas

The existing conditions drainage areas were modified based on the Proposed site plan. The Proposed Conditions Drainage Area Map can be found in Figure 2 in Appendix E. These drainage areas were established with special care exercised to keep all existing flow patterns as consistent as possible. East and West Ditches were added on either side of the diversion to allow for local drainage to continue to the north where impacted by the Project features.

4.3 Loss Method – SCS Curve Number

Analogous to the existing conditions analysis, a weighted SCS CN was assigned to each subbasin based on the area's hydrologic soil group, land cover, and land use type.

Table 4-1: Proposed Conditions Curve Numbers

Subbasin	CN
1	85.8
2	80.0
3a	91.8
3b	79.5
4	79.0
5	78.9
6	80.0
7	83.9
8	76.7
9	81.5
10	82.8

4.4 Transform Method – SCS Unit Hydrograph

Table 4-2 shows a summary of the times of concentration and lag times calculated for each subbasin. These values were calculated based on the methodology described in Section 2. Detailed calculations can be found in Appendix B: Times of Concentration and Lag Times.

Table 4-2: Proposed Conditions Times of Concentration and Lag Times

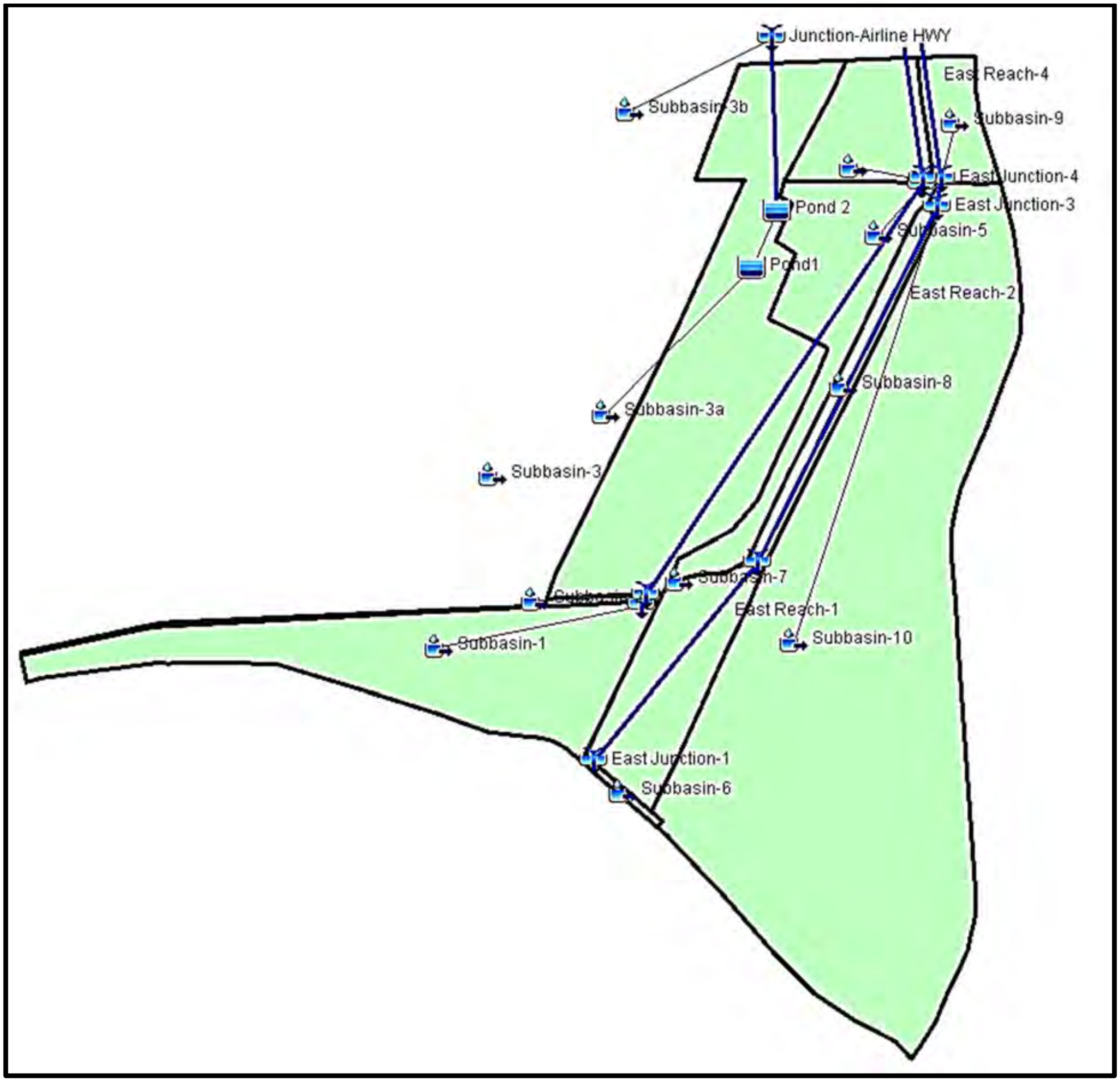
Subbasin	Time of Concentration (hours)	Lag Time (minutes)
1	4.2	152
2	4.4	159
3a	10.4	373
3b	1.3	48
4	2.2	79
5	4.2	152
6	1.4	51
7	1.5	55
8	0.60	21
9	2.2	80
10	12.6	454.

4.5 Muskingum-Cunge Routing

Muskingum-Cunge Routing was also used in the Proposed conditions HEC-HMS model. Detailed information on the physical characteristics from which this method is based can be found in Section 2.5.

Figure 4-1 shows the schematic of the Proposed Conditions watershed area from HEC-HMS. This schematic shows the network of subbasins and routing reaches as it is shown in the model.

Figure 4-1: Proposed Conditions HEC-HMS Schematic



4.6 Rainfall Data

The rainfall data used in the developed conditions HEC-HMS model is consistent with the values used and described in Section 2.6.

Based on the hydrologic analysis of the Proposed Conditions, it can be concluded that the Proposed Conditions will not cause an increase to the 10-year or 100-year peak runoff. Table 4-4 shows a comparison of these values to the existing 10-year and 100-year peak runoff values at the pertinent locations.

Table 4-3: Existing Conditions versus Proposed Conditions Peak Runoff Comparisons

Location	Existing Conditions 10-year Peak Runoff (cfs)	Existing Conditions 100-year Peak Runoff (cfs)	Proposed Conditions 10-year Peak Runoff (cfs)	Proposed Conditions 100-year Peak Runoff (cfs)
West Junction 1	166.9	303.2	166.9	303.2
West Junction 2	6.6	12.7	173.4 This is an increase	315.9 This is an increase
East Junction 1	5.5	10.5	5.5	10.5
East Junction 2	251.6	469.5	177.4	331.1
East Junction 3	372	706.3	263.5	494.7
East Junction 4	441.7	844.4	266.4	499.8

4.7 Design Storm Peak Flows

Table 4-5 shows a summary of the 10-year and 100-year results of the HEC-HMS model. These values represent the peak flows that were used in the hydraulic model of the local drainage ditches to analyze the 10-year and 100-year peak water surface elevations, as described in Section 3 of this report.

Table 4-4: Proposed Conditions HEC-HMS Peak Flows

Element	10-year Peak Runoff (cfs)	100-year Peak Runoff (cfs)
Subbasin-10	252.6	475.5
Subbasin-6	5.5	10.5
East Junction-1	**5.5**	**10.5**
Subbasin-7	138.9	254
Subbasin-8	76.6	148.9
East Junction-2	**177.4**	**331.1**
East Junction-3	**263.5**	**494.7**
Subbasin-9	39.5	74.1
East Junction-4	**266.4**	**499.8**
Subbasin-1	166.9	303.2

Element	10-year Peak Runoff (cfs)	100-year Peak Runoff (cfs)
West Junction-1	**166.9**	**303.2**
Subbasin-2	6.6	12.7
West Junction-2	**173.4**	**315.9**
Subbasin-5	78.7	152.4
West Junction-3	**246**	**458.4**
Subbasin-4	68.2	131
West Junction-4	**274.8**	**515.6**
Subbasin-3	153.4	272.5
Subbasin-3a	109	190.8
Reach Marathon-Airline	42.5	190.7
Subbasin-3b	83.1	158.4
Junction-Airline HWY	123.5	199.9

5 Section 5 – Proposed Conditions Hydraulic Analysis

5.1 Methodology

The hydraulic analysis of the Proposed conditions was performed using HEC-RAS 5.0.7 to model the Maurepas Diversion\WSLP Project and the proposed local drainage ditches.
The following subsections further describe the components and steps included in this analysis.

5.2 Geometry

The geometry of the existing Project Site was modified to account for the proposed geometry of the Maurepas Diversion\WSLP Project and the proposed local drainage ditches. The cross sections of the proposed diversion were taken from the original drainage study and updated per the current 15% design drawings. The diversion consists of a combination of earthen channel and sized so that the 10-year design storm will be contained within its banks.

Table 5-1 shows a breakdown of the channel geometry for the entire Project reach.

Table 5-1: Maurepas Diversion, East and West Ditch Geometry

Location	Top Width (ft)	Bottom Width (ft)	Side Slopes	Average Depth (ft)
West Ditch 1	29	5	3	4
West Ditch 2	29	5	3	4
West Ditch 3	34	10	3	4
West Ditch 4	37	10	3	4.5
East Ditch 1	14	5	3	1.5
East Ditch 2	29	5	3	4
East Ditch 3	37	10	3	4.5
East Ditch 4	37	10	3	4.5

The existing condition was updated with the 15% Proposed Maurepas Diversion\WSLP Project and the new local drainage ditches. The ditches are designed to move the flow that currently flows eastward in the ditches along the CN RR, which would be blocked by the floodwall of the WSLP Project, northward for ultimate discharge into the swamp.

See Figure 5-1 for the centerline of the Maurepas Diversion. East and West Ditches, this figure can also be found in Appendix E.

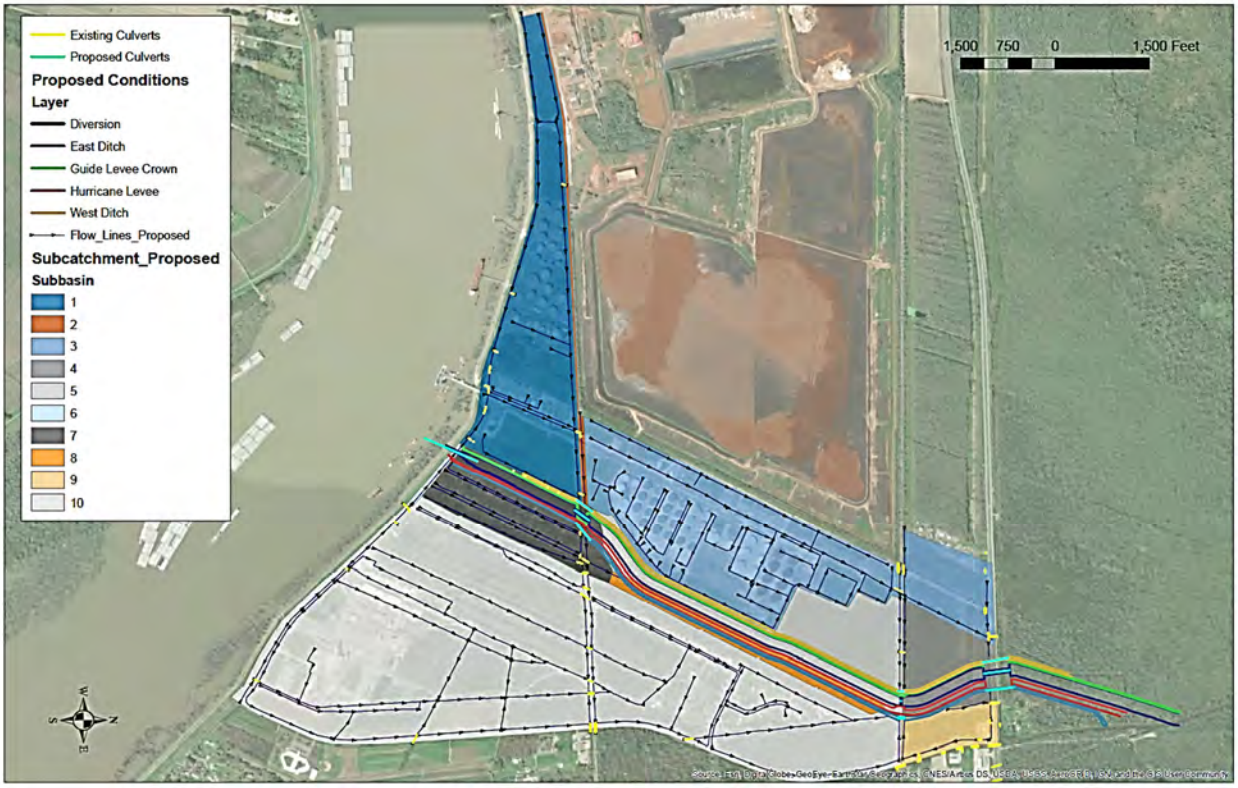


Figure 5-1: Proposed Diversion and Ditch Alignment

The HEC-RAS model of the Maurepas Diversion and local Ditches also includes the proposed roadway, railroad, and bridge crossings (including culverts underneath the features, as applicable) (as shown in Figure 5-1). See Table 5-2 for a summary of the crossings.

Table 5-2: Proposed Crossings

Crossing ID	Crossing Type
West Ditch 1 at Railroad	5x5 Concrete Box
West Ditch 3 at Railroad	10x5 Concrete Box
West Ditch 4 at Airline	10x5 Concrete Box
East Ditch 1 at Railroad	5x5 Concrete Box
East Ditch 3 at Railroad	10x5 Concrete Box
East Ditch 4 at Airline	10x5 Concrete Box

Note:

5.3 Flow Files

New flow files were created using the results of the proposed conditions HEC-HMS model. These flow values account for the proposed site plan and the flow paths of the proposed site.

5.4 HEC-RAS Results

Figure 5-2 shows a map of the HEC-RAS 2d locations. Table 5-3 shows the 10-year peak water surface elevations at the outfall of the Marathon Ditch into the Swamp downstream of Airline Road.

Table 5-3: Proposed Conditions HEC-RAS Results

Time Step at Cross Section	10-year Peak Water Surface Elevation
01Sep2008 0000	1.5000
01Sep2008 0020	1.1285
01Sep2008 0040	1.1289
01Sep2008 0100	1.1290
01Sep2008 0120	1.1295
01Sep2008 0140	1.1315
01Sep2008 0200	1.1356
01Sep2008 0220	1.1444
01Sep2008 0240	1.1610
01Sep2008 0300	1.2299
01Sep2008 0320	1.3151
01Sep2008 0340	1.3924
01Sep2008 0400	1.4355
01Sep2008 0420	1.4685
01Sep2008 0440	1.4954
01Sep2008 0500	1.5175
01Sep2008 0520	1.5375
01Sep2008 0540	1.5742
01Sep2008 0600	1.6099
01Sep2008 0620	1.6400
01Sep2008 0640	1.6680
01Sep2008 0700	1.6938
01Sep2008 0720	1.7173
01Sep2008 0740	1.7381
01Sep2008 0800	1.7566
01Sep2008 0820	1.7725
01Sep2008 0840	1.7858
01Sep2008 0900	1.7967
01Sep2008 0920	1.8047
01Sep2008 0940	1.8104

Time Step at Cross Section	10-year Peak Water Surface Elevation
01Sep2008 1000	1.8143
01Sep2008 1020	1.8166
01Sep2008 1040	1.8176
01Sep2008 1100	1.8174
01Sep2008 1120	1.8161
01Sep2008 1140	1.8140
01Sep2008 1200	1.8111
01Sep2008 1220	1.8061
01Sep2008 1240	1.7998
01Sep2008 1300	1.7931
01Sep2008 1320	1.7859
01Sep2008 1340	1.7780
01Sep2008 1400	1.7694
01Sep2008 1420	1.7604
01Sep2008 1440	1.7510
01Sep2008 1500	1.7415
01Sep2008 1520	1.7320
01Sep2008 1540	1.7227
01Sep2008 1600	1.7134
01Sep2008 1620	1.7042
01Sep2008 1640	1.6951
01Sep2008 1700	1.6864
01Sep2008 1720	1.6777
01Sep2008 1740	1.6693
01Sep2008 1800	1.6612
01Sep2008 1820	1.6532
01Sep2008 1840	1.6453
01Sep2008 1900	1.6379
01Sep2008 1920	1.6307
01Sep2008 1940	1.6237
01Sep2008 2000	1.6168
01Sep2008 2020	1.6103
01Sep2008 2040	1.6039
01Sep2008 2100	1.5978
01Sep2008 2120	1.5915
01Sep2008 2140	1.5853
01Sep2008 2200	1.5798

Time Step at Cross Section	10-year Peak Water Surface Elevation
01Sep2008 2220	1.5738
01Sep2008 2240	1.5686
01Sep2008 2300	1.5636
01Sep2008 2320	1.5585
01Sep2008 2340	1.5531
02Sep2008 0000	1.5482

Note: Water Surface Elevations are referenced to the North American Datum of 1983 (NAD 83), Louisiana South Zone (1702), US Survey Feet; and The North American Vertical Datum of 1988 (NAVD 88), Epoch 2012.0293, Feet, as per O.P.U.S. solution at the MSI Network Base Station.

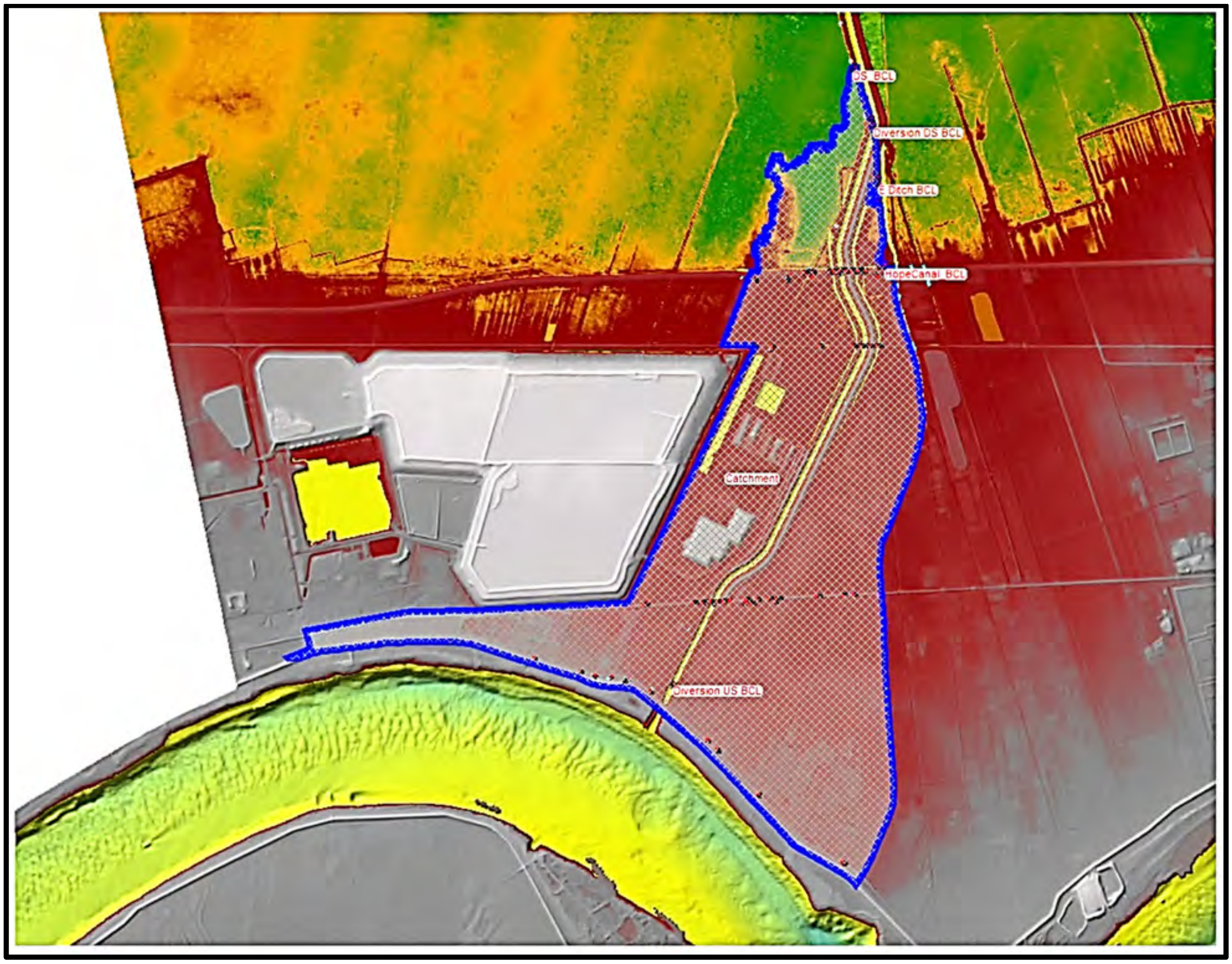


Figure 5-2: Proposed Conditions HEC-RAS Geometry

5.5 Scour Protection

Significant bends in channels can produce large amounts of scour and erosion. To eliminate this potential, the Maurepas Diversion was riprap lined upstream and downstream of each crossing. An analysis was performed on the diversion channel geometry to determine these extents. This analysis was based on peak velocities through the channel.

6 Section 6 – Analysis of Results

6.1 Results

The following tables show a summary of the 10-year and 100-year peak runoff values and peak water surface elevations at pertinent locations entering and leaving the project site.

Table 6-1: Existing Conditions versus Proposed Conditions Results Comparisons

Location	Existing Conditions 10-year	Proposed Conditions 10-year	Difference in Proposed and Existing
Peak Water Surface Elevation Leaving Project at Maurepas Swamp at 9:00 Time Step (ft)	1.47	1.80	0.33

Notes: 1. Water Surface Elevations are referenced to the North American Datum of 1983 (NAD 83), Louisiana South Zone (1702), US Survey Feet; and The North American Vertical Datum of 1988 (NAVD 88), Epoch 2012.0293, Feet, as per O.P.U.S. solution at the MSI Network Base Station.

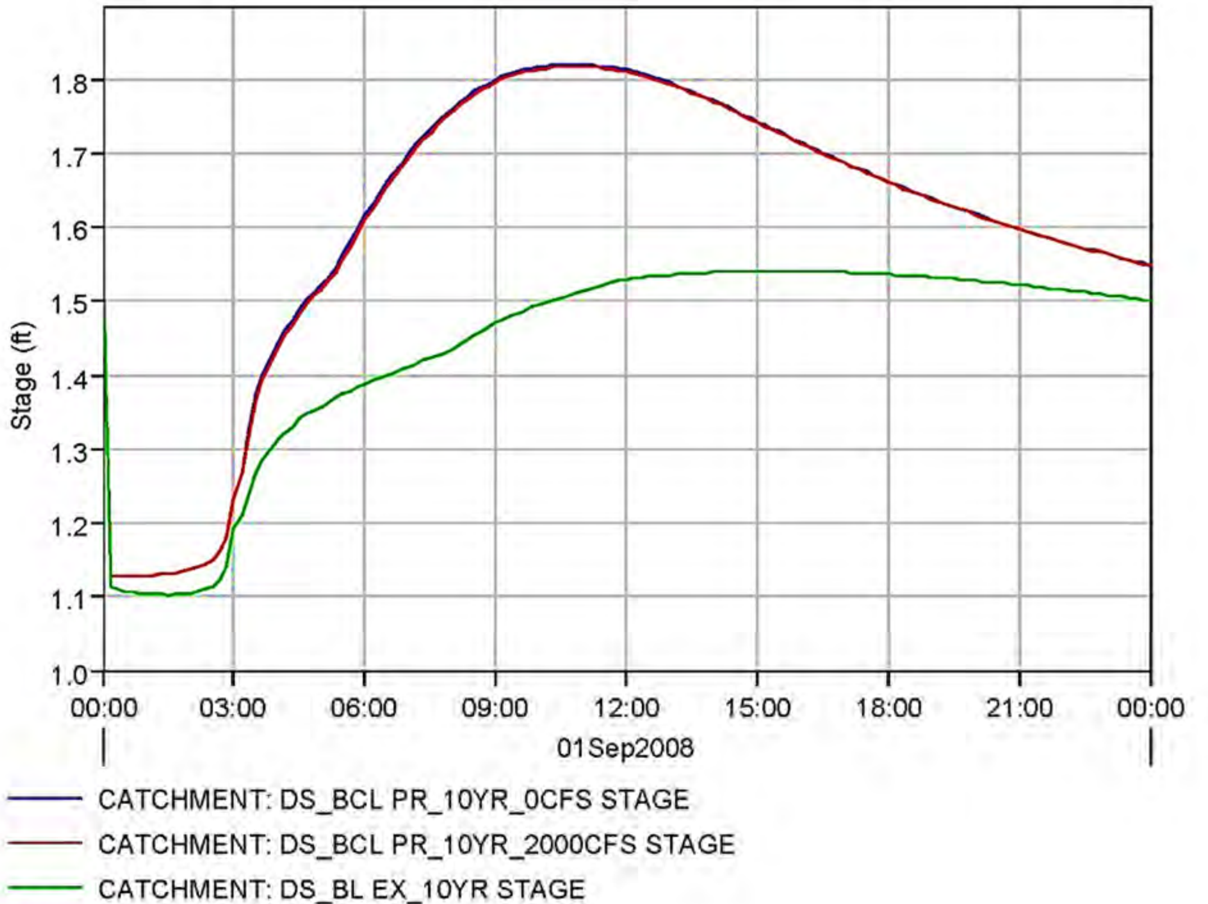


Figure 3:Unsteady Comparison of Peak Water Surface Elevation at Marathon Ditch confluence with Swamp

6.2 Conclusion

Based on the analysis contained within this report, the proposed development of the Maurepas Diversion\WSLP Project, including the proposed additional local drainage through the East and West Ditches, will not cause any adverse drainage impacts to surrounding properties or areas. All design storm peak water surface elevations and peak discharges will be at minimally impact the existing conditions analysis. Further refinement of the model with additional survey, breaklines, and design components will be completed as the project progresses.

6.3 35% Design Considerations

As part of the 35% Design, the 2D modeling for the Maurepas Diversion would be updated to include the latest available survey data, optimize proposed culverts, and optimize the dispersion feature. In addition, the need to model existing culverts as silted would be considered, and any recommendations for maintenance to improve local drainage made in the report.

The historical 1D model of the diversion would be updated. The current version of the model would be opened and run in the original HEC-RAS version from 2007, HEC-RAS 3.1.1. This would ensure that it opens and to locate the latest version of all files, fix any errors or issues. The modeling would be saved as and run in latest HEC-RAS 5.0.7. The runs would be compared to see if any adjustments are needed to ensure the assumptions from 2007 are applied as intended in 5.0.7. Then boundary conditions reviewed and ensured steady state and still applicable. Cross sections would be reviewed and updates with any changes per the 35% design. Any structures like culverts would be updated and optimized in the model as needed and applicable.

The modeling would then be rerun with updates and compared to 3.1.1 version and corrected proposed 5.0.7, to see what changes have been made and impacts. It would be verified that the flow, plan, and geometry are reviewed and are in alignment with 35% plans. A sensitivity analysis done with respect to manning's values would be completed since calibration is not an option. Manning's currently used would be adjusted to a 0.05 higher and 0.05 lower and the associated WSEL reviewed to determine the model's sensitivity to the change in manning's. In addition, a normal depth boundary condition run to determine the sensitivity and further document the boundary condition of known WSEL being appropriate. Throughout the modeling the methodology would be compared the USACE report as necessary. All updated then documented in the report.

Appendix A: Curve Numbers

CPRA Maurepas
Developed Curve Number - September 2020

**CN values were estimated using a combination of existing conditions calcs. and land use drawging provided by Marathon.

Subbasin	Cover Type	Cover Description	HSG	CN	Area	Prod.
1	Industrial	Rail Yard/Industrial	D	93	0.063961	5.95
	Open	Open Space	D	80	0.016268	1.30
	Open	Open Space	D	80	0.043874	3.51
	Open	Open Space	D	80	0.022904	1.83
	Woods	Wooded	D	79	0.016885	1.33
	Woods-Grass	Woods and Grass	D	82	0.034281	2.81
	Industrial	Rail Yard/Industrial	D	93	0.038213	3.55
Totals					**0.236386**	20.29
Composite CN						**85.84**
Impervious area not included in CN					0	

Subbasin	Cover Type	Cover Description	HSG	CN	Area	Prod.
2	Open	Open Space	D	80	0.005614	0.45
	Open	Open Space	D	80	0.005254	0.42
Totals					**0.010868**	0.87
Composite CN						**80.00**
Impervious area not included in CN					0	

**Includes Off3 and Of4

Subbasin	Cover Type	Cover Description	HSG	CN	Area	Prod.
3	Woods Grass	Wooded with Grass	D	82	0.011293	0.93
	Woods	Woods	D	79	0.050094	3.96
	Industrial	Industrial	D	93	0.246031	22.88
	Open	Open Space	C	79	0.004774	0.38
	Open	Open Space	D	80	0.020218	1.62
Totals					**0.33241**	29.76
Composite CN						**89.52**
Impervious area not included in CN					0	

Subbasin	Cover Type	Cover Description	HSG	CN	Area	Prod.
4	Woods	Woods	D	79	0.054148	4.28
	Woods	Woods	D	79	0.016137	1.27
Totals					**0.070285**	5.55
Composite CN						**79.00**
Impervious area not included in CN					0	

Subbasin	Cover Type	Cover Description	HSG	CN	Area	Prod.
5	Woods	Woods	D	79	0.00047	0.04
	Woods	Woods	D	79	0.071904	5.68
	Open	Open Pasture	C	74	0.006209	0.46
	Woods	Woods	C	73	0.000439	0.03
	Open	Open Pasture	D	80	0.006502	0.52
	Open	Open Pasture	D	80	0.018952	1.52
	Woods	Woods	D	79	0.022938	1.81
Totals					**0.127414**	10.06
Composite CN						**78.94**
Impervious area not included in CN					0	

Subbasin	Cover Type	Cover Description	HSG	CN	Area	Prod.
6	Open	Open Sace	D	80	0.003219	0.26
	Open	Open Sace	D	80	0.000945	0.08
						0.00
						0.00
Totals					**0.004164**	0.33
Composite CN						**80.00**
Impervious area not included in CN					0	

Subbasin	Cover Type	Cover Description	HSG	CN	Area	Prod.
7	Residential	Residential 1/4 acre	D	**87**	0.066701	5.80
	Woods	Woods	C	73	0.004024	0.29
	Woods	Woods	D	79	0.022491	1.78
	Woods	Woods	D	79	0.009058	0.72
	Woods	Woods	D	79	0.000782	0.06
Totals					**0.103056**	8.65
Composite CN						**83.94**
Impervious area not included in CN					0	

Subbasin	Cover Type	Cover Description	HSG	CN	Area	Prod.
8	Woods	Woods	D	79	0.015357	1.21
	Woods	Woods	D	79	0.00889	0.70
	Woods	Woods	D	79	0.000339	0.03
	Woods	Woods	C	73	0.01486	1.08
Totals					**0.039446**	3.03
Composite CN						**76.74**
Impervious area not included in CN					0	

Subbasin	Cover Type	Cover Description	HSG	CN	Area	Prod.
9	Open	Open Space	D	80	0.012588	1.01
	Open	Open Space	D	80	0.000372	0.03
	Woods	Woods	D	79	0.017945	1.42
	Woods	Woods	D	79	0.001706	0.13
	Industrial	Impervious Industrial	D	93	0.006239	0.58
Totals					**0.03885**	3.17
Composite CN						**81.58**
Impervious area not included in CN					0	

Subbasin	Cover Type	Cover Description	HSG	CN	Area	Prod.
10	Woods	Woods	D	79	0.104402	8.25
	Woods	Woods	C	73	0.000356	0.03
	Woods	Woods	C	73	0.027347	2.00
	Open	Open Space	C	74	0.02038	1.51
	Residential	Residential 1/4 acre	C	**83**	0.021938	1.82
	Woods	Woods and Grass	D	82	0.070476	5.78
	Industrial	Impervious Industrial	D	93	0.157175	14.62
	Woods	Woods and Grass	D	82	0.112814	9.25
	Woods	Woods	D	79	0.126724	10.01
	Residential	Residential 1/4 acre	D	**87**	0.081419	7.08
	Open	Open Space	C	74	0.023327	1.73
	Industrial	Impervious Industrial	C	91	0.006696	0.61
	Woods	Woods and Grass	C	76	0.003458	0.26
	Woods	Woods and Grass	C	76	0.027987	2.13
	Woods	Woods	C	73	0.007368	0.54
	Woods	Woods	C	73	0.017232	1.26
	Residential	Residential 1/4 acre	D	87	0.04402	3.83
Totals					**0.853119**	70.69
Composite CN						**82.86**
Impervious area not included in CN					0	

Appendix B: Times of Concentration and Lag Times

Maurepas

Developed Time of Concentration - September 2020

Subbasin	Element	Lo (max 300 ft)	L (ft)	u/s Elev (ft)	d/s Elev (ft)	S (ft/ft)	n Tbl 3.1	n	Paved (Y or N)	V (fps) Fig 3.1	depth/dia (ft)	W (ft)	ss (hor/vir)	V (fps)	Tt (hr)
1	Overland flow	300		-	-	0.0125	0.400								0.793
	Gully		5819	-	-	0.0010			N	0.51					3.168
	Pipe		1540	-	-	0.0030		0.012						3.00	0.143
	Channel		1127			0.0030								3.00	0.104
	Totals		8786												4.208
Tc (hr) =	4.208					Area	0.23639								
T_{Lag} (hr) =	2.525	151.502119													

Subbasin	Element	Lo (max 300 ft)	L (ft)	u/s Elev (ft)	d/s Elev (ft)	S (ft/ft)	n Tbl 3.1	n	Paved (Y or N)	V (fps) Fig 3.1	depth/dia (ft)	W (ft)	ss (hor/vir)	V (fps)	Tt (hr)
2	Overland flow	300		-	-	0.0125	0.400								0.793
	Gully		7578	-	-	0.0013			N	0.58					3.618
	Pipe		0	-	-	0.0000		0.012						3.00	0.000
	Totals		7878												4.412
Tc (hr) =	4.412					Area	0.01087								
T_{Lag} (hr) =	2.647	158.827662													

**Includes Off3 and Of4

Subbasin	Element	Lo (max 300 ft)	L (ft)	u/s Elev (ft)	d/s Elev (ft)	S (ft/ft)	n Tbl 3.1	n	Paved (Y or N)	V (fps) Fig 3.1	depth/dia (ft)	W (ft)	ss (hor/vir)	V (fps)	Tt (hr)
3	Overland flow	300		-	-	0.0125	0.400								0.793
	Gully		9299	-	-	0.0005			N	0.35					7.464
	Pipe		0	-	-	0.0000		0.012						3.00	0.000
	Totals		9599												8.258
Tc (hr) =	8.258					Area	0.33241								
T_{Lag} (hr) =	4.955	297.283893													

Subbasin	Element	Lo (max 300 ft)	L (ft)	u/s Elev (ft)	d/s Elev (ft)	S (ft/ft)	n Tbl 3.1	n	Paved (Y or N)	V (fps) Fig 3.1	depth/dia (ft)	W (ft)	ss (hor/vir)	V (fps)	Tt (hr)
4	Overland flow	300		-	-	0.0125	0.400								0.793
	Gully		1498	-	-	0.0003			N	0.30					1.399
	Pipe		0	-	-	0.0000		0.012						3.00	0.000
	Totals		1798												2.192
Tc (hr) =	2.192					Area	0.07029								

Maurepas
Developed Time of Concentration - September 2020

T_{Lag} (hr) = **1.315** 78.9147748

Subbasin	Element	Lo (max 300 ft)	L (ft)	u/s Elev (ft)	d/s Elev (ft)	S (ft/ft)	n Tbl 3.1	n	Paved (Y or N)	V (fps) Fig 3.1	depth/dia (ft)	W (ft)	ss (hor/vir)	V (fps)	Tt (hr)
5	Overland flow	300		-	-	0.0125	0.400								0.793
	Gully		5731	-	-	0.0008			N	0.46					3.425
	Pipe		0	-	-	0.0000		0.012						3.00	0.000
	Totals		6031												4.218

Tc (hr) = **4.218** Area 0.12741

T_{Lag} (hr) = **2.531** 151.855032

Subbasin	Element	Lo (max 300 ft)	L (ft)	u/s Elev (ft)	d/s Elev (ft)	S (ft/ft)	n Tbl 3.1	n	Paved (Y or N)	V (fps) Fig 3.1	depth/dia (ft)	W (ft)	ss (hor/vir)	V (fps)	Tt (hr)
6	Overland flow	300		-	-	0.0125	0.400								0.793
	Gully		996	-	-	0.0008			N	0.45					0.618
	Pipe		0	-	-	0.0000		0.012						3.00	0.000
	Totals		1296												1.411

Tc (hr) = **1.411** Area 0.00416

T_{Lag} (hr) = **0.847** 50.8090957

Subbasin	Element	Lo (max 300 ft)	L (ft)	u/s Elev (ft)	d/s Elev (ft)	S (ft/ft)	n Tbl 3.1	n	Paved (Y or N)	V (fps) Fig 3.1	depth/dia (ft)	W (ft)	ss (hor/vir)	V (fps)	Tt (hr)
7	Overland flow	300		-	-	0.0125	0.400								0.793
	Gully		1035	-	-	0.0012			N	0.56					0.514
	Pipe		2344	-	-	0.0030		0.012						3.00	0.217
	Totals		3679												1.525

Tc (hr) = **1.525** Area 0.10306

T_{Lag} (hr) = **0.915** 54.8941002

Subbasin	Element	Lo (max 300 ft)	L (ft)	u/s Elev (ft)	d/s Elev (ft)	S (ft/ft)	n Tbl 3.1	n	Paved (Y or N)	V (fps) Fig 3.1	depth/dia (ft)	W (ft)	ss (hor/vir)	V (fps)	Tt (hr)
8	Overland flow	203		-	-	0.0125	0.400								0.580
	Gully		0	-	-	0.0012			N	0.56					0.000
	Pipe		0	-	-	0.0030		0.012						3.00	0.000
	Totals		203												0.580

Tc (hr) = **0.580** Area 0.03945

Maurepas

Developed Time of Concentration - September 2020

T_{Lag} (hr) = **0.348** 20.8977733

Subbasin	Element	Lo (max 300 ft)	L (ft)	u/s Elev (ft)	d/s Elev (ft)	S (ft/ft)	n Tbl 3.1	n	Paved (Y or N)	V (fps) Fig 3.1	depth/dia (ft)	W (ft)	ss (hor/vir)	V (fps)	Tt (hr)
9	Overland flow	300		-	-	0.0125	0.400								0.793
	Gully		1783	-	-	0.0005			N	0.35					1.416
	Pipe		0	-	-	0.0030		0.012						3.00	0.000
	Totals		2083												2.209

Tc (hr) = **2.209** Area 0.03885

T_{Lag} (hr) = **1.326** 79.5365485

Subbasin	Element	Lo (max 300 ft)	L (ft)	u/s Elev (ft)	d/s Elev (ft)	S (ft/ft)	n Tbl 3.1	n	Paved (Y or N)	V (fps) Fig 3.1	depth/dia (ft)	W (ft)	ss (hor/vir)	V (fps)	Tt (hr)
10	Overland flow	300		-	-	0.0125	0.400								0.793
	Gully		15119	-	-	0.0005			N	0.36					11.641
	Pipe		1963	-	-	0.0030		0.012						3.00	0.182
	Totals		17382												12.616

Tc (hr) = **12.616** Area 0.85312

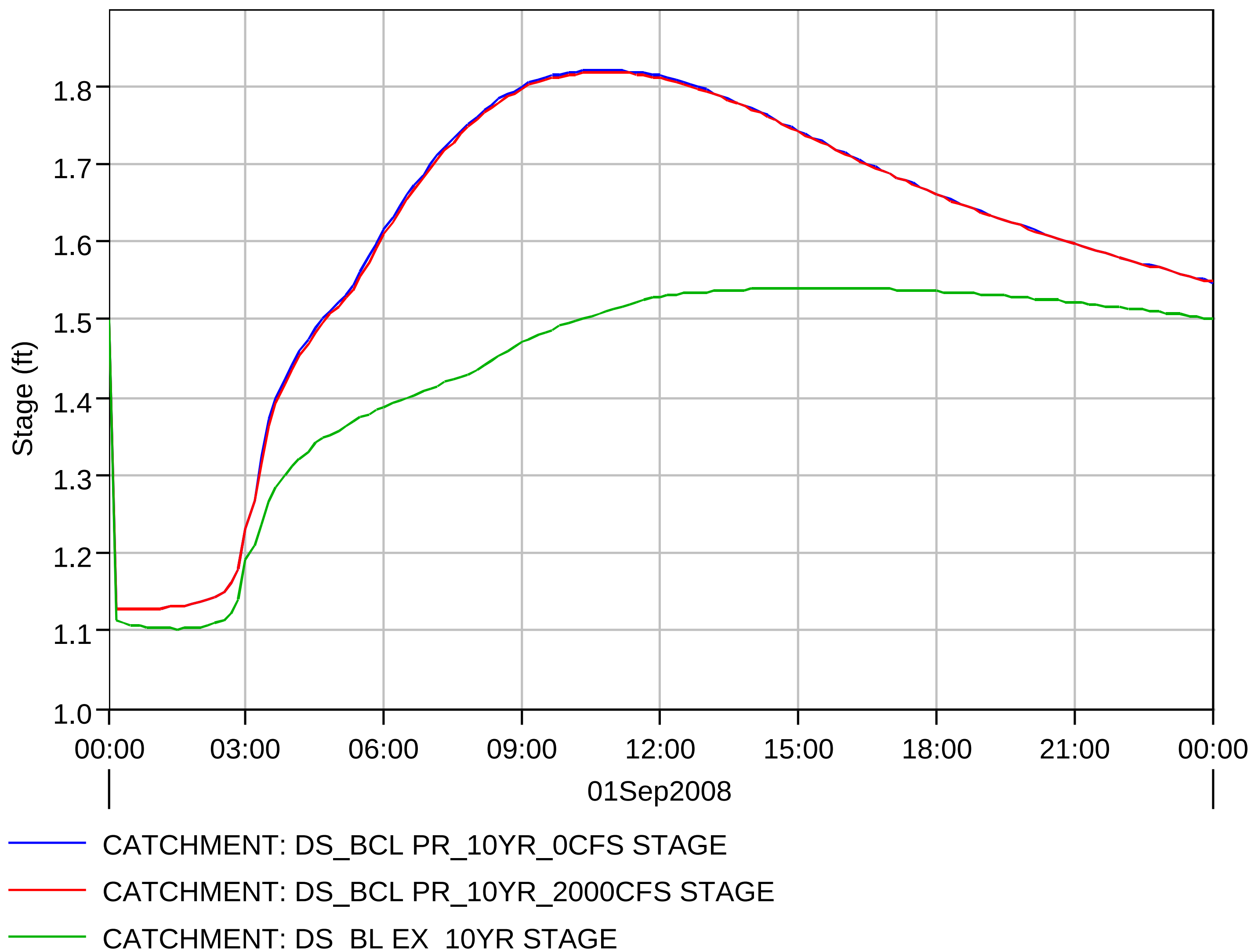
T_{Lag} (hr) = **7.570** 454.172217

Appendix C: Muskingum-Cunge Routing Reaches

Proposed Conditions

Reach	**Length (feet)**	**Slope (ft./ft.)**	**Manning's n (Channel)**	**Manning's n (Overbank)**
East Ditch 1	3413	0.001	0.035	0.1
East Ditch 2	4831	0.001	0.035	0.1
East Ditch 3	379	0.001	0.035	0.1
East Ditch 4	1648	0.001	0.035	0.1
West Ditch 1	109	0.001	0.035	0.1
West Ditch 2	6324	0.001	0.035	0.1
West Ditch 3	80	0.001	0.035	0.1
West Ditch 4	1598	0.001	0.035	0.1

Appendix D: Maurepas MS River Diversion Water Surface Profiles


Stage (ft)
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
01Sep2008
CATCHMENT: DS_BCL PR_10YR_0CFS STAGE
CATCHMENT: DS_BCL PR_10YR_2000CFS STAGE
CATCHMENT: DS_BL EX_10YR STAGE

/BCLINE/CATCHMENTDS_BCL/STAGE/01AUG2008/20MIN/PR_10YR_0CFS/

Ordinate	Date / Time	CATCHMENT: DS_BCL STAGE PR_10YR_0CFS	CATCHMENT: DS_BCL STAGE PR_10YR_2000CFS	CATCHMENT: DS_BL STAGE EX_10YR
Units		FEET	FEET	FEET
Type		INST-VAL	INST-VAL	INST-VAL
1	31 Aug 08, 24:00	1.5000	1.5000	1.5000
2	01 Sep 08, 00:20	1.1284	1.1285	1.1093
3	01 Sep 08, 00:40	1.1289	1.1289	1.1060
4	01 Sep 08, 01:00	1.1290	1.1290	1.1040
5	01 Sep 08, 01:20	1.1297	1.1295	1.1028
6	01 Sep 08, 01:40	1.1318	1.1315	1.1029
7	01 Sep 08, 02:00	1.1359	1.1356	1.1045
8	01 Sep 08, 02:20	1.1442	1.1444	1.1102
9	01 Sep 08, 02:40	1.1610	1.1610	1.1233
10	01 Sep 08, 03:00	1.2299	1.2299	1.1910
11	01 Sep 08, 03:20	1.3222	1.3151	1.2378
12	01 Sep 08, 03:40	1.3996	1.3924	1.2843
13	01 Sep 08, 04:00	1.4417	1.4355	1.3104
14	01 Sep 08, 04:20	1.4740	1.4685	1.3294
15	01 Sep 08, 04:40	1.5002	1.4954	1.3468
16	01 Sep 08, 05:00	1.5217	1.5175	1.3574
17	01 Sep 08, 05:20	1.5440	1.5375	1.3679
18	01 Sep 08, 05:40	1.5811	1.5742	1.3782
19	01 Sep 08, 06:00	1.6161	1.6099	1.3880
20	01 Sep 08, 06:20	1.6458	1.6400	1.3954
21	01 Sep 08, 06:40	1.6733	1.6680	1.4031
22	01 Sep 08, 07:00	1.6987	1.6938	1.4110
23	01 Sep 08, 07:20	1.7217	1.7173	1.4188
24	01 Sep 08, 07:40	1.7423	1.7381	1.4264
25	01 Sep 08, 08:00	1.7604	1.7566	1.4342
26	01 Sep 08, 08:20	1.7759	1.7725	1.4475
27	01 Sep 08, 08:40	1.7890	1.7858	1.4600
28	01 Sep 08, 09:00	1.7997	1.7967	1.4704
29	01 Sep 08, 09:20	1.8075	1.8047	1.4790
30	01 Sep 08, 09:40	1.8130	1.8104	1.4871
31	01 Sep 08, 10:00	1.8167	1.8143	1.4946
32	01 Sep 08, 10:20	1.8189	1.8166	1.5016
33	01 Sep 08, 10:40	1.8198	1.8176	1.5081
34	01 Sep 08, 11:00	1.8195	1.8174	1.5142
35	01 Sep 08, 11:20	1.8181	1.8161	1.5198
36	01 Sep 08, 11:40	1.8159	1.8140	1.5249
37	01 Sep 08, 12:00	1.8129	1.8111	1.5295
38	01 Sep 08, 12:20	1.8078	1.8061	1.5322
39	01 Sep 08, 12:40	1.8015	1.7998	1.5341
40	01 Sep 08, 13:00	1.7947	1.7931	1.5357
41	01 Sep 08, 13:20	1.7875	1.7859	1.5371
42	01 Sep 08, 13:40	1.7796	1.7780	1.5382
43	01 Sep 08, 14:00	1.7710	1.7694	1.5392
44	01 Sep 08, 14:20	1.7619	1.7604	1.5399
45	01 Sep 08, 14:40	1.7525	1.7510	1.5404
46	01 Sep 08, 15:00	1.7429	1.7415	1.5408
47	01 Sep 08, 15:20	1.7333	1.7320	1.5409
48	01 Sep 08, 15:40	1.7239	1.7227	1.5408
49	01 Sep 08, 16:00	1.7145	1.7134	1.5406
50	01 Sep 08, 16:20	1.7053	1.7042	1.5402
51	01 Sep 08, 16:40	1.6962	1.6951	1.5396
52	01 Sep 08, 17:00	1.6873	1.6864	1.5389
53	01 Sep 08, 17:20	1.6786	1.6777	1.5381
54	01 Sep 08, 17:40	1.6701	1.6693	1.5372
55	01 Sep 08, 18:00	1.6618	1.6612	1.5361
56	01 Sep 08, 18:20	1.6539	1.6532	1.5349
57	01 Sep 08, 18:40	1.6462	1.6453	1.5336
58	01 Sep 08, 19:00	1.6387	1.6379	1.5322
59	01 Sep 08, 19:20	1.6315	1.6307	1.5307
60	01 Sep 08, 19:40	1.6244	1.6237	1.5291
61	01 Sep 08, 20:00	1.6174	1.6168	1.5274
62	01 Sep 08, 20:20	1.6108	1.6103	1.5256
63	01 Sep 08, 20:40	1.6044	1.6039	1.5238
64	01 Sep 08, 21:00	1.5982	1.5978	1.5218
65	01 Sep 08, 21:20	1.5920	1.5915	1.5198
66	01 Sep 08, 21:40	1.5860	1.5853	1.5177
67	01 Sep 08, 22:00	1.5802	1.5798	1.5155
68	01 Sep 08, 22:20	1.5744	1.5738	1.5132
69	01 Sep 08, 22:40	1.5693	1.5686	1.5109
70	01 Sep 08, 23:00	1.5640	1.5636	1.5084
71	01 Sep 08, 23:20	1.5584	1.5585	1.5059
72	01 Sep 08, 23:40	1.5537	1.5531	1.5034
73	01 Sep 08, 24:00	1.5473	1.5482	1.5008

Appendix E: Additional Figures

Figure 1: Existing Conditions Drainage Area Map

Figure 2: Proposed Conditions Drainage Area Map

Figure 3: Proposed Conditions Culverts

Figure 4: Proposed Conditions Ditch Locations

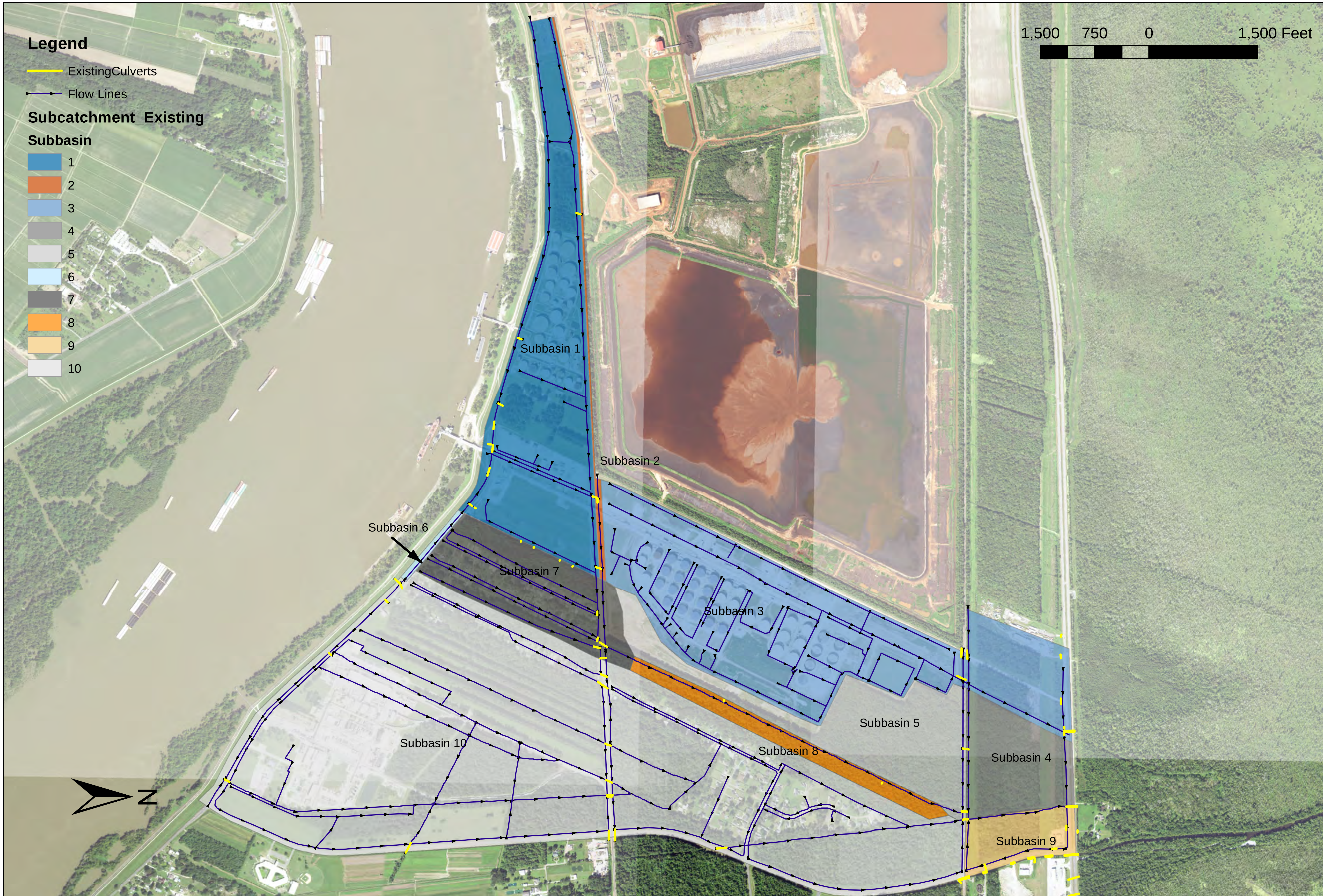


Figure 1: Existing Conditions Drainage Area Map

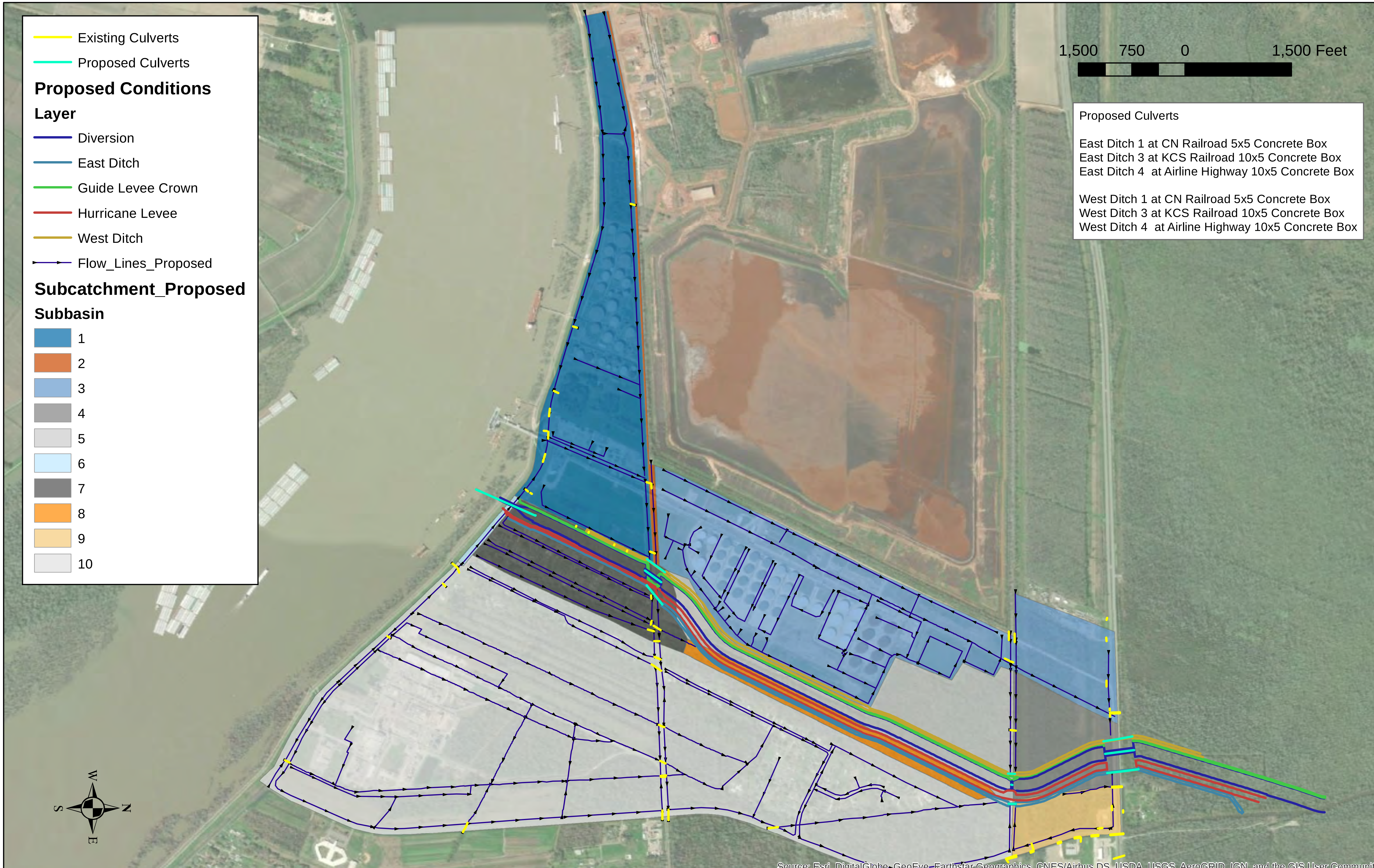


Figure 2: Proposed Conditions Drainage Area Map

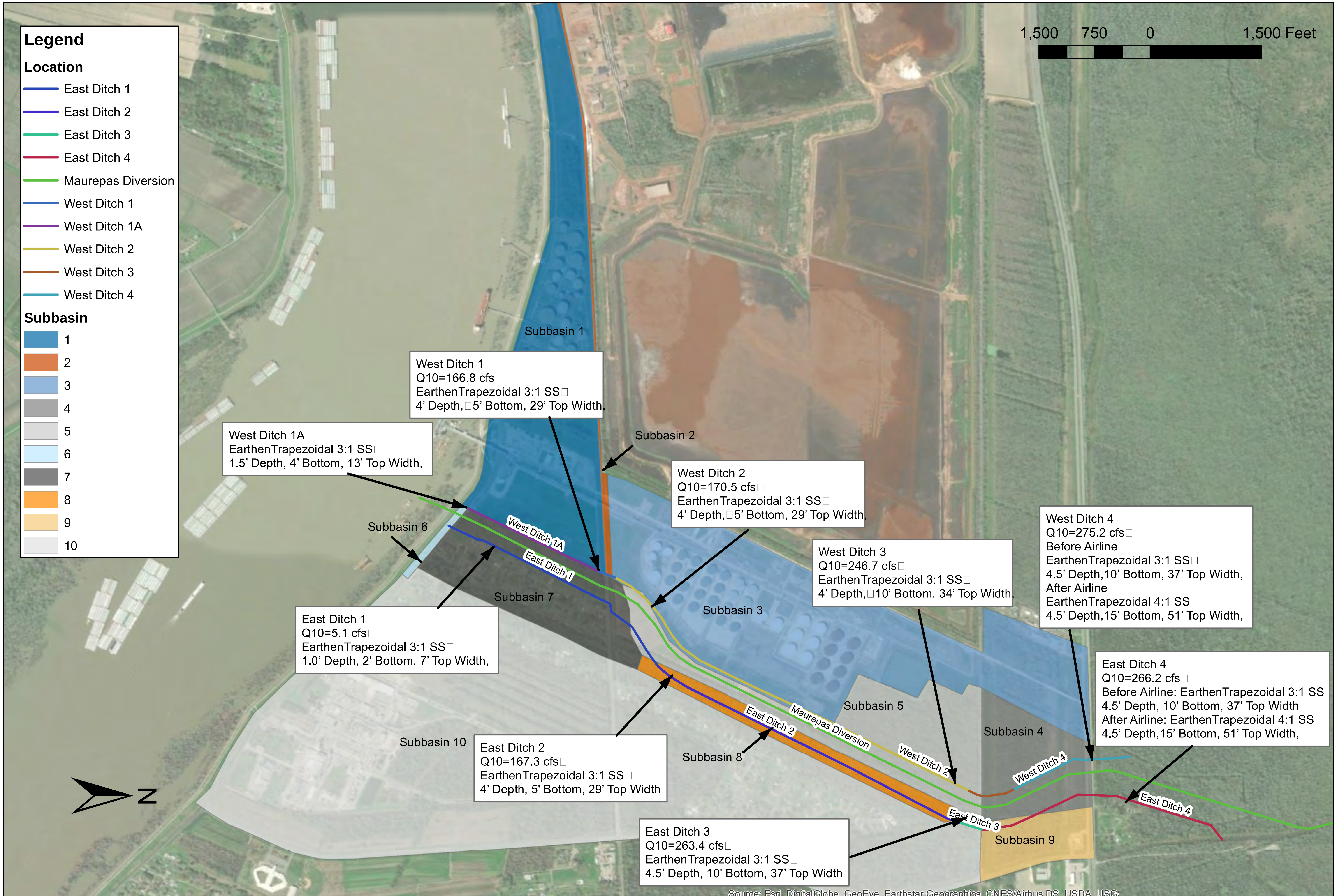


Figure 3: Proposed Conditions Ditch Locations

Appendix F: Hydraulic Design Criteria

Hydraulic Design Criteria

Hydrology:

- LADOTD, Hydraulics Manual, 2011;
- Natural Resources Conservation Service TR-55 methodology - Urban Hydrology for Small Watersheds, USDA, NRCS, Technical Release 55, June 1986
- SCS Unit Hydrograph Method
- USACE HEC TP-135 Muskingum-Cunge Channel Flow Routing Method for Drainage Networks, 1991
- Rainfall Distribution SCS Type III
- Rainfall depth comes from the NOAA Atlas 14 Volume 9 Version 2PDS Estimates for Garyville LA, Table 3.4-2 Louisiana Rainfall Depths (inches for 100 Year Return Period Duration (Hour) 24.,
- LiDAR data 2017,
- USGS Quad Maps and Aerial Photography,
- National Hydrographic Dataset,
- Historical SWMM modeling

Hydraulics:

- LADOTD, Hydraulics Manual, 2011;
- USACE Report "West Shore Lake Pontchartrain Hydraulic Design of Pump Stations and Drainage Structures Draft Report April 2019"
- USACE Report "West Shore Lake Pontchartrain Hydraulic Design of Pump Stations and Drainage Structures Addendum to Main H&H Report September 2019"
- LiDAR data 2017,
- Fenstermaker Survey and LiDAR along project site

Computer programs:

HEC-HMS 4.6.1 – for determining the peak values of existing and proposed conditions for the sub basins flowing into Hope Canal and Marathon Ditch

Hydraulic Toolbox- for checking ditch sizing using peak values from HEC-HMS

HEC-RAS 1D converted to version 5.0.7- the original 2007 Diversion modeling was done in 1D.

HEC-RAS 2D version 5.0.7- The USACE model was adjusted and limited to the proposed site from the Mississippi River to Airline Highway for the purposes of developing the existing and proposed conditions. The existing conditions are for Fall 2020, compared to the proposed conditions of a diversion channel and West Shore Lake Pontchartrain (WSLP) flood protection system. Also included in the proposed conditions are the proposed east and west ditches to convey water that would have otherwise have flown past the diversion or into Angelina canal.

ESRI ArcMap 10.8. GIS software was used to process LiDAR raster files, develop exhibits, process channel and existing survey shapefiles, and view land coverage raster files.

Limitations and Constraints

- Maintain increase in Water Surface Elevation (WSE) in CN RR ditch < 0.1-ft,
- Maintain increase in WSE in Marathon detention pond < 0.1-ft,
- Minimize required acquisition of land to the east of the project (by keeping width of west ditch as small as possible)
- Minimize impacts to or improve existing flow paths

Other Reference Documents

- USACE EM 1110-2-1601 Hydraulic Design of Flood Control Channels, Rev. 1994
- USACE Hydraulic Design Criteria, Sheet 703-1, Riprap Protection Trapezoidal Channel, Rev. 2014
- USACE Hydraulic Design Criteria Vol 1, Rev. 1977
- USACE Hydraulic Design Criteria Vol 2, Rev. 5-59

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water resources / environmental consultants

WATER QUALITY MODELING OF PROPOSED RIVER REINTRODUCTION INTO MAUREPAS SWAMP (PO-0029)

OCTOBER 3, 2019

WATER QUALITY MODELING OF PROPOSED RIVER REINTRODUCTION INTO MAUREPAS SWAMP (PO-0029)

Prepared for

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October 3, 2019

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1.0 INTRODUCTION

The proposed River Reintroduction into Maurepas Swamp (PO-0029) project (the Project) located near Garyville, Louisiana, will divert flow from the Mississippi River to the Maurepas Swamp wetlands (Figure A.1). In 2014, URS provided 95% level design of the proposed PO-0029 project to the Coastal Protection and Restoration Authority (CPRA) of Louisiana (URS 2014). The project consists of a gated intake structure at the river capable of diverting 2000 cfs river water, a large sand settling basin, and a long, banked conveyance channel. Approximately halfway along the route, just north of US Highway 61, the channel follows the existing Hope Canal alignment to distribute the diverted water into the wetlands on the north side of Interstate 10. The proposed diversion channel from the Mississippi River to its end approximately 1000 ft north of its crossing with I-10 highway. The channel has a variable cross-section along its way. The longest segment between the Highway 61 and I-10 has a 60 ft wide bottom and 1V:5H side slope. The invert is -7 ft- and -8 ft, NAVD88 at Highway 61 and I-10, respectively. Additionally, the culvert crossings under I-10 between LA 641 and Mississippi Bayou are proposed to be closed to prohibit backflow from the diversion into the swamp between I-10 and Highway 61. The design also proposes gaps in the railroad embankment along the west bank of Hope Canal. For details, the reader is referred to the 95% Level Design Report (URS 2014).

To support the hydraulic design of the proposed diversion and to evaluate its effect on swamp hydrology, URS developed a two-dimensional (2D) ADvanced CIRCulation (ADCIRC) Model. URS also developed a one-dimensional (1D) Storm Water Management Model (SWMM) of the Garyville-Reserve drainage system to evaluate effects of the water levels in the swamp on the drainage.

The hydrodynamic modeling performed for the 95% level design did not include modeling the transport of nutrients introduced from the Mississippi River diversion water throughout the swamp. The purpose of the modeling efforts outlined in this document is to develop a water quality model (two-dimensional Delft3D) for the study to simulate transport of nutrients carried by the diverted water.

The approach for simulating nutrients in the Maurepas Swamp was initially presented in a memorandum from FTN Associates, Ltd. (FTN) to the CPRA dated August 7, 2018. The information from that memorandum is included in Section 2 of this report with only minor revisions from the memorandum. The nutrient simulations are driven by calibrated hydrodynamic model described in Appendix A.

The model results are presented in Section 3 of this report. The simulation is of a steady flow of 2,000 cfs of Mississippi River water introduced into the swamp via Hope Canal for a duration of 31 days followed by 10 days of simulations without the diversion flow. The results include predictions for water surface elevation, velocity, and nutrients during summer and winter. The results from a "salinity flushing" scenario is also included to demonstrate effects of diversion flow on an initial saline conditions in the swamp.

2.0 APPROACH FOR SIMULATING NUTRIENTS

2.1 Overview of Approach

The objectives for simulating nutrients for this project are to: a) evaluate the fate and transport of nutrients throughout the swamp, and b) evaluate effects of the diversion on nutrient concentrations in Lake Maurepas.

To begin with, a hydrodynamic model of the study area was developed and calibrated. The details regarding the basis for model selection, development of the model geometry, calibration and validation are described in Appendix A. The simulated hydrodynamics (water surface elevations and velocities throughout the study area) are then used to drive the nutrient transport described in the following sections.

As discussed in Appendix A, the Delft3D model was selected to simulate hydraulics. Nutrients and salinity are being simulated with DELWAQ, which is the water quality model in the Delft3D suite of models. Nutrients are being simulated as total nitrogen (TN) and total phosphorus (TP) rather than individual species of nutrients (e.g., ammonia nitrogen, nitrate nitrogen, etc.). Although nutrients in organic and particulate forms are not immediately available for uptake by algae or vegetation, they can be transformed later into inorganic, dissolved forms that have the potential to cause eutrophication. Therefore, predictions for TN and TP are considered appropriate for addressing the modeling objectives.

TN and TP are simulated using a “black box” approach that characterizes the overall loss of nutrients from the water column as the water moves through the swamp. With this approach, the model does not simulate individual processes (mineralization, nitrification, denitrification, sorption of phosphorus, uptake by algae and plants, etc.), but the rates of nutrient loss from the water column are based on published measurements that account for the combined overall effect of all processes. This “black box” approach is being used instead of a more detailed approach of simulating individual processes due to a lack of site-specific data for calibrating numerous coefficients for the processes. The importance of calibration data in applications of complex models is noted in the following statement: “Highly detailed representations of system structures may not be useful to simulate TP dynamics in treatment wetlands if comprehensive data sets are not available to constrain each pathway" (Paudel and Jawitz 2012). Other studies have successfully modeled losses of nutrients from water moving through wetlands without detailed simulations of individual processes (Day et al. 2004; Kadlec et al. 2011; CH2M Hill 2012; CH2M Hill 2013; Kadlec 2016; Merriman et al. 2017).

TN and TP are being simulated with generic user-defined constituents in the model. The nutrient state variables are designated to represent actual concentrations minus background concentrations (i.e., a concentration of zero in the model represents an actual concentration equal to background). With this configuration, the model simulates conditions that represent actual concentrations asymptotically approaching background concentrations without dropping below background concentrations. The assumption that actual concentrations cannot drop below background concentrations has been successfully used in various other studies that estimate losses of nutrients from water moving through wetlands (Kadlec et al. 2011; CH2M Hill 2012; CH2M Hill 2013; Kadlec 2016; Merriman et al. 2017).

The DELWAQ model has been set up to simulate losses of TN and TP from the water column with first order decay rates. For the generic user-defined constituents, the DELWAQ model does not provide any kinetics that are more complex than first order decay. First order decay is not a perfect representation of nutrient loss kinetics in wetlands (Kadlec 2000), but it forms the basis of equations that have been used in recent studies to calculate nutrient loss in wetlands receiving diverted river water and in wetlands receiving municipal wastewater. One of these equations is the "relaxed tanks-in-series" model, also known as the PkC* model (Kadlec and Wallace 2009):

$$\frac{(C_{OUT} - C^*)}{(C_{IN} - C^*)} = \left[1 + \frac{k}{P\,q}\right]^{-P}$$

where: C_{OUT} = Concentration at outlet of wetland (mg/L)
C_{IN} = Concentration at inlet of wetland (mg/L)
C^* = Background concentration (mg/L)
k = First order areal rate constant (m/yr)
q = Hydraulic loading rate per unit area (m/yr)
P = Apparent number of tanks in series (dimensionless)

The parameter “P” in the equation above accounts for: 1) hydraulic inefficiencies of flow through the wetland (i.e., it represents flow through multiple well-mixed tanks in series as opposed to uniform plug flow), and 2) “weathering”, which is a term that describes the effect of different loss rates for different fractions of the component (e.g., loss rates for nitrate and ammonia are individually different than an overall loss rate for TN).

For small areas with short residence times, the value of “P” in the equation above approaches 1.0 and the results become similar to a first order decay equation (with a background concentration incorporated):

$$\frac{(C_{OUT} - C^*)}{(C_{IN} - C^*)} = \exp(-k/h \times t)$$

where: h = depth of water (m)
t = residence time (yr)

For example, for k = 0.05 m/day (18.25 m/yr) and h = 0.5 m, the results from the two equations above differ by only 0.5% for a residence time of 1 day.

The DELWAQ model allows the user to vary the first order decay rates spatially or temporally, but not both. For this project, the decay rates are being varied spatially based on predicted depths. The model cells that represent shallow water moving through the swamp have been assigned higher decay rates and model cells that represent deeper, channelized flow have been assigned lower decay rates. Nutrient loss (from the water column) is expected to be greater in shallow vegetated areas due to vegetative uptake, settling and burial of particulates, and transformations by biological organisms that are either on the bottom or attached to vegetation and/or debris.

2.2 Nutrient Loss Rates

Tables B.1 and B.2 (located in Appendix B) summarize information from published literature that was considered for selection of nutrient loss rates for the Delft3D model. These tables include values for first order decay rates that were calculated based on hydraulic residence time and percent reduction of TN or TP (except where noted). These tables also include “k” values for the PkC* model that were either reported by the author or calculated as the first order decay rate multiplied times the depth of water.

These studies represent a range of situations with different source water (river water or treated municipal wastewater), different types of wetlands (forested swamp, estuarine marsh, and constructed wetlands), and different climates (southern Louisiana as well as several other states). The studies based on municipal wastewater are presented for comparison but were not directly used for estimating nutrient loss rates for this project.

The lowest values of first order decay rate and “k” value occurred for the systems with the longest residence times (77 – 512 days for Mandeville, Thibodaux, Luling, and Breaux Bridge). These first order decay rates and “k” values for these systems were not considered useful for developing inputs to the Delft3D model because the residence times for those systems are much longer than the residence time for individual cells in the Delft3D model. Also, the TN and TP concentrations entering those four wetlands are much higher than the concentrations in the Mississippi River water that will be diverted into the Maurepas swamp.

In addition to the studies with field data summarized in Tables B.1 and B.2, a modeling study was conducted by CH2M Hill (2013) in which nutrient retention was simulated in various wetlands (including Maurepas swamp) with existing or proposed diversions of water from the Mississippi River. The CH2M Hill study used the PkC* model with the following “k” values:

- 27.8 m/yr for nitrate in vegetated habitat,
- 8.2 m/yr for nitrate in shallow lake habitat,
- 14.2 m/yr for ammonium,
- 17.3 m/yr for organic nitrogen, and
- 10.0 m/yr for TP.

The published literature that was reviewed for this project demonstrates variability in first order decay rates and “k” values not only among different sites, but also among different seasons. Much of the loss of nutrients from the water column is due to biological processes whose rates vary based on temperature. Therefore, nutrient loss rates are expected to be generally higher during summer and lower during winter.

To address both the uncertainty of nutrient loss rates for the Maurepas swamp as well as seasonal variability of nutrient loss rates, simulations have been run for summer (with higher loss rates) and for winter (with lower loss rates). Based on the CH2M Hill (2013) study, as well as the information in Tables B.1 and B.2, the following “k” values were selected for use in the Delft3D model:

- Winter (low) rates for TN: 15 m/yr in swamp, 5 m/yr in Lake Maurepas;
- Summer (high) rates for TN: 30 m/yr in swamp, 10 m/yr in Lake Maurepas;
- Winter (low) rate for TP: 5 m/yr; and
- Summer (high) rate for TP 15 m/yr.

A script file was used to divide these “k” values by the predicted water depth in each cell in the model (after previously running the model for hydraulics) to obtain the first order decay rate that the Delft3D model needs for each cell in the model.

2.3 Background Concentrations

For this project, the background concentrations are based on existing concentrations in the Maurepas swamp and in Lake Maurepas. Table 2.1 provides summaries of TN and TP data measured in the Maurepas swamp (Hope Canal, Mississippi Bayou, and Dutch Bayou) and in Lake Maurepas. Table 2.1 includes data collected by Rob Lane during 2002-2003 and routine monitoring data collected by the Louisiana Department of Environmental Quality (LDEQ). Locations of the sampling sites are shown on Figure 2.1.

Table 2.1. Summary statistics for TN and TP data in Maurepas swamp and in Lake Maurepas.

Sampling location [A]	Period of record for nutrient data	TN data			TP data		
		No. of values	Median (mg/L)	Range (mg/L)	No. of values	Median (mg/L)	Range (mg/L)
Sites within the Maurepas swamp simulation area:							
Site 1 (Hope Canal)	4/04/02 – 5/13/03	11	0.79	0.51 – 1.32	11	0.75	0.04 – 1.21
Site 2 (Hope Canal)	4/04/02 – 5/13/03	11	0.78	0.61 – 1.52	11	0.15	0.07 – 0.66
Site 3 (Hope Canal)	4/04/02 – 5/13/03	11	0.82	0.57 – 1.75	11	0.13	0.05 – 1.00
Site 4 (Dutch Bayou)	4/04/02 – 5/13/03	11	0.65	0.49 – 1.58	11	0.11	0.05 – 0.20
Site 5 (Mississippi Bayou)	4/04/02 – 5/13/03	11	0.76	0.45 – 3.89	11	0.11	0.04 – 0.85
Site 0155 (Mississippi Bayou)	5/20/86 – 4/14/98	45	1.00	0.56 – 3.01	45	0.20	0.06 – 0.51
Site 4870 (Dutch Bayou)	10/03/17 – 4/03/18	7	0.94	0.37 – 4.15	7	0.15	0.09 – 0.19
Sites in Lake Maurepas:							
Site 16 (Lake Maurepas – SW)	4/04/02 – 5/13/03	12	0.64	0.44 – 2.42	12	0.11	0.01 – 0.20
Site 17 (Lake Maurepas – S)	4/04/02 – 5/13/03	12	0.59	0.39 – 0.99	12	0.12	0.08 – 0.17
Site 18 (Lake Maurepas – E)	4/04/02 – 5/13/03	11	0.58	0.43 – 0.91	11	0.10	0.03 – 0.16
Site 19 (Lake Maurepas – NE)	4/04/02 – 5/13/03	12	0.53	0.40 – 0.90	12	0.11	0.06 – 0.35
Site 1105 (Lake Maurepas – N)	1/09/01 – 9/25/07	24	0.67	0.30 – 1.82	24	0.09	0.05 – 0.19
Site 4471 (Lake Maurepas – SW)	10/01/13 – 4/03/18	19	0.85	0.35 – 1.39	19	0.15	0.05 – 0.29
Sites representing inflow entering the simulation area:							
Site 11 (Blind River)	4/04/02 – 5/13/03	12	0.60	0.46 – 0.82	12	0.10	0.05 – 0.69
Site 0036 (Pass Manchac)	3/06/78 – 9/08/16	290	0.90	0.09 – 5.54	291	0.10	< 0.05 – 0.51
Site 0228 (Amite River)	1/16/01 – 4/10/18	54	0.86	0.34 – 2.83	56	0.12	0.05 – 0.38
Site 0243 (Blind River)	1/16/01 – 4/03/18	62	0.82	0.24 – 1.42	64	0.15	0.05 – 0.44
Site 0268 (Amite R. Diversion Canal)	1/16/01 – 4/03/18	55	0.86	0.39 – 1.74	58	0.13	0.05 – 0.30
Site 1102 (Blind River near mouth)	1/16/01 – 4/03/18	62	0.80	0.20 – 4.40	64	0.15	0.05 – 0.29
Site 1106 (Tickfaw River)	1/09/01 – 9/03/15	48	0.98	0.21 – 2.57	56	0.13	0.05 – 0.39

Notes:

A. Site numbers between 1 and 19 are Rob Lane's monitoring sites. Site numbers between 0036 and 4870 are LDEQ monitoring sites.

Figure 2.1. Locations of LDEQ and Rob Lane water quality monitoring stations.

In general, the nutrient concentrations in the swamp were slightly higher than in Lake Maurepas. Median TN values in the swamp were mostly between 0.65 and 0.94 mg/L, while median TN values in Lake Maurepas were between 0.53 and 0.85 mg/L. For TP, median values were mostly between 0.11 and 0.15 mg/L in the swamp, while median values in Lake Maurepas were mostly between 0.09 and 0.11 mg/L. Although measured background concentrations of nutrients vary by location, the background concentrations used in the model need to be spatially constant in order to preserve the calculated mass of nutrients being transported in the model. The following values were selected for use as background concentrations for the DELWAQ model:

- Background TN = 0.60 mg/L, and
- Background TP = 0.10 mg/L.

These two proposed background concentrations are more representative of Lake Maurepas than the Maurepas swamp, but it is better to select values towards the low end of the range because the model is able to simulate concentrations above these values, but it cannot simulate concentrations below these values (i.e., the model is not allowed to simulate negative concentrations).

2.4 Boundary Concentrations and Flows

Concentrations of TN, TP, and salinity must be specified in the model for each boundary where water can flow into the simulated area. The locations of these boundaries are shown on Figure 2.2. Pass Manchac is simulated as a tidal water level boundary (water can flow in or out of the simulated area based on head differences); all of the other boundaries are simulated as flow boundaries (the flow into the simulated area is specified by the user).

Figure 2.2. Locations where boundary conditions were specified in the model.

For each flow boundary (except the diversion of Mississippi River water), the flow was set to a constant value to represent median (i.e., typical) flow conditions (see Table 2.2). The diversion of Mississippi River water into Hope Canal was set to a constant value of 2,000 cfs. A flow of 280 cfs was taken out of the Hope Canal and introduced (140 cfs on either side) into the wetlands (known as Central Swamp) between the Interstate-10 and the Airline Highway. This flow was released only for the first 7 days during the diversion operation. The release reflects the proposed lateral release valves feature of the project. Thus, for the first 7 days, only 1,720 cfs diversion flow reached the swamps north of Interstate-10.

The stage boundary at Pass Manchac was specified with hourly values to represent typical tidal fluctuations about the historical median water level (See Appendix A).

TN and TP data for the Mississippi River are summarized in Table 2.3 for US Geological Survey (USGS) monitoring stations at Baton Rouge and Belle Chasse. Although these two stations are located 86 miles upstream and 68 miles downstream, respectively, of the proposed diversion location near Garyville, the TN and TP concentrations are similar between the two stations, which suggests that these data are representative of concentrations at Garyville.

Concentrations of TN, TP, and salinity that are being used in the model at each boundary location are summarized in Tables 2.4 and 2.5. Initial conditions for TN, TP and salinity are specified in Table 2.6.

Table 2.2. Input values for flows and stages at model boundaries.

Location of boundary	Model input value	Comment
Hope Canal (diversion from Mississippi River)	2,000 cfs	Assumed operational flow rate
Hope Canal outflow to Central Swamp (between I-10 and Airline Highway)	2 x 140 cfs	Assumed flow released from Hope Canal each to the east and to the west adjoining marsh between the I-10 and Airline Highway for first 7 days. This is a proposed project feature using lateral release valves.
Tickfaw River	412 cfs	Sum of median flows for Oct. 1989 – Sep. 2017 for Tickfaw River at Holden (158 cfs) and Natalbany River at Baptist (27 cfs) multiplied times ratio of published drainage area at the mouth (727 mi^2; USGS 1971) to combined drainage area at the two gages (247 mi^2 + 79.5 mi^2).
Amite River (old channel)	173 cfs	Median flow for Amite River at Port Vincent (USGS 07380120) for entire period of record (Oct 1987 – Sep 2015) is 1,090 cfs. Assumed flow split is 16% into old channel and 84% into Diversion Canal based on 5/09/2007 flow measurements published by Amite River Basin Drainage and Water Conservation District (2007).
Amite River Diversion Canal	917 cfs	
Blind River	40 cfs	Approximate median flow per unit area of 0.6 cfs/mi^2 (based on USGS gages on Amite, Tickfaw, and Natalbany rivers) multiplied times estimated drainage areas (outside the model grid) of about 60-70 mi^2 for Blind River and < 10 mi^2 for Mississippi Bayou and Reserve Relief Canal
Mississippi Bayou	5 cfs	
Reserve Relief Canal	5 cfs	
Pass Manchac	0.71 – 1.21 ft NAVD88	Synthetic stage hydrograph based on tidal cycle of 24.7 hours, typical tidal fluctuation of 0.5 ft, and median water level of 0.96 ft over entire period of record (Feb. 2002 – Aug. 2018) at Corps station 85420 (Pass Manchac near Ponchatoula)

Table 2.3. Monthly statistics for TN and TP in the Mississippi River.

Month	TN Data			TP Data		
	Number of values	Median (mg/L)	Range (mg/L)	Number of values	Median (mg/L)	Range (mg/L)
USGS 07374000 Mississippi River at Baton Rouge (5/18/04 – 2/13/17):						
January	14	1.88	1.49 – 2.77	13	0.23	0.13 – 0.34
February	13	2.11	1.63 – 3.00	12	0.27	0.15 – 0.33
March	21	2.07	1.56 – 3.48	20	0.24	0.15 – 0.51
April	26	2.15	1.41 – 3.23	26	0.22	0.14 – 0.33
May	23	2.15	1.43 – 3.75	23	0.21	0.14 – 0.37
June	25	2.54	1.62 – 3.38	26	0.25	0.14 – 0.68
July	10	2.63	1.86 – 3.68	10	0.24	0.10 – 0.32
August	14	1.67	1.10 – 2.38	14	0.23	0.13 – 0.35
September	3	1.30	1.21 – 1.57	3	0.22	0.18 – 0.25
October	11	1.39	0.94 – 2.52	10	0.19	0.16 – 0.33
November	6	1.69	1.15 – 2.69	6	0.24	0.14 – 0.29
December	11	1.79	1.30 – 2.41	10	0.22	0.12 – 0.36
All Months	177	2.06	0.94 – 3.75	173	0.22	0.10 – 0.68
USGS 07374525 Mississippi River at Belle Chase (5/11/06 – 5/08/18):						
January	12	1.95	1.50 – 2.79	11	0.28	0.17 – 0.39
February	11	1.97	1.69 – 2.80	10	0.25	0.17 – 0.51
March	23	2.02	1.51 – 3.34	21	0.29	0.17 – 0.62
April	24	2.15	1.50 – 3.80	22	0.25	0.18 – 0.39
May	26	1.99	1.33 – 3.78	25	0.24	0.16 – 0.39
June	24	2.48	1.61 – 3.51	24	0.24	0.14 – 0.35
July	9	2.59	1.99 – 3.86	9	0.27	0.14 – 0.43
August	12	1.83	1.00 – 2.37	12	0.26	0.11 – 0.40
September	2	1.18	1.15 – 1.21	2	0.17	0.17 – 0.17
October	10	1.37	0.81 – 2.54	9	0.22	0.09 – 0.38
November	4	1.48	1.03 – 2.57	4	0.20	0.16 – 0.29
December	10	1.74	1.19 – 2.65	9	0.23	0.14 – 0.37
All Months	167	2.00	0.81 – 3.86	158	0.25	0.09 – 0.62

Table 2.4. Input values for nutrient concentrations at model boundaries.

Location of boundary	Actual concentrations	Model input concentrations*	Comment
Hope Canal (diversion from Mississippi River)	Summer: 2.6 mg/L TN 0.26 mg/L TP Winter: 2.0 mg/L TN 0.25 mg/L TP	Summer: 2.0 mg/L TN 0.16 mg/L TP Winter: 1.4 mg/L TN 0.15 mg/L TP	Developed using USGS data for Mississippi River at Baton Rouge (07374000) and Mississippi River at Belle Chasse (07374525) for 2004 – 2018. Summer values are based on medians for July and winter values are based on medians for Jan.-Feb.
Tickfaw River	0.98 mg/L TN 0.13 mg/L TP	0.38 mg/L TN 0.03 mg/L TP	Median values for LDEQ station 1106 (Tickfaw River near Lake Maurepas) for |2001 – 2015
Amite River (old channel)	0.86 mg/L TN 0.12 mg/L TP	0.26 mg/L TN 0.02 mg/L TP	Median values for LDEQ station 0228 (Amite River at mile 6.5, at Clio) for 2001 – 2018
Amite River Diversion Canal	0.86 mg/L TN 0.13 mg/L TP	0.26 mg/L TN 0.03 mg/L TP	Median values for LDEQ station 0268 (Amite River Diversion Canal north of Gramercy) for 2001 – 2018
Blind River	1.33 mg/L TN 0.24 mg/L TP	0.73 mg/L TN 0.14 mg/L TP	Median values for LDEQ station 0117 (Blind River near Gramercy) for 1978 – 1998
Mississippi Bayou	0.76 mg/L TN 0.11 mg/L TP	0.16 mg/L TN 0.01 mg/L TP	Median values for Station 5 (Mississippi Bayou) from Rob Lane's 2002 – 2003 data
Reserve Relief Canal	0.79 mg/L TN 0.13 mg/L TP	0.19 mg/L TN 0.03 mg/L TP	Median values for Stations 1 and 2 (Hope Canal) and station 5 (Miss. Bayou) from Rob Lane's 2002 – 2003 data
Pass Manchac	0.90 mg/L TN 0.10 mg/L TP	0.30 mg/L TN 0 mg/L TP	Median values for LDEQ station 0036 (Pass Manchac at Manchac) for 1978 – 2016

* Model input concentrations are actual concentrations minus background concentrations.

Table 2.5. Input values for salinity at model boundaries.

Location of boundary	Model input values	Comment
Hope Canal (diversion from Mississippi River)	0.20 ppt	Median value for LDEQ stations 0047 (Mississippi River at Luling) and 0048 (Mississippi River near Luling) for 1978 – 1989
Tickfaw River	0.11 ppt	Median values for LDEQ station 1106 (Tickfaw River near Lake Maurepas) for 2001 – 2015
Amite River (old channel)	0.05 ppt	Median value for LDEQ station 0228 (Amite River at mile 6.5, at Clio) for 2001 – 2018
Amite River Diversion Canal	0.05 ppt	Median value for LDEQ station 0268 (Amite River Diversion Canal north of Gramercy) for 2001 – 2018
Blind River	0.30 ppt	Median value for LDEQ station 0117 (Blind River near Gramercy) for 1978 – 1998
Mississippi Bayou	0.25 ppt	Median value for station 5 (Mississippi Bayou) from Rob Lane's 2002 – 2003 data
Reserve Relief Canal	0.30 ppt	Median values for stations 1 and 2 (Hope Canal) and station 5 (Miss. Bayou) from Rob Lane's 2002 – 2003 data
Pass Manchac	5.0 ppt	Assumed to be the same as the initial concentration (see Table 2.6 below). Because the source of the initial salinity in Lake Maurepas and the Maurepas swamp is exchange with Lake Pontchartrain (via Pass Manchac), then the salinity in Pass Manchac should be similar to the initial value for Lake Maurepas and the Maurepas swamp.

Table 2.6. Input values for initial conditions for water quality.

Constituent	Model input value	Comment
Total nitrogen (TN)	0 mg/L	Zero in the model represents background concentrations for TN and TP. Nutrient concentrations throughout the modeled area are assumed to be at background levels at the beginning of each simulation.
Total phosphorus (TP)	0 mg/L	
Salinity	5.0 ppt	Assumed value for conditions following a tropical storm surge or possibly an extreme drought

3.0 MODEL APPLICATION AND RESULTS

3.1 Model Scenarios

A modeling scenario of 41-day duration was simulated. The diversion was operated at a constant, continuous flow of 2,000 cfs for 31 days followed by 10 days of closure. Additionally, during the first 7 days, a flow of 280 cfs was released to the Central Swamp (wetlands between the Interstate-10 and the Airline Highway) from Hope Canal. Therefore, for the first 7 days, only 1,720 cfs reached to the swamp north of Interstate-10. A synthetic diurnal tidal water level boundary was specified at Lake Maurepas with a mean water level of 1.0 ft, NAVD88 and tidal range of 0.5 ft. See Table 2.2 for flows specified at other existing locations. The nutrients (TN and TP) were simulated under summer and winter conditions as reflected in the specified boundary input concentrations.

A separate "salinity flushing" scenario was simulated to evaluate benefits of diversion for salinity reduction after a high salinity event in the swamp. For this scenario, all boundary conditions (flows and tidal water levels) were specified as in the above scenario. The initial water level was set to 1.0 ft, NAVD88 and the initial salinity was set to 5.0 ppt throughout the study area. The salinities at all flow input boundaries, including the diversion, were set to 0 ppt and a constant salinity of 1.5 ppt was specified at the tidal boundary at Pass Manchac.

The model topography represents features proposed in the 95% E&D report. The details are outlined in Appendix A, Section 7.

3.2 Predicted Water Surface Elevation and Velocity

Figures 3.1 and 3.2 show snapshots of contours of water surface elevation and velocity, respectively, at the end of 7, 20, 31 and 41 days. The variation of water surface elevation and velocity (time-series charts) at selected locations over the simulation period is shown in Figure 3.3. These locations are selected to coincide with some of the gages shown in Figure A.6. The maximum water surface elevation in the swamp is predicted to be about 3 ft, NAVD88 and it occurs where the diversion enters the swamp (i.e. in the Hope Canal immediately north of Interstate-10). The velocities peak up to 2.4 ft/s at this location. However, in the adjoining swamp, the high velocities are around 0.1 to 0.2 ft/s just outside the Hope Canal and lesser in the swamp away from the canal. Under the continuous diversion inflow of 2,000 cfs, the water surface elevation in the swamp reaches a steady state in about 10 days, setting a constant water surface gradient across the swamp from high at Hope Canal to low near Lake Maurepas. Note that the oscillation seen at locations S-9 and S-16 are due to the influence of tides specified at Pass Manchac.

It is seen that the diversion water spreads throughout the most of the system within a week. A steady water surface elevation and gradient is established in the system within about 2 weeks. During the last 10 days of the simulation when the diversion is closed, the water surface elevation recedes rapidly in the swamp closer to the diversion canal (location S-9) and slowly in the areas farther from the diversion canal (e.g. location S-23). The rate of water level drop is about 0.75 ft/10-day, becoming slower as time goes by.

Model results show that the diversion water spreading east is intercepted by the Reserve Relief Canal hindering distribution to the wetlands east of this canal in spite of the artificial gapping implemented in the model. This suggests that limited gapping on the east bank of the Reserve Relief Canal may not distribute commensurate quantities of diversion water to the east side. No gapping on the west bank of this canal was tested.

As a result of the 7-day controlled release of the diversion water, the water levels in the wetlands between the I-10 and the Airline Highway reach a water level of about 1.4 ft, NAVD88. Subsequent to closing of this release the water levels drop to about 1.2 ft. In reality, the water level will continue to lower in the absence of any other inflows due to evapotranspiration which is not included in this scenario.

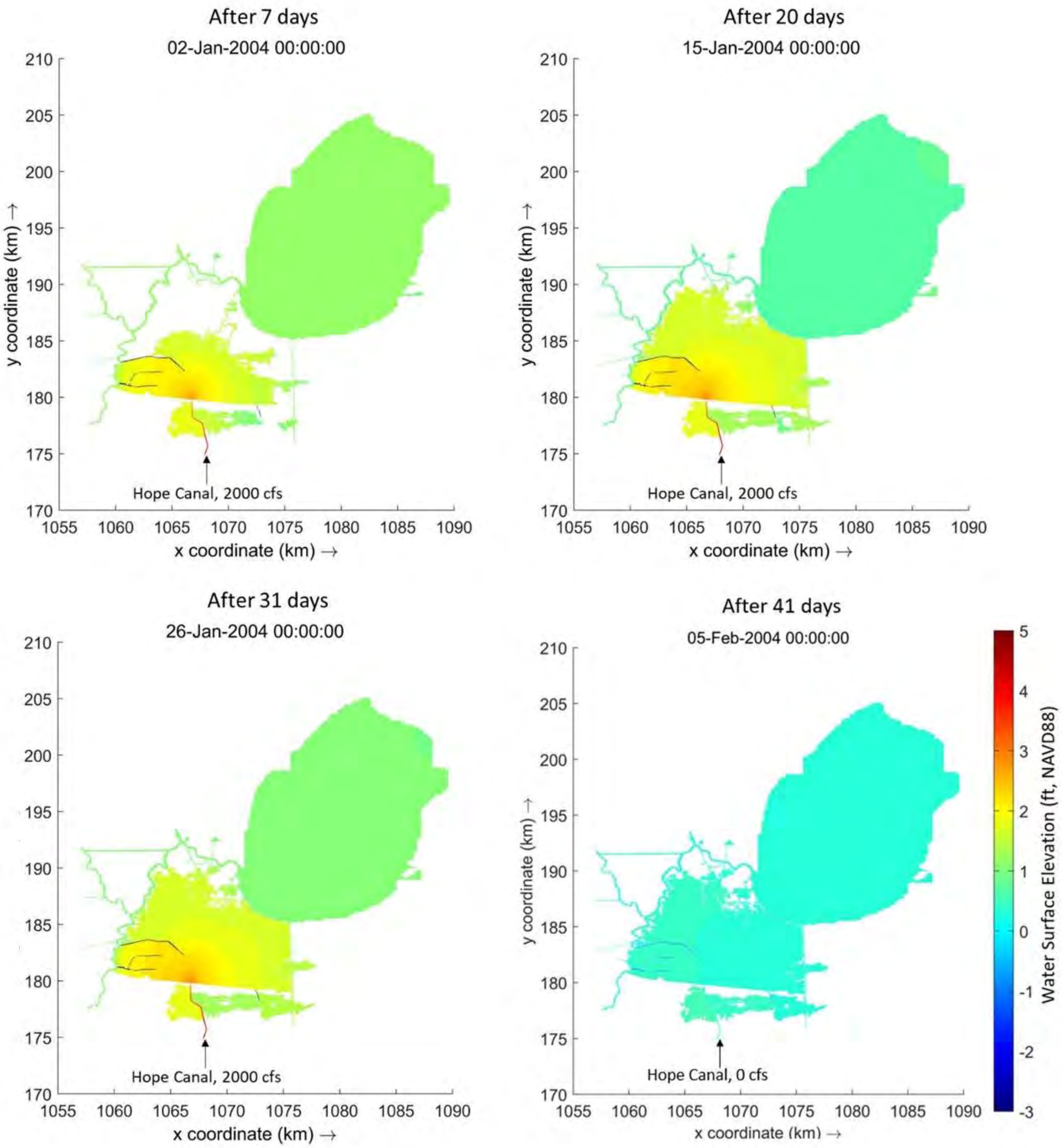

Figure 3.1. Predicted water surface elevation contours at the end of 7, 20, 31 and 41 days.

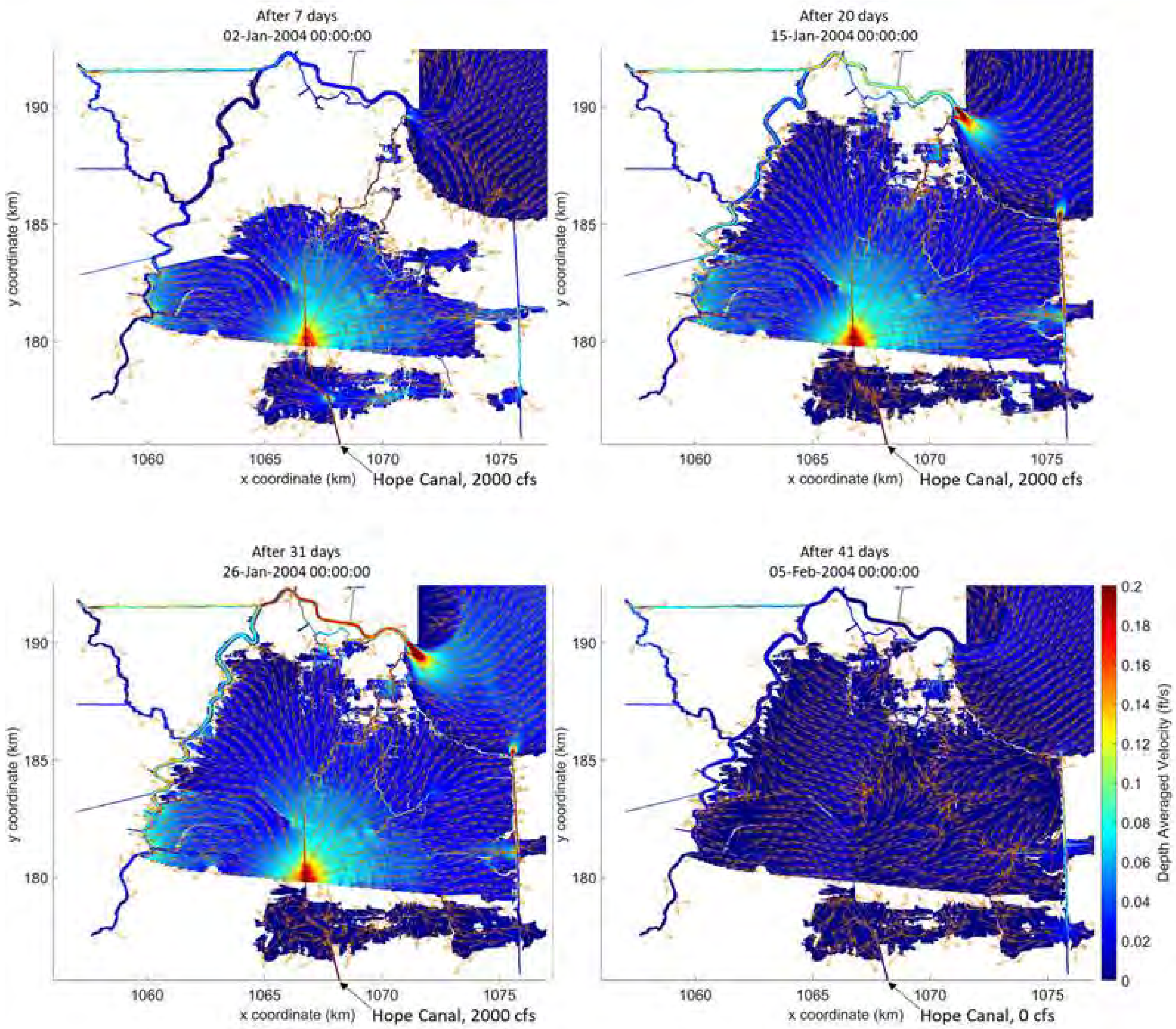

Figure 3.2. Predicted velocity contours at the end of 7, 20, 31 and 41 days.

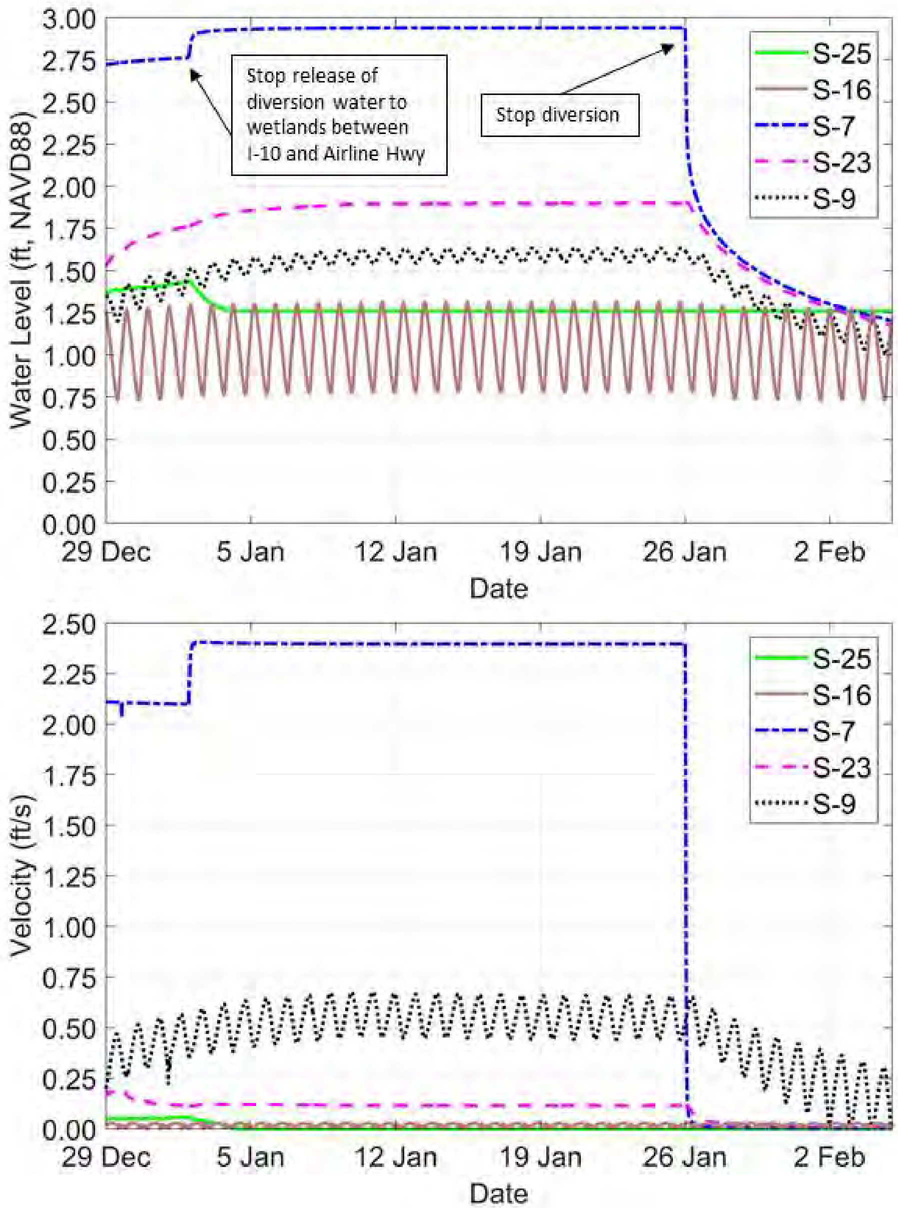

Figure 3.3. Predicted water surface elevation (upper panel) and velocity (lower panel) profiles over the model simulation period at selected locations S-7 (Hope Canal north of I-10), S-9 (Dutch Bayou), S-16 (Blind River), S-23 (North Swamp) and S-25 (Central Swamp).

3.3 Predicted Percent Mississippi River Water

One of the Delft3D model parameters allows accounting of the percentage of water in each model grid cell that originated from the Mississippi River diversion. The purpose of simulating this variable (percent Mississippi River water) was to show where the Mississippi River water travels once introduced into the swamp. The boundary "concentrations" for this variable were set to 100 for the inflow from the Mississippi River (via Hope Canal) and zero for all other boundaries. The initial concentration was set to zero for the entire model grid.

Figures 3.4 shows the predicted values of percent Mississippi River water at the end of 7, 20, 31, and 41 days. The model predicts that the Mississippi River water replaces the majority of the water that existed in the swamp before start of the diversion; no significant amount of water enters Blind River; and that the southern areas of Lake Maurepas are about 40% Mississippi River water after 31 days.

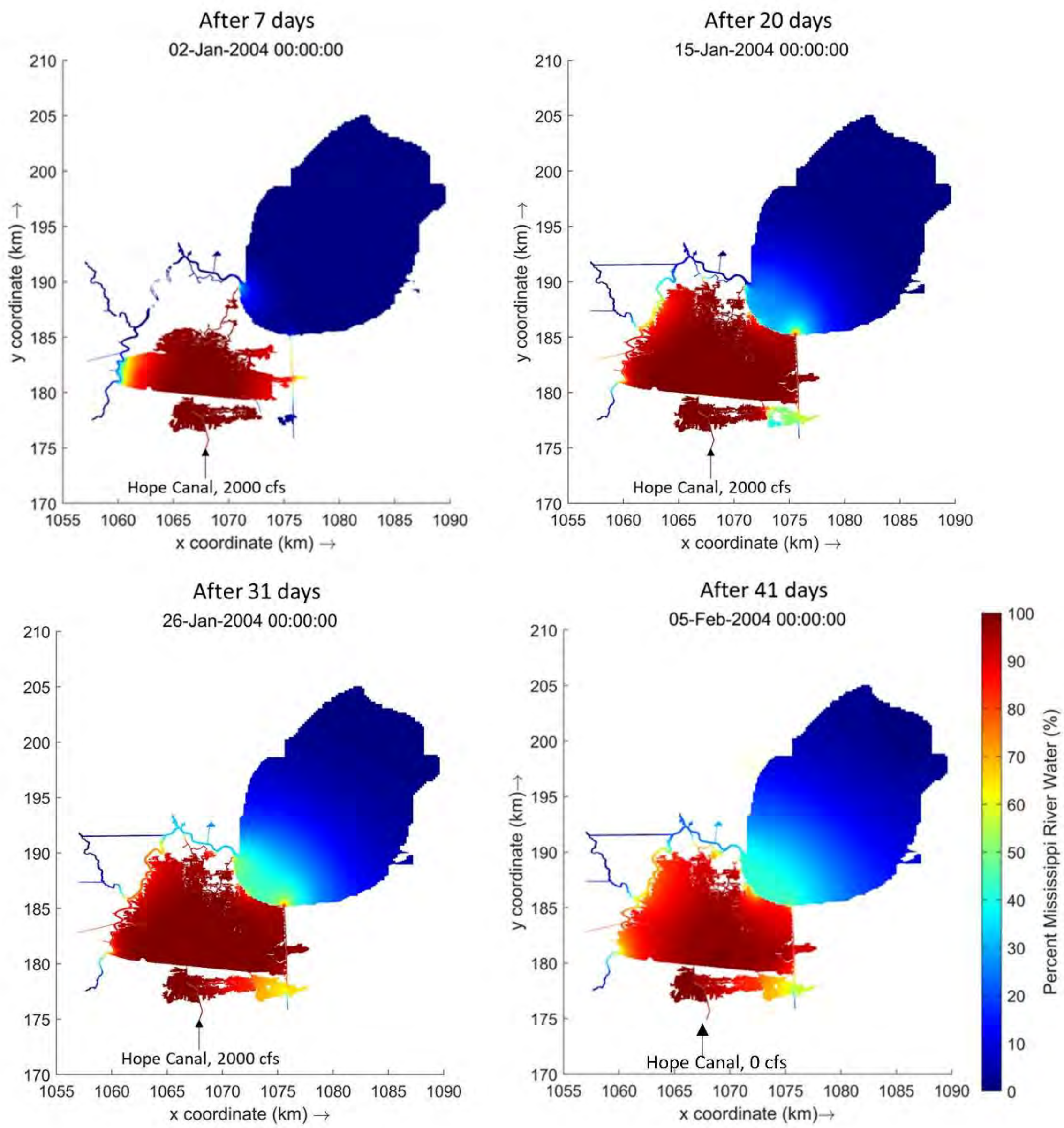

Figure 3.4. Predicted percent Mississippi River water contours at the end of 7, 20, 31 and 41 days.

3.4 Predicted Total Nitrogen Transport

The TN results are shown in Figures 3.5 and 3.6 for summer and winter, respectively. Note that the TN concentration for the Mississippi River inflow was higher for summer (2.6 mg/L) than for winter (2.0 mg/L).

As expected, the highest predicted concentrations of TN are in Hope Canal and its immediately surrounding areas north of Interstate-10. As the Mississippi River water spreads into the swamp and even along channels (e.g., Hope Canal to Tent Bayou to Dutch Bayou), the TN concentrations decrease due to losses from the water column that are simulated with the first order decay rates.

Based on the spatial patterns of predicted TN concentrations in Lake Maurepas, it appears that Dutch Bayou and Reserve Relief Canal are contributing similar loadings of TN to Lake Maurepas. In both the summer and winter simulations, the predicted TN concentrations in the southwest corner of Lake Maurepas (excluding the small areas right at the mouth of Dutch Bayou and the mouth of Reserve Relief Canal) were between 0.8 and 1.0 mg/L at the end of day 20. This represents a small increase over the assumed background concentration of 0.6 mg/L.

The TN in the Mississippi River water consists of approximately 71% nitrate, 2% ammonium, and 27% organic nitrogen (based on long term averages of USGS data at Baton Rouge and Belle Chasse). Among these three forms of nitrogen, nitrate is the form that is expected to undergo the greatest losses from the water column because it can be removed from the water column through denitrification (which is one of the most significant removal mechanisms in wetlands) or uptake by algae or plants. By the time the Mississippi River water reaches Lake Maurepas, the remaining TN is expected to consist mostly of organic nitrogen, which is not available for algal uptake unless it is first converted back to inorganic nitrogen through the process of mineralization, which is a relatively slow process.

After the diversion inflow stops on day 31, the predicted TN values throughout the swamp and in Lake Maurepas return to near background levels by day 41.

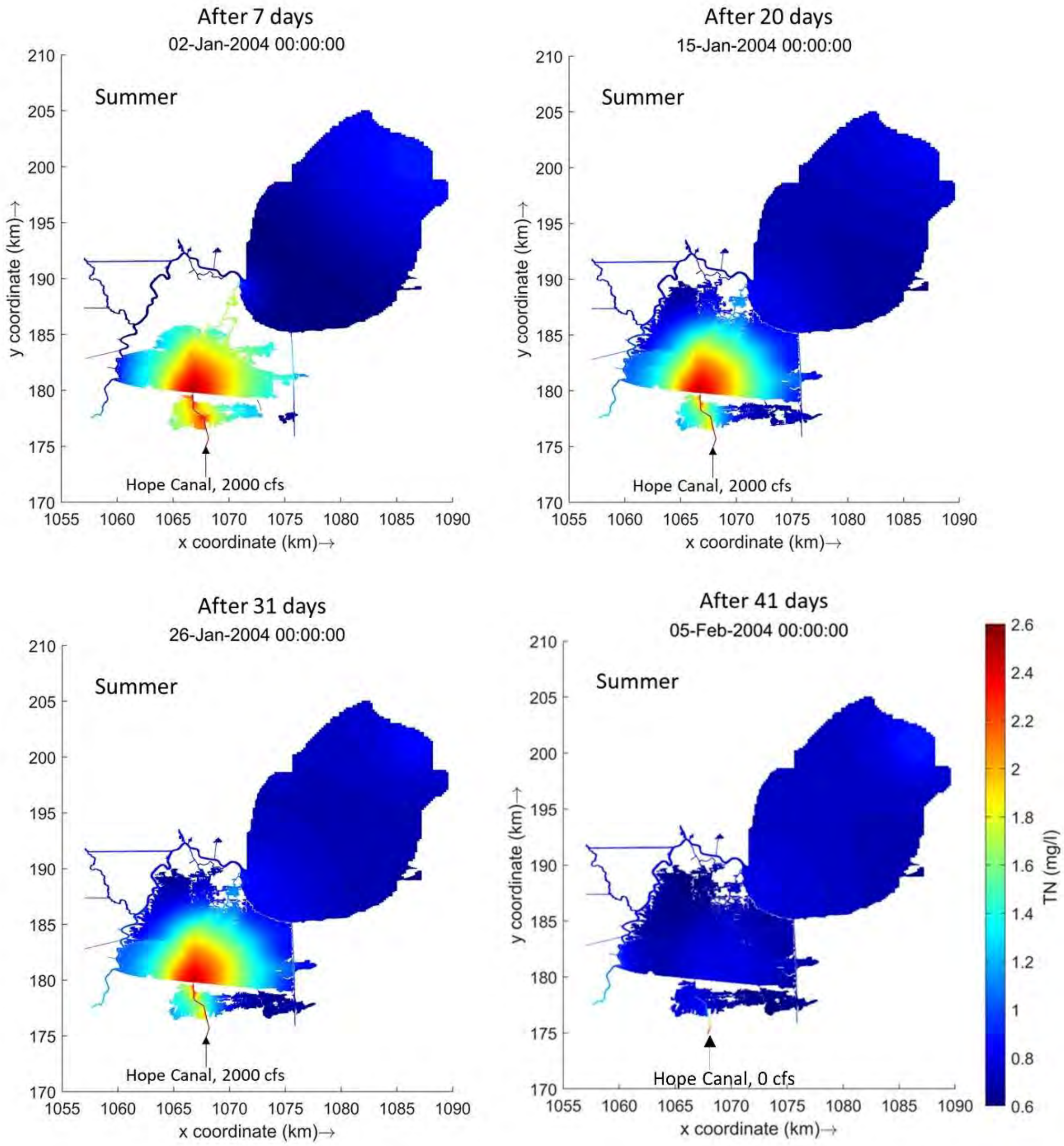

Figure 3.5 Predicted TN concentrations for summer at the end of days 7, 20, 31 and 41 days.

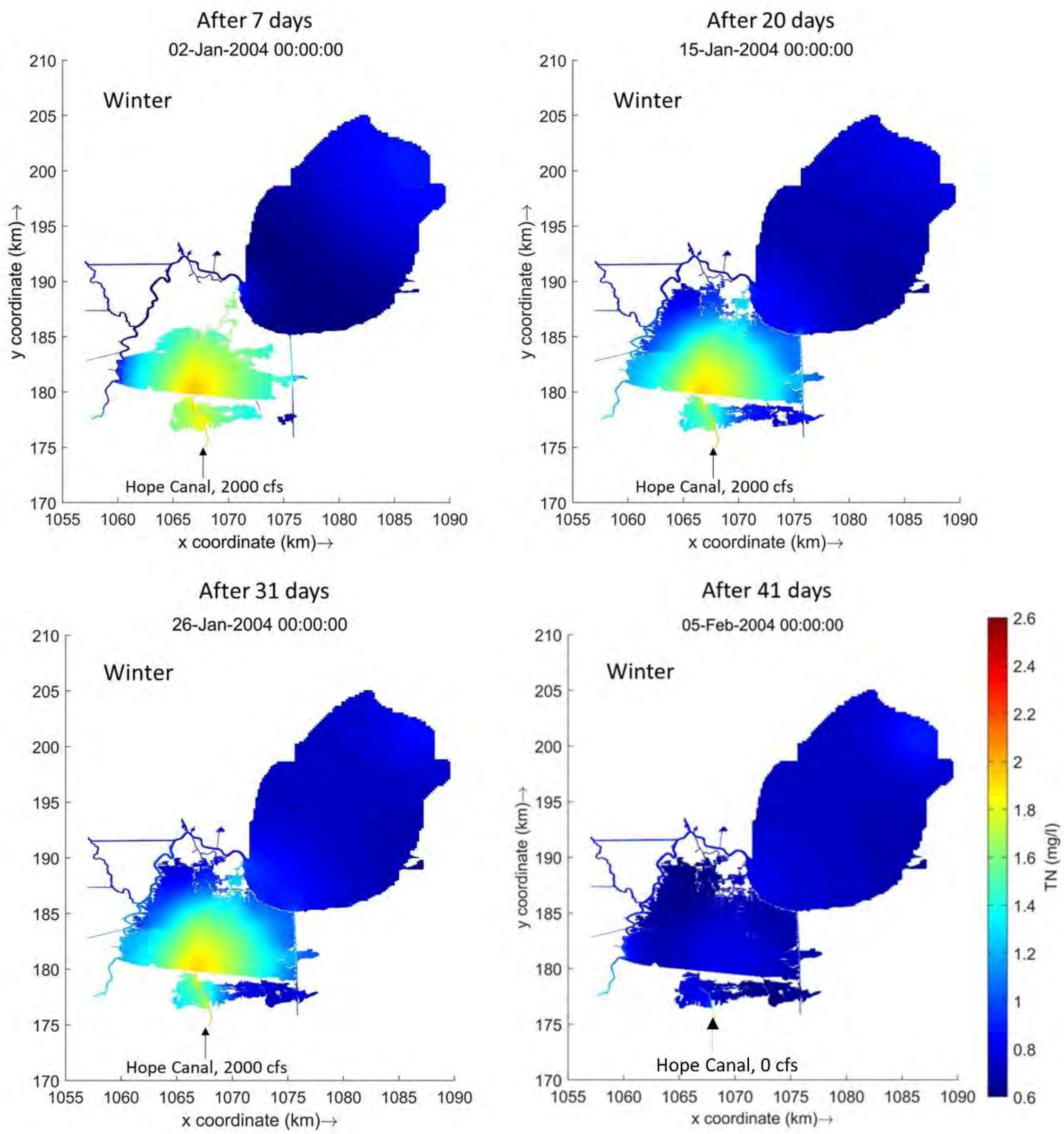

Figure 3.6. Predicted TN concentrations for winter at the end of 7, 20, 31 and 41 days.

3.5 Predicted Total Phosphorus Transport

The TP results are shown in Figure 3.7 and 3.8 for summer and winter, respectively. The TP concentration for the Mississippi River inflow was similar between summer (0.26 mg/L) and winter (0.25 mg/L).

As with TN, the highest predicted concentrations of TP are in Hope Canal and the immediately surrounding areas north of Interstate 10.

For TP, the results are different between summer and winter due to the seasonal difference in decay rates. As the water moves into the swamp and along channels, the decrease in TP concentrations is greater for summer than for winter. This trend continues into Lake Maurepas; the predicted TP concentrations in the southwest corner of Lake Maurepas are slightly higher for winter than for summer.

Dutch Bayou and Reserve Relief Canal appear to be contributing similar loadings of TP to Lake Maurepas.

After the diversion inflow stops on day 31, the predicted TP values decrease in the swamp and in Lake Maurepas. By day 41, predicted TP values return to near background levels in Lake Maurepas but are still higher than background in the swamp.

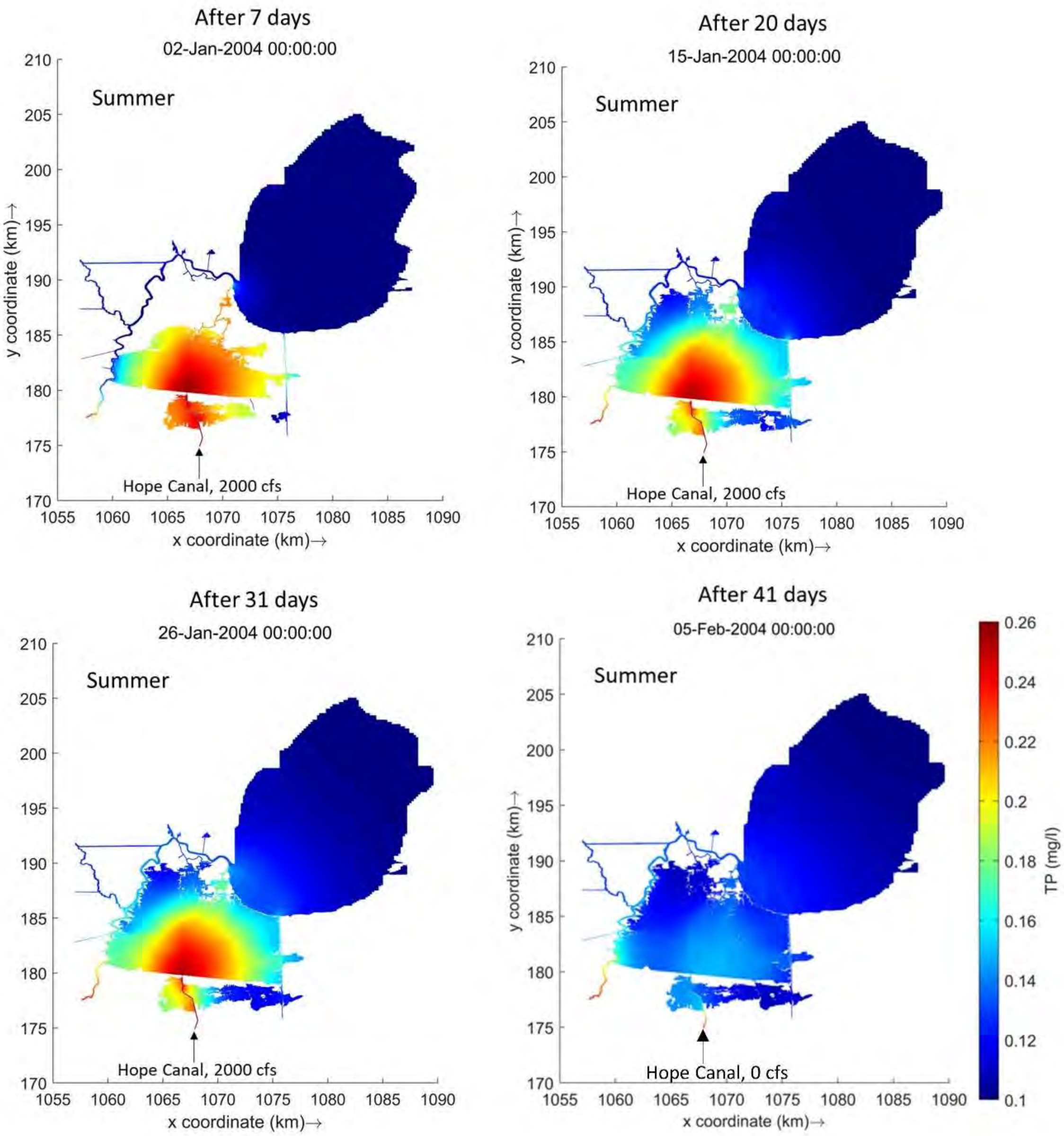

Figure 3.7. Predicted TP concentrations for summer at the end of 7, 20, 31 and 41 days.

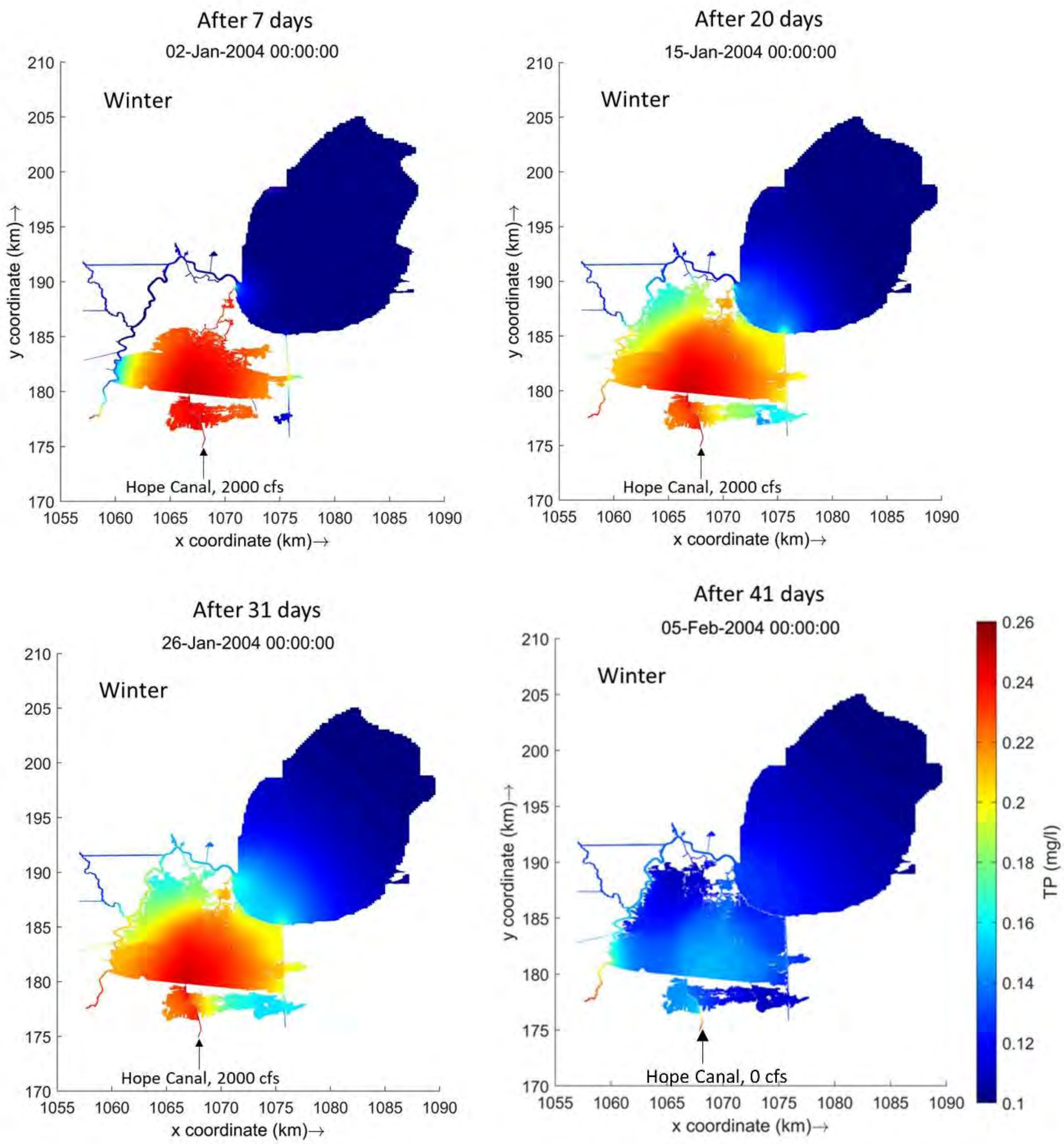

Figure 3.8. Predicted TP concentrations for winter at the end of 7, 20, 31 and 41 days.

3.6 Salinity Flushing Results

The purpose of this simulation is to demonstrate the freshening effect of the diversion on a swamp that has experienced high salinity event due to a tropical storm. Figure 3.9 shows contours of salinity after 7 days of diversion inflow. The initial water surface elevation and the salinity is set to 1.0 ft, NAVD88 and 5 ppt, respectively, throughout the entire study area (model domain). In reality, the Central Swamp (south of Interstate-10) is very unlikely to have a storm surge overtopping Interstate-10 resulting in a high salinity. However, due to the model limitations, it is not possible to specify spatially varying values of initial salinity so the entire domain is set to 5 ppt. Additionally, the constant salinity value of 1.5 ppt specified at Pass Manchac (Lake Maurepas) boundary may not be realistic. However, this does not affect results in our primary area of interest which is the swamp north of Interstate-10. Therefore, the focus of presented results is this region. Also, note that the initial water specified for this simulation is 1.0 ft, NAVD88, higher than -3.0 ft, NAVD88, that was specified for the 41-day diversion simulation. Therefore, the marginal inundation areas may not match for these two simulations.

Figure 3.9 shows that salinity is rapidly flushed out of the swamp by diversion flow. As expected, the flushing process is slower in the areas where little diversion flow reaches. The 7-day duration results demonstrate the freshening effects of the diversion flow. The results are generally expected to be similar to those shown by the Percent Mississippi River Water parameter in Figure 3.4; therefore, a longer simulation was not performed.

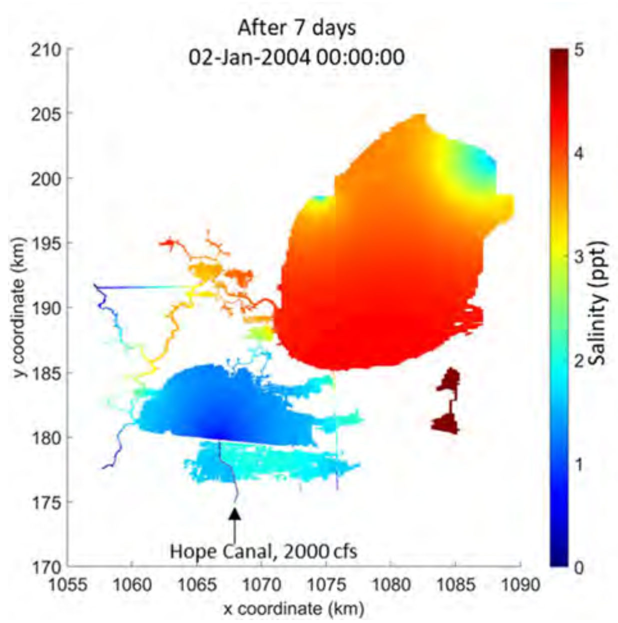

Figure 3.9. Predicted salinity concentrations at the end of 7 days.

3.7 Comparison with Previous Modeling Studies

The TN predictions discussed in Section 3.2 can be compared with two previous modeling studies for the Maurepas swamp. Comparisons must be done with caution because each study used different modeling approaches based on project objectives and available data.

Day et al. (2004) used output from a two-dimensional hydraulic model to calculate nitrate transport and loss in the Maurepas swamp. The model simulated water being diverted from the Mississippi River into Hope Canal and then moving through the swamp towards the Blind River, Reserve Relief Canal, or Lake Maurepas. The swamp was divided into cells and the equation used to estimate nitrate loss in each cell was:

Percent removal = -14.13 * LN (X) + 25
where X = nitrate loading entering that cell ($g/m^2/day$)

The predicted losses of nitrate for water reaching Lake Maurepas were 87% and 81% for diversion flow rates of 1,500 cfs and 2,500 cfs, respectively (Table 4.4 in Day et al. [2004]). It should be noted that this modeling study did not utilize a background concentration for nitrate because existing concentrations of nitrate in the Maurepas swamp are low.

CH2M Hill (2013) conducted modeling to estimate total nutrient removal for multiple planned and existing diversions along the Mississippi River. Based on objectives of this project and the large area that it encompassed, this modeling was developed at spatial and temporal resolutions that were much coarser than the DELWAQ modeling presented in this report. The CH2M Hill modeling used the pKC* model (described in Section 2.1) with background concentrations of zero for nitrate and ammonium, 0.6 mg/L for organic nitrogen, and 0.042 mg/L for total phosphorus. The model predicted a 57% loss of TN and 46% loss of TP in the Maurepas swamp for “average operations” (Table 14 of CH2M Hill [2013]).

In order to compare the DELWAQ results with these two studies, percentage losses of TN and TP were calculated. For the summer simulations, Mississippi River water was introduced into the swamp with concentrations of 2.6 mg/L TN and 0.26 mg/L TP. Water entering Lake Maurepas at the mouth of Dutch Bayou at the end of day 20 had concentrations of approximately 1.2 mg/L of TN and 0.17 mg/L TP, resulting in percentage losses of 54% for TN and 35% for TP. These percentage losses are similar to the results from CH2M Hill (2013). The percentage loss for TN is lower than the nitrate losses calculated by Day et al. (2004), but nitrate losses are expected to be greater than TN losses because nitrate can be removed from the water column through denitrification and uptake by algae or plants, whereas organic nitrogen (the other primary component of TN in Mississippi River water) can be removed from the water column only by settling of the particulate fraction.

3.8 Comparison with Nutrient Concentrations in Lake Pontchartrain

The predictions of TN in the southern end of Lake Maurepas can be compared with TN concentrations that were observed in Lake Pontchartrain after the Bonnet Carré Spillway was opened in 2008 and in 2011. When the Bonnet Carré Spillway is opened, large volumes of Mississippi River water are diverted into Lake Pontchartrain during a short time. This water reaches Lake Pontchartrain quickly with minimal nutrient loss. In both 2008 and 2011, increased algae concentrations were observed in the lake (including cyanobacteria that and were presumably caused by the nutrient loading from the diverted Mississippi River water.

In 2008, the spillway was open for about a month, with a total volume of diverted water that exceeded the volume of Lake Pontchartrain (Bargu et al. 2011). The average concentration of nitrate nitrogen that was measured within the plume during the spillway opening was 1.3 mg/L (Bargu et al. 2011). The modeling for Lake Maurepas does not specify what portions of the TN are nitrate, ammonium, and organic nitrogen, but the TN in the water that reaches Lake Maurepas is expected to be mostly organic nitrogen (see Section 3.2). If the predicted TN in the southern end of Lake Maurepas is assumed to include about 0.5 mg/L of organic nitrogen (most of the background concentration of TN is expected to consist of organic nitrogen), then the predicted TN values of 0.8 to 1.0 mg/L in the southern end of Lake Maurepas would correspond to nitrate concentrations of about 0.3 to 0.5 mg/L. These are much lower than the average nitrate concentration measured within the plume in Lake Pontchartrain during the spillway opening (1.3 mg/L).

In 2011, the spillway was open from May 9 to June 20, with a total volume of diverted water that was approximately 330% of the combined volume of Lake Pontchartrain and the downstream estuary (Smith 2014). The average concentration of nitrate nitrogen that was measured along a transect extending from the Bonnet Carré Spillway to the approximate center of the lake was 0.6 mg/L (individual values ranged from below the reporting limit up to 1.4 mg/L; Smith 2014). It is apparent that some dilution or other nutrient loss mechanisms affected some of these values because the nitrate concentrations measured by the USGS in the Mississippi River during the spillway opening ranged from 1.1 to 1.4 mg/L (3 samples at Baton and 6 samples at Belle Chasse). Nitrate concentrations in Lake Pontchartrain near the spillway were probably more similar to the Mississippi River values than the average concentrations reported by Smith (2014) for an entire transect. As discussed above, the TN values predicted for the southern end of Lake Maurepas correspond to estimated nitrate concentrations of about 0.3 to 0.5 mg/L, which are significantly lower than estimated nitrate concentrations in Lake Pontchartrain near the spillway.

4.0 SUMMARY AND CONCLUSIONS

A two-dimensional Delft3D hydrodynamic and water quality model was developed and calibrated for the study area. The model was applied to simulate water surface elevations, velocity, TN, and TP under a diversion operation scenario. Under this 41-day scenario, the diversion introduced a constant 2000 cfs of Mississippi River water into the swamp continuously for 31 days followed by 10 days of closure. These simulations showed that after the Mississippi River water reaches the north side of Interstate 10, its flow rate greatly exceeds the capacity of Hope Canal, causing the water to flow into the swamp and spread west as far as Blind River, east as far as Reserve Relief Canal (and slightly beyond), and northward into swamps along Dutch Bayou.

The shallow and relatively slow flow through the swamp allows for nutrients to be removed from the water column before the water reaches Lake Maurepas via Dutch Bayou and Reserve Relief Canal. By the time the Mississippi River water reaches Lake Maurepas, it has lost about 54% of its TN and 35% of its TP. Predicted concentrations of TN in the southern end of Lake Maurepas correspond to nitrate concentrations that are much lower than observed concentrations in Lake Pontchartrain that led to increased algae concentrations in 2008 and 2011 after opening the Bonnet Carré Spillway.

Based on these projection simulations, the proposed diversion of Mississippi River water into the Maurepas swamp is expected to provide beneficial freshening and nutrients to a large area of swamp without causing large increases in nutrient concentrations in Lake Maurepas.

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APPENDIX A

Hydrodynamic Modeling

1.0 INTRODUCTION

The proposed River Reintroduction into Maurepas Swamp (PO-0029) project (the Project) located near Garyville, Louisiana, will divert flow from the Mississippi River to the Maurepas Swamp wetlands (Figure A.1; figures are located at the end of this appendix). In 2014, URS provided 95% level design of the proposed PO-29 project to CPRA (URS 2014). The project consists of a gated intake structure at the river capable of diverting 2,000 cfs river water, a large sand settling basin, and a long, banked conveyance channel. Approximately halfway along the route, just north of US 61, the channel follows the existing Hope Canal alignment to distribute the diverted water into the wetlands on the north side of Interstate 10.

To support the hydraulic design of the proposed diversion and to evaluate its effect on swamp hydrology, URS developed a two-dimensional (2D) ADvanced CIRCulation (ADCIRC) Model. URS also developed a one-dimensional (1D) Storm Water Management Model (SWMM) of the Garyville-Reserve drainage system to evaluate effects of the water levels in the swamp on the drainage.

The hydrodynamic modeling performed for the 95% level design, did not include modeling the transport of nutrients introduced from the Mississippi River diversion water throughout the swamp. The purpose of the modeling efforts outlined in this document is to develop a hydraulic model of the study area which will be used to simulate transport of nutrients carried by the diverted water. For the purpose of this analysis, it is not necessary to represent the Mississippi River and the gated structure in the model.

2.0 STUDY OBJECTIVES

The objective of the modeling study is to develop and apply a hydraulic model to simulate water surface elevations and velocities throughout the receiving swamp when the diversion flow is introduced in the system. This hydraulics will then be used as an input to a water quality simulation to evaluate fate and transport of nutrients. The hydraulics will also be used to evaluate freshening of the swamp after a high salinity event.

3.0 MODELING PROGRAM SELECTION AND DESCRIPTION

The study area is an extensive swamp forest surrounding Lake Maurepas in the upper reaches of Pontchartrain estuary. The area is tidally influenced by diurnal micro-tidal regime introduced from Pass Manchac connecting Lake Maurepas with Lake Pontchartrain. The study area includes several natural and man-made channels that carry flow in and out of the swamp while distributing it in the swamp wherever low banks are present. For the purpose of the study, it is appropriate to assume the dominant velocities being in the longitudinal and transverse direction (two dimensions). Due to the relatively shallow water depths, the velocities and accelerations in the vertical direction (the third dimension) are negligible and the flow can be assumed vertically well-mixed. This assumption allows us to apply a two-dimensional (2D) model instead of a three-dimensional (3D) model. A 3D model for the study area will be extremely computationally intensive resulting in prohibitive simulation times without adding to the accuracy of the results. On the other hand, an over-simplified one-dimensional (1D) model will be less applicable for the study purpose. Therefore, two-dimensional depth-averaged (2D) model is an appropriate type of model for this study.

Various public domain and commercial/proprietary computer software is available for 2D, vertically averaged hydrodynamic transport modeling. These models solve the hydrodynamic and constituent transport equations using either a structured or an unstructured computational mesh.

The structured-grid models consist of rectangular or square elements and are simpler in parallel programming implementation as they employ finite-difference schemes to solve governing equations and different portions of the grid can be distributed to multiple processors for optimal load balancing. Additionally, finite difference schemes do not suffer from mass conservation problems often inherent in the finite element schemes of unstructured grids. However, the accuracy in the complex edge-of-the-water geometry in structured grids may not be as good as the unstructured-grid models. The unstructured models (finite element or finite volume-based), on the other hand, allow elements of various shapes (line, triangle, or quadrilateral), which enables fitting elements more closely to the topographic features. Further, the unstructured mesh allows variation of element size in a single mesh enabling creation of a denser mesh where more details are necessary. However, implementation of finite-element models is not as straightforward as finite-difference models. This is mainly due to approximation of the fields within each element with a simple linear, quadratic or polynomial function with finite number of degrees of freedom.

The following are some of the modeling programs commonly used to model 2D, vertically averaged hydrodynamics:

1. RMA-2 model (unstructured mesh) by Resource Modelling Associates, Inc;
2. ADCIRC from the University of North Carolina at Chapel Hill (unstructured mesh);
3. MIKE-21 from the Danish Hydraulic Institute (unstructured mesh); and
4. Delft3D from Deltares (structured mesh).

Although the first two options can better represent present area with broken swamp, lake, channels and bayous, the Delft3D option was considered for this study because it has been widely applied in south Louisiana and for the Louisiana Coastal Master Plan. Delft3D is highly scalable on High Performance Computing (HPC) infrastructures. Equally important is the fact that Delft3D with its DELWAQ module can model a wide range of water quality parameters including secondary processes. DELWAQ can model 18 independent principal substances with over 20 different sub-substances. It has been applied in studies involving eutrophication, Dissolved Oxygen depletion, contaminated sediment, and outfall temperatures. A particularly useful feature of DELWAQ is its ability to specify user-defined spatially variable, depth dependent decay rate constants for the constituents of interest.

3.1 Overview of Approach

FTN developed and applied Delft3D model version 4.02.03 (Deltares 2018) to predict the tidal circulation and the transport of suspended nutrients. Delft3D FLOW module simulates water levels and velocity driven by boundary conditions of tides and currents. The output from DELFT3D FLOW is used in DELWAQ to simulate the advection and dispersion of nutrients.

The Delft3D FLOW module utilizes a robust numerical finite-difference scheme where model results are computed on a horizontal staggered grid. The water level points are designated in the center of a continuity cell and the velocity components are perpendicular to the grid cell faces. Delft3D can be operated in a 2D (vertically averaged) or a 3D mode. In the present application, Delft3D is used in 2D mode only.

4.0 DATA COLLECTION TO SUPPORT MODELING

The following topographic survey data and hydraulic monitoring data were used in this modeling study.

4.1 Topographic Data

The topographic field data are used to develop the model geometry which is a digital representation of the terrain. Specifically, the topographic data were required for Lake Maurepas, the streams and the swamp.

The Lake Maurepas bathymetry was obtained from USGS and is also from the 2002 surveys. Existing channel cross-section data were available at 29 locations on streams in the main swamp north of I-10 (URS 2005). To evaluate whether the cross-sections have changed significantly over the years, new topographic surveys were collected in April 2018 at 6 selected cross-sections (MPH 2018). The original 29 and new 6 survey locations are shown in Figure A.2. Figures A.3 through A.5 compare the old and the new cross-sections. The comparison shows that the previously collected cross-sections have not changed significantly in the cross-sectional area and can be used for the purpose of this study.

To represent the swamp, it would have been prohibitively expensive to collect topographic field survey data in the forested swamp. Therefore, the LIDAR data from 2012 were used. The data contained excessively higher elevations in the main swamp north of Interstate-10 not generally found in this region, therefore upon the recommendation of the Technical Advisory

Group[1] the marsh floor elevation was capped at 1.0 ft, NAVD88. The revised topographic contours are show in Figure A.6.

4.2 Hydraulic Monitoring Data

Hydraulic monitoring data needed for modeling typically consists of time series of water surface elevations, velocity or discharge. These data are used to specify boundary conditions and for calibration/validation of the model. Since the major channels were found to have no major changes, the previously collected monitoring data (URS 2006) were judged to be appropriate for use in this study. The monitoring gage locations are shown in Figure A.7. Water surface elevations were collected at all locations and velocity was collected at location S-9.

5.0 MODEL GEOMETRY DEVELOPMENT

The model geometry is a mathematical representation of the study area topography. The model domain size was selected such that the boundary conditions are specified far away from the area of interest. The domain is represented by a two-dimensional computational grid composed of 1.3 million points. The grid is most refined (cell size 12 m) at Hope Canal, Mississippi Bayou, Relief Canal, Dutch Bayou, and the interior channels connecting them, where detailed hydrodynamic and nutrient dynamics are expected, and becomes coarser (cell size 200 m) towards the boundary at Lake Maurepas. The interior swamps enjoy 12 to 50 m of resolution depending upon location and priority in nutrient dispersal. Figure A.8 shows the model grid for existing conditions.

The bathymetry of the primary channels was assigned using previously collected channel cross-sections. The bathymetry of the swamp areas was assigned using the LIDAR data. Figure A.9 shows the model bathymetry. It should be noted that bathymetry does not capture numerous rivulets and small open water areas that are widespread in the swamp, rather, it represents the overall relief in the terrain. This is the limitation of LIDAR data that were used for the bathymetry.

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[1] Prof. Gary Shaffer, Southeastern Louisiana University; Prof. Richard Keim and Prof. Jim Chambers, Louisiana State University; and Dr. Ken Krauss, USGS.

6.0 MODEL CALIBRATION AND VALIDATION

Model calibration is an iterative process where model coefficients are systematically varied or “tuned” through a series of simulations to improve model’s reproduction of observed data. The range of values used when varying model coefficients should be limited to that which reasonably reflects the physical conditions and processes during the simulation periods. If unreasonable values are required to calibrate a model, it should serve as a warning that there is a process or feature not being represented in the model.

Model validation involves simulating one or more independent sets of conditions, using model coefficients determined in the calibration process, to assess how well the calibrated model can reproduce observed data for those independent conditions. The hydrologic conditions represented by the calibration and validation periods should be similar. For example, a model calibrated for average conditions should not be validated with hurricane conditions. The primary purpose of model calibration and validation is to provide greater confidence in the model when it is used to predict the system response to differing scenarios.

For the present study, two independent observed data periods were available for calibration and validation at monitoring stations shown in A.8. The first period was from December 26, 2003, through January 1, 2004, and represents normal hydrologic conditions. The second period was from October 4, 2004, through October 18, 2004, and represents tropical storm conditions (Tropical Storm Matthew). The two periods represent two distinct hydrologic conditions. Therefore, instead of using them as a calibration and a validation period, they were used as two calibration periods. The water movement in a forested swamp at high water levels can be quite different than the water movement at normal conditions due to the additional frictional drag presented by the tree trunks.

The model parameters involved in calibration are typically coefficients related to the simulation of physical processes in the model (e.g., friction coefficients in fluid flow simulation). However, model calibration may also involve variation of other parameters that have uncertainty associated with them, for example, model geometry or boundary conditions (driving forces).

The model was calibrated and validated for water surface elevation and velocity thorough a series of Delft3D FLOW simulations. The calibration is accomplished mainly through improvement in geometry of the channels and tuning the roughness coefficient to improve the accuracy of the model predictions.

The calibration simulations were performed by applying known tidal water surface elevations at the Pass Manchac boundary. For the normal and tropical storm conditions, Pass Manchac is the most important boundary condition that drives the water movement in the study area. The inflows at the other major boundaries such as Blind River, Amite River, Hope Canal, and Reserve Relief Canal were not measured during the data collection period. However, they have much smaller influence on the swamp water levels under the available conditions. Therefore, these inflows were not specified as the boundary conditions during calibration. These inflows affect local water levels where they enter the study area. Figure A.10 shows the locations of the gages and nodal coordinates where observed and predicted water surface elevations are compared.

The calibration for the normal conditions is shown in Figures A.11 through A.14. The tidal elevations at Pass Manchac are shown in the figures for reference as they are the most important boundary conditions driving water movement in the system. After a series of trial runs, a uniform Manning's roughness of 0.035 s/($m^{1/3}$) is applied for the whole domain. In the case of normal conditions, the statistical measures shown on the figures indicate a good model performance. The model performance is better at the gages in the middle of the swamp. At the gages near I-10 and south, the water surface elevations are more affected by the local runoff from the adjacent areas which are outside the model domain. Rainfall contribution was not modeled in this simulation as it was not the driving force for hydraulics in the mid-swamp region. In the primary area of interest – the mid-swamp region – where the nutrient assimilation is expected, the model performance is excellent.

The calibration for the tropical storm hydrologic conditions is shown in Figures A.15 through A.19. The final selected values of roughness (Manning's n) were 0.02, 0.035 and 0.2 s/($m^{1/3}$) for Lake Maurepas, the channels, and the swamp, respectively. The swamp region is assigned a high roughness due to additional vegetation drag. The open water body lake is assigned a low roughness. The channels are assigned a typical roughness value used for natural streams. The statistical measures of correlation coefficient and root-mean-square error provided for each gage indicate the satisfactory performance of the model predictions. In general, the rising limb and peak of the storm hydrograph is matched well by the model. During the falling limb of the hydrograph, the model underpredicts the water levels indicating faster outgoing flow than observed.

7.0 MODEL APPLICATION – GEOMETRY MODIFICATION

The calibrated model was used to simulate a diversion scenario. First, the model geometry was modified to represent the diversion channel and outfall management features proposed in the 95% design report (URS 2014). The following model geometry modifications were performed:

- Added the proposed diversion channel from the Mississippi River to its end approximately 1000 ft north of its crossing with I-10 highway. The channel has a variable cross-section along its way. The longest segment between the Highway 61 and I-10 has a 60 ft wide bottom and 1V:5H side slope. The invert is -7 ft- and -8 ft, NAVD88 at Highway 61 and I-10, respectively.
- Closed culvert crossings under I-10 between LA 641 and Mississippi Bayou to prohibit backflow from the diversion into the swamp between I-10 and Highway 61.
- Added gaps in the railroad embankment along the west bank of Hope Canal.

The Mississippi River, the details of diversion complex or the sediment settling basin were not represented in the model as they were not necessary to simulate the hydraulics in the swamp which is the purpose of this modeling effort. The model geometry representing proposed diversion is shown in Figure A.19.

The results of the model application are discussed in Section 3.0 of the main report.

8.0 REFERENCES

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MPH. 2018. *Topographic Survey in the outfall management area of the Mississippi River Reintroduction into the Maurepas Swamp (PO-29)*, Prepared by Morris P. Hebert, Inc for the Coastal Protection and Restoration Authority, Louisiana. July 18, 2018.

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URS. 2006. *Mississippi River Diversion into Maurepas Swamp Project PO-29, Volume IV of VII, Hydrologic Data, Prepared for the Coastal Protection and Restoration Authority, Louisiana*. June 29, 2006.

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Figure A.1. Maurepas swamp hydraulic modeling study area.

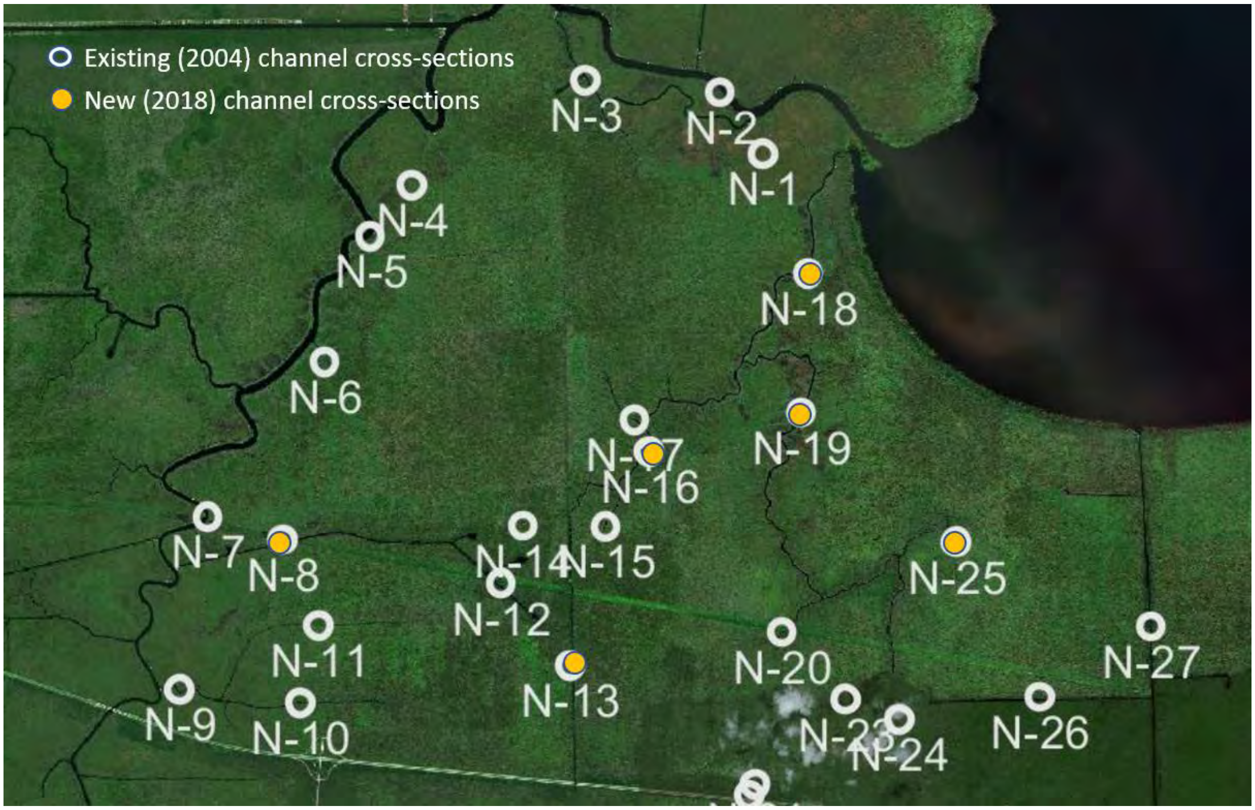
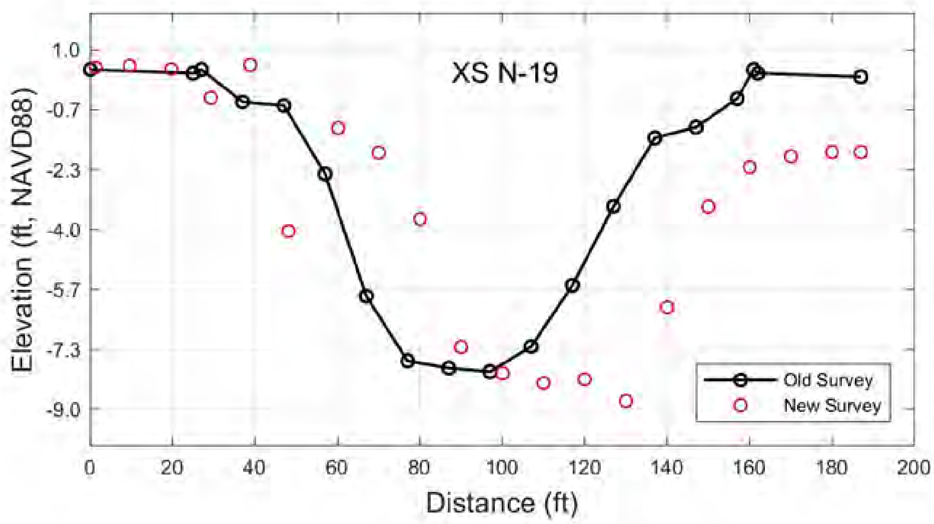
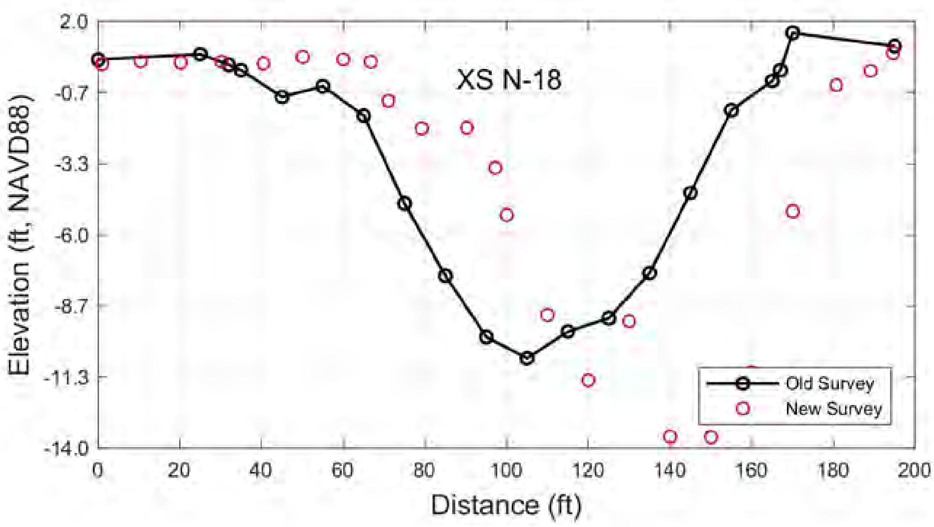
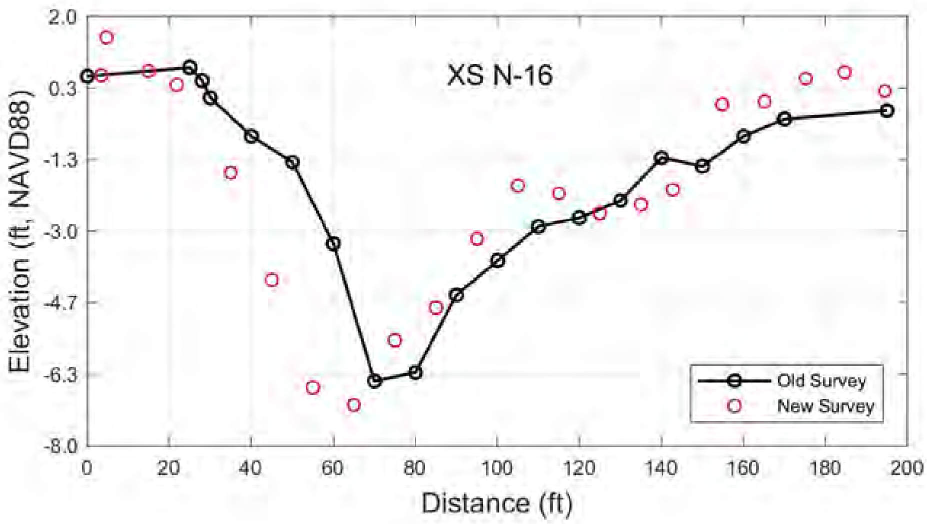


Figure A.2. Locations of existing (2004) and new (2018) channel cross-section field surveys.





FigureA.3. Comparison of old (2004) and new (2018) channel cross-sections at N-19 and N-18.



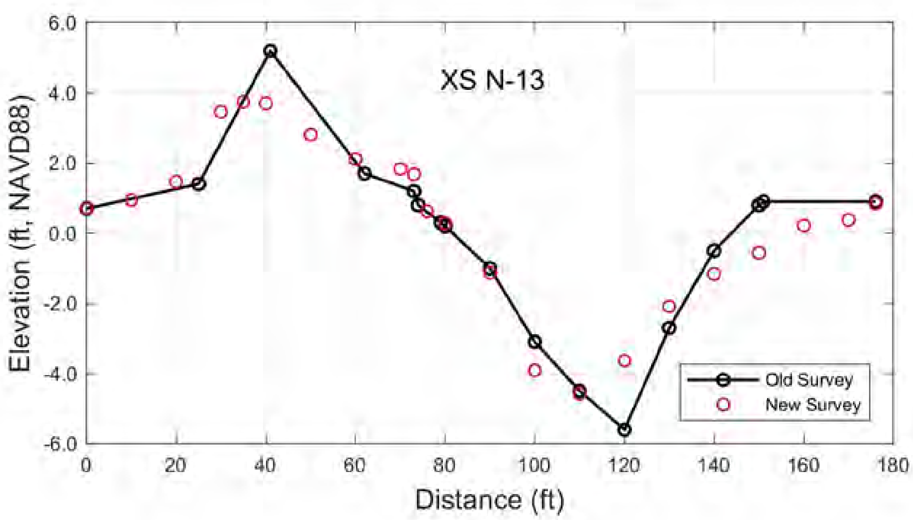
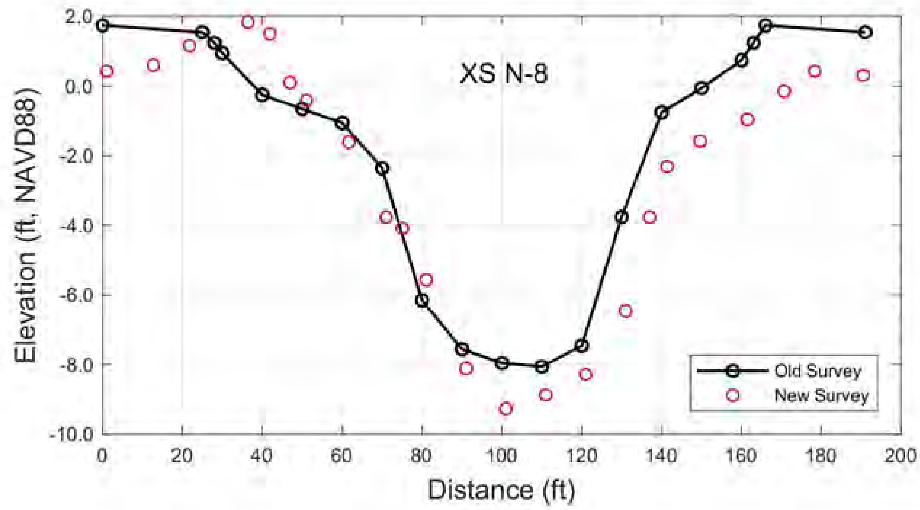


Figure A.4. Comparison of old (2004) and new (2018) channel cross-sections at N-16 and N-13.



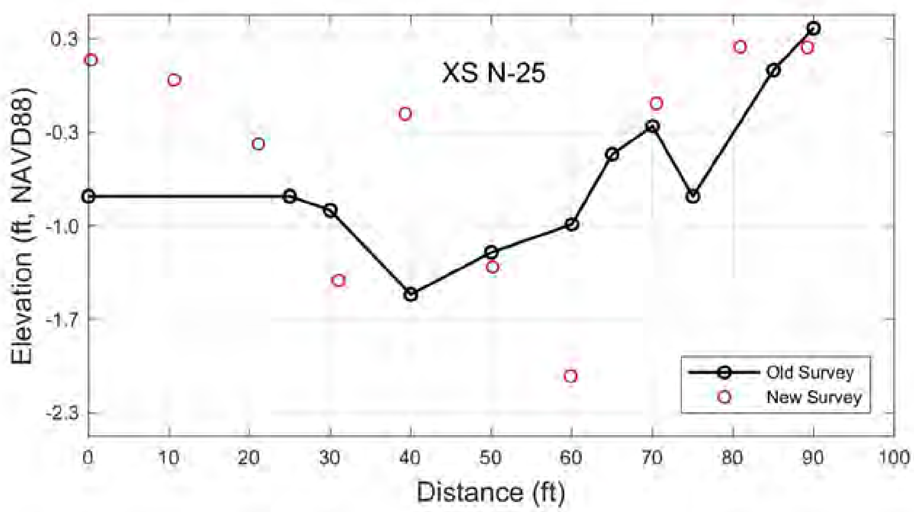


Figure A.5. Comparison of old (2004) and new (2018) channel cross-sections at N-8 and N-25.

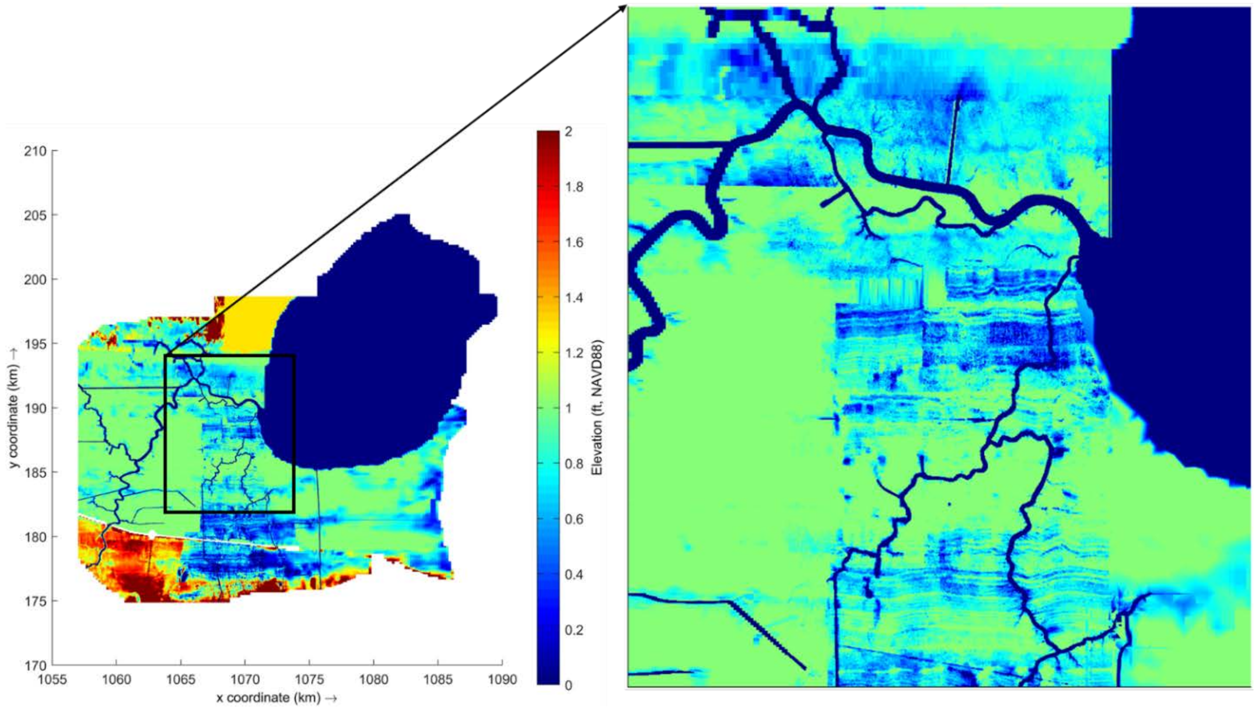


Figure A.6. Delft3D model bathymetry using topographic contours from 2012 LIDAR data. Swamp floor elevation capped at 1.0 ft in the region shown by the inset.

Figure A.7. Locations of hydraulic monitoring gages.

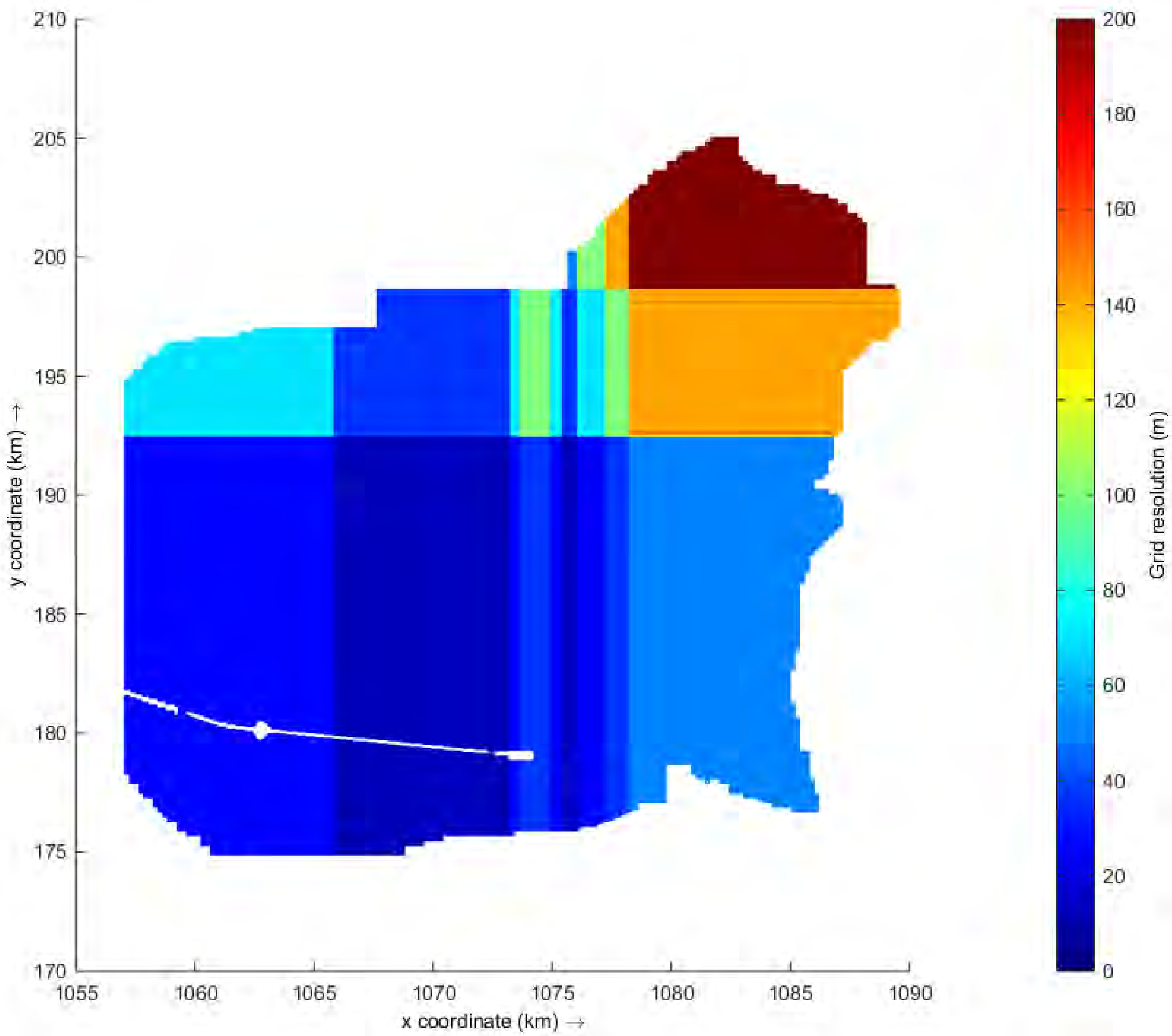


Figure A.8. Maurepas swamp Delft3D model grid resolution.

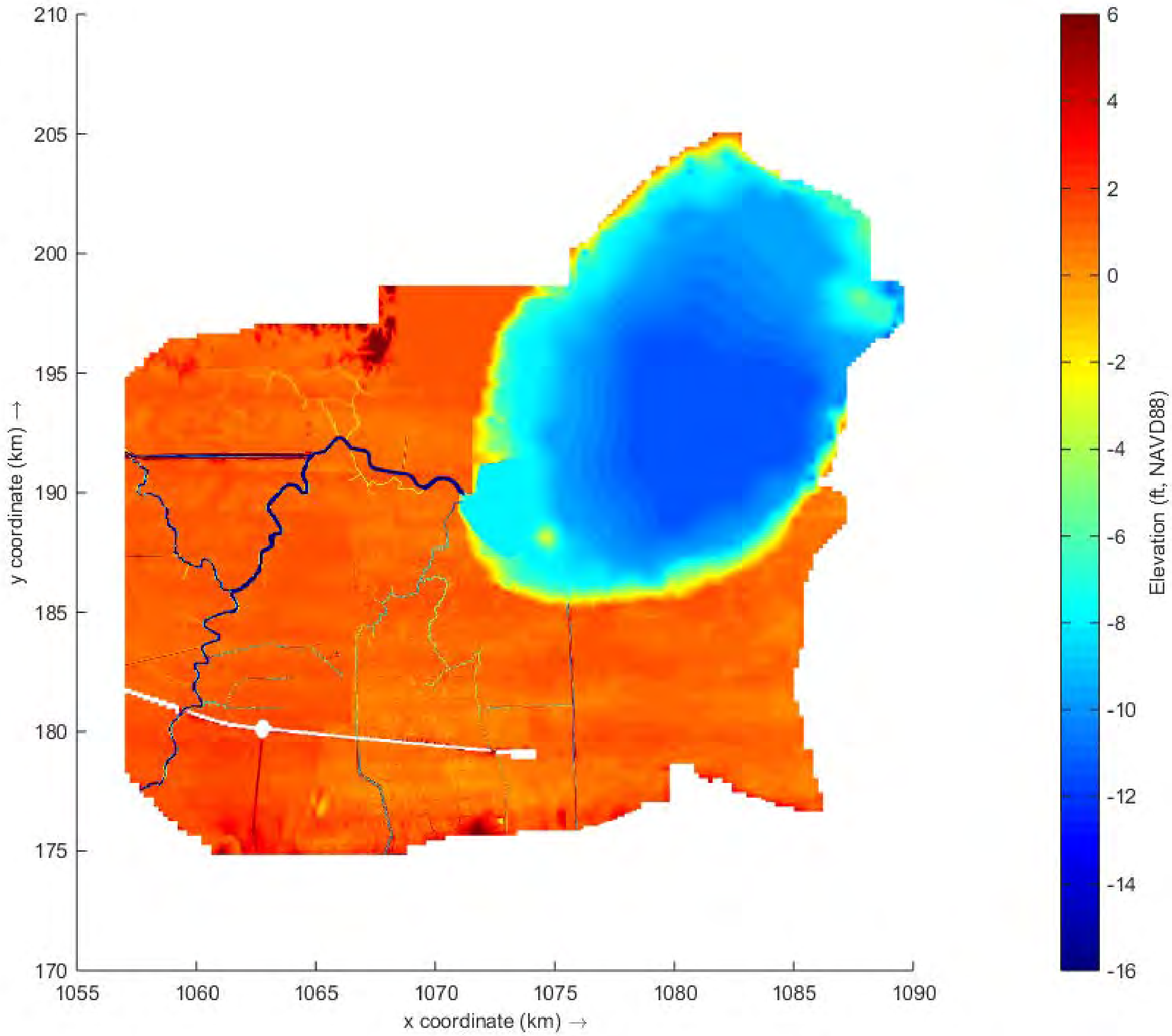


Figure A.9. Maurepas swamp Delft3D model bathymetry.

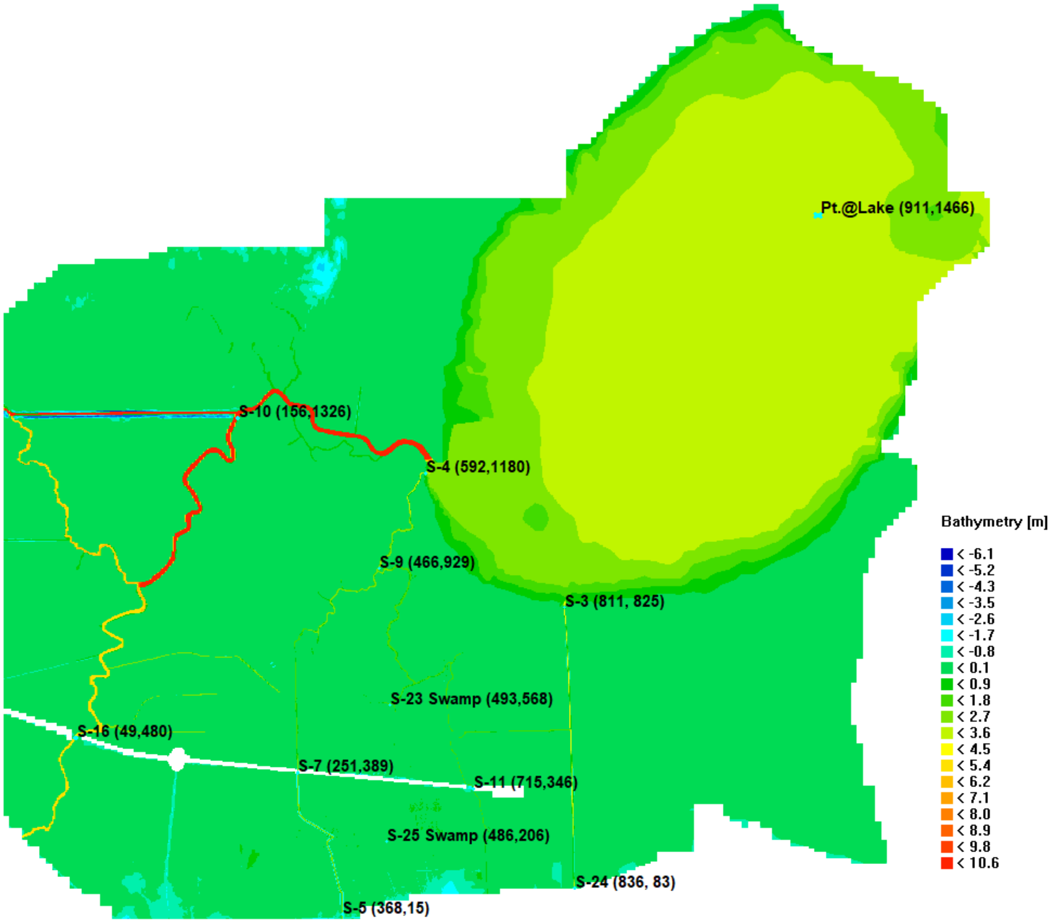


Figure A.10. Delft3D model nodal coordinates closest to the monitoring gages.

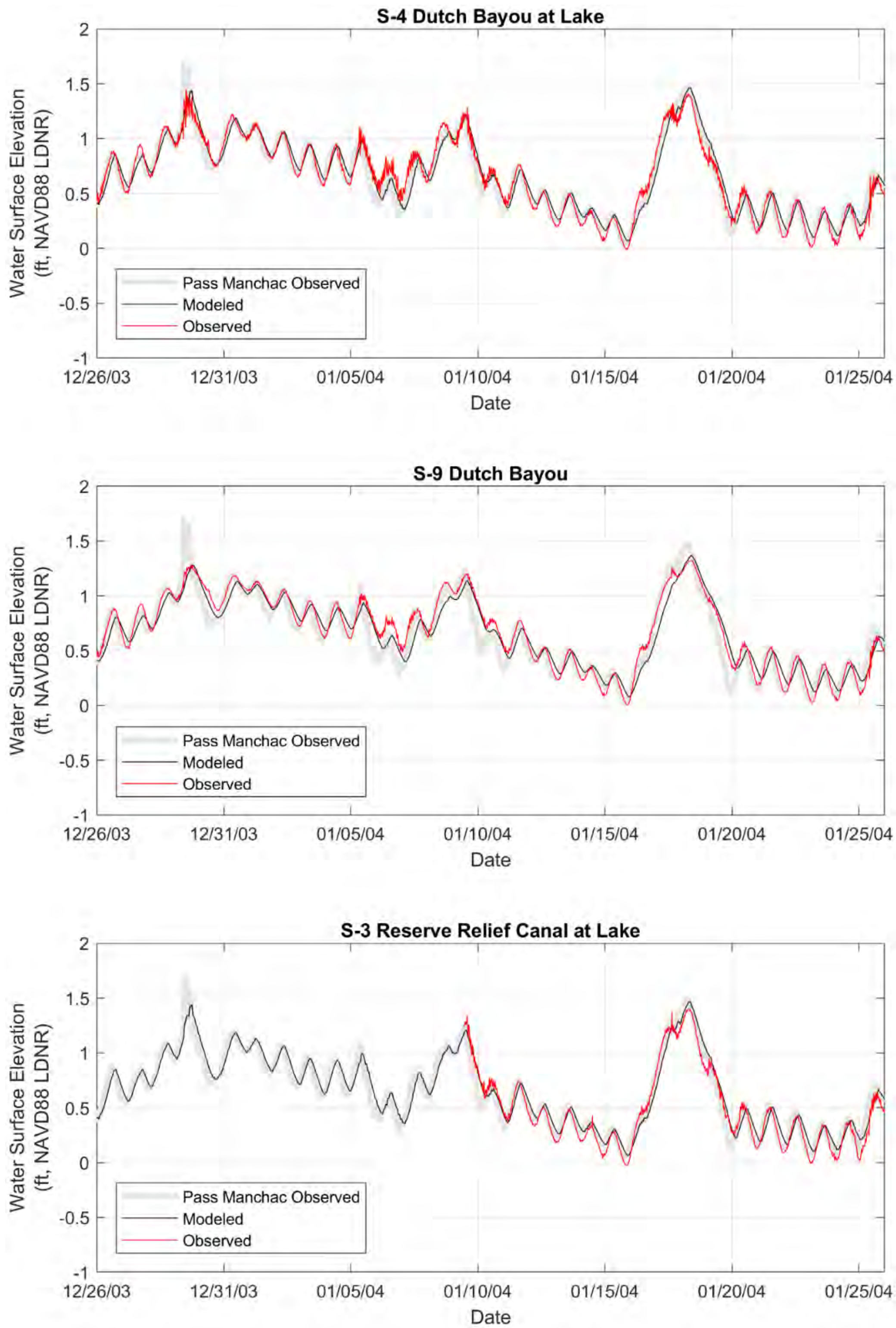


Figure A.11. Observed and predicted water surface elevations at gages S-4, S-9 and S-3 under normal conditions.

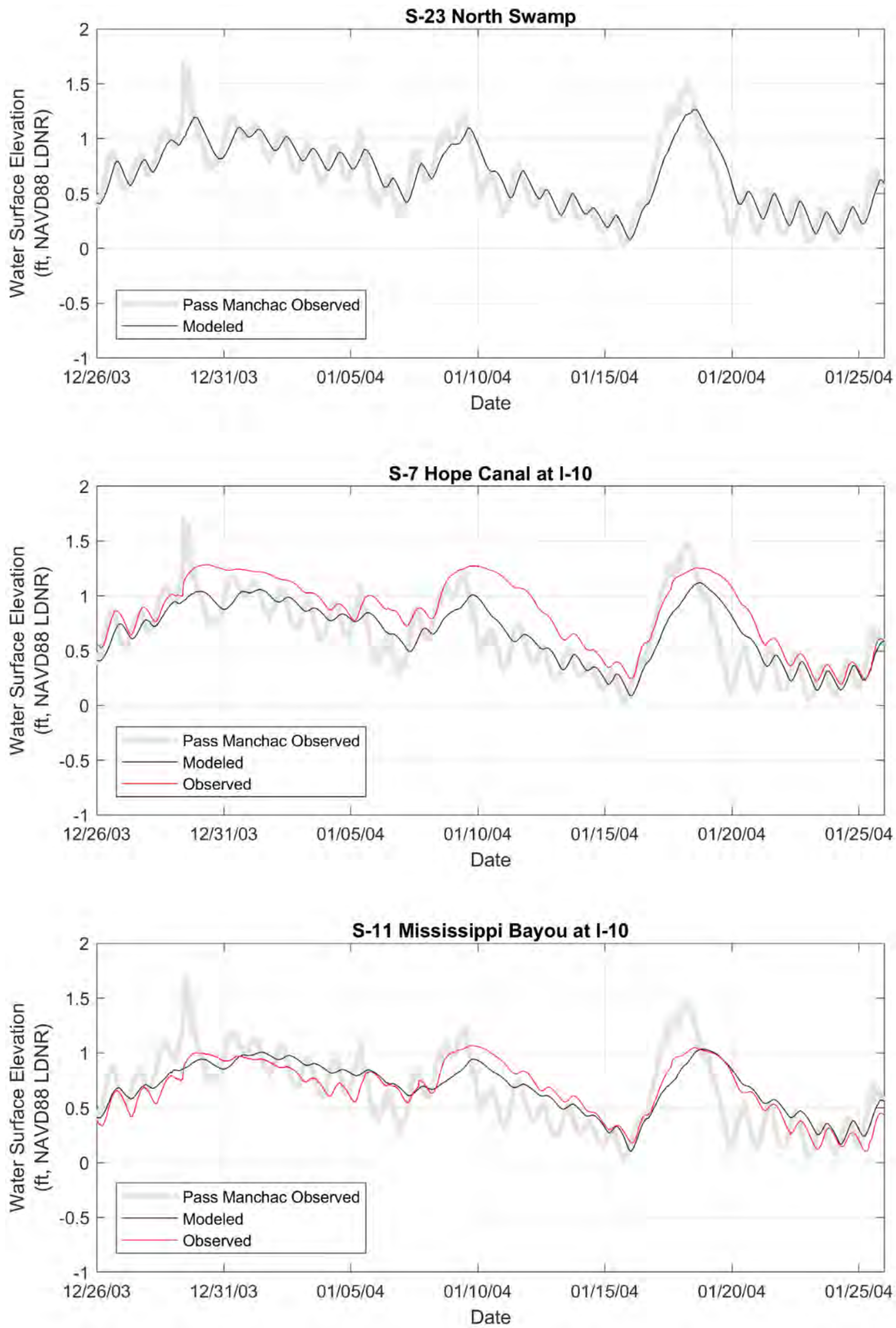


Figure A.12. Observed and predicted water surface elevations at gages S-23, S-7 and S-11 under normal conditions.

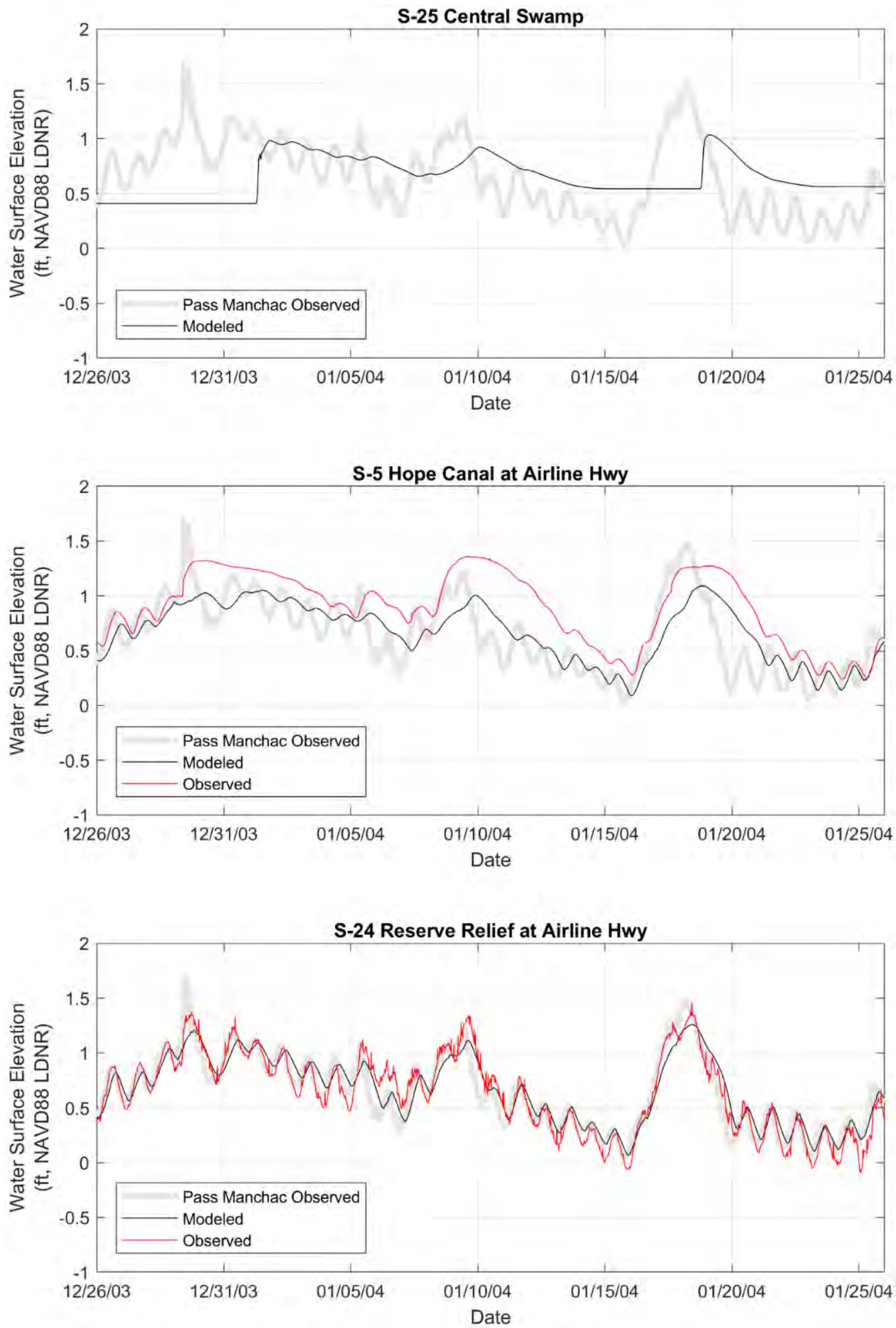


Figure A.13. Observed and predicted water surface elevations at gages S-25, S-5 and S-24 under normal conditions.

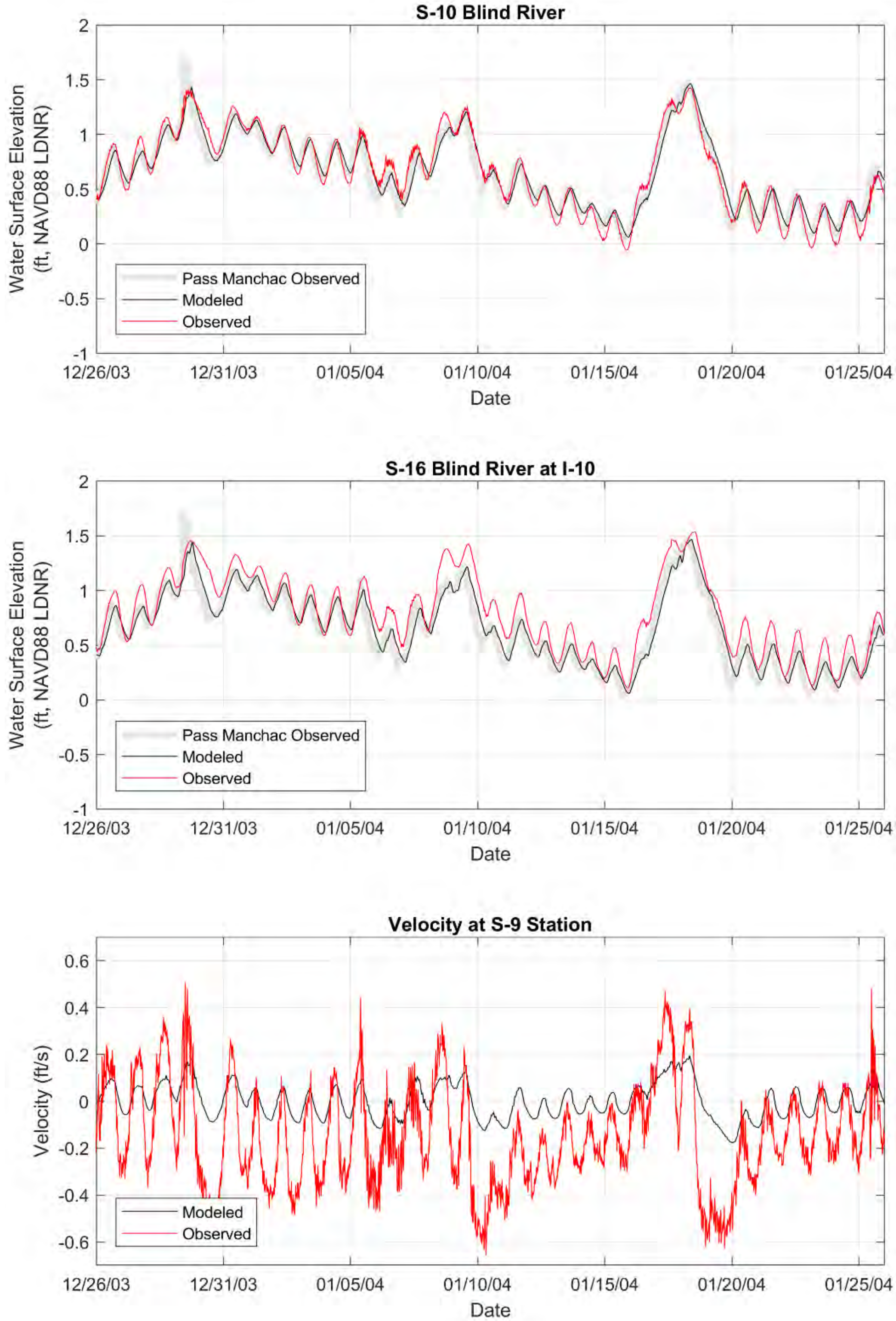


Figure A.14. Observed and predicted water surface elevations at gages S-10, S-16 and velocity at S-9 under normal conditions.

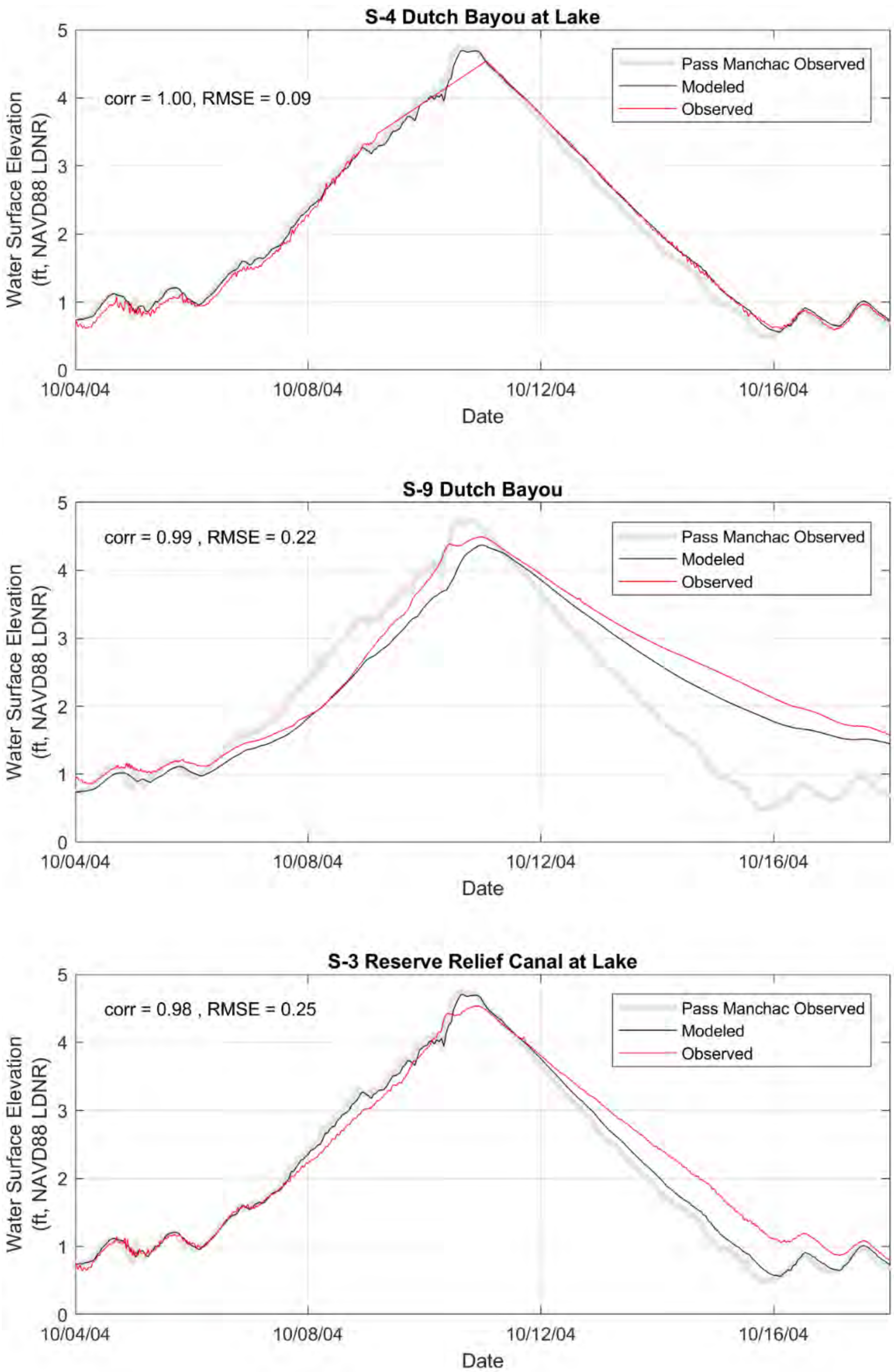


Figure A.15. Observed and predicted water surface elevations at gages S-4, S-9 and S-3 under tropical storm conditions.

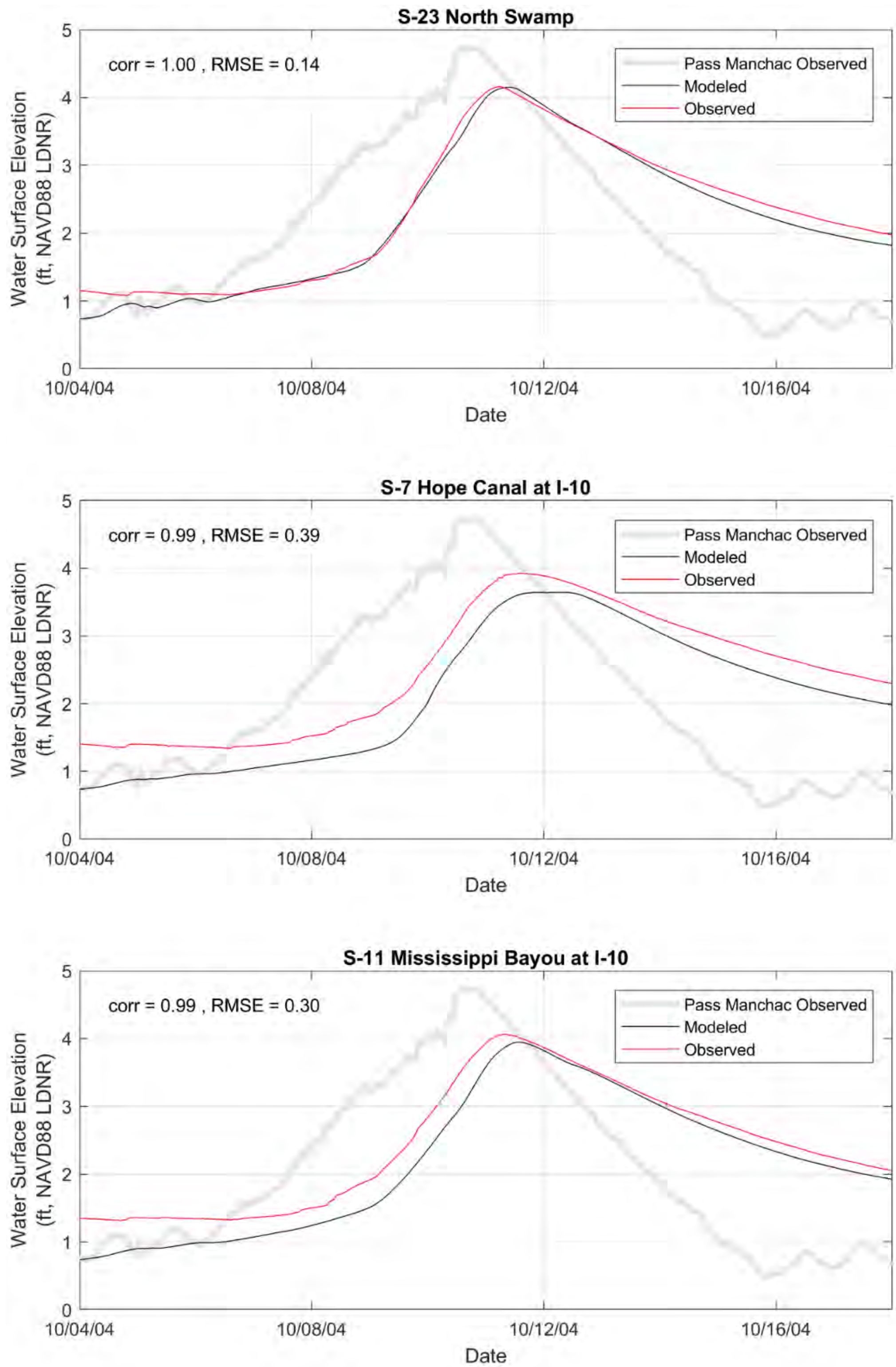


Figure A.16. Observed and predicted water surface elevations at gages S-23, S-7 and S-11 under tropical storm conditions.

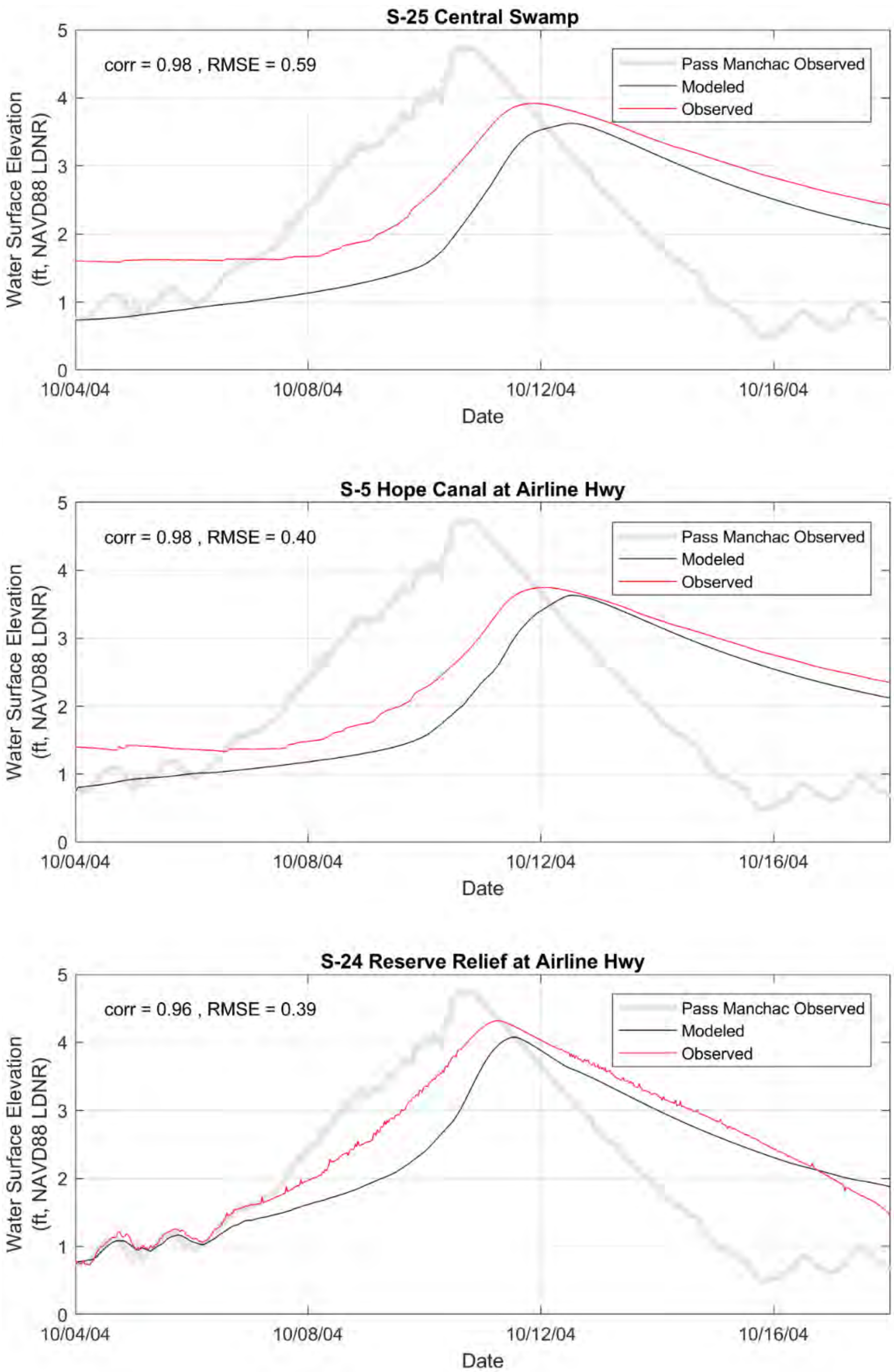


Figure A.17. Observed and predicted water surface elevations at gages S-25, S-5 and S-24 under tropical storm conditions.

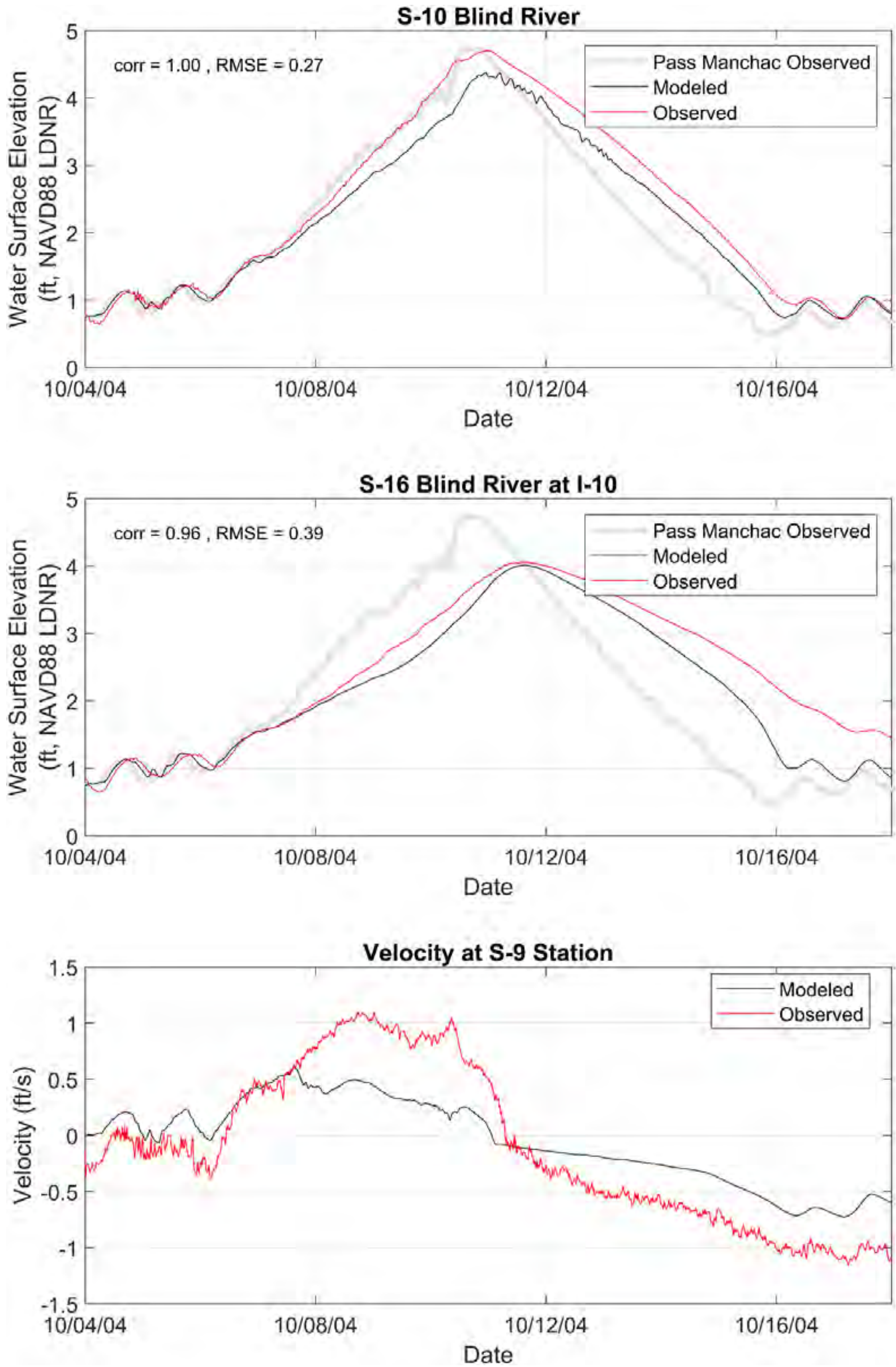


Figure A.18. Observed and predicted water surface elevations at gages S-10, S-16 and velocity at S-9 under tropical storm conditions.

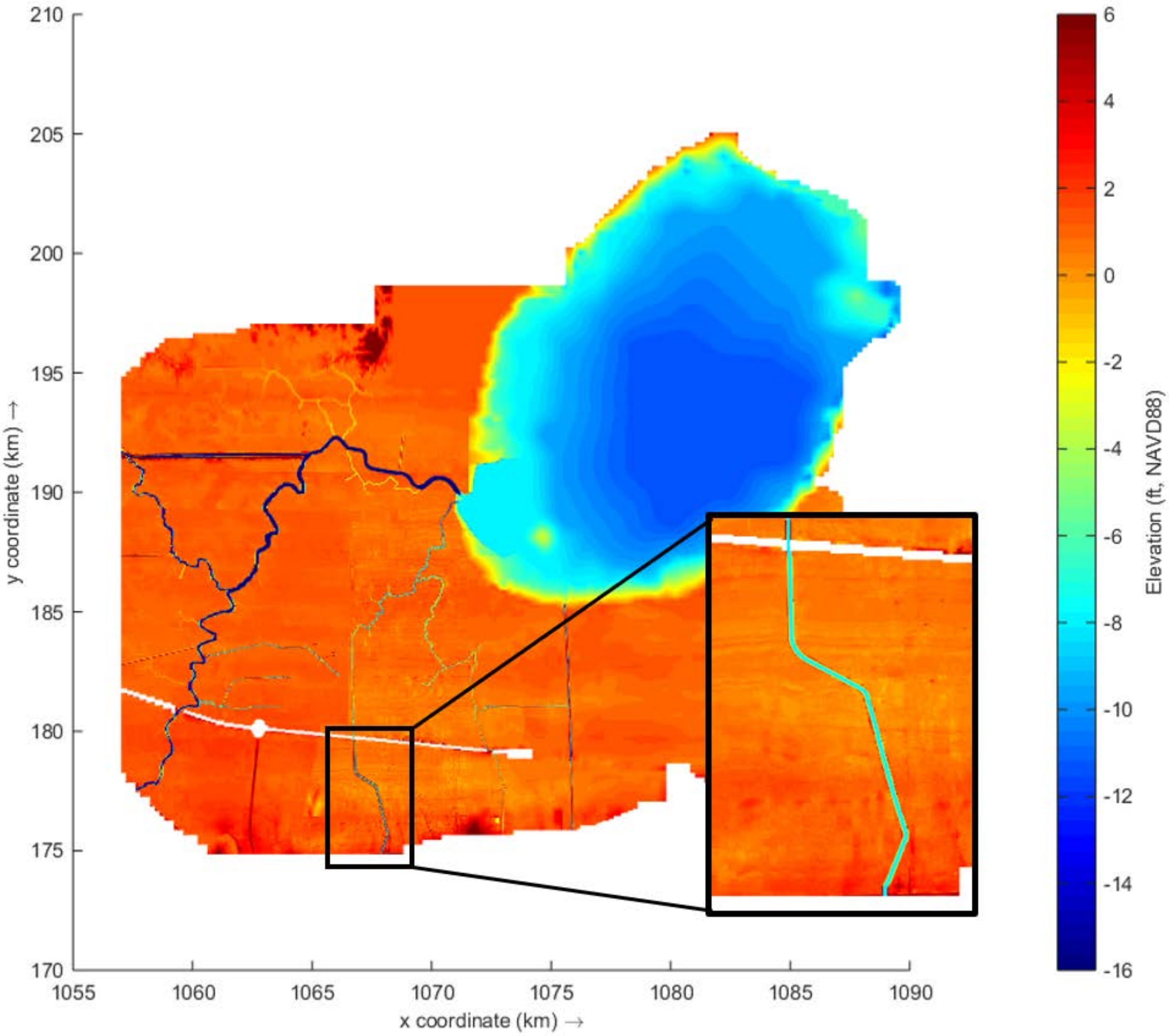


Figure A.19. Maurepas swamp Delft3D model grid with the proposed diversion channel.

APPENDIX B

Information from Published Literature Used to Develop Loss Rates

Table B.1. Information from published literature used to develop loss rates for TN.

Description or name of wetlands	TN conc. entering wetland (mg/L)	TN conc. leaving wetland (mg/L)	TN percent reduction (%)	Hydraulic residence time (days)	First order decay rate for TN (1/day)	Average depth (m)	"k" value for PkC* model (m/yr)	Comments
Wetlands below Caernarvon Diversion [1]	1.94	0.51 – 0.89 [A]	38% [B]	"about two weeks"	0.034	not reported	--	Data were collected during a March 2001 pulse; reductions measured over a distance of about 33 – 39 km. Receives water from Mississippi River.
Fourleague Bay [2]	1.2 – 1.6	0.4 – 0.6	Feb: 42% [C] Mar: 38% [C] Apr: 37% [C]	Feb: 5.3 Mar: 5.0 Apr: 18.7	Feb: 0.103 Mar: 0.096 Apr: 0.025	~ 1	Feb: 37.6 Mar: 34.9 Apr: 9.0	Data collected during Feb. – April 1994. This is an open waterbody. Primary source of nutrients is Atchafalaya River.
City of Mandeville – Bayou Chinchuba wetland [3]	7.5	--	65%	77 [D]	0.014	approx. 0.3	1.5	Data collected during Sep. 1998 – Oct. 2000. This is a forested wetland receiving treated municipal wastewater.
City of Thibodaux treatment wetland [4]	12.6	1.08	91%	120	0.021	0.33	2.4	Data were collected during Mar. 1992 – Mar. 1994. This is forested wetland receiving treated municipal wastewater.
City of Luling treatment wetland [5]	7.06	1.18	83%	512 [D]	0.003	not reported	--	Data were collected during 2006 – 2013. This is forested wetland receiving treated municipal wastewater.
City of Breaux Bridge treatment wetland [5]	8.44	1.38	84%	410 [D]	0.004	not reported	--	Data were collected during 2001 – 2013. This is forested wetland receiving treated municipal wastewater.
Richland-Chambers treatment wetlands in Texas [6] [E]	PS1: 4.95 PS2: 4.43 PS3: 4.43 FSS: 3.53	PS1: 1.32 PS2: 1.14 PS3: 1.36 FSS: 1.44	PS1: 73% PS2: 74% PS3: 69% FSS: 59%	PS1: 9.2 PS2: 7.8 PS3: 11.2 FSS: 8.2	PS1: 0.144 PS2: 0.174 PS3: 0.105 FSS: 0.110	PS1: 0.29 PS2: 0.25 PS3: 0.28 FSS: 0.40	PS1: 33.0 PS2: 55.4 PS3: 29.0 FSS: 32.8	Data were collected during Nov. 1993 – Jul. 2000 for pilot systems and Jun. 2003 – May 2008 for field scale system. Inflow is from Trinity River.

Table B.1 (continued)

Description or name of wetlands	TN conc. entering wetland (mg/L)	TN conc. leaving wetland (mg/L)	TN percent reduction (%)	Hydraulic residence time (days)	First order decay rate for TN (1/day)	Average depth (m)	"k" value for PkC* model (m/yr)	Comments
Stormwater treatment wetlands in North Carolina [7]	0.74 – 2.69	0.56 – 2.06	not calculated	0.1 – 3.0	0.056 – 1.26 [F]	0.1 – 0.3	5.1 – 63.1 (median = 46.1)	Ranges are for 10 constructed wetlands receiving stormwater in different regions of North Carolina.
Olentangy River Wetland Research Park [8]	2.90 [G]	1.97 [G]	31.9%	3.7 [G]	0.104	approx. 0.4 [G]	16.1	Data were collected during 2004 – 2010. Inflow is from Olentangy River. Located in Ohio.
Des Plaines River Experimental Wetlands [9] [H]	< 0.5 to ~ 7.5 [I]	0.5 to 1.5 [I]	EW3: 54% EW4: 75% EW5: 59%	EW3: 12 EW4: 95 EW5: 13	EW3: 0.065 EW4: 0.015 EW5: 0.069	0.6 – 0.7 [G]	EW3: 14.6 EW4: 3.6 EW5: 16.7	Data were collected during Apr. – Nov. 1991. Inflow is from Des Plaines River. Located in Illinois.

Notes:

A. Concentrations leaving the wetland are affected by dilution as well as other (e.g., biological and chemical) processes.
B. The effects of dilution were excluded in the calculations for this reduction percentage.
C. Percent reduction was calculated as 100% minus the percent exported from the bay into the Gulf of Mexico.
D. Estimated value obtained from Table 1 in Hunter et. al. (2009).
E. PS1 = Pilot system #1, PS2 = Pilot system #2, PS3 = Pilot system #3, FSS = Fields scale system.
F. Calculated as "k" value for PkC* model divided by average depth. "k" values were calculated by the author.
G. Calculated using other information in the article.
H. EW3 = Experimental wetland #3, EW4 = Experimental wetland #4, EW5 = Experimental wetland #5.
I. Estimated from Figure 4 (time series plot) in article.

References:

[1] Lane et. al. (2004)
[2] Perez et. al. (2011)
[3] Brantley et. al. (2008)
[4] Zhang et. al. (2000)
[5] Hunter et. al. (2018)
[6] Kadlec et. al. (2011)
[7] Merriman et. al. (2017)
[8] Mitsch et. al. (2014)
[9] Phipps and Crumpton (1994)

Table B.2. Information from published literature used to develop loss rates for TP.

Description or name of wetlands	TP conc. entering wetland (mg/L)	TP conc. leaving wetland (mg/L)	TP percent reduction (%)	Hydraulic residence time (days)	First order decay rate for TP (1/day)	Average depth (m)	"k" value for PkC* model (m/yr)	Comments
Wetlands below Caernarvon Diversion [1]	0.16	0.059 – 0.065 [A]	35% [B]	"about two weeks"	0.031	not reported	--	Data were collected during a March 2001 pulse; reductions measured over a distance of about 33 – 39 km. Receives water from Mississippi River.
Fourleague Bay [2]	0.11 – 0.15	0.06 – 0. 10	Feb: 0% [C] Mar: 12% [C] Apr: 58% [C]	Feb: 5.3 Mar: 5.0 Apr: 18.7	Feb: 0 Mar: 0.025 Apr: 0.046	~ 1	Feb: 0 Mar: 9.1 Apr: 16.9	Data collected during Feb. – April 1994. This is an open waterbody. Primary source of nutrients is Atchafalaya River.
City of Mandeville – Bayou Chinchuba wetland [3]	2.0	--	50%	77 [D]	0.009	approx. 0.3	1.0	Data collected during Sep. 1998 – Oct. 2000. This is a forested wetland receiving treated municipal wastewater.
City of Thibodaux treatment wetland [4]	2.46	0.85	65%	120	0.009	0.33	1.1	Data were collected during Mar. 1992 – Mar. 1994. This is forested wetland receiving treated municipal wastewater.
City of Luling treatment wetland [5]	2.34	0.51	78%	512 [D]	0.003	not reported	--	Data were collected during 2006 – 2013. This is forested wetland receiving treated municipal wastewater.
City of Breaux Bridge treatment wetland [5]	2.42	0.47	81%	410 [D]	0.004	not reported	--	Data were collected during 2001 – 2013. This is forested wetland receiving treated municipal wastewater.
Richland-Chambers treatment wetlands in Texas [6] [E]	PS1: 0.727 PS2: 0.719 PS3: 0.724 FSS: 0.888	PS1: 0.457 PS2: 0.342 PS3: 0.347 FSS: 0.539	PS1: 37% PS2: 52% PS3: 52% FSS: 39%	PS1: 9.2 PS2: 7.8 PS3: 11.2 FSS: 8.2	PS1: 0.050 PS2: 0.095 PS3: 0.066 FSS: 0.061	PS1: 0.29 PS2: 0.25 PS3: 0.28 FSS: 0.40	PS1: 6.2 PS2: 10.9 PS3: 5.7 FSS: 10.7	Data were collected during Nov. 1993 – Jul. 2000 for pilot systems and Jun. 2003 – May 2008 for field scale system. Inflow is from Trinity River.

Table B.2 (continued)

Description or name of wetlands	TP conc. entering wetland (mg/L)	TP conc. leaving wetland (mg/L)	TP percent reduction (%)	Hydraulic residence time (days)	First order decay rate for TP (1/day)	Average depth (m)	"k" value for PkC* model (m/yr)	Comments
Stormwater treatment wetlands in North Carolina [7]	0.17 – 0.38	0.05 – 0.48	not calculated	0.1 – 3.0	0.048 – 1.01 [F]	0.1 – 0.3	4.4 – 84.2 (median = 37.0)	Ranges are for 10 constructed wetlands receiving stormwater in different regions of North Carolina.
Olentangy River Wetland Research Park [8]	0.148 [G]	0.085 [G]	42.7%	4.1 [G]	0.136	approx. 0.4 [G]	21.2	Data were collected during 1994 – 2001 and 2003 – 2010. Inflow is from Olentangy River. Located in Ohio.
37 large constructed wetlands [9]	median = 0.114	median = 0.038	variable	variable	--	variable	median = 12.5	This is literature review of wetlands with measured data; the PkC* model was calibrated for each system.

Notes:

A. Concentrations leaving the wetland are affected by dilution as well as other (e.g., biological and chemical) processes.
B. The effects of dilution were excluded in the calculations for this reduction percentage.
C. Percent reduction was calculated as 100% minus the percent exported from the bay into the Gulf of Mexico.
D. Estimated value obtained from Table 1 in Hunter et. al. (2009).
E. PS1 = Pilot system #1, PS2 = Pilot system #2, PS3 = Pilot system #3, FSS = Fields scale system.
F. Calculated as "k" value for PkC* model divided by average depth. "k" values were calculated by the author.
G. Calculated using other information in the article.

References:

[1] Lane et. al. (2004)
[2] Perez et. al. (2011)
[3] Brantley et. al. (2008)
[4] Zhang et. al. (2000)
[5] Hunter et. al. (2018)
[6] Kadlec et. al. (2011)
[7] Merriman et. al. (2017)
[8] Mitsch et. al. (2014)
[9] Kadlec (2016)

STATE OF LOUISIANA
COASTAL PROTECTION AND RESTORATION AUTHORITY

RIVER REINTRODUCTION INTO MAUREPAS SWAMP AND WEST SHORE LAKE PONTCHARTRAIN FLOOD RISK REDUCTION PROJECT PO-0029
STATE PROJECT No. PO-0062
LaGOV NO. 4400019214

BASIS OF DESIGN REPORT
15% DESIGN

APPENDIX E

TASK ORDER 1 STRUCTURAL CALCULATIONS

Maurepas Swamp

WSLP

CONCRETE FOUNDATIONS

AECOM Project: 60632162

SECTION 1

AECOM

Date: Dec-20

AECOM

Job	Maurepas Swamp	Project No.	60589133		
	WSLP				
Description	CONCRETE FOUNDATIONS	Computed by		Date	Dec-20
	AECOM Project: 60632162				
	Table of Contents	Checked by		Date	Dec-20
					References

TABLE OF CONTENTS

Reference: 95% Maurepas Geotech Information and Pile Capacity Curves

Maurepaus Swamp

Gate Monolith

River Road Gate Monolith

AECOM Project : 60632162

Foundation, Wall & Slab

1555 Poydras Street

Suite 1200

New Orleans, LA 70112

(504) 586-8111

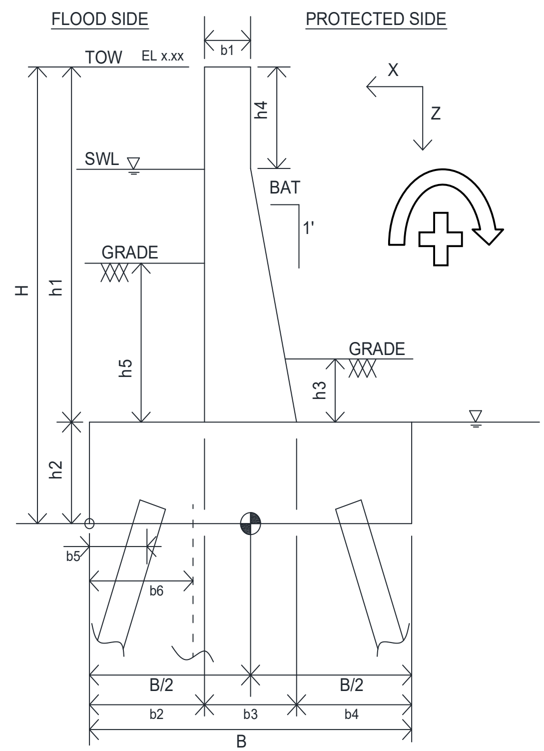
Computed by:	JMH	Checked by:	AML
Date:	Dec-20	Date:	Dec-20

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Wall Geometry	Checked by	AML	Date	Dec-20

References

WALL GEOMETRY:

Top of Pilaster EL.	16.13	NAVD88
Top of Wall EL.	16.13	NAVD88
100 Yr. Water El.		NAVD88
10 Yr. Water El.		NAVD88
Top of Slab EL.	10.49	NAVD88
H=	8.64	ft.
h1=	5.64	ft.
h2=	3.00	ft. (Base Slab Height)
h3=	0.00	ft. (P.S. Soil Height)
h4=	0.00	ft.
h5=	0.00	ft. (F.S. Soil Height)
B=	10.00	ft. (Base Slab Width)
b1=	1.50	ft. (Wall Stem Width, top)
b2=	6.25	ft. (F.S. Slab Width)
b3=	1.50	ft. (Wall Stem Width, bottom)
b4=	2.25	ft. (P.S. Slab Width)
b5=	2.00	ft. (F.S. Pile Row Edge Space)
b6=	5.00	ft. (Sheet Pile Edge Space)
BAT=	0.00	(Wall Batter, N/A)
PS Grade =	10.49	NAVD88 (Average of PS soil for all)
Monolith Length =	66.0	ft
Bottom Of Slab =	7.49	NAVD88



T-WALL CROSS-SECTION

Notes: 1) positive 'Y' axis is into page

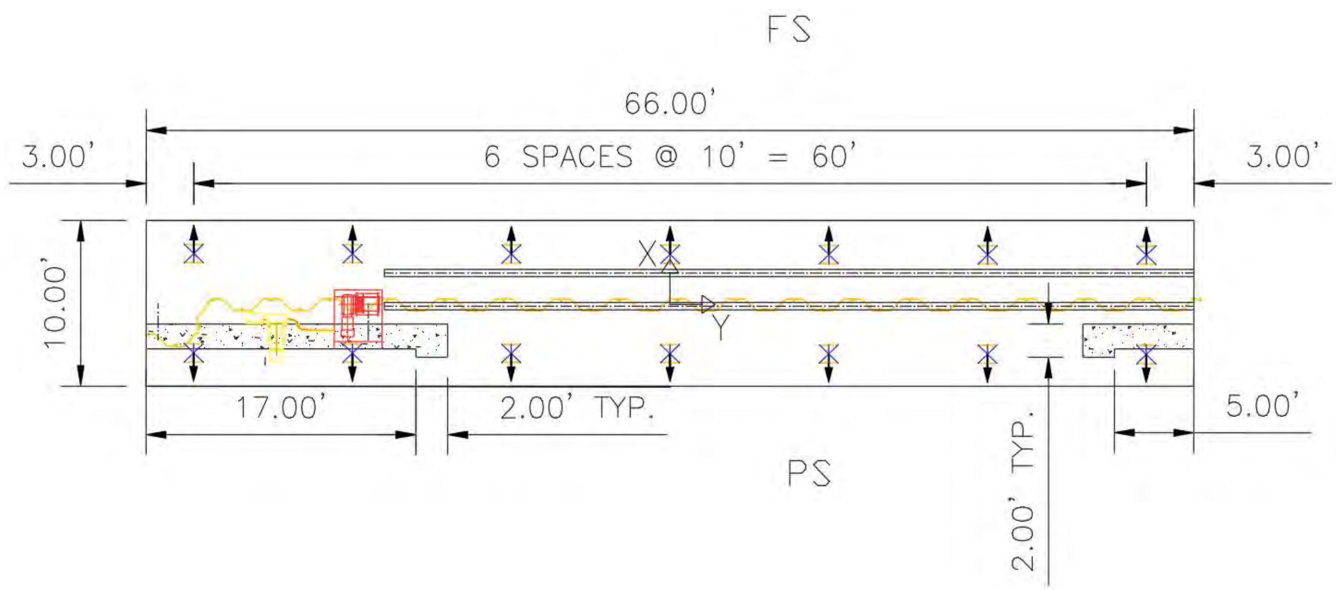
2) pile batters vary from those shown in diagram

Note: In this report, white boxes are for input data and colored boxes are calculated values.

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Applied Loads in SAP Model	Checked by	AML	Date	Dec-20

References

Pile and Pilaster Layout:



Job	**Maurepaus Swamp**	**Project No.**	**60632162**		
Description	**Gate Monolith**	**Computed by**	**JMH**	**Date**	**Dec-20**
	River Road Gate Monolith				
	Assumptions	**Checked by**	**AML**	**Date**	**Dec-20**

References

Unit Weight of Storm Water =	0.0624	kcf
Wet Unit Weight of Soil =	0.1200	kcf
Sat Unit Weight of Soil =	0.0576	kcf
Unit Weight of Concrete =	0.1500	kcf
Impact Load =	0.0000	k/ft
FS Wind force above SWL=	0.0500	ksf
Construction Surcharge Pressure =	0.2500	ksf
Unbalanced Load for Stability Analysis:		
F_{cap} (k/ft) =	0.00	(10y SWL Case; Force acts at bottom of slab)
F_{cap} (k/ft) =	0.00	(100y SWL Case; Force acts at bottom of slab)
F_{cap} (k/ft) =	0.00	(Water to TOW Case; Force acts at bottom of slab)
K_0, Granular fill =	0.95	(for lateral soil forces)
Assumed Wall Reinforcement Cover =	0.25	ft
Assumed Wall d_{bar} =	0.06	ft
Gate Length =	42.00	ft
Gate Opening =	40.00	ft *Tributary Length = 20'
Gate Weight =	13.86	kip *Taken from similar roller gate from Hoboken project.

***NOTE:** Gate calculations show a gate weight of 14.7 kips:

14.7/13.86 = 1.06 so that the gate weight is a 6% difference in weight; by inspection, gate weight will not drastically affect the design and the new gate weight passes with the pile capacities along with the shear and moment capacities on the slab. The gate weight will be updated and analyzed for the next submittal.

AECOM

Job	**Maurepaus Swamp**	**Project No.**	**60632162**
Description	**Gate Monolith**	**Computed by**	**JMH**
	River Road Gate Monolith	**Date**	**Dec-20**
	Load Cases	**Checked by**	**AML**
		Date	**Dec-20**
			References

No. of Load Cases	3	**Update**

No.	DCD LC No.	Description	FS Water El.	PS Water El.	Pile Design Over Stresses
1	1	Construction Surcharge	7.49	7.49	1.17
2	2a	Water to TOW (impervious cutoff)	16.13	7.49	1.33
3	2b	Water to TOW (pervious cutoff)	16.13	7.49	1.33

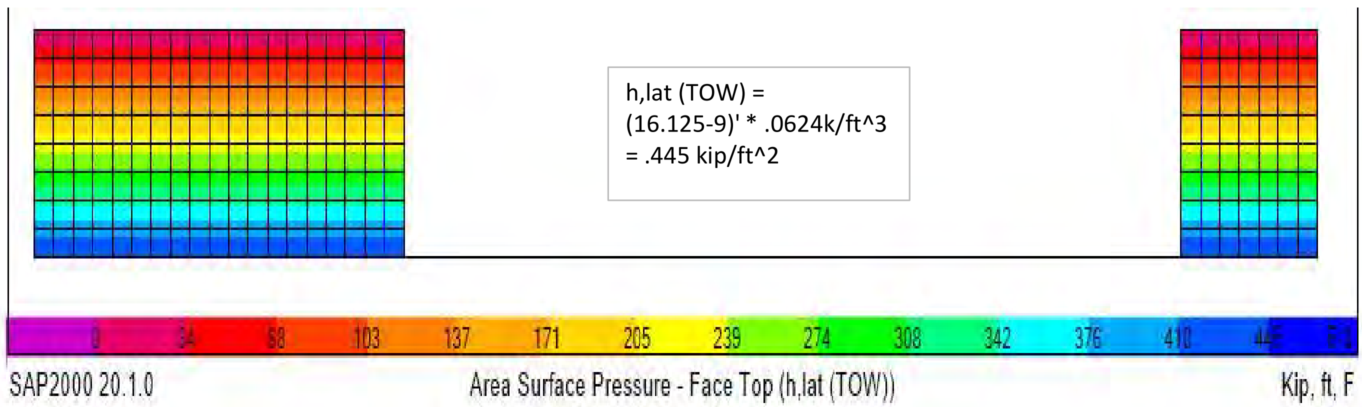
* Impact load is not applicable for this section, so it is excluded from the load combinations
* Forces induced by 10y water elevation are not applicable for this section, so they are excluded from the load combinations

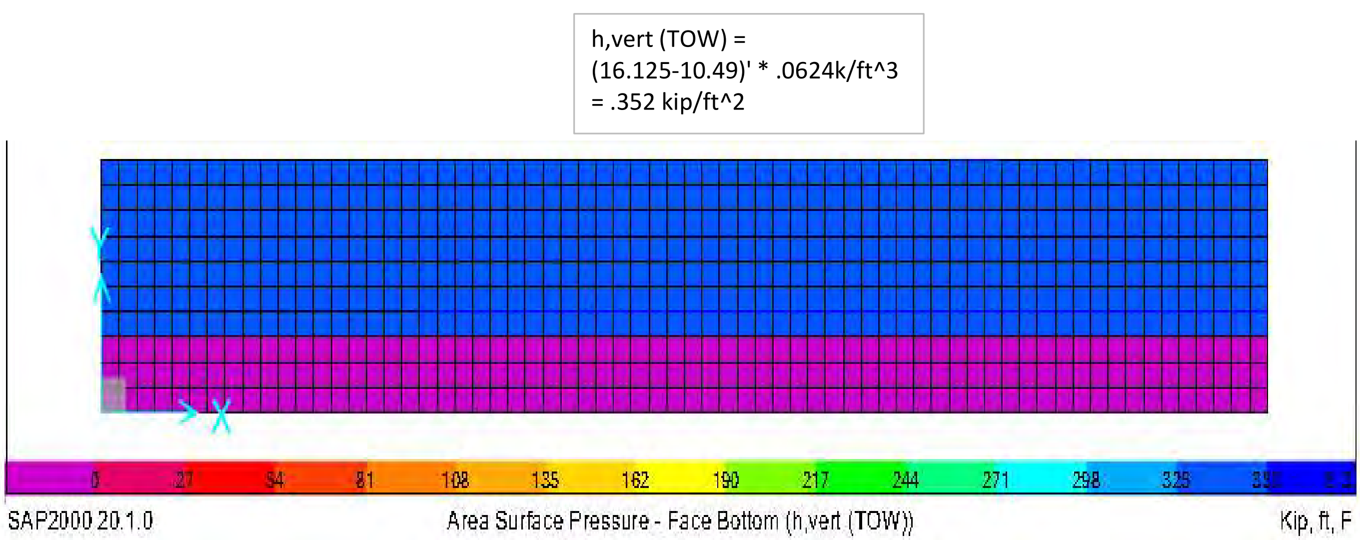
*Earthquake and Wave Loads are to be determined and are excluded from these calculations

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Applied Loads in SAP Model	Checked by	AML	Date	Dec-20

References

*The following diagrams represent the loads applied in the SAP Model; base reactions were taken from SAP to plug into CPGA to get the pile reactions of the structure.

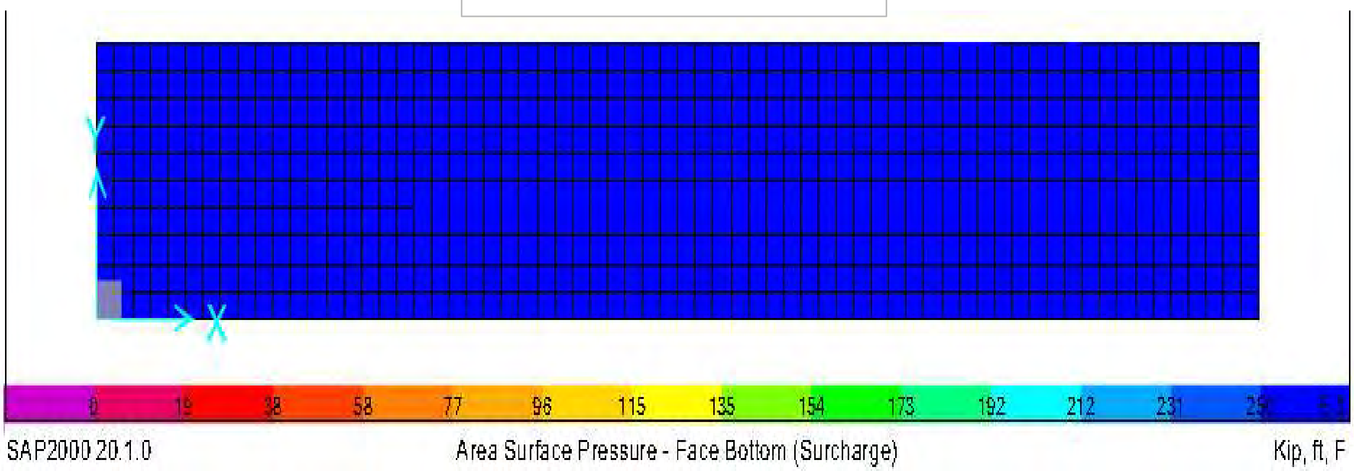


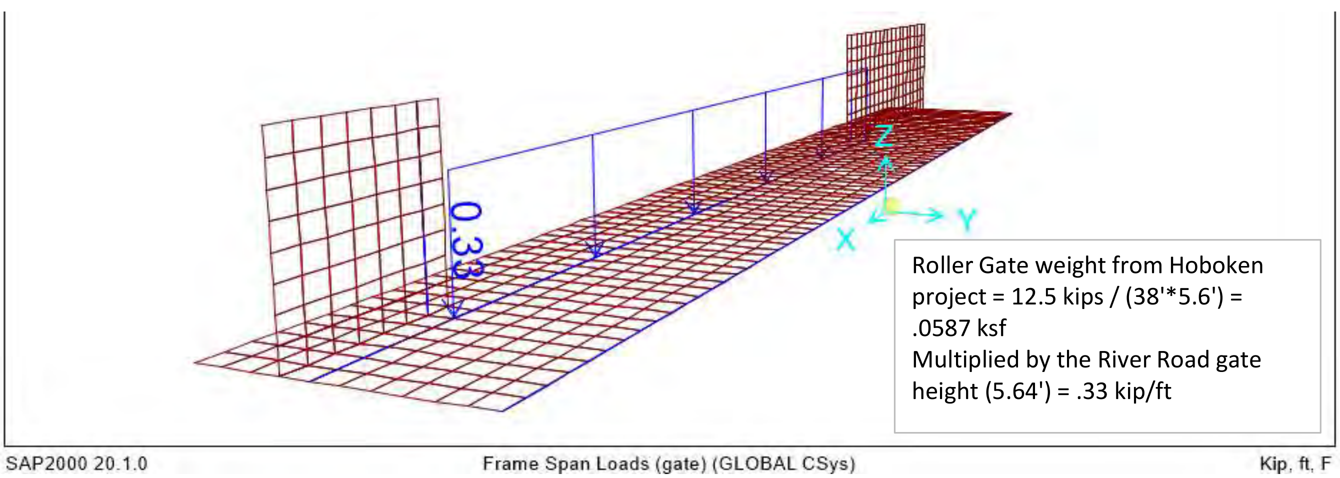


AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Applied Loads in SAP Model	Checked by	AML	Date	Dec-20
					References

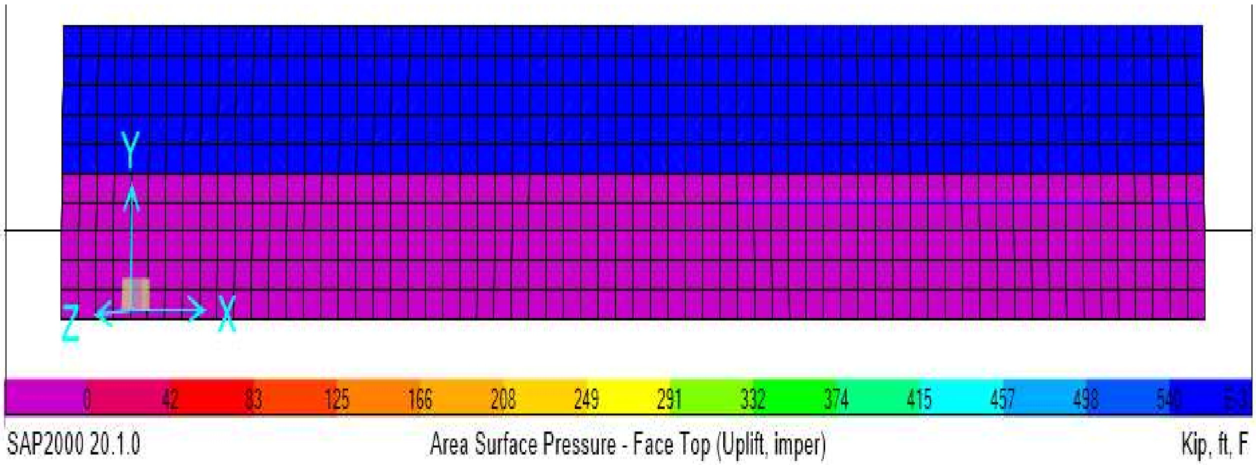
A surcharge of .25 kip/ft^2 is applied to both protected and flood sides of slab. See Assumptions page



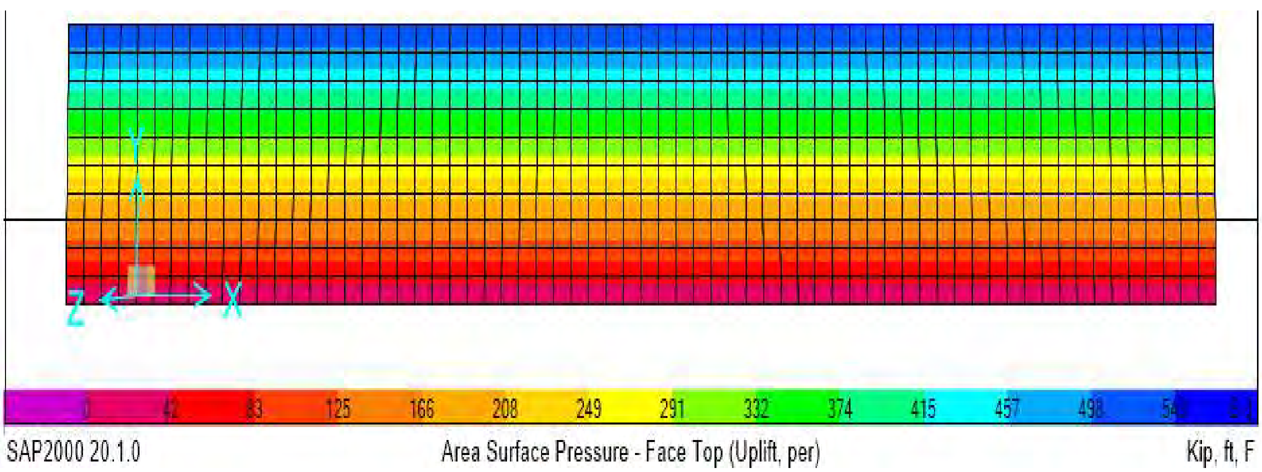


Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Applied Loads in SAP Model	Checked by	AML	Date	Dec-20

References



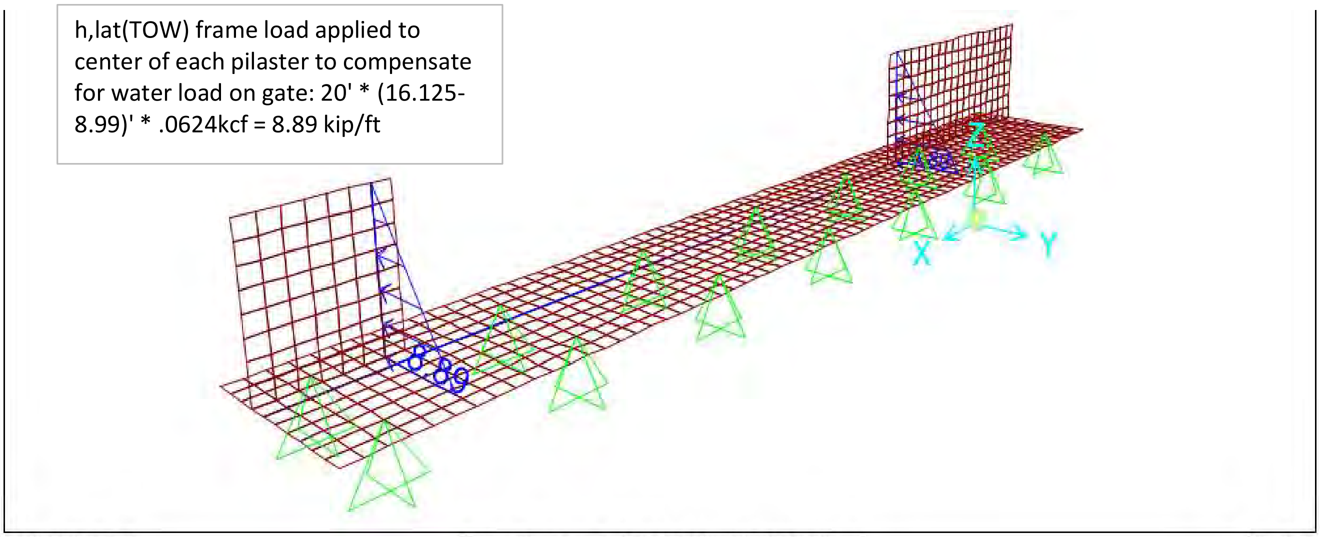
Impervious and Pervious Uplift =
(16.125' - 7.49') * .0624kcf = .54 ksf



Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Applied Loads in SAP Model	Checked by	AML	Date	Dec-20

References

h,lat(TOW) frame load applied to center of each pilaster to compensate for water load on gate: 20' * (16.125-8.99)' * .0624kcf = 8.89 kip/ft



SAP2000 20.1.0 Frame Span Loads (h,lat (TOW)) (GLOBAL CSys) Kip, ft, F

AECOM

Job	Maurepaus Swamp	Project No.	60589133
Description	Gate Monolith	Computed by	JMH
	River Road Gate Monolith	Date	Dec-20
	Summary of Foundation Loads	Checked by	AML
		Date	Dec-20
			References

UNFACTORED LOADS FOR CPGA						
Load Case	Fx (kips)	Fy (kips)	Fz (kips)	Mx (kip-ft)	My (kip-ft)	Mz (kip-ft)
LC1	0.00	0.00	505.82	-371.93	87.64	0.00
LC2	-153.38	0.00	339.10	-288.77	745.31	0.00
LC3	-153.38	0.00	339.10	-288.77	596.81	0.00

This table represents the base reactions taken from SAP. The moments were taken from the centroid of the structure with positive-x facing the flood side and positive-z facing downwards.

*NOTE: Loads exported from SAP 2000 are within 5% on the conservative side of the actual loads on the monolith; OK for this submittal.

FACTORED LOADS FOR CPGA						
Load Case	Fx (kips)	Fy (kips)	Fz (kips)	Mx (kip-ft)	My (kip-ft)	Mz (kip-ft)
LC1	0.00	0.00	809.31	-595.08	140.22	0.00
LC2	-245.40	0.00	542.56	-462.02	1192.50	0.00
LC3	-245.40	0.00	542.56	-462.02	954.90	0.00

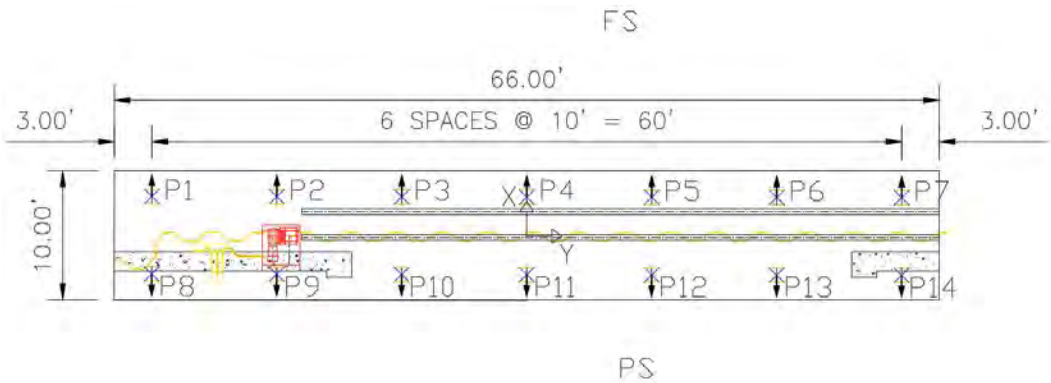
AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Soil & Pile Information Required for CPGA	Checked by	AML	Date	Dec-20
					References

Pile Layout: 14 HP Piles

Row 1 / Row 2

pile no.	x	y	pile no.	x	y
1	3.00	-30.00	8	-3.00	-30.00
2	3.00	-20.00	9	-3.00	-20.00
3	3.00	-10.00	10	-3.00	-10.00
4	3.00	0.00	11	-3.00	0.00
5	3.00	10.00	12	-3.00	10.00
6	3.00	20.00	13	-3.00	20.00
7	3.00	30.00	14	-3.00	30.00



Tip Elevation: (For CPGA, need Tip Elevation as a function of CPGA Axis at B.O. Slab, +Z points downward)

B.O.S. Elevation =	7.49	NAVD88
Pile Tip El. =	-35	NAVD89
"TIP" in CPGA =	**42.49**	**ft**

Pile Properties & Attributes

E =	29000000.00	psi	
A =	21.40	in^2	HP14X73
I_x =	729.00	in^4	
I_y =	261.00	in^4	
C_{33} =	1.70	(factor for method of axial load transfer from pile to soil; = 1 full tip bearing, = 2 full skin friction)	
S_x =	107.00	in^3	
S_y =	35.80	in^3	
F_y =	50.00	ksi	

*Note: All soil properties and pile capacities are taken from 95% submittal for Maurepas intake structure.

Allowable Compression (AC) =	50.00	kips
Allowable Tension (AT) =	30.00	kips
ACC =	492.66	kips
ATT =	535.00	kips
AM1 =	2972.22	kip-in
AM2 =	994.44	kip-in

AECOM

Job	Maurepaus Swamp	Project No.	60632162
Description	Gate Monolith	Computed by	JMH
	River Road Gate Monolith	Date	Dec-20
	Soil & Pile Information Required for CPGA	Checked by	AML
		Date	Dec-20

References

Es Value for CPGA Run:

Monolith width = 66 ft

E_s = 540.40 psi = 0.5404 ksi

GROUP FACTORS	
Pile Spacing in Direction of Loading	From EM1110-2-2906
	D
3B	0.33
4B	0.38
5B	0.45
6B	0.56
7B	0.71
8B	1

Group reduction is based on distance between piles in direction of loading. This includes distance due to battering and is taken over the distance 10 x d_{pile} (point of fixety).

Assume a batter of 6.00

B = d_{pile} = 13.6 in = 1.133 ft

Distance between piles at B.O. Slab = 6.00 ft

Average distance between piles over 10*dpile = 7.89 ft

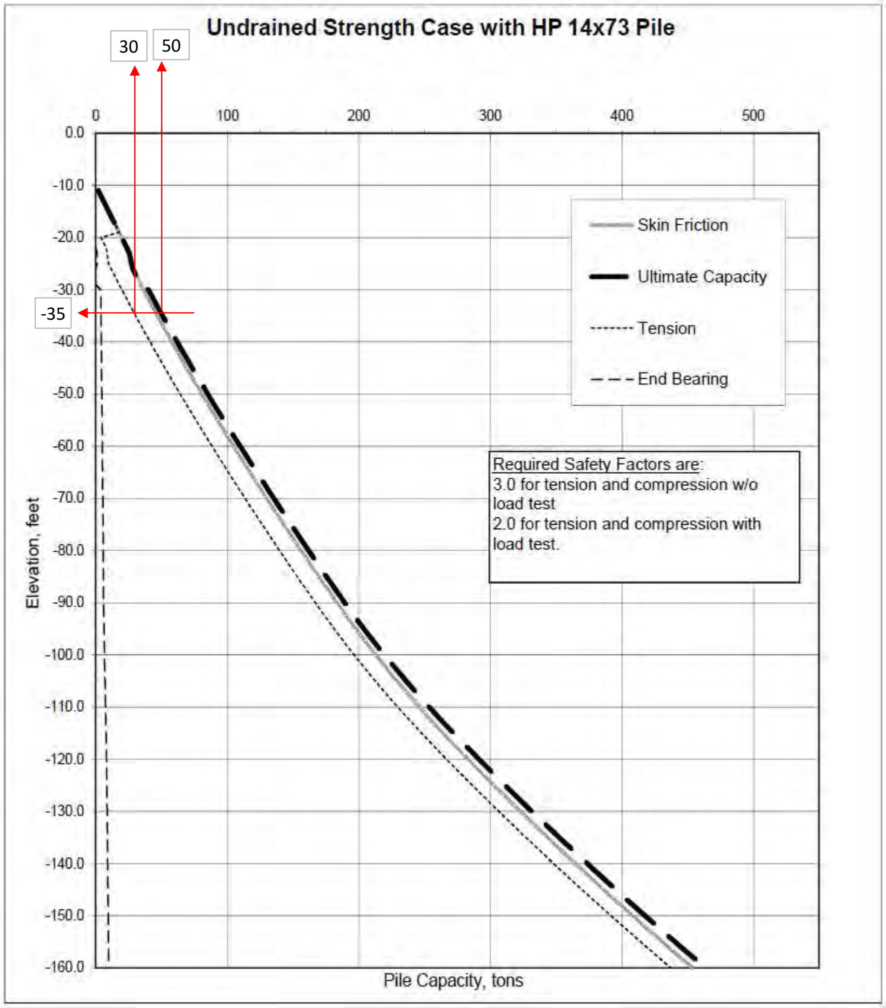
Average distance between piles in terms of pile width B = 6.96 B

Group Reduction "D" value for this distance = 0.70

Therefore, Es including group reduction = 0.38 ksi

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Soil & Pile Information Required for CPGA	Checked by	AML	Date	Dec-20
					References



AECOM

Job	**Maurepaus Swamp**	**Project No.**	**60632162**		
Description	**Gate Monolith**	**Computed by**	**JMH**	**Date**	**Dec-20**
	River Road Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	**Checked by**	**AML**	**Date**	**Dec-20**

Input file:

```
100 MONOLITH, TOW EL. 16.13, TOS EL.10.49; HP 14X73  PILES
200 PROP 29000 729 261 21.4 1.7 0 ALL
300 SOIL ES 0.3805 TIP 42.49 0 ALL
400 PIN ALL
500 ALLOW H 50 30 492.7 535 2972.2 994.4 ALL
600 FOVSTR 1.17 1.17 1
700 FOVSTR 1.33 1.33 2 3
800 BATTER 6 All
1200 ANGLE 180 8 TO 14
1300 PILE 1 3 -30 0
1400 PILE 2 3 -20 0
1500 PILE 3 3 -10 0
1600 PILE 4 3 0 0
1700 PILE 5 3 10 0
1800 PILE 6 3 20 0
1900 PILE 7 3 30 0
2000 PILE 8 -3 -30 0
2100 PILE 9 -3 -20 0
2200 PILE 10 -3 -10 0
2300 PILE 11 -3 0 0
2400 PILE 12 -3 10 0
2500 PILE 13 -3 20 0
2600 PILE 14 -3 30 0
4500 LOAD 1 0 0 505.8 -371.9 87.6 0
4600 LOAD 2 -153.4 0 339.1 -288.8 745.3 0
4700 LOAD 3 -153.4 0 339.1 -288.8 596.8 0
9000 FOUT 1 2 3 4 5 6 7 RR01P.DOC
9100 PFO ALL
9200 PLB ALL
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

CPGA RESULTS without Load Factors (pinned connection)

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 06-DEC-20     RUN TIME: 19:01:34




    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.10.49; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE  14 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                    X          Y          Z
                                  -----      -----      -----
WITH DIAGONAL COORDINATES = (     -3.00 ,   -30.00 ,     0.00 )
                            (      3.00 ,    30.00 ,     0.00 )


*******************************************************************************

         PILE PROPERTIES AS INPUT


      E           I1           I2           A           C33          B66
     KSI         IN**4        IN**4       IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         SOIL DESCRIPTIONS AS INPUT
```

AECOM

Job	Maurepaus Swamp		Project No.	60632162		
Description	Gate Monolith		Computed by	JMH	Date	Dec-20
	River Road Gate Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	AML	Date	Dec-20

```
   ES      ESOIL       LENGTH        L            LU
         K/IN**2                    FT            FT
        0.38050E+00     T       0.42490E+02   0.00000E+00

  ESOIL(ORIGINAL)      RGROUP     RCYCLIC
    K/IN**2
   0.38050E+00       0.1000E+01 0.1000E+01

 THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

     ALL


 *******************************************************************************

          PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


  0.17968E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.23229E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.20410E+04  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


 THIS MATRIX APPLIES TO THE FOLLOWING PILES -

       1


 *******************************************************************************
```

AECOM

Job	Maurepaus Swamp		Project No.	60632162		
Description	Gate Monolith		Computed by	JMH	Date	Dec-20
	River Road Gate Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	AML	Date	Dec-20

PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM	X FT	Y FT	Z FT	BATTER	ANGLE	LENGTH FT	FIXITY
1	3.00	-30.00	0.00	6.00	0.00	43.08	P
2	3.00	-20.00	0.00	6.00	0.00	43.08	P
3	3.00	-10.00	0.00	6.00	0.00	43.08	P
4	3.00	0.00	0.00	6.00	0.00	43.08	P
5	3.00	10.00	0.00	6.00	0.00	43.08	P
6	3.00	20.00	0.00	6.00	0.00	43.08	P
7	3.00	30.00	0.00	6.00	0.00	43.08	P
8	-3.00	-30.00	0.00	6.00	180.00	43.08	P
9	-3.00	-20.00	0.00	6.00	180.00	43.08	P
10	-3.00	-10.00	0.00	6.00	180.00	43.08	P
11	-3.00	0.00	0.00	6.00	180.00	43.08	P
12	-3.00	10.00	0.00	6.00	180.00	43.08	P
13	-3.00	20.00	0.00	6.00	180.00	43.08	P
14	-3.00	30.00	0.00	6.00	180.00	43.08	P

603.07

****

APPLIED LOADS

LOAD CASE	PX K	PY K	PZ K	MX FT-K	MY FT-K	MZ FT-K	OVERSTRESS COM	TEN
1	0.0	0.0	505.8	-371.9	87.6	0.0	1.17	1.17
2	-153.4	0.0	339.1	-288.8	745.3	0.0	1.33	1.33
3	-153.4	0.0	339.1	-288.8	596.8	0.0	1.33	1.33

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

```
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         ORIGINAL PILE GROUP STIFFNESS MATRIX

  0.10170E+04 -0.84181E-05  0.11369E-11 -0.14552E-10 -0.16534E+06  0.30305E-03
 -0.84181E-05  0.32521E+03  0.55885E-04  0.00000E+00  0.20119E-02 -0.62528E-11
  0.11369E-11  0.55885E-04  0.27809E+05  0.11642E-09  0.29104E-10 -0.20119E-02
  0.43656E-10  0.43368E-18 -0.11642E-09  0.16018E+10 -0.37253E-08 -0.44703E-07
 -0.16534E+06  0.20119E-02  0.29104E-10 -0.37253E-08  0.36040E+08 -0.72427E-01
  0.30305E-03 -0.62528E-11 -0.20119E-02 -0.59605E-07 -0.72427E-01  0.59002E+08



                     14 PILES   3 LOAD CASES

 LOAD CASE    1.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    2.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    3.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.


*******************************************************************************

         PILE CAP DISPLACEMENTS

 LOAD
 CASE        DX          DY          DZ          RX          RY          RZ
             IN          IN          IN         RAD         RAD         RAD

    1   0.1866E-01 -0.3353E-08  0.1819E-01 -0.2786E-05  0.1148E-03  0.6652E-12
    2  -0.4347E+00 -0.2545E-08  0.1219E-01 -0.2164E-05 -0.1746E-02  0.5051E-12
    3  -0.4664E+00 -0.2161E-08  0.1219E-01 -0.2164E-05 -0.1941E-02  0.4287E-12


*******************************************************************************
              ELASTIC CENTER INFORMATION



 ELASTIC CENTER IN PLANE X-Z         X             Z
                                    FT            FT
                                   0.00          0.00


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Job	Maurepaus Swamp		Project No.	60632162		
Description	Gate Monolith		Computed by	JMH	Date	Dec-20
	River Road Gate Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	AML	Date	Dec-20

PILE FORCES IN LOCAL GEOMETRY

M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
* INDICATES PILE FAILURE
# INDICATES CBF BASED ON MOMENTS DUE TO
(F3*EMIN) FOR CONCRETE PILES
B INDICATES BUCKLING CONTROLS

LOAD CASE - 1

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	0.3	0.0	36.6	0.0	-8.7	0.0	0.63	0.07
2	0.3	0.0	35.9	0.0	-8.7	0.0	0.61	0.07
3	0.3	0.0	35.2	0.0	-8.8	0.0	0.60	0.07
4	0.3	0.0	34.6	0.0	-8.8	0.0	0.59	0.07
5	0.3	0.0	33.9	0.0	-8.8	0.0	0.58	0.07
6	0.3	0.0	33.2	0.0	-8.9	0.0	0.57	0.07
7	0.3	0.0	32.5	0.0	-8.9	0.0	0.56	0.06
8	-0.4	0.0	40.7	0.0	12.2	0.0	0.70	0.08
9	-0.4	0.0	40.0	0.0	12.1	0.0	0.68	0.08
10	-0.4	0.0	39.3	0.0	12.1	0.0	0.67	0.08
11	-0.4	0.0	38.7	0.0	12.1	0.0	0.66	0.08
12	-0.4	0.0	38.0	0.0	12.0	0.0	0.65	0.08
13	-0.4	0.0	37.3	0.0	12.0	0.0	0.64	0.08
14	-0.4	0.0	36.7	0.0	12.0	0.0	0.63	0.07

LOAD CASE - 2

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	-7.9	0.0	6.8	0.0	241.1	0.0	0.10	0.19
2	-7.9	0.0	6.3	0.0	241.1	0.0	0.09	0.19
3	-7.9	0.0	5.8	0.0	241.1	0.0	0.09	0.19
4	-7.9	0.0	5.2	0.0	241.1	0.0	0.08	0.19
5	-7.9	0.0	4.7	0.0	241.0	0.0	0.07	0.19
6	-7.9	0.0	4.2	0.0	241.0	0.0	0.06	0.19
7	-7.9	0.0	3.7	0.0	241.0	0.0	0.06	0.19
8	7.9	0.0	45.4	0.0	-238.8	0.0	0.68	0.25
9	7.9	0.0	44.9	0.0	-238.8	0.0	0.68	0.25
10	7.9	0.0	44.4	0.0	-238.9	0.0	0.67	0.25
11	7.9	0.0	43.9	0.0	-238.9	0.0	0.66	0.25
12	7.9	0.0	43.3	0.0	-238.9	0.0	0.65	0.25
13	7.9	0.0	42.8	0.0	-238.9	0.0	0.64	0.25
14	7.9	0.0	42.3	0.0	-238.9	0.0	0.64	0.25

Job	Maurepaus Swamp		Project No.	60632162		
Description	Gate Monolith		Computed by	JMH	Date	Dec-20
	River Road Gate Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	AML	Date	Dec-20

LOAD CASE - 3

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	-8.5	0.0	10.3	0.0	258.8	0.0	0.15	0.21
2	-8.5	0.0	9.8	0.0	258.8	0.0	0.15	0.21
3	-8.5	0.0	9.3	0.0	258.8	0.0	0.14	0.21
4	-8.5	0.0	8.7	0.0	258.7	0.0	0.13	0.21
5	-8.5	0.0	8.2	0.0	258.7	0.0	0.12	0.21
6	-8.5	0.0	7.7	0.0	258.7	0.0	0.12	0.21
7	-8.5	0.0	7.2	0.0	258.7	0.0	0.11	0.21
8	8.4	0.0	41.9	0.0	-256.5	0.0	0.63	0.26
9	8.4	0.0	41.4	0.0	-256.5	0.0	0.62	0.26
10	8.4	0.0	40.9	0.0	-256.5	0.0	0.61	0.26
11	8.4	0.0	40.4	0.0	-256.6	0.0	0.61	0.26
12	8.4	0.0	39.8	0.0	-256.6	0.0	0.60	0.25
13	8.4	0.0	39.3	0.0	-256.6	0.0	0.59	0.25
14	8.4	0.0	38.8	0.0	-256.6	0.0	0.58	0.25

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PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	6.3	0.0	36.0	0.0	0.0	0.0
2	6.2	0.0	35.4	0.0	0.0	0.0
3	6.1	0.0	34.7	0.0	0.0	0.0
4	6.0	0.0	34.0	0.0	0.0	0.0
5	5.9	0.0	33.4	0.0	0.0	0.0
6	5.7	0.0	32.7	0.0	0.0	0.0
7	5.6	0.0	32.1	0.0	0.0	0.0
8	-6.3	0.0	40.2	0.0	0.0	0.0
9	-6.2	0.0	39.5	0.0	0.0	0.0
10	-6.1	0.0	38.9	0.0	0.0	0.0
11	-6.0	0.0	38.2	0.0	0.0	0.0
12	-5.9	0.0	37.6	0.0	0.0	0.0
13	-5.7	0.0	36.9	0.0	0.0	0.0
14	-5.6	0.0	36.2	0.0	0.0	0.0

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

LOAD CASE - 2

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-6.7	0.0	8.0	0.0	0.0	0.0
2	-6.8	0.0	7.5	0.0	0.0	0.0
3	-6.9	0.0	7.0	0.0	0.0	0.0
4	-7.0	0.0	6.5	0.0	0.0	0.0
5	-7.0	0.0	6.0	0.0	0.0	0.0
6	-7.1	0.0	5.4	0.0	0.0	0.0
7	-7.2	0.0	4.9	0.0	0.0	0.0
8	-15.2	0.0	43.5	0.0	0.0	0.0
9	-15.1	0.0	43.0	0.0	0.0	0.0
10	-15.0	0.0	42.5	0.0	0.0	0.0
11	-15.0	0.0	42.0	0.0	0.0	0.0
12	-14.9	0.0	41.5	0.0	0.0	0.0
13	-14.8	0.0	40.9	0.0	0.0	0.0
14	-14.7	0.0	40.4	0.0	0.0	0.0

LOAD CASE - 3

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-6.7	0.0	11.6	0.0	0.0	0.0
2	-6.8	0.0	11.0	0.0	0.0	0.0
3	-6.9	0.0	10.5	0.0	0.0	0.0
4	-7.0	0.0	10.0	0.0	0.0	0.0
5	-7.0	0.0	9.5	0.0	0.0	0.0
6	-7.1	0.0	9.0	0.0	0.0	0.0
7	-7.2	0.0	8.5	0.0	0.0	0.0
8	-15.2	0.0	40.0	0.0	0.0	0.0
9	-15.1	0.0	39.5	0.0	0.0	0.0
10	-15.0	0.0	38.9	0.0	0.0	0.0
11	-15.0	0.0	38.4	0.0	0.0	0.0
12	-14.9	0.0	37.9	0.0	0.0	0.0
13	-14.8	0.0	37.4	0.0	0.0	0.0
14	-14.7	0.0	36.9	0.0	0.0	0.0

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

CPGA RESULTS without Load Factors (fixed connection)

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CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 06-DEC-20     RUN TIME: 19:04:12




    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.10.49; HP 14X73  PILES
DATA UNKNOWN - REJECTED.




THERE ARE  14 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                   X          Y          Z
                                 -----      -----      -----
WITH DIAGONAL COORDINATES = (     -3.00 ,   -30.00 ,     0.00 )
                            (      3.00 ,    30.00 ,     0.00 )


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         PILE PROPERTIES AS INPUT
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Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

E	I1	I2	A	C33	B66
KSI	IN**4	IN**4	IN**2		
0.29000E+05	0.72900E+03	0.26100E+03	0.21400E+02	0.17000E+01	0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

ALL

****

SOIL DESCRIPTIONS AS INPUT

ES	ESOIL	LENGTH	L	LU
	K/IN**2		FT	FT
	0.38050E+00	T	0.42490E+02	0.00000E+00

ESOIL(ORIGINAL)	RGROUP	RCYCLIC
K/IN**2		
0.38050E+00	0.1000E+01	0.1000E+01

THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

ALL

****

PILE STIFFNESSES AS CALCULATED FROM PROPERTIES

0.35937E+02	0.00000E+00	0.00000E+00	0.00000E+00	0.16971E+04	0.00000E+00
0.00000E+00	0.46458E+02	0.00000E+00	-0.28362E+04	0.00000E+00	0.00000E+00
0.00000E+00	0.00000E+00	0.20410E+04	0.00000E+00	0.00000E+00	0.00000E+00
0.00000E+00	-0.28362E+04	0.00000E+00	0.34630E+06	0.00000E+00	0.00000E+00
0.16971E+04	0.00000E+00	0.00000E+00	0.00000E+00	0.16028E+06	0.00000E+00
0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

THIS MATRIX APPLIES TO THE FOLLOWING PILES -

1

****

PILE GEOMETRY AS INPUT AND/OR GENERATED

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

NUM	X FT	Y FT	Z FT	BATTER	ANGLE	LENGTH FT	FIXITY
1	3.00	-30.00	0.00	6.00	0.00	43.08	F
2	3.00	-20.00	0.00	6.00	0.00	43.08	F
3	3.00	-10.00	0.00	6.00	0.00	43.08	F
4	3.00	0.00	0.00	6.00	0.00	43.08	F
5	3.00	10.00	0.00	6.00	0.00	43.08	F
6	3.00	20.00	0.00	6.00	0.00	43.08	F
7	3.00	30.00	0.00	6.00	0.00	43.08	F
8	-3.00	-30.00	0.00	6.00	180.00	43.08	F
9	-3.00	-20.00	0.00	6.00	180.00	43.08	F
10	-3.00	-10.00	0.00	6.00	180.00	43.08	F
11	-3.00	0.00	0.00	6.00	180.00	43.08	F
12	-3.00	10.00	0.00	6.00	180.00	43.08	F
13	-3.00	20.00	0.00	6.00	180.00	43.08	F
14	-3.00	30.00	0.00	6.00	180.00	43.08	F

603.07

****

APPLIED LOADS

LOAD CASE	PX K	PY K	PZ K	MX FT-K	MY FT-K	MZ FT-K	OVERSTRESS COM	TEN
1	0.0	0.0	505.8	-371.9	87.6	0.0	1.17	1.17
2	-153.4	0.0	339.1	-288.8	745.3	0.0	1.33	1.33
3	-153.4	0.0	339.1	-288.8	596.8	0.0	1.33	1.33

****

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

```
        ORIGINAL PILE GROUP STIFFNESS MATRIX

  0.12618E+04 -0.74392E-05  0.45475E-12 -0.19142E-03 -0.14044E+06  0.18838E-03
 -0.74392E-05  0.65041E+03  0.55389E-04 -0.39167E+05  0.21854E-02 -0.68212E-11
  0.45475E-12  0.55389E-04  0.27815E+05  0.47527E-04  0.00000E+00 -0.19940E-02
 -0.19142E-03 -0.39167E+05  0.47527E-04  0.16069E+10 -0.28383E-01 -0.44703E-07
 -0.14044E+06  0.21854E-02  0.00000E+00 -0.28383E-01  0.38574E+08 -0.88241E-01
  0.18838E-03 -0.45475E-11 -0.19940E-02 -0.37253E-07 -0.88241E-01  0.74123E+08



                    14 PILES    3 LOAD CASES

 LOAD CASE    1.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    2.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   7.

 LOAD CASE    3.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   6.


 ******************************************************************************

         PILE CAP DISPLACEMENTS

 LOAD
 CASE       DX          DY          DZ          RX          RY          RZ
            IN          IN          IN          RAD         RAD         RAD

    1   0.5100E-02 -0.1675E-03  0.1818E-01 -0.2781E-05  0.4582E-04  0.5308E-12
    2  -0.1610E+00 -0.1301E-03  0.1219E-01 -0.2160E-05 -0.3544E-03  0.3153E-12
    3  -0.1697E+00 -0.1301E-03  0.1219E-01 -0.2160E-05 -0.4320E-03  0.2448E-12


 ******************************************************************************
              ELASTIC CENTER INFORMATION



 ELASTIC CENTER IN PLANE X-Z          X             Z
                                      FT            FT
                                     0.00          0.00
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

****

PILE FORCES IN LOCAL GEOMETRY

M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
* INDICATES PILE FAILURE
# INDICATES CBF BASED ON MOMENTS DUE TO
(F3*EMIN) FOR CONCRETE PILES
B INDICATES BUCKLING CONTROLS

LOAD CASE - 1

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	0.2	0.0	37.0	-0.5	11.0	0.0	0.63	0.07
2	0.2	0.0	36.3	-0.5	11.1	0.0	0.62	0.07
3	0.2	0.0	35.7	-0.5	11.2	0.0	0.61	0.07
4	0.2	0.0	35.0	-0.5	11.3	0.0	0.60	0.07
5	0.2	0.0	34.3	-0.5	11.4	0.0	0.59	0.07
6	0.2	0.0	33.7	-0.5	11.5	0.0	0.58	0.07
7	0.2	0.0	33.0	-0.5	11.5	0.0	0.56	0.07
8	-0.4	0.0	40.2	0.5	-21.7	0.0	0.69	0.09
9	-0.4	0.0	39.6	0.5	-21.6	0.0	0.68	0.09
10	-0.4	0.0	38.9	0.5	-21.5	0.0	0.66	0.09
11	-0.4	0.0	38.2	0.5	-21.4	0.0	0.65	0.08
12	-0.4	0.0	37.5	0.5	-21.3	0.0	0.64	0.08
13	-0.4	0.0	36.9	0.5	-21.2	0.0	0.63	0.08
14	-0.4	0.0	36.2	0.5	-21.1	0.0	0.62	0.08

LOAD CASE - 2

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	-6.5	0.0	-2.2	-0.4	-333.5	0.0	0.06	0.26
2	-6.5	0.0	-2.8	-0.4	-333.4	0.0	0.07	0.26
3	-6.5	0.0	-3.3	-0.4	-333.4	0.0	0.08	0.26
4	-6.5	0.0	-3.8	-0.4	-333.3	0.0	0.10	0.26
5	-6.5	0.0	-4.3	-0.4	-333.2	0.0	0.11	0.26
6	-6.5	0.0	-4.8	-0.4	-333.1	0.0	0.12	0.26
7	-6.5	0.0	-5.4	-0.4	-333.1	0.0	0.13	0.26
8	6.3	0.0	54.5	0.4	326.3	0.0	0.82	0.33
9	6.3	0.0	53.9	0.4	326.3	0.0	0.81	0.33
10	6.3	0.0	53.4	0.4	326.4	0.0	0.80	0.33
11	6.3	0.0	52.9	0.4	326.5	0.0	0.80	0.33
12	6.3	0.0	52.4	0.4	326.6	0.0	0.79	0.33
13	6.3	0.0	51.8	0.4	326.6	0.0	0.78	0.33
14	6.3	0.0	51.3	0.4	326.7	0.0	0.77	0.33

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

LOAD CASE - 3

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	-6.9	0.0	0.5	-0.4	-361.2	0.0	0.01	0.27
2	-6.9	0.0	0.0	-0.4	-361.1	0.0	0.00	0.27
3	-6.9	0.0	-0.5	-0.4	-361.1	0.0	0.01	0.27
4	-6.9	0.0	-1.1	-0.4	-361.0	0.0	0.03	0.27
5	-6.9	0.0	-1.6	-0.4	-360.9	0.0	0.04	0.28
6	-6.9	0.0	-2.1	-0.4	-360.8	0.0	0.05	0.28
7	-6.9	0.0	-2.6	-0.4	-360.8	0.0	0.07	0.28
8	6.8	0.0	51.7	0.4	354.0	0.0	0.78	0.35
9	6.8	0.0	51.2	0.4	354.0	0.0	0.77	0.35
10	6.8	0.0	50.7	0.4	354.1	0.0	0.76	0.35
11	6.8	0.0	50.2	0.4	354.2	0.0	0.75	0.34
12	6.8	0.0	49.6	0.4	354.3	0.0	0.75	0.34
13	6.8	0.0	49.1	0.4	354.3	0.0	0.74	0.34
14	6.8	0.0	48.6	0.4	354.4	0.0	0.73	0.34

****

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	6.2	0.0	36.5	-0.5	11.0	0.1
2	6.1	0.0	35.8	-0.5	11.1	0.1
3	6.0	0.0	35.2	-0.5	11.2	0.1
4	5.9	0.0	34.5	-0.5	11.3	0.1
5	5.8	0.0	33.8	-0.5	11.4	0.1
6	5.7	0.0	33.2	-0.5	11.5	0.1
7	5.6	0.0	32.5	-0.5	11.5	0.1
8	-6.2	0.0	39.7	-0.5	21.7	-0.1
9	-6.1	0.0	39.1	-0.5	21.6	-0.1
10	-6.0	0.0	38.4	-0.5	21.5	-0.1
11	-5.9	0.0	37.8	-0.5	21.4	-0.1
12	-5.8	0.0	37.1	-0.5	21.3	-0.1
13	-5.7	0.0	36.4	-0.5	21.2	-0.1
14	-5.6	0.0	35.8	-0.5	21.1	-0.1

Job	Maurepaus Swamp		Project No.	60632162		
Description	Gate Monolith		Computed by	JMH	Date	Dec-20
	River Road Gate Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	AML	Date	Dec-20

LOAD CASE - 2

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	-6.7	0.0	-1.1	-0.4	-333.5	0.1
2	-6.8	0.0	-1.7	-0.4	-333.4	0.1
3	-6.9	0.0	-2.2	-0.4	-333.4	0.1
4	-7.0	0.0	-2.7	-0.4	-333.3	0.1
5	-7.1	0.0	-3.2	-0.4	-333.2	0.1
6	-7.2	0.0	-3.7	-0.4	-333.1	0.1
7	-7.2	0.0	-4.2	-0.4	-333.1	0.1
8	-15.2	0.0	52.7	-0.4	-326.3	-0.1
9	-15.1	0.0	52.2	-0.4	-326.3	-0.1
10	-15.0	0.0	51.6	-0.4	-326.4	-0.1
11	-14.9	0.0	51.1	-0.4	-326.5	-0.1
12	-14.8	0.0	50.6	-0.4	-326.6	-0.1
13	-14.8	0.0	50.1	-0.4	-326.6	-0.1
14	-14.7	0.0	49.6	-0.4	-326.7	-0.1

LOAD CASE - 3

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	-6.7	0.0	1.6	-0.4	-361.2	0.1
2	-6.8	0.0	1.1	-0.4	-361.1	0.1
3	-6.9	0.0	0.6	-0.4	-361.1	0.1
4	-7.0	0.0	0.1	-0.4	-361.0	0.1
5	-7.1	0.0	-0.4	-0.4	-360.9	0.1
6	-7.2	0.0	-1.0	-0.4	-360.8	0.1
7	-7.2	0.0	-1.5	-0.4	-360.8	0.1
8	-15.2	0.0	49.9	-0.4	-354.0	-0.1
9	-15.1	0.0	49.4	-0.4	-354.0	-0.1
10	-15.0	0.0	48.9	-0.4	-354.1	-0.1
11	-14.9	0.0	48.4	-0.4	-354.2	-0.1
12	-14.8	0.0	47.8	-0.4	-354.3	-0.1
13	-14.8	0.0	47.3	-0.4	-354.3	-0.1
14	-14.7	0.0	46.8	-0.4	-354.4	-0.1

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	AML	Date	Dec-20

Input file:

```
100 MONOLITH, TOW EL. 16.13, TOS EL.10.49; HP 14X73  PILES
200 PROP 29000 729 261 21.4 1.7 0 ALL
300 SOIL ES 0.3805 TIP 42.49 0 ALL
400 PIN ALL
500 ALLOW H 50 30 492.7 535 2972.2 994.4 ALL
600 FOVSTR 1 1 1
700 FOVSTR 1 1 2 3
800 BATTER 6 All
1200 ANGLE 180 8 TO 14
1300 PILE 1 3 -30 0
1400 PILE 2 3 -20 0
1500 PILE 3 3 -10 0
1600 PILE 4 3 0 0
1700 PILE 5 3 10 0
1800 PILE 6 3 20 0
1900 PILE 7 3 30 0
2000 PILE 8 -3 -30 0
2100 PILE 9 -3 -20 0
2200 PILE 10 -3 -10 0
2300 PILE 11 -3 0 0
2400 PILE 12 -3 10 0
2500 PILE 13 -3 20 0
2600 PILE 14 -3 30 0
4500 LOAD 1 0 0 809.3 -595.1 140.2 0
4600 LOAD 2 -245.4 0 542.6 -462 1192.5 0
4700 LOAD 3 -245.4 0 542.6 -462 954.9 0
9000 FOUT 1 2 3 4 5 6 7 RR01S.DOC
9100 PFO ALL
9200 PLB ALL
```

CPGA RESULTS with Load Factors

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 06-DEC-20     RUN TIME: 19:05:17




    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.10.49; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE  14 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                    X          Y          Z
                                  -----      -----      -----
WITH DIAGONAL COORDINATES = (     -3.00 ,   -30.00 ,     0.00 )
                            (      3.00 ,    30.00 ,     0.00 )


******************************************************************************

         PILE PROPERTIES AS INPUT


      E           I1           I2            A           C33          B66
     KSI         IN**4        IN**4        IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


******************************************************************************

         SOIL DESCRIPTIONS AS INPUT
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	AML	Date	Dec-20

```
   ES      ESOIL       LENGTH       L            LU
         K/IN**2                    FT           FT
        0.38050E+00     T      0.42490E+02   0.00000E+00

 ESOIL(ORIGINAL)      RGROUP      RCYCLIC
   K/IN**2
  0.38050E+00       0.1000E+01 0.1000E+01

THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


 0.17968E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.23229E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.20410E+04  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


THIS MATRIX APPLIES TO THE FOLLOWING PILES -

      1


*******************************************************************************
```

AECOM

Job	Maurepaus Swamp		Project No.	60632162		
Description	Gate Monolith		Computed by	JMH	Date	Dec-20
	River Road Gate Monolith					
	CPGA Input & Output Files (Concrete Design)		Checked by	AML	Date	Dec-20

```
        PILE GEOMETRY AS INPUT AND/OR GENERATED

 NUM        X          Y          Z      BATTER   ANGLE   LENGTH  FIXITY
           FT         FT         FT                         FT

   1      3.00     -30.00       0.00      6.00     0.00    43.08     P
   2      3.00     -20.00       0.00      6.00     0.00    43.08     P
   3      3.00     -10.00       0.00      6.00     0.00    43.08     P
   4      3.00       0.00       0.00      6.00     0.00    43.08     P
   5      3.00      10.00       0.00      6.00     0.00    43.08     P
   6      3.00      20.00       0.00      6.00     0.00    43.08     P
   7      3.00      30.00       0.00      6.00     0.00    43.08     P
   8     -3.00     -30.00       0.00      6.00   180.00    43.08     P
   9     -3.00     -20.00       0.00      6.00   180.00    43.08     P
  10     -3.00     -10.00       0.00      6.00   180.00    43.08     P
  11     -3.00       0.00       0.00      6.00   180.00    43.08     P
  12     -3.00      10.00       0.00      6.00   180.00    43.08     P
  13     -3.00      20.00       0.00      6.00   180.00    43.08     P
  14     -3.00      30.00       0.00      6.00   180.00    43.08     P
                                                          ------
  603.07


 ******************************************************************************

                      APPLIED LOADS

 LOAD      PX         PY         PZ          MX          MY          MZ
 CASE       K          K          K         FT-K        FT-K        FT-K

   1       0.0        0.0      809.3      -595.1       140.2         0.0
   2    -245.4        0.0      542.6      -462.0      1192.5         0.0
   3    -245.4        0.0      542.6      -462.0       954.9         0.0


 ******************************************************************************

        ORIGINAL PILE GROUP STIFFNESS MATRIX

  0.10170E+04 -0.84181E-05  0.11369E-11 -0.14552E-10 -0.16534E+06  0.30305E-03
 -0.84181E-05  0.32521E+03  0.55885E-04  0.00000E+00  0.20119E-02 -0.62528E-11
  0.11369E-11  0.55885E-04  0.27809E+05  0.11642E-09  0.29104E-10 -0.20119E-02
  0.43656E-10  0.43368E-18 -0.11642E-09  0.16018E+10 -0.37253E-08 -0.44703E-07
 -0.16534E+06  0.20119E-02  0.29104E-10 -0.37253E-08  0.36040E+08 -0.72427E-01
  0.30305E-03 -0.62528E-11 -0.20119E-02 -0.59605E-07 -0.72427E-01  0.59002E+08
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	AML	Date	Dec-20

```
                    14 PILES    3 LOAD CASES

 LOAD CASE    1.  NUMBER OF FAILURES =  14.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    2.  NUMBER OF FAILURES =   7.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    3.  NUMBER OF FAILURES =   7.  NUMBER OF PILES IN TENSION =   0.


 ******************************************************************************

          PILE CAP DISPLACEMENTS

 LOAD
 CASE       DX          DY          DZ          RX          RY          RZ
            IN          IN          IN          RAD         RAD         RAD

    1   0.2986E-01 -0.5364E-08  0.2910E-01 -0.4458E-05  0.1837E-03  0.1064E-11
    2  -0.6954E+00 -0.4073E-08  0.1951E-01 -0.3461E-05 -0.2793E-02  0.8082E-12
    3  -0.7460E+00 -0.3458E-08  0.1951E-01 -0.3461E-05 -0.3105E-02  0.6861E-12


 ******************************************************************************
               ELASTIC CENTER INFORMATION



 ELASTIC CENTER IN PLANE X-Z          X             Z
                                     FT            FT
                                    0.00          0.00


 ******************************************************************************

          PILE FORCES IN LOCAL GEOMETRY

              M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
              * INDICATES PILE FAILURE
              # INDICATES CBF BASED ON MOMENTS DUE TO
                          (F3*EMIN) FOR CONCRETE PILES
              B INDICATES BUCKLING CONTROLS
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	AML	Date	Dec-20

LOAD CASE - 1

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF	
1	0.5	0.0	58.5	0.0	-13.9	0.0	1.17	0.13	*
2	0.5	0.0	57.5	0.0	-14.0	0.0	1.15	0.13	*
3	0.5	0.0	56.4	0.0	-14.0	0.0	1.13	0.13	*
4	0.5	0.0	55.3	0.0	-14.1	0.0	1.11	0.13	*
5	0.5	0.0	54.2	0.0	-14.1	0.0	1.08	0.12	*
6	0.5	0.0	53.1	0.0	-14.2	0.0	1.06	0.12	*
7	0.5	0.0	52.1	0.0	-14.2	0.0	1.04	0.12	*
8	-0.6	0.0	65.1	0.0	19.4	0.0	1.30	0.15	*
9	-0.6	0.0	64.0	0.0	19.4	0.0	1.28	0.15	*
10	-0.6	0.0	63.0	0.0	19.4	0.0	1.26	0.15	*
11	-0.6	0.0	61.9	0.0	19.3	0.0	1.24	0.15	*
12	-0.6	0.0	60.8	0.0	19.3	0.0	1.22	0.14	*
13	-0.6	0.0	59.7	0.0	19.2	0.0	1.19	0.14	*
14	-0.6	0.0	58.7	0.0	19.2	0.0	1.17	0.14	*

LOAD CASE - 2

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF	
1	-12.7	0.0	10.9	0.0	385.7	0.0	0.22	0.41	
2	-12.7	0.0	10.1	0.0	385.7	0.0	0.20	0.41	
3	-12.7	0.0	9.2	0.0	385.7	0.0	0.18	0.41	
4	-12.7	0.0	8.4	0.0	385.6	0.0	0.17	0.40	
5	-12.7	0.0	7.6	0.0	385.6	0.0	0.15	0.40	
6	-12.7	0.0	6.7	0.0	385.5	0.0	0.13	0.40	
7	-12.7	0.0	5.9	0.0	385.5	0.0	0.12	0.40	
8	12.6	0.0	72.7	0.0	-382.0	0.0	1.45	0.53	*
9	12.6	0.0	71.8	0.0	-382.0	0.0	1.44	0.53	*
10	12.6	0.0	71.0	0.0	-382.1	0.0	1.42	0.53	*
11	12.6	0.0	70.2	0.0	-382.1	0.0	1.40	0.53	*
12	12.6	0.0	69.3	0.0	-382.2	0.0	1.39	0.53	*
13	12.6	0.0	68.5	0.0	-382.2	0.0	1.37	0.52	*
14	12.6	0.0	67.7	0.0	-382.2	0.0	1.35	0.52	*

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	AML	Date	Dec-20

LOAD CASE - 3

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF	
	K	K	K	IN-K	IN-K	IN-K			
1	-13.6	0.0	16.5	0.0	414.0	0.0	0.33	0.45	
2	-13.6	0.0	15.6	0.0	414.0	0.0	0.31	0.45	
3	-13.6	0.0	14.8	0.0	413.9	0.0	0.30	0.45	
4	-13.6	0.0	14.0	0.0	413.9	0.0	0.28	0.44	
5	-13.6	0.0	13.1	0.0	413.9	0.0	0.26	0.44	
6	-13.6	0.0	12.3	0.0	413.8	0.0	0.25	0.44	
7	-13.6	0.0	11.5	0.0	413.8	0.0	0.23	0.44	
8	13.5	0.0	67.1	0.0	-410.3	0.0	1.34	0.55	*
9	13.5	0.0	66.3	0.0	-410.3	0.0	1.33	0.55	*
10	13.5	0.0	65.4	0.0	-410.4	0.0	1.31	0.55	*
11	13.5	0.0	64.6	0.0	-410.4	0.0	1.29	0.54	*
12	13.5	0.0	63.8	0.0	-410.4	0.0	1.28	0.54	*
13	13.5	0.0	62.9	0.0	-410.5	0.0	1.26	0.54	*
14	13.5	0.0	62.1	0.0	-410.5	0.0	1.24	0.54	*

****

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	10.1	0.0	57.7	0.0	0.0	0.0
2	9.9	0.0	56.6	0.0	0.0	0.0
3	9.7	0.0	55.5	0.0	0.0	0.0
4	9.5	0.0	54.5	0.0	0.0	0.0
5	9.4	0.0	53.4	0.0	0.0	0.0
6	9.2	0.0	52.3	0.0	0.0	0.0
7	9.0	0.0	51.3	0.0	0.0	0.0
8	-10.1	0.0	64.3	0.0	0.0	0.0
9	-9.9	0.0	63.3	0.0	0.0	0.0
10	-9.7	0.0	62.2	0.0	0.0	0.0
11	-9.5	0.0	61.1	0.0	0.0	0.0
12	-9.4	0.0	60.1	0.0	0.0	0.0
13	-9.2	0.0	59.0	0.0	0.0	0.0
14	-9.0	0.0	58.0	0.0	0.0	0.0

Job	Maurepaus Swamp		Project No.	60632162		
Description	Gate Monolith		Computed by	JMH	Date	Dec-20
	River Road Gate Monolith					
	CPGA Input & Output Files (Concrete Design)		Checked by	AML	Date	Dec-20

LOAD CASE - 2

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	-10.7	0.0	12.8	0.0	0.0	0.0
2	-10.9	0.0	12.0	0.0	0.0	0.0
3	-11.0	0.0	11.2	0.0	0.0	0.0
4	-11.1	0.0	10.4	0.0	0.0	0.0
5	-11.3	0.0	9.5	0.0	0.0	0.0
6	-11.4	0.0	8.7	0.0	0.0	0.0
7	-11.5	0.0	7.9	0.0	0.0	0.0
8	-24.3	0.0	69.6	0.0	0.0	0.0
9	-24.2	0.0	68.8	0.0	0.0	0.0
10	-24.1	0.0	68.0	0.0	0.0	0.0
11	-23.9	0.0	67.1	0.0	0.0	0.0
12	-23.8	0.0	66.3	0.0	0.0	0.0
13	-23.7	0.0	65.5	0.0	0.0	0.0
14	-23.5	0.0	64.7	0.0	0.0	0.0

LOAD CASE - 3

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	-10.7	0.0	18.5	0.0	0.0	0.0
2	-10.9	0.0	17.7	0.0	0.0	0.0
3	-11.0	0.0	16.8	0.0	0.0	0.0
4	-11.1	0.0	16.0	0.0	0.0	0.0
5	-11.3	0.0	15.2	0.0	0.0	0.0
6	-11.4	0.0	14.4	0.0	0.0	0.0
7	-11.5	0.0	13.5	0.0	0.0	0.0
8	-24.3	0.0	64.0	0.0	0.0	0.0
9	-24.2	0.0	63.1	0.0	0.0	0.0
10	-24.1	0.0	62.3	0.0	0.0	0.0
11	-23.9	0.0	61.5	0.0	0.0	0.0
12	-23.8	0.0	60.7	0.0	0.0	0.0
13	-23.7	0.0	59.8	0.0	0.0	0.0
14	-23.5	0.0	59.0	0.0	0.0	0.0

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Summary of Shear & Moment	Checked by	AML	Date	Dec-20
					References

Load Case	$V_{u,max}$ (kip/ft)	$M_{u,max}$ (kip/ft)
LC1	0.00	0.00
LC2	1.59	2.98
LC3	1.59	2.98

*Note: LC 1 only has vertical forces, so there is no shear or moment on the wall.

The following calculations are the max shear (Vu) and moment (Mu) on the wall form LC 2 and LC 3:

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JOB TITLE Maurepas WSLP Structures – River Road
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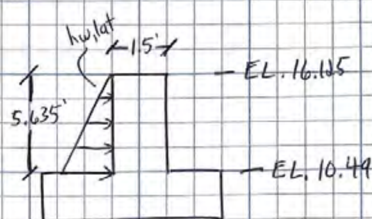
Wall Calculations:

Assumptions:

★ These calculations only show the loading condition for water to TOW (LC 2 & 3)

$t = 1.5' = 18''$
cover = 3"
$d = 18'' - 3'' - .75''$ → Assume #6 bars
$b = 12''$
$\phi_{shear} = .75$
$\phi_{moment} = .9$
$F_y = 60$ ksi
$f'_c = 4$ ksi



(1) Shear Calculations:

hw,lat

$$V_u = \tfrac{1}{2}(\gamma_{water})(H^2) = \tfrac{1}{2}(.0624\ K/ft^3)(5.635')^2$$

$$V_u = .991\ Kip/ft$$

$$1.6\ V_u = \boxed{1.59\ Kip/ft = V_u \text{ on } 1' \text{ of wall}}$$

(2) Moment Calculations:

$$M_u = V_u\left(\tfrac{H}{3}\right) = (1.59)\left(\tfrac{5.635'}{3}\right) = \boxed{2.98\ \tfrac{k\text{-}ft}{ft} = M_u \text{ on } 1' \text{ of wall}}$$

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Shear & Moment Check for Wall	Checked by	AML	Date	Dec-20
				References	

*** Given Information:**

Wall Thickness:	1.50	ft
Clear Cover:	0.25	ft
Diameter Bar to Start:	0.06	ft
Maximum Shear (V_u):	1.59	kips per foot
Maximum Moment (M_u):	2.98	kip-ft per foot
φ_{shear} =	0.75	(ACI 318)
φ_{moment} =	0.9	(ACI 318)
$f_{y,\ rebar}$ =	60	ksi
f'_c =	4	ksi

*** Shear Calculations:**

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u) (ACI Eq. 11-1)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75	
f'_c =	4	ksi
b =	1	ft strip
d =	1.22	ft

φV_c =	16649.4	lbs	
	16.65	kips	** φVc=16.6 ≥ Vu=1.6, **Shear Capacity OK**

*** Reinforcement Calculations:**

Limit of Maximum Reinforcement: 0.25 x ρ_b (Design Criteria, EM 1110-2-2104, 3-5)

where ρ_b =	0.0285	for f'_c = 4,000psi, fy = 60,000psi
Max Rebar =	0.00713	*b * d

Maximum Reinforcement:	0.0071	* b * d =	1.25 in^2	per 1ft strip

A_{gross} = 1.5 ft * 12 in/ft * 12 in strip = 216.00 in^2

Limits of Minimum Reinforcement: 0.005 x Agross =	1.08	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
$(3*\sqrt{(f'_c)}*b*d)/f_y$ =	0.55	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)
$(200*b*d)/f_y$ =	0.59	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)

Min Reinforcement, temp & shrinkage:	0.54	in^2	per 1ft strip, per face
Min Reinforcement, flexural:	0.59	in^2	per 1ft strip, per face

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Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Shear & Moment Check for Wall	Checked by	AML	Date	Dec-20
					References

*** Moment Calculations:**

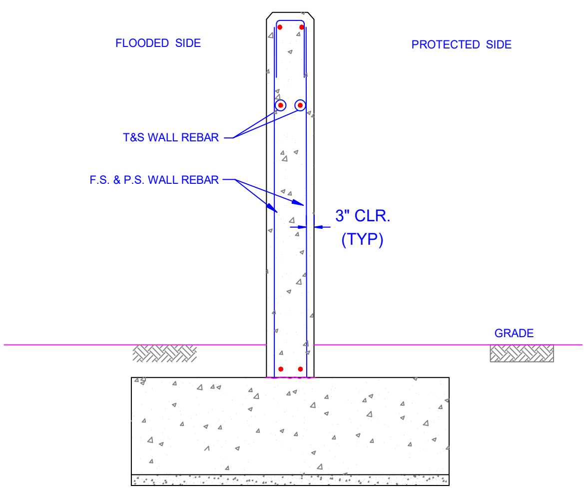
* $T = A_s \times f_y$
* $C = 0.85 \times f'_c \times a \times b$
* Assuming Tension = Compression $\longrightarrow$ $A_s \times f_y = 0.85 \times f'_c \times a \times b$
* $\varphi Mn = \varphi \times T \times (d - (a / 2))$
$= \varphi \times A_s \times f_y \times (d - (a / 2))$

* Capacity of Min Flexural Reinforcement:

A_s =	0.585	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	1.21875	
φ_{moment} =	0.9	

$a = (A_s \times f_y) / (0.85 \times f'_c \times b)$
= 0.860 in

φM_n =	448.4	kip-in
=	37.37	kip-ft



* Capacity of Maximum Reinforcement:

A_s =	1.250	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	1.22	
φ_{moment} =	0.9	

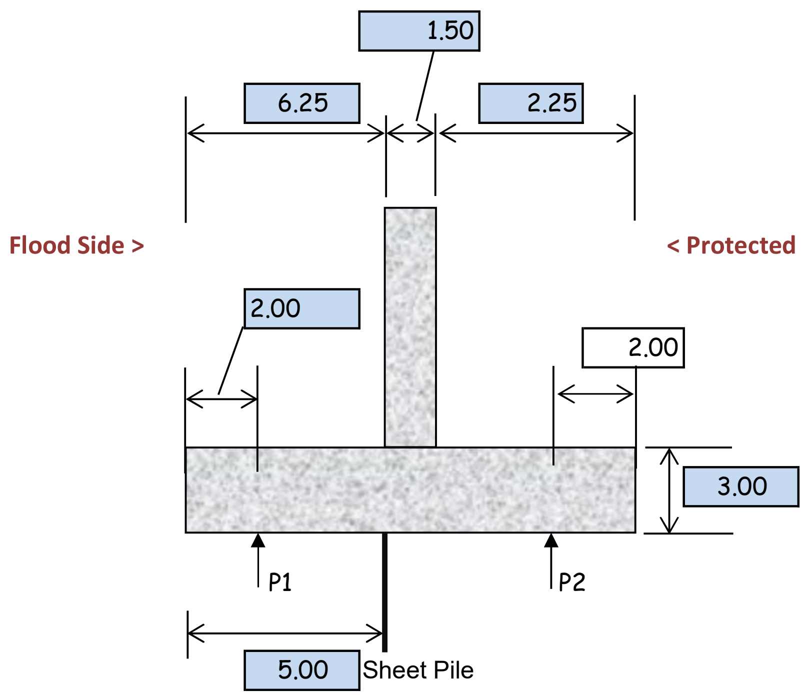
$a = (A_s \times f_y) / (0.85 \times f'_c \times b)$
= 1.839 in

φMn =	925.4	kip-in
=	77.12	kip-ft

**** φMn=77.1 ≥ Mu=3, Section OK**

The minimum proposed reinforcement for T&S Wall Rebar is #6 @ 9" (A = 0.59 in^2) and the minimum proposed reinforcement for F.S. & P.S. Wall Rebar is #6 @ 9"(A=0.59 in^2).

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Slab	Checked by	AML	Date	Dec-20
					References



Tributary width (pile spacing): 10 ft Referred to as "width" in calculations

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Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
					References

*Note: The following calculations represent the total shear (Vu) and moment (Mu) on both sides of the slab for all load cases. Capacity calculations for the slab can be found in the "Slab Conc Check" tab. All reactions are taken from the pinned or fixed results from CPGA.

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Slab Calculations:

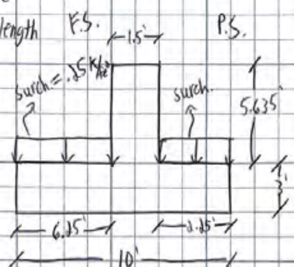
① Construction Surcharge

→ Dead wt

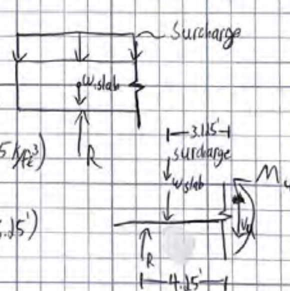
→ Surcharge = .25 kip/ft²

→ Assume 10' of trib length between piles

→ $\gamma_{conc.}$ = .15 K/ft³



Flood Side:



V_u: R = 36.5 kip from CPGA

$W_{slab} = (6.25')(10')(3')(.15\ kip/ft^3)$
$= 28.125$ kip

Surcharge $= (.25\ k/ft^2)(10')(6.25')$
$= 15.63$ kip

$V_u = 15.63 + 28.125 - 36.5$

$V_u = 7.3$ kip

$V_u = 1.6(7.3\ kip) = \frac{11.7\ kip}{10'} = 1.17$ kip/ft

10' → trib length

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
					References

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M_u:

R → 36.5 kip @ 4.25' (−)

w_{slab} → 28.125 kip @ 3.125' (+)

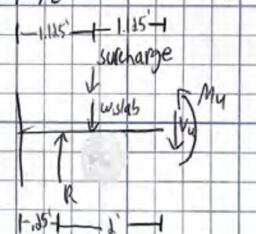
Surch → 15.63 kip @ 3.125' (+)

$$M_u = (28.125)(3.125) + (15.63)(3.125) - (36.5)(4.25)$$

$$M_u = -18.39 \text{ kip-ft}$$

$$M_u = 1.6(-18.39) = \frac{-29.43 \text{ kip-ft}}{10'} = -2.943 \frac{\text{kip-ft}}{\text{ft}}$$

trib length



Protected Side:

V_u → R = 40.2 kip from CPGA

$$w_{slab} = (2.25')(10')(3')(.15\ k/ft^3)$$

$$w_{slab} = 10.125 \text{ kip}$$

$$\text{Surcharge} = (.25\ k/ft^2)(10')(2.25')$$

$$\text{Surcharge} = 5.625 \text{ kip}$$

$$V_u = 5.625 + 10.125 - 40.2$$

$$V_u = -24.45 \text{ kip}$$

$$V_u = 1.6(-24.45) = \frac{-39.12 \text{ kip}}{10'} = -3.912 \text{ kip/ft}$$

trib length

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
					References

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$M_u =$ R → 40.2 kip @ .25' ⊖
w_{slab} → 10.125 kip @ 1.125' ⊕
Surcharge → 5.625 kip @ 1.125' ⊕

$M_u = -(40.2)(.25) + (10.125)(1.125) + (5.625)(1.125)$

$M_u = 7.67$ kip-ft

$M_u = 1.6(7.67) = \frac{12.27 \text{ kip-ft}}{10'} = 1.227 \frac{\text{kip-ft}}{\text{ft}}$

10' → trib length

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
					References

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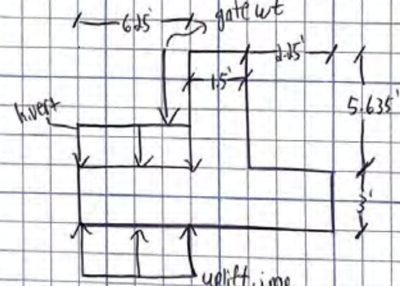
Water to TOW:
↳ LC 2 (impervious)
LC 3 (pervious)
→ assume 10' of trib. length between piles

LC 2 (imp.)

→ Dead Wt
→ h, lat (can be ignored)
→ h, vert
→ gate wt — assume .33 Kip/ft
→ Uplift, impervious
(Assume sheet pile in middle of slab)

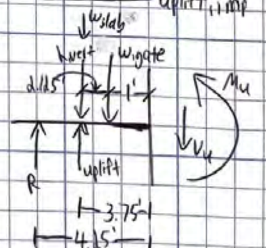
*wt. taken from similar sized roller gate



Flood Side:

$V_u \rightarrow$ R = -4.2 Kip from CPGA

$w_{gate} = (.33\ k/ft)(10')$
$= 3.3$ Kip



$w_{slab} = (6.25')(10')(3')(.15\ k/ft^3)$
$= 28.125$ Kip

$h_{vert} = (5.635')(10')(6.25')(.0624\ k/ft^3)$
$= 21.98$ Kip

$Uplift = (8.635')(10')(5')(.0624\ k/ft^3) = 26.94$ Kips

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
					References

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$V_u = 4.2 + 3.3 + 28.125 + 21.98 - 26.94$

$V_u = 30.67$ kip

$V_u = 1.6(30.67) = \frac{49.1 \text{ kips}}{10' \text{ (trib length)}} = 4.91$ kip/ft

M_u: R → -4.2 kip @ 4.25' (+)

w,gate → 3.3 kip @ 1' (+)

w,slab → 28.125 kip @ 3.125' (+)

h,vert → 21.98 kip @ 3.125' (+)

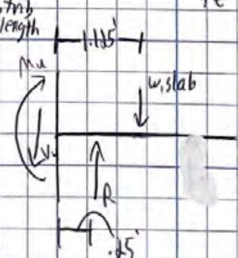
Uplift → 26.94 kip @ 3.75' (−)

$M_u = (4.2)(4.25') + (3.3)(1') + (28.125)(3.125) + (21.98)(3.125') - (26.94)(3.75)$

$M_u = 76.7$ kip-ft

$M_u = 1.6(76.7 \text{ k-ft}) = \frac{122.73 \text{ kip-ft}}{10 \text{ (trib length)}} = 12.273 \frac{\text{kip-ft}}{\text{ft}}$

Protected Side:



V_u → R = 52.7 Kip from CPGA

$w_{,slab} = (2.25')(10')(3')(.15 \text{ k/ft}^3)$

$= 10.125$ kip

$V_u = 10.125 - 52.7$

$= \frac{-42.58 \text{ kip}}{10' \text{ (trib length)}} = (-4.258 \text{ kip/ft})1.6 = V_u = -6.812$ kip/ft

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
					References

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M_y: $R \rightarrow$ 52.7 kip @ .25' ⊖

$w_{slab} \rightarrow$ 10.125 kip @ 1.125' ⊕

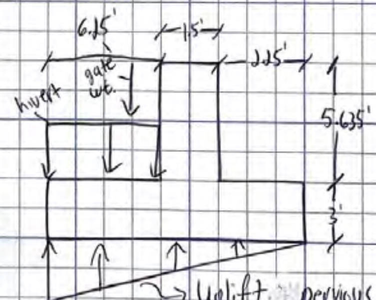
$M_u = (10.125)(1.125) - (52.7)(.25)$

$M_u = \dfrac{-1.78 \text{ kip-ft}}{10'} = \left(-.178 \dfrac{\text{kip-ft}}{\text{ft}}\right) 1.6$

$= M_u = -.286 \dfrac{\text{k-ft}}{\text{ft}}$

LC3 (pervious)

→ Dead wt
→ h, lat (can be ignored)
→ h, vert
→ gate wt – .33 k/ft
→ Uplift, pervious



Flood side:

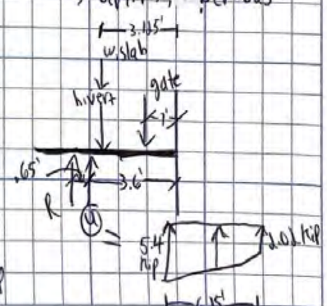
$V_u \rightarrow$ R = -1.5 kip from CPGA

$w_{gate} = 3.3$ kip

$w, slab = 15.125$ kip

$h_{vert} = 21.94$ kip

$\text{Uplift} = \left(\dfrac{5.4 + 2.02}{2}\right) 6.25 = 23.19$ kip



4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
					References

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$V_u = 1.5 + 3.3 + 28.125 + 21.98 - 23.19$

$= (31.715\ \text{kip})1.6 = V_u = \dfrac{50.74\ \text{kip}}{10'} = 5.074\ \text{k/ft}$

10' → trib length

M_u: R → -1.5 k @ 4.25' (+)

w, gate → 3.3 k @ 1' (+)

w, slab → 28.125 k @ 3.125' (+)

h, vert → 21.98 k @ 3.125' (+)

Uplift → 23.19 k @ 3.6' (−)

$M_u = (1.5)(4.25') + (3.3)(1') + (28.125)(3.125) + (21.98)(3.125) - (23.19)(3.6)$

$M_u = (82.77\ \text{kip-ft})1.6 = \dfrac{132.43\ \text{kip-ft}}{10'} = 13.243\ \dfrac{\text{kip-ft}}{\text{ft}}$

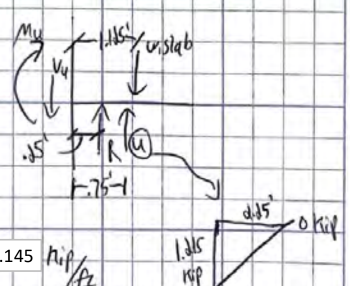
10' → trib length

Protected Side:

V_u → R = 49.9 kip

wslab = 10.125 kip

$U = \frac{1}{2}bh = 1.37$ kip



$V_u = 10.125 + 1.37 - 49.9$

$V_u = (-38.41\ \text{kip})1.6 = \dfrac{-61.45\ \text{kip}}{10'} = -6.145\ \text{kip/ft}$

10' → trib length

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
					References

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M_u: R → 49.9 kip @ .25' ⊖
W_{slab} → 10.125 kip @ 1.125' ⊕
Uplift → 1.37 kip @ .75' ⊖

$M_u = (10.125)(1.125) - (49.9)(.25) - (1.37)(.75)$
$= (-2.11 \text{ kip-ft})\,1.6 = \dfrac{-3.38 \text{ kip-ft}}{10'} = -.338 \dfrac{\text{kip-ft}}{\text{ft}}$

slab length

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Slab Conc. Check	Checked by	AML	Date	Dec-20
					References

**** Given Information:***

Slab Thickness:	3.00	ft			
Slab Width:	10.00	ft			
Clear Cover:	0.75	ft			
Diameter Bar to Start:	0.09	ft			
Diameter of Pile:	1.13	ft			
			Load Fact.		
Maximum Pile Reaction:	69.60	kips	1	69.60 kips	*From Factored CPGA Results
Maximum Shear:	6.81	kips			
Maximum Moment (Top):	13.24	kip-ft			
Maximum Moment (Bottom):	2.94	kip-ft			

φ_{shear} =	0.75	*(ACI 318)*
φ_{moment} =	0.9	*(ACI 318)*
$f_{y,\ rebar}$ =	60	ksi
f'_c =	4	ksi

**** Shear Calculations:***

1- Shear Capacity:

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ *(ACI Eq. 11-3)*

φ_{shear} =	0.75			
f'_c =	4	ksi		
b =	1	ft strip		
d =	2.20	ft	26.44	in

φV_c =	30095.3	lbs	
	30.10	kips	**** φVc=30.1 ≥ Vu=6.8, Shear Capacity OK**

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Slab Conc. Check	Checked by	AML	Date	Dec-20
					References

2- Punching Shear Capacity (ACI 318-14 Table 22.6.5.2):

Vc = minimum value = Eq. a: $4 \times \sqrt{f'_c} \times b_0 \times d$ for $\beta_c < 2.0$

Eq. b: $(2 + (4 / \beta_c)) \times \sqrt{f'_c} \times b_0 \times d$ for $\beta_c > 2.0$

Eq. c: $((\alpha_s \times d) / b_0 + 2) \times \sqrt{f'_c} \times b_0 \times d$ b_0 / d effect based on α_s

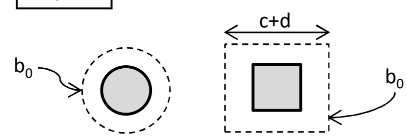
(interior column: α_s = 40, edge column: α_s = 30, corner column: α_s = 20)

d for piles = 26.203 in (Slab thickness - 9" pile embed - cover - $0.5d_{bar}$)

where β_c = Long side / Short side = 1

b_0 = Perimeter of Critical Section = $\pi*(D_{pile} + d)$ = 125.045

α_s = 20 (worst case - corner column)



Vc = minimum value = Eq. a: 828.91 kips

Eq. b: 1243.36 kips

Eq. c: 1282.94 kips

φV_c = 621.68 kips

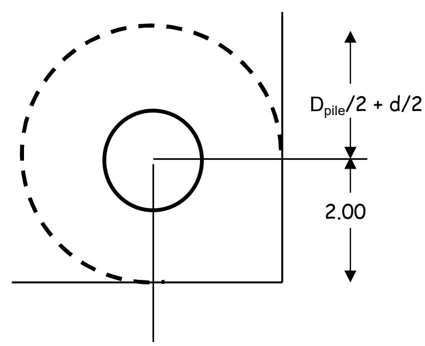
Check corner pile failure to edge of slab:

$D_{pile}/2+d/2$ = 1.66 ft

Diameter of corner failure = 1.658 + 2 ft

= 3.66 ft

Dia. punching shear calc above = 3.32



Diameter of punching shear calculation is smaller than the diameter of this corner failure area. Therefore, no re-check of corner punching failure is required.

φVc used in design = 30.10 kips

** φVc = 30.1k ≥ Vu = 6.8k, Shear Capacity OK

Maximum Pile Reaction = 69.60

** φVc=622k ≥ Vu=70k, Punching Shear Capacity OK

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Slab Conc. Check	Checked by	AML	Date	Dec-20
					References

3- Deep Beam One-Way Shear Capacity (φV_{c1}):

For $(w/d) \geq 1.0$, a one-way (normal) shear investigation with loads outside the critical section (located at a distance d from the face of the column, b = footing width) and

$$v_c = 1.9\sqrt{f'_c} + 2500\rho_w\left(\frac{V_u d}{M_u}\right) \geq 2\sqrt{f'_c} \quad \text{(ACI Eq. 11-5)}$$

which reduces for $\rho_w \approx 0.002$ and $3{,}000$ psi $\leq f'_c \leq$ $4{,}000$ psi to $v_c = 1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}(V_u d/M_u) \geq 2\sqrt{f'_c}$.

For $(w/d) < 1.0$, $1.0 > M_u/V_u d > 0$; $\infty > V_u d/M_u \geq 1.0$ (no limits on $M_u, V_u d$, other than above)

$$v_c = \left(\frac{d}{w}\right)\left[3.5 - 2.5\left(\frac{M_u}{V_u d}\right)\right]\left[1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}\left(\frac{V_u d}{M_u}\right)\right] \leq 10\sqrt{f'_c} \quad \text{(ACI Eq. 13-2)}$$

w = 0.5 ft — Distance from CL pile to face of Wall + 3" lateral installation tolerance

M_u = 13.24 kip-ft
V_u = 6.81 kips

v_c = 725.9 psi ≤ 10 x √f'c = 632.5 psi limit on shear strength
φV_{c1} = 150.48 kips — ** φVc=150.5 ≥ Vu=6.8, OK

Therefore, Slab is OK for shear forces found in slab analysis.

*** Reinforcement Calculations:**

Limit of Maximum Reinforcement: 0.25 x ρ_b (Design Criteria, EM 1110-2-2104, 3-5)
where ρ_b = 0.0285 for f'$_c$ = 4,000psi, fy = 60,000psi
Max Rebar = 0.00713 *b * d

Maximum Reinforcement:	0.0071	* b * d =	2.26	in^2	per 1ft strip

A_{gross} = 3 ft * 12 in/ft * 12 in strip = 432.00 in^2

Limits of Minimum Reinforcement:			
0.005 x Agross =	2.16	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
(3*√(f'$_c$) *b*d)/f$_y$ =	1.00	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)
(200*b*d)/f$_y$ =	1.06	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)

Min Reinforcement, temp & shrinkage:	1.08	in^2	per 1ft strip, per face
Min Reinforcement, flexural:	1.06	in^2	per 1ft strip, per face

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Slab Conc. Check	Checked by	AML	Date	Dec-20
					References

*** Moment Calculations:**

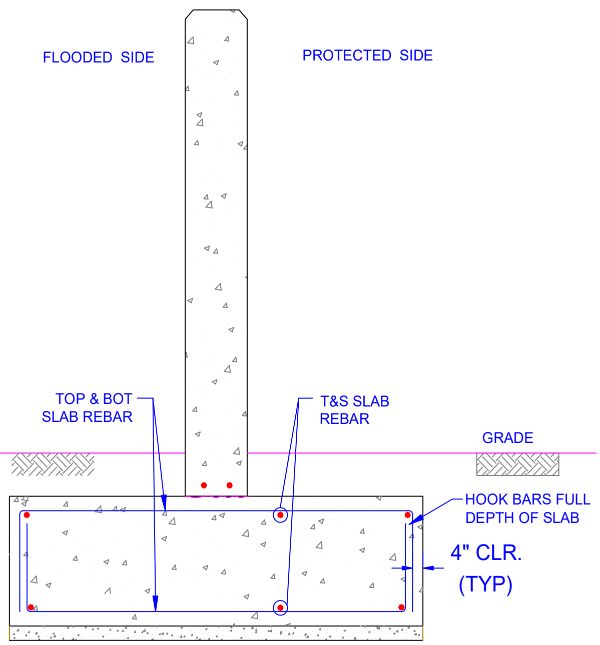
* $T = A_s \times f_y$

* $C = 0.85 \times f'_c \times a \times b$

* Assuming Tension = Compression $\longrightarrow$ $A_s \times f_y = 0.85 \times f'_c \times a \times b$

* $\varphi Mn = \varphi \times T \times (d - (a / 2))$

$= \varphi \times A_s \times f_y \times (d - (a / 2))$



* Capacity of Min Flexural Reinforcement:

A_s =	1.057	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	2.203	
φ_{moment} =	0.9	

$a = (A_s \times f_y) / (0.85 \times f'_c \times b)$

= 1.555 in

φM_n =	1465.1	kip-in
=	122.10	kip-ft

* Capacity of Maximum Reinforcement:

A_s =	2.260	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	2.20	
φ_{moment} =	0.9	

The minimum proposed reinforcement for to T&S Slab Rebar is #6 @ 6"(A = 0.88 in2) and the minimum proposed reinforcment for Top & Bot Slab Rebar is #7 @ 6"(A =1.2in2).

$a = (A_s \times f_y) / (0.85 \times f'_c \times b)$

= 3.324 in

φMn =	3023.8	kip-in
=	251.98	kip-ft

** $\varphi Mn=252 \geq Mu=13.2$, Section OK	TOP
** $\varphi Mn=252 \geq Mu=2.9$, Section OK	Bottom

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
					References

*Note: The following calculations represent the total shear (Vu) and moment (Mu) on both sides of the slab for all load cases. Capacity calculations for the slab can be found in the "Slab Conc Check" tab.

AECOM Imagine it. Delivered.

JOB TITLE Maurepas WSLP Structures – River Road
PROJECT/JOB NO. CALCULATION NO.
COMPUTED BY JH DATE
VERIFIED BY DATE
SCALE SHEET NO. 10 OF

• Shear & Moment on Pilaster:

→ Assume gate opening is 40' wide (tributary length = 20')

→ Pilasters are 2' × 2'

→ wall stem height = 5.635'

① $V_u \rightarrow \frac{1}{2}(\gamma_{water})(H)^2(\text{trib length})$

$= \frac{1}{2}(.0624\ k/ft^3)(5.635')^2(20')$

$= (19.81\ kips)\ 1.6 = 31.7\ kip$

② $M_u \rightarrow (V_u)(H/3) = (31.7\ kip)\left(\frac{5.635'}{3}\right)$

$M_u = 59.54\ kip\text{-}ft$

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	GATE SUPPORT STRUCTURES	Computed by	JMH	Date	Dec-20
	River Road Gate Monolith				
S, M & T Check for Pilaster River Road Gate		Checked by	AML	Date	Dec-20
				References	

*** Given Information:**

Pilaster Width:	2.00	ft			
Pilaster Thickness:	2.00	ft			
Clear Cover:	0.33	ft	=	4.00	in
Diameter Bar to Start:	0.08	ft	=	1.00	in
Stirup Bar Dia:	0.05	ft	=	0.625	in

Maximum Shear (V_u):	31.7	kips per foot
Maximum Moment (M_u):	59.54	kip-ft per foot
Gate Wt. Induced Moment ($M_{u,gate}$):	N/A	kip-ft per foot
Maximum Torsion (T_u):	0	kip-ft *Center line of latches are at center of pilaster, so Tu = 0

φ_{shear} =	0.75	(ACI 318)
φ_{moment} =	0.9	(ACI 318)
$\varphi_{torsion}$ =	0.75	(ACI 318)
$f_{y,\,rebar}$ =	60	ksi
f'_c =	4	ksi

*** Shear Calculations:**

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u) (ACI Eq. 11-1)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75			
f'_c =	4	ksi		
b =	2	ft strip		
d =	1.63	ft	19.50	in

φV_c =	44398.4	lbs	
	44.40	kips	** φVc=44.4 ≥ Vu=31.7, Shear Capacity OK

AECOM

Job	**Maurepaus Swamp**	**Project No.**	**60632162**		
Description	**GATE SUPPORT STRUCTURES**	**Computed by**	**JMH**	**Date**	**Dec-20**
	River Road Gate Monolith				
S, M & T Check for Pilaster River Road Gate		**Checked by**	**AML**	**Date**	**Dec-20**
				References	

*** Reinforcement Calculations:**

Limit of Maximum Reinforcement: $0.25 \times \rho_b$ (Design Criteria, EM 1110-2-2104, 3-5)

where ρ_b = 0.0285 for f'_c = 4,000psi, fy = 60,000psi

Max Rebar = 0.00713 *b * d

Maximum Reinforcement: 0.0071 * b * d = 3.33 in^2 per 2ft strip

A_{gross} = 2 ft * 12 in/ft * 24 in strip = 576.00 in^2

Limits of Minimum Reinforcement:			
0.003 x Agross =	1.73	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
$(3*\sqrt{f'_c}*b*d)/f_y$ =	1.48	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)
$(200*b*d)/f_y$ =	1.56	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)

Min Reinforcement, temp & shrinkage:	0.86	in^2	per 2ft strip, per face
Min Reinforcement, flexural:	1.56	in^2	per 2ft strip, per face

*** Moment Calculations:**

* $T = A_s \times f_y$
* $C = 0.85 \times f'_c \times a \times b$
* Assuming Tension = Compression $\longrightarrow$ $A_s \times f_y = 0.85 \times f'_c \times a \times b$
* $\varphi Mn = \varphi \times T \times (d - (a / 2))$

  $= \varphi \times A_s \times f_y \times (d - (a / 2))$

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	GATE SUPPORT STRUCTURES River Road Gate Monolith	Computed by	JMH	Date	Dec-20
S, M & T Check for Pilaster River Road Gate		Checked by	AML	Date	Dec-20
				References	

* Capacity of Min Flexural Reinforcement:

A_s =	1.560	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	2	ft strip
d =	1.63	
φ_{moment} =	0.9	

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$

= 1.147 in

φM_n =	1594.4	kip-in
=	132.86	kip-ft

Min reinforcement is sufficient.

* Capacity of Maximum Reinforcement:

A_s =	3.335	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	2	ft strip
d =	1.625	
φ_{moment} =	0.9	

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$

= 2.452 in

φMn =	3290.5	kip-in
=	274.21	kip-ft

** φMn=274.2 ≥ Mu=59.5, Section OK

Maurepaus Swamp

Storage Monolith

River Road Storage Monolith

AECOM Project : 60632162

Foundation, Wall & Slab

AECOM

1555 Poydras Street

Suite 1200

New Orleans, LA 70112

(504) 586-8111

Computed by:	JMH	Checked by:	ND
Date:	Dec-20	Date:	Dec-20

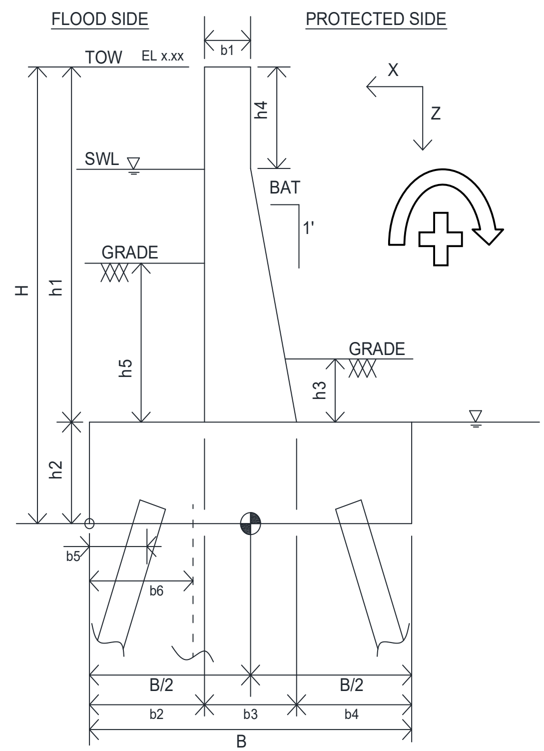
AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Wall Geometry	Checked by	ND	Date	Dec-20

References

WALL GEOMETRY:

Top of Pilaster EL.	16.13	NAVD88
Top of Wall EL.	16.13	NAVD88
100 Yr. Water El.		NAVD88
10 Yr. Water El.		NAVD88
Top of Slab EL.	10.49	NAVD88
H=	8.64	ft.
h1=	5.64	ft.
h2=	3.00	ft. (Base Slab Height)
h3=	0.00	ft. (P.S. Soil Height)
h4=	0.00	ft.
h5=	0.00	ft. (F.S. Soil Height)
B=	10.00	ft. (Base Slab Width)
b1=	1.50	ft. (Wall Stem Width, top)
b2=	6.25	ft. (F.S. Slab Width)
b3=	1.50	ft. (Wall Stem Width, bottom)
b4=	2.25	ft. (P.S. Slab Width)
b5=	2.00	ft. (F.S. Pile Row Edge Space)
b6=	5.00	ft. (Sheet Pile Edge Space)
BAT=	0.00	(Wall Batter, N/A)
PS Grade =	10.49	NAVD88 (Average of PS soil for all)



T-WALL CROSS-SECTION

Notes: 1) positive 'Y' axis is into page

2) pile batters vary from those shown in diagram

Monolith Length =	52.7	ft

Bottom Of Slab =	7.49	NAVD88

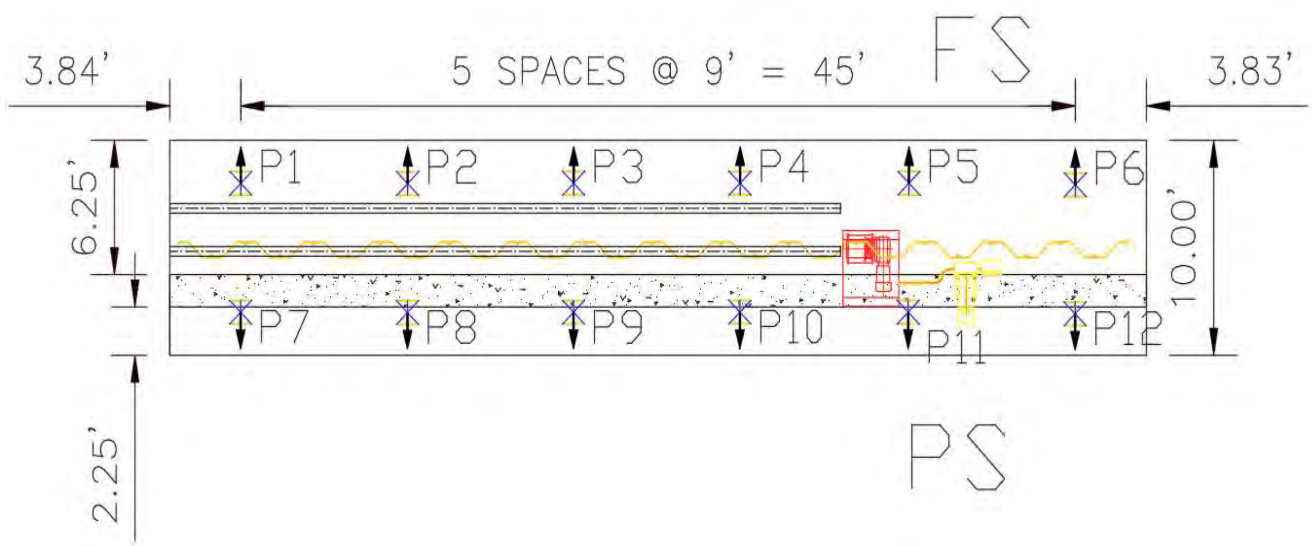
Note: In this report, white boxes are for input data and colored boxes are calculated values.

Note: The monolith is considered and analyzed as a straigh t-wall with no turn for this submittal.

Job	**Maurepaus Swamp**	**Project No.**	**60632162**		
Description	**Storage Monolith**	**Computed by**	**JMH**	**Date**	**Dec-20**
	River Road Storage Monolith				
	Applied Loads in SAP Model	**Checked by**	**ND**	**Date**	**Dec-20**

References

Pile Layout:



Job	**Maurepaus Swamp**	**Project No.**	**60632162**		
Description	**Storage Monolith**	**Computed by**	**JMH**	**Date**	**Dec-20**
	River Road Storage Monolith				
	Assumptions	**Checked by**	**ND**	**Date**	**Dec-20**

References

Unit Weight of Storm Water =	0.0624	kcf
Wet Unit Weight of Soil =	0.1200	kcf
Sat Unit Weight of Soil =	0.0576	kcf
Unit Weight of Concrete =	0.1500	kcf
Impact Load =	0.0000	k/ft
FS Wind force above SWL=	0.0500	ksf
Construction Surcharge Pressure =	0.2500	ksf
Unbalanced Load for Stability Analysis:		
F_{cap} (k/ft) =	0.00	(10y SWL Case; Force acts at bottom of slab)
F_{cap} (k/ft) =	0.00	(100y SWL Case; Force acts at bottom of slab)
F_{cap} (k/ft) =	0.00	(Water to TOW Case; Force acts at bottom of slab)
K_0, Granular fill =	0.95	(for lateral soil forces)
Assumed Wall Reinforcement Cover =	0.25	ft
Assumed Wall d_{bar} =	0.06	ft
Gate Length =	42.00	ft
Gate Weight =	13.86	kip

*Taken from similar roller gate from Hoboken project.

AECOM

Job	Maurepaus Swamp	Project No.	60632162
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Load Cases	Checked by	ND	Date	Dec-20
					References

No. of Load Cases	3

Update

No.	DCD LC No.	Description	FS Water El.	PS Water El.	Pile Design Over Stresses
1	1	Construction Surcharge	7.49	7.49	1.17
2	2a	Water to TOW (impervious cutoff)	16.13	7.49	1.33
3	2b	Water to TOW (pervious cutoff)	16.13	7.49	1.33

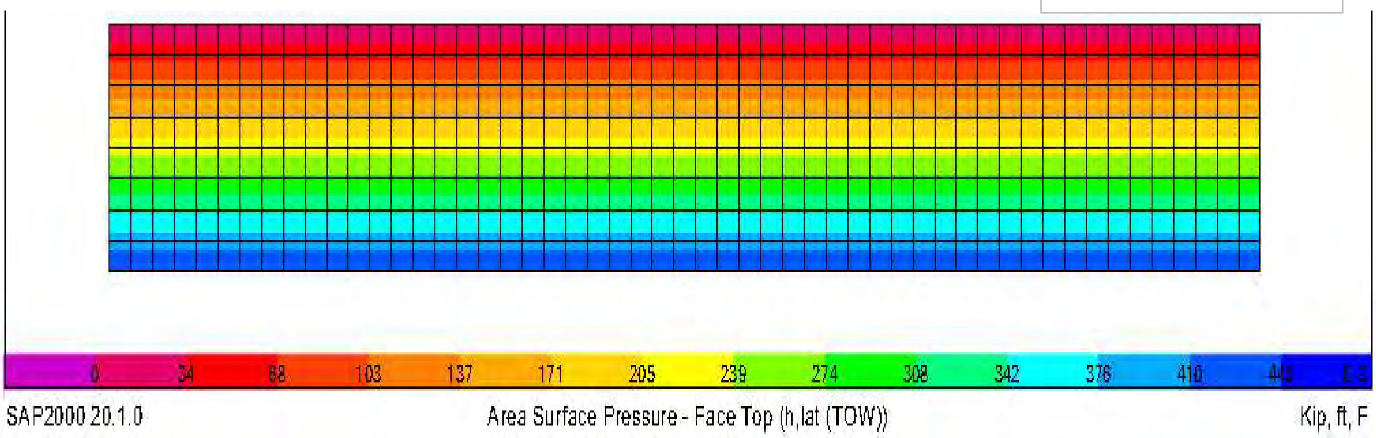
* Impact load is not applicable for this section, so it is excluded from the load combinations
* Forces induced by 10y water elevation are not applicable for this section, so they are excluded from the load combinations
*Earthquake and Wave Loads are to be determined and are excluded from these calculations
*Forces from the gate and the construction surcharge will not act simultaneously; for the construction case, surcharge governs over the gate weight so that the gate weight is excluded from these calculations.

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Applied Loads in SAP Model	Checked by	ND	Date	Dec-20

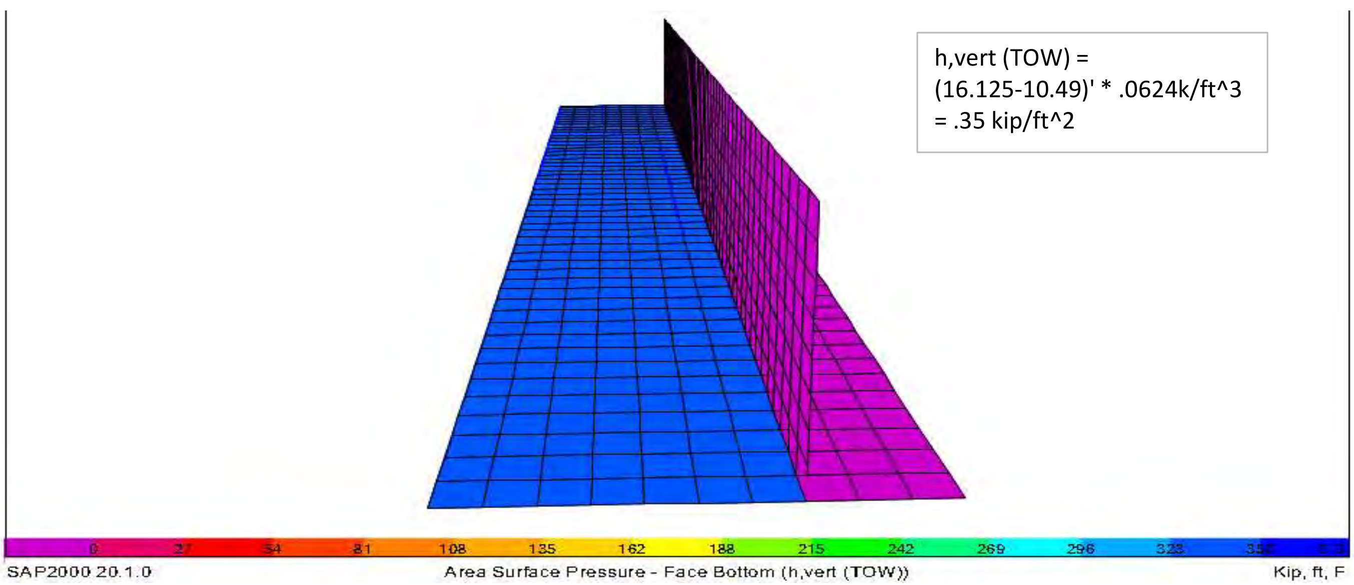
References

*The following diagrams represent the loads applied in the SAP Model; base reactions were taken from SAP to plug into CPGA to get the pile reactions of the structure.

h,lat (TOW) =
(16.125-9)' * .0624k/ft^3
= .445 kip/ft^2



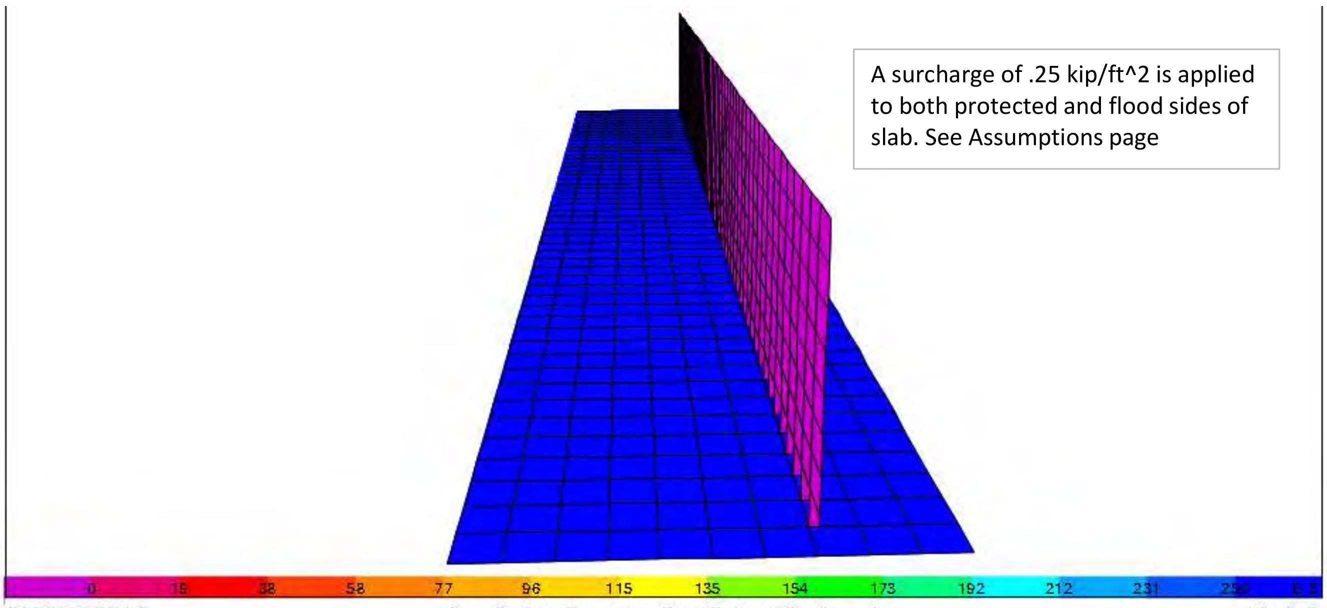
h,vert (TOW) =
(16.125-10.49)' * .0624k/ft^3
= .35 kip/ft^2



Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Applied Loads in SAP Model	Checked by	ND	Date	Dec-20

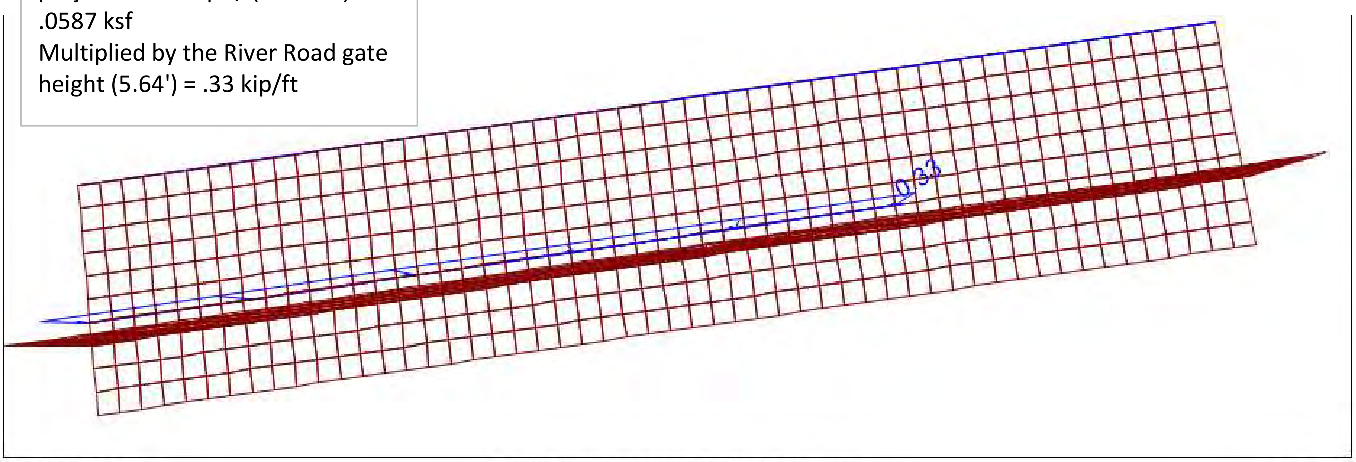
References

A surcharge of .25 kip/ft^2 is applied to both protected and flood sides of slab. See Assumptions page



SAP2000 20.1.0 Area Surface Pressure - Face Bottom (Surcharge) Kip, ft, F

Roller Gate weight from Hoboken project = 12.5 kips / (38'*5.6') = .0587 ksf
Multiplied by the River Road gate height (5.64') = .33 kip/ft

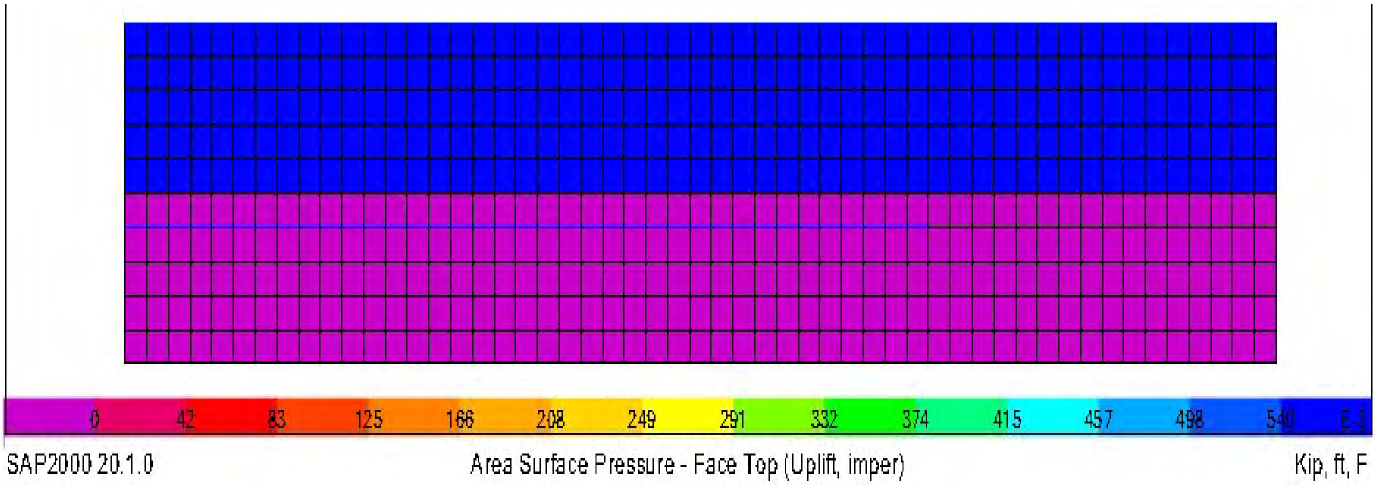


SAP2000 20.1.0 Frame Span Loads (gate) (GLOBAL CSys) Kip, ft, F

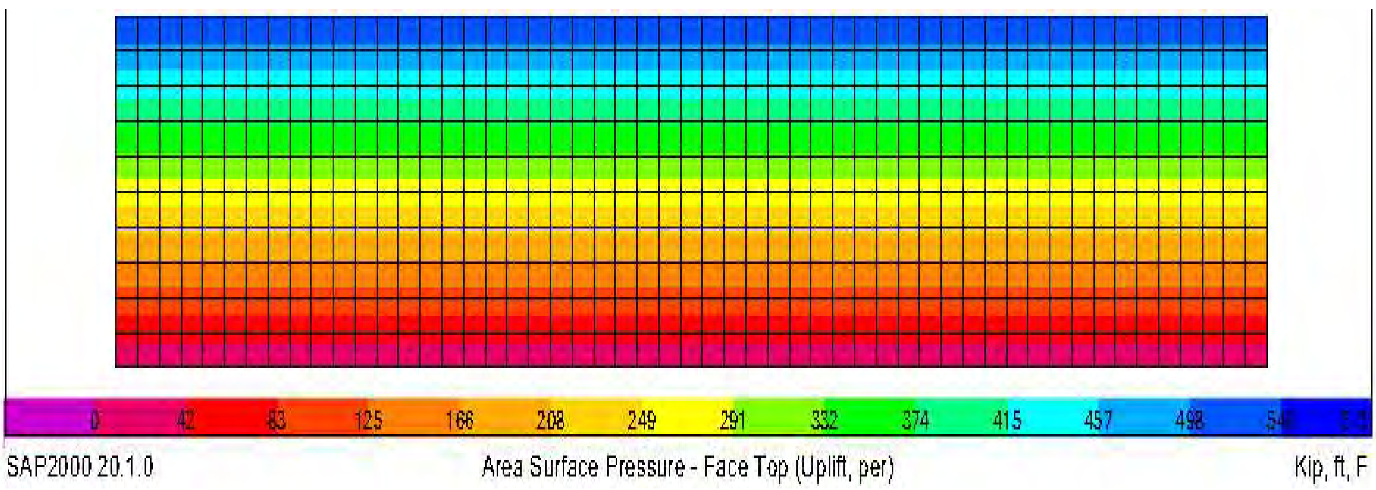
AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Applied Loads in SAP Model	Checked by	ND	Date	Dec-20

References



Impervious and Pervious Uplift =
(16.125' - 7.49') * .0624kcf = .54 ksf



AECOM

Job	Maurepaus Swamp	Project No.	60589133
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith		
	Summary of Foundation Loads	Checked by	ND	Date	Dec-20
			References

UNFACTORED LOADS FOR CPGA						
Load	Fx	Fy	Fz	Mx	My	Mz
Case	(kips)	(kips)	(kips)	(kip-ft)	(kip-ft)	(kip-ft)
LC1	0.00	0.00	453.13	0.00	168.87	0.00
LC2	-122.40	0.00	308.28	0.00	683.76	0.00
LC3	-122.40	0.00	308.28	0.00	565.26	0.00

This table represents the base reactions taken from SAP. The moments were taken from the centroid of the structure with positive-x facing the flood side and positive-z facing downwards.

FACTORED LOADS FOR CPGA						
Load	Fx	Fy	Fz	Mx	My	Mz
Case	(kips)	(kips)	(kips)	(kip-ft)	(kip-ft)	(kip-ft)
LC1	0.00	0.00	725.00	0.00	270.20	0.00
LC2	-195.84	0.00	493.26	0.00	1094.02	0.00
LC3	-195.84	0.00	493.26	0.00	904.41	0.00

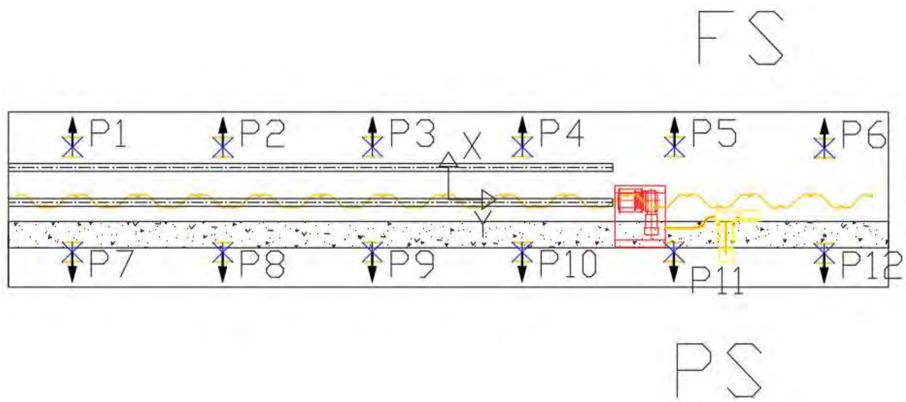
AECOM

Job	Maurepaus Swamp	Project No.	60632162
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith		
	Soil & Pile Information Required for CPGA	Checked by	ND	Date	Dec-20
			References

Pile Layout: 14 HP Piles

Row 1 / Row 2

pile no.	x	y	pile no.	x	y
1	3.00	-22.50	7	-3.00	-22.50
2	3.00	-13.50	8	-3.00	-13.50
3	3.00	-4.50	9	-3.00	-4.50
4	3.00	4.50	10	-3.00	4.50
5	3.00	13.50	11	-3.00	13.50
6	3.00	22.50	12	-3.00	22.50



Tip Elevation: (For CPGA, need Tip Elevation as a function of CPGA Axis at B.O. Slab, +Z points downward)

B.O.S. Elevation =	7.49	NAVD88
Pile Tip El. =	-35	NAVD89
"TIP" in CPGA =	**42.49**	**ft**

Pile Properties & Attributes

E =	29000000.00	psi	
A =	21.40	in^2	HP14X73
I_x =	729.00	in^4	
I_y =	261.00	in^4	
C_{33} =	1.70	(factor for method of axial load transfer from pile to soil; = 1 full tip bearing, = 2 full skin friction)	
S_x =	107.00	in^3	
S_y =	35.80	in^3	
F_y =	50.00	ksi	

*Note: All soil properties and pile capacities are taken from 95% submittal for Maurepas intake structure.

Allowable Compression (AC) =	50.00	kips
Allowable Tension (AT) =	30.00	kips
ACC =	492.66	kips
ATT =	535.00	kips
AM1 =	2972.22	kip-in
AM2 =	994.44	kip-in

AECOM

Job	Maurepaus Swamp	Project No.	60632162
Description	Storage Monolith	Computed by	JMH	Date Dec-20
	River Road Storage Monolith		
	Soil & Pile Information Required for CPGA	Checked by	ND	Date Dec-20
			References

Es Value for CPGA Run:

Monolith width = 53 ft

E_s = 540.40 psi = 0.5404 ksi

GROUP FACTORS	
Pile Spacing in Direction of Loading	From EM1110-2-2906
	D
3B	0.33
4B	0.38
5B	0.45
6B	0.56
7B	0.71
8B	1

Group reduction is based on distance between piles in direction of loading. This includes distance due to battering and is taken over the distance 10 x d_{pile} (point of fixety).

Assume a batter of 6.00

B = d_{pile} = 13.6 in = 1.133 ft

Distance between piles at B.O. Slab = 6.00 ft

Average distance between piles over 10*dpile = 7.89 ft

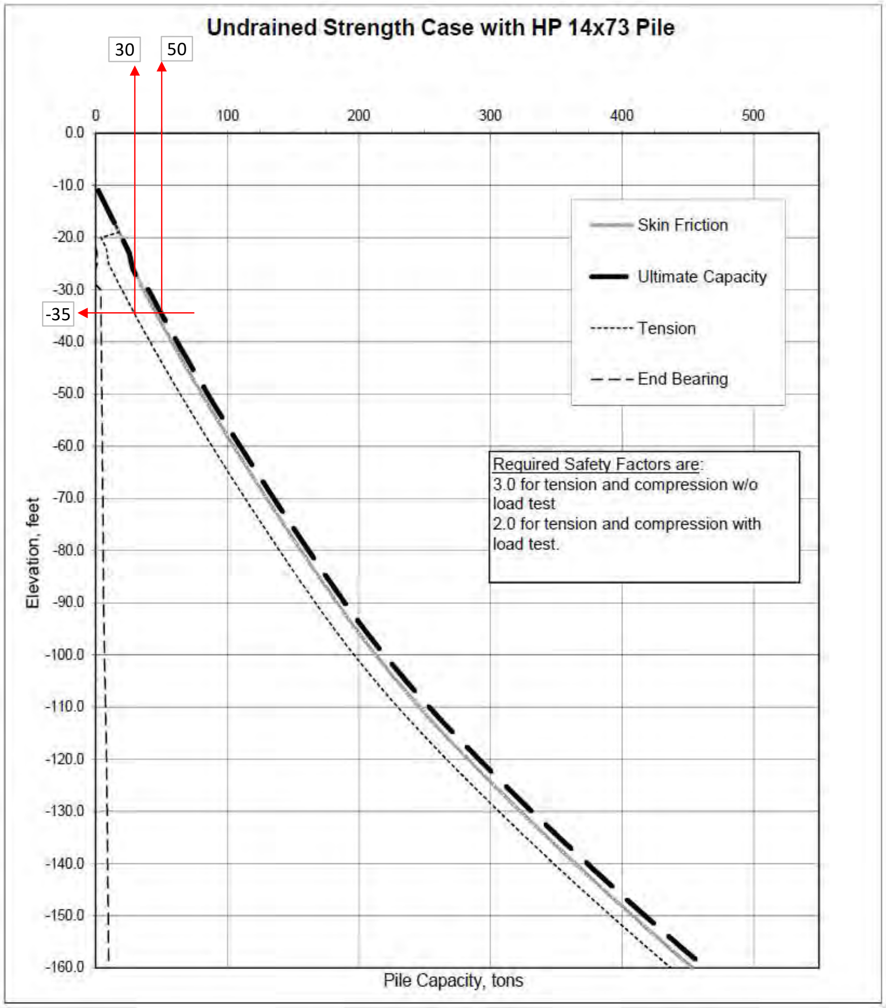
Average distance between piles in terms of pile width B = 6.96 B

Group Reduction "D" value for this distance = 0.70

Therefore, Es including group reduction = 0.38 ksi

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Soil & Pile Information Required for CPGA	Checked by	ND	Date	Dec-20
					References



Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	ND	Date	Dec-20

Input file:

```
100 MONOLITH, TOW EL. 16.13, TOS EL.10.49; HP 14X73  PILES
200 PROP 29000 729 261 21.4 1.7 0 ALL
300 SOIL ES 0.3805 TIP 42.49 0 ALL
400 PIN ALL
500 ALLOW H 50 30 492.7 535 2972.2 994.4 ALL
600 FOVSTR 1.17 1.17 1
700 FOVSTR 1.33 1.33 2 3
800 BATTER 6 All
1200 ANGLE 180 7 TO 12
1300 PILE 1 3 -22.5 0
1400 PILE 2 3 -13.5 0
1500 PILE 3 3 -4.5 0
1600 PILE 4 3 4.5 0
1700 PILE 5 3 13.5 0
1800 PILE 6 3 22.5 0
1900 PILE 7 -3 -22.5 0
2000 PILE 8 -3 -13.5 0
2100 PILE 9 -3 -4.5 0
2200 PILE 10 -3 4.5 0
2300 PILE 11 -3 13.5 0
2400 PILE 12 -3 22.5 0
4500 LOAD 1 0 0 453.1 0 168.9 0
4600 LOAD 2 -122.4 0 308.3 0 683.8 0
4700 LOAD 3 -122.4 0 308.3 0 565.3 0
9000 FOUT 1 2 3 4 5 6 7 RR01P.DOC
9100 PFO ALL
9200 PLB ALL
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	ND	Date	Dec-20

CPGA RESULTS without Load Factors (pinned connection)

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 11-DEC-20     RUN TIME: 12:16:33



    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.10.49; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE  12 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                    X          Y          Z
                                  -----      -----      -----
WITH DIAGONAL COORDINATES = (     -3.00 ,   -22.50 ,     0.00 )
                            (      3.00 ,    22.50 ,     0.00 )


*******************************************************************************

         PILE PROPERTIES AS INPUT


      E            I1           I2            A           C33          B66
     KSI          IN**4        IN**4        IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         SOIL DESCRIPTIONS AS INPUT
```

Job	Maurepaus Swamp		Project No.	60632162		
Description	Storage Monolith		Computed by	JMH	Date	Dec-20
	River Road Storage Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	ND	Date	Dec-20

```
    ES      ESOIL       LENGTH        L            LU
          K/IN**2                    FT            FT
         0.38050E+00     T      0.42490E+02   0.00000E+00

  ESOIL(ORIGINAL)      RGROUP     RCYCLIC
    K/IN**2
   0.38050E+00       0.1000E+01 0.1000E+01

 THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

     ALL


 *******************************************************************************

          PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


  0.17968E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.23229E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.20410E+04  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


 THIS MATRIX APPLIES TO THE FOLLOWING PILES -

       1


 *******************************************************************************
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	ND	Date	Dec-20

PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM	X FT	Y FT	Z FT	BATTER	ANGLE	LENGTH FT	FIXITY
1	3.00	-22.50	0.00	6.00	0.00	43.08	P
2	3.00	-13.50	0.00	6.00	0.00	43.08	P
3	3.00	-4.50	0.00	6.00	0.00	43.08	P
4	3.00	4.50	0.00	6.00	0.00	43.08	P
5	3.00	13.50	0.00	6.00	0.00	43.08	P
6	3.00	22.50	0.00	6.00	0.00	43.08	P
7	-3.00	-22.50	0.00	6.00	180.00	43.08	P
8	-3.00	-13.50	0.00	6.00	180.00	43.08	P
9	-3.00	-4.50	0.00	6.00	180.00	43.08	P
10	-3.00	4.50	0.00	6.00	180.00	43.08	P
11	-3.00	13.50	0.00	6.00	180.00	43.08	P
12	-3.00	22.50	0.00	6.00	180.00	43.08	P

516.91

****

APPLIED LOADS

LOAD CASE	PX K	PY K	PZ K	MX FT-K	MY FT-K	MZ FT-K	OVERSTRESS COM	TEN
1	0.0	0.0	453.1	0.0	168.9	0.0	1.17	1.17
2	-122.4	0.0	308.3	0.0	683.8	0.0	1.33	1.33
3	-122.4	0.0	308.3	0.0	565.3	0.0	1.33	1.33

****

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	ND	Date	Dec-20

```
        ORIGINAL PILE GROUP STIFFNESS MATRIX

 0.87174E+03 -0.72155E-05  0.90949E-12 -0.14552E-10 -0.14172E+06  0.25976E-03
-0.72155E-05  0.27875E+03  0.47902E-04  0.00000E+00  0.17245E-02 -0.48885E-11
 0.90949E-12  0.47902E-04  0.23836E+05  0.11642E-09  0.29104E-10 -0.17245E-02
 0.14552E-10  0.00000E+00  0.00000E+00  0.81090E+09 -0.37253E-08 -0.22352E-07
-0.14172E+06  0.17245E-02  0.29104E-10  0.00000E+00  0.30891E+08 -0.62081E-01
 0.25976E-03 -0.51159E-11 -0.17245E-02 -0.14901E-07 -0.62081E-01  0.30018E+08



                    12 PILES   3 LOAD CASES

LOAD CASE    1.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    2.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    3.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.


******************************************************************************

         PILE CAP DISPLACEMENTS

LOAD
CASE       DX           DY           DZ           RX           RY           RZ
           IN           IN           IN          RAD          RAD          RAD

   1   0.4197E-01 -0.3777E-08  0.1901E-01  0.4328E-21  0.2582E-03  0.1263E-11
   2  -0.3825E+00 -0.2911E-08  0.1293E-01  0.2263E-22 -0.1489E-02  0.9731E-12
   3  -0.4120E+00 -0.2553E-08  0.1293E-01 -0.2810E-21 -0.1670E-02  0.8534E-12


******************************************************************************
             ELASTIC CENTER INFORMATION


ELASTIC CENTER IN PLANE X-Z          X             Z
                                    FT            FT
                                   0.00          0.00


******************************************************************************
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	ND	Date	Dec-20

```
PILE FORCES IN LOCAL GEOMETRY

    M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
    * INDICATES PILE FAILURE
    # INDICATES CBF BASED ON MOMENTS DUE TO
                (F3*EMIN) FOR CONCRETE PILES
    B INDICATES BUCKLING CONTROLS



LOAD CASE -    1

PILE    F1      F2      F3        M1        M2        M3   ALF  CBF
         K       K       K      IN-K      IN-K      IN-K

  1     0.7     0.0    33.6       0.0     -21.7       0.0 0.58 0.08
  2     0.7     0.0    33.6       0.0     -21.7       0.0 0.58 0.08
  3     0.7     0.0    33.6       0.0     -21.7       0.0 0.58 0.08
  4     0.7     0.0    33.6       0.0     -21.7       0.0 0.58 0.08
  5     0.7     0.0    33.6       0.0     -21.7       0.0 0.58 0.08
  6     0.7     0.0    33.6       0.0     -21.7       0.0 0.58 0.08
  7    -0.8     0.0    42.9       0.0      25.2       0.0 0.73 0.10
  8    -0.8     0.0    42.9       0.0      25.2       0.0 0.73 0.10
  9    -0.8     0.0    42.9       0.0      25.2       0.0 0.73 0.10
 10    -0.8     0.0    42.9       0.0      25.2       0.0 0.73 0.10
 11    -0.8     0.0    42.9       0.0      25.2       0.0 0.73 0.10
 12    -0.8     0.0    42.9       0.0      25.2       0.0 0.73 0.10


LOAD CASE -    2

PILE    F1      F2      F3        M1        M2        M3   ALF  CBF
         K       K       K      IN-K      IN-K      IN-K

  1    -7.0     0.0     5.6       0.0     212.2       0.0 0.08 0.17
  2    -7.0     0.0     5.6       0.0     212.2       0.0 0.08 0.17
  3    -7.0     0.0     5.6       0.0     212.2       0.0 0.08 0.17
  4    -7.0     0.0     5.6       0.0     212.2       0.0 0.08 0.17
  5    -7.0     0.0     5.6       0.0     212.2       0.0 0.08 0.17
  6    -7.0     0.0     5.6       0.0     212.2       0.0 0.08 0.17
  7     6.9     0.0    46.5       0.0    -209.9       0.0 0.70 0.23
  8     6.9     0.0    46.5       0.0    -209.9       0.0 0.70 0.23
  9     6.9     0.0    46.5       0.0    -209.9       0.0 0.70 0.23
 10     6.9     0.0    46.5       0.0    -209.9       0.0 0.70 0.23
 11     6.9     0.0    46.5       0.0    -209.9       0.0 0.70 0.23
 12     6.9     0.0    46.5       0.0    -209.9       0.0 0.70 0.23
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	ND	Date	Dec-20

LOAD CASE - 3

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	-7.5	0.0	8.9	0.0	228.6	0.0	0.13	0.19
2	-7.5	0.0	8.9	0.0	228.6	0.0	0.13	0.19
3	-7.5	0.0	8.9	0.0	228.6	0.0	0.13	0.19
4	-7.5	0.0	8.9	0.0	228.6	0.0	0.13	0.19
5	-7.5	0.0	8.9	0.0	228.6	0.0	0.13	0.19
6	-7.5	0.0	8.9	0.0	228.6	0.0	0.13	0.19
7	7.4	0.0	43.2	0.0	-226.3	0.0	0.65	0.24
8	7.4	0.0	43.2	0.0	-226.3	0.0	0.65	0.24
9	7.4	0.0	43.2	0.0	-226.3	0.0	0.65	0.24
10	7.4	0.0	43.2	0.0	-226.3	0.0	0.65	0.24
11	7.4	0.0	43.2	0.0	-226.3	0.0	0.65	0.24
12	7.4	0.0	43.2	0.0	-226.3	0.0	0.65	0.24

****

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	6.2	0.0	33.1	0.0	0.0	0.0
2	6.2	0.0	33.1	0.0	0.0	0.0
3	6.2	0.0	33.1	0.0	0.0	0.0
4	6.2	0.0	33.1	0.0	0.0	0.0
5	6.2	0.0	33.1	0.0	0.0	0.0
6	6.2	0.0	33.1	0.0	0.0	0.0
7	-6.2	0.0	42.4	0.0	0.0	0.0
8	-6.2	0.0	42.4	0.0	0.0	0.0
9	-6.2	0.0	42.4	0.0	0.0	0.0
10	-6.2	0.0	42.5	0.0	0.0	0.0
11	-6.2	0.0	42.5	0.0	0.0	0.0
12	-6.2	0.0	42.5	0.0	0.0	0.0

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	ND	Date	Dec-20

LOAD CASE - 2

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-6.0	0.0	6.7	0.0	0.0	0.0
2	-6.0	0.0	6.7	0.0	0.0	0.0
3	-6.0	0.0	6.7	0.0	0.0	0.0
4	-6.0	0.0	6.7	0.0	0.0	0.0
5	-6.0	0.0	6.7	0.0	0.0	0.0
6	-6.0	0.0	6.7	0.0	0.0	0.0
7	-14.4	0.0	44.7	0.0	0.0	0.0
8	-14.4	0.0	44.7	0.0	0.0	0.0
9	-14.4	0.0	44.7	0.0	0.0	0.0
10	-14.4	0.0	44.7	0.0	0.0	0.0
11	-14.4	0.0	44.7	0.0	0.0	0.0
12	-14.4	0.0	44.7	0.0	0.0	0.0

LOAD CASE - 3

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-6.0	0.0	10.0	0.0	0.0	0.0
2	-6.0	0.0	10.0	0.0	0.0	0.0
3	-6.0	0.0	10.0	0.0	0.0	0.0
4	-6.0	0.0	10.0	0.0	0.0	0.0
5	-6.0	0.0	10.0	0.0	0.0	0.0
6	-6.0	0.0	10.0	0.0	0.0	0.0
7	-14.4	0.0	41.4	0.0	0.0	0.0
8	-14.4	0.0	41.4	0.0	0.0	0.0
9	-14.4	0.0	41.4	0.0	0.0	0.0
10	-14.4	0.0	41.4	0.0	0.0	0.0
11	-14.4	0.0	41.4	0.0	0.0	0.0
12	-14.4	0.0	41.4	0.0	0.0	0.0

Job	Maurepaus Swamp		Project No.	60632162		
Description	Storage Monolith		Computed by	JMH	Date	Dec-20
	River Road Storage Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	ND	Date	Dec-20

CPGA RESULTS without Load Factors (fixed connection)

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 11-DEC-20     RUN TIME: 12:17:15



    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.10.49; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE  12 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                    X          Y          Z
                                  -----      -----      -----
WITH DIAGONAL COORDINATES = (     -3.00 ,   -22.50 ,     0.00 )
                            (      3.00 ,    22.50 ,     0.00 )


******************************************************************************

         PILE PROPERTIES AS INPUT
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	ND	Date	Dec-20

```
      E            I1            I2            A            C33           B66
     KSI          IN**4         IN**4        IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         SOIL DESCRIPTIONS AS INPUT



   ES     ESOIL      LENGTH       L            LU
         K/IN**2                  FT           FT
        0.38050E+00    T      0.42490E+02   0.00000E+00

 ESOIL(ORIGINAL)     RGROUP     RCYCLIC
   K/IN**2
  0.38050E+00       0.1000E+01 0.1000E+01

THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


 0.35937E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.16971E+04  0.00000E+00
 0.00000E+00  0.46458E+02  0.00000E+00 -0.28362E+04  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.20410E+04  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00 -0.28362E+04  0.00000E+00  0.34630E+06  0.00000E+00  0.00000E+00
 0.16971E+04  0.00000E+00  0.00000E+00  0.00000E+00  0.16028E+06  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


THIS MATRIX APPLIES TO THE FOLLOWING PILES -

      1


*******************************************************************************

         PILE GEOMETRY AS INPUT AND/OR GENERATED
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	ND	Date	Dec-20

```
NUM        X          Y          Z     BATTER   ANGLE   LENGTH  FIXITY
          FT         FT         FT                       FT

  1      3.00     -22.50      0.00     6.00     0.00    43.08    F
  2      3.00     -13.50      0.00     6.00     0.00    43.08    F
  3      3.00      -4.50      0.00     6.00     0.00    43.08    F
  4      3.00       4.50      0.00     6.00     0.00    43.08    F
  5      3.00      13.50      0.00     6.00     0.00    43.08    F
  6      3.00      22.50      0.00     6.00     0.00    43.08    F
  7     -3.00     -22.50      0.00     6.00   180.00    43.08    F
  8     -3.00     -13.50      0.00     6.00   180.00    43.08    F
  9     -3.00      -4.50      0.00     6.00   180.00    43.08    F
 10     -3.00       4.50      0.00     6.00   180.00    43.08    F
 11     -3.00      13.50      0.00     6.00   180.00    43.08    F
 12     -3.00      22.50      0.00     6.00   180.00    43.08    F
                                                        ------
 516.91


******************************************************************************

                       APPLIED LOADS

LOAD     PX         PY         PZ          MX          MY          MZ  OVERSTRESS
CASE      K          K          K         FT-K        FT-K        FT-K  COM   TEN

  1       0.0        0.0      453.1         0.0       168.9         0.0 1.17 1.17
  2    -122.4        0.0      308.3         0.0       683.8         0.0 1.33 1.33
  3    -122.4        0.0      308.3         0.0       565.3         0.0 1.33 1.33


******************************************************************************
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	ND	Date	Dec-20

```
         ORIGINAL PILE GROUP STIFFNESS MATRIX

  0.10815E+04 -0.63764E-05  0.45475E-12 -0.16407E-03 -0.12038E+06  0.16147E-03
 -0.63764E-05  0.55750E+03  0.47476E-04 -0.33572E+05  0.18732E-02 -0.59117E-11
  0.45475E-12  0.47476E-04  0.23842E+05  0.40737E-04  0.00000E+00 -0.17091E-02
 -0.16407E-03 -0.33572E+05  0.40737E-04  0.81514E+09 -0.24328E-01 -0.14901E-07
 -0.12038E+06  0.18732E-02  0.00000E+00 -0.24328E-01  0.33063E+08 -0.75636E-01
  0.16147E-03 -0.22737E-11 -0.17091E-02 -0.74506E-08 -0.75636E-01  0.38031E+08



                     12 PILES   3 LOAD CASES

 LOAD CASE    1.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    2.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   6.

 LOAD CASE    3.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.


 ******************************************************************************

         PILE CAP DISPLACEMENTS

 LOAD
 CASE       DX          DY          DZ          RX          RY          RZ
            IN          IN          IN         RAD         RAD         RAD

    1   0.1147E-01 -0.1838E-08  0.1900E-01 -0.7126E-13  0.1031E-03  0.1010E-11
    2  -0.1438E+00 -0.1827E-08  0.1293E-01 -0.1131E-12 -0.2755E-03  0.6439E-12
    3  -0.1519E+00 -0.1676E-08  0.1293E-01 -0.1106E-12 -0.3478E-03  0.5343E-12


 ******************************************************************************
              ELASTIC CENTER INFORMATION



 ELASTIC CENTER IN PLANE X-Z         X              Z
                                    FT             FT
                                   0.00           0.00


 ******************************************************************************
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	ND	Date	Dec-20

PILE FORCES IN LOCAL GEOMETRY

M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
* INDICATES PILE FAILURE
# INDICATES CBF BASED ON MOMENTS DUE TO
(F3*EMIN) FOR CONCRETE PILES
B INDICATES BUCKLING CONTROLS

LOAD CASE - 1

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	0.5	0.0	34.6	0.0	31.5	0.0	0.59	0.09
2	0.5	0.0	34.6	0.0	31.5	0.0	0.59	0.09
3	0.5	0.0	34.6	0.0	31.5	0.0	0.59	0.09
4	0.5	0.0	34.6	0.0	31.5	0.0	0.59	0.09
5	0.5	0.0	34.6	0.0	31.5	0.0	0.59	0.09
6	0.5	0.0	34.6	0.0	31.5	0.0	0.59	0.09
7	-0.7	0.0	41.9	0.0	-42.1	0.0	0.72	0.11
8	-0.7	0.0	41.9	0.0	-42.1	0.0	0.72	0.11
9	-0.7	0.0	41.9	0.0	-42.1	0.0	0.72	0.11
10	-0.7	0.0	41.9	0.0	-42.1	0.0	0.72	0.11
11	-0.7	0.0	41.9	0.0	-42.1	0.0	0.72	0.11
12	-0.7	0.0	41.9	0.0	-42.1	0.0	0.72	0.11

LOAD CASE - 2

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	-5.7	0.0	-2.3	0.0	-291.3	0.0	0.06	0.22
2	-5.7	0.0	-2.3	0.0	-291.3	0.0	0.06	0.22
3	-5.7	0.0	-2.3	0.0	-291.3	0.0	0.06	0.22
4	-5.7	0.0	-2.3	0.0	-291.3	0.0	0.06	0.22
5	-5.7	0.0	-2.3	0.0	-291.3	0.0	0.06	0.22
6	-5.7	0.0	-2.3	0.0	-291.3	0.0	0.06	0.22
7	5.5	0.0	54.3	0.0	284.1	0.0	0.82	0.30
8	5.5	0.0	54.3	0.0	284.1	0.0	0.82	0.30
9	5.5	0.0	54.3	0.0	284.1	0.0	0.82	0.30
10	5.5	0.0	54.3	0.0	284.1	0.0	0.82	0.30
11	5.5	0.0	54.3	0.0	284.1	0.0	0.82	0.30
12	5.5	0.0	54.3	0.0	284.1	0.0	0.82	0.30

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	ND	Date	Dec-20

LOAD CASE - 3

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	-6.1	0.0	0.3	0.0	-317.1	0.0	0.00	0.24
2	-6.1	0.0	0.3	0.0	-317.1	0.0	0.00	0.24
3	-6.1	0.0	0.3	0.0	-317.1	0.0	0.00	0.24
4	-6.1	0.0	0.3	0.0	-317.1	0.0	0.00	0.24
5	-6.1	0.0	0.3	0.0	-317.1	0.0	0.00	0.24
6	-6.1	0.0	0.3	0.0	-317.1	0.0	0.00	0.24
7	6.0	0.0	51.8	0.0	309.9	0.0	0.78	0.31
8	6.0	0.0	51.8	0.0	309.9	0.0	0.78	0.31
9	6.0	0.0	51.8	0.0	309.9	0.0	0.78	0.31
10	6.0	0.0	51.8	0.0	309.9	0.0	0.78	0.31
11	6.0	0.0	51.8	0.0	309.9	0.0	0.78	0.31
12	6.0	0.0	51.8	0.0	309.9	0.0	0.78	0.31

****

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	6.2	0.0	34.1	0.0	31.5	0.0
2	6.2	0.0	34.1	0.0	31.5	0.0
3	6.2	0.0	34.1	0.0	31.5	0.0
4	6.2	0.0	34.1	0.0	31.5	0.0
5	6.2	0.0	34.1	0.0	31.5	0.0
6	6.2	0.0	34.1	0.0	31.5	0.0
7	-6.2	0.0	41.4	0.0	42.1	0.0
8	-6.2	0.0	41.4	0.0	42.1	0.0
9	-6.2	0.0	41.4	0.0	42.1	0.0
10	-6.2	0.0	41.4	0.0	42.1	0.0
11	-6.2	0.0	41.4	0.0	42.1	0.0
12	-6.2	0.0	41.4	0.0	42.1	0.0

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	ND	Date	Dec-20

LOAD CASE - 2

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-6.0	0.0	-1.3	0.0	-291.3	0.0
2	-6.0	0.0	-1.3	0.0	-291.3	0.0
3	-6.0	0.0	-1.3	0.0	-291.3	0.0
4	-6.0	0.0	-1.3	0.0	-291.3	0.0
5	-6.0	0.0	-1.3	0.0	-291.3	0.0
6	-6.0	0.0	-1.3	0.0	-291.3	0.0
7	-14.4	0.0	52.7	0.0	-284.1	0.0
8	-14.4	0.0	52.7	0.0	-284.1	0.0
9	-14.4	0.0	52.7	0.0	-284.1	0.0
10	-14.4	0.0	52.7	0.0	-284.1	0.0
11	-14.4	0.0	52.7	0.0	-284.1	0.0
12	-14.4	0.0	52.7	0.0	-284.1	0.0

LOAD CASE - 3

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-6.0	0.0	1.3	0.0	-317.1	0.0
2	-6.0	0.0	1.3	0.0	-317.1	0.0
3	-6.0	0.0	1.3	0.0	-317.1	0.0
4	-6.0	0.0	1.3	0.0	-317.1	0.0
5	-6.0	0.0	1.3	0.0	-317.1	0.0
6	-6.0	0.0	1.3	0.0	-317.1	0.0
7	-14.4	0.0	50.1	0.0	-309.9	0.0
8	-14.4	0.0	50.1	0.0	-309.9	0.0
9	-14.4	0.0	50.1	0.0	-309.9	0.0
10	-14.4	0.0	50.1	0.0	-309.9	0.0
11	-14.4	0.0	50.1	0.0	-309.9	0.0
12	-14.4	0.0	50.1	0.0	-309.9	0.0

Job	Maurepaus Swamp	Project No.	60632162
Description	Storage Monolith	Computed by JMH	Date Dec-20
	River Road Storage Monolith		
	CPGA Input & Output Files (Concrete Design)	Checked by ND	Date Dec-20

Input file:

```
100 MONOLITH, TOW EL. 16.13, TOS EL.10.49; HP 14X73  PILES
200 PROP 29000 729 261 21.4 1.7 0 ALL
300 SOIL ES 0.3805 TIP 42.49 0 ALL
400 PIN ALL
500 ALLOW H 50 30 492.7 535 2972.2 994.4 ALL
600 FOVSTR 1 1 1
700 FOVSTR 1 1 2 3
800 BATTER 6 All
1200 ANGLE 180 7 TO 12
1300 PILE 1 3 -22.5 0
1400 PILE 2 3 -13.5 0
1500 PILE 3 3 -4.5 0
1600 PILE 4 3 4.5 0
1700 PILE 5 3 13.5 0
1800 PILE 6 3 22.5 0
1900 PILE 7 -3 -22.5 0
2000 PILE 8 -3 -13.5 0
2100 PILE 9 -3 -4.5 0
2200 PILE 10 -3 4.5 0
2300 PILE 11 -3 13.5 0
2400 PILE 12 -3 22.5 0
4500 LOAD 1 0 0 725 0 270.2 0
4600 LOAD 2 -195.8 0 493.3 0 1094 0
4700 LOAD 3 -195.8 0 493.3 0 904.4 0
9000 FOUT 1 2 3 4 5 6 7 RR01S.DOC
9100 PFO ALL
9200 PLB ALL
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	ND	Date	Dec-20

CPGA RESULTS with Load Factors

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 11-DEC-20     RUN TIME: 12:18:54



    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.10.49; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE  12 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                    X          Y          Z
                                  -----      -----      -----
WITH DIAGONAL COORDINATES = (     -3.00 ,   -22.50 ,     0.00 )
                            (      3.00 ,    22.50 ,     0.00 )


*******************************************************************************

         PILE PROPERTIES AS INPUT


      E           I1           I2           A           C33          B66
     KSI         IN**4        IN**4        IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         SOIL DESCRIPTIONS AS INPUT
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	ND	Date	Dec-20

```
   ES      ESOIL       LENGTH        L            LU
         K/IN**2                    FT           FT
        0.38050E+00     T       0.42490E+02   0.00000E+00

  ESOIL(ORIGINAL)      RGROUP      RCYCLIC
    K/IN**2
   0.38050E+00        0.1000E+01 0.1000E+01

 THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

     ALL


 ******************************************************************************

          PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


  0.17968E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.23229E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.20410E+04  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


 THIS MATRIX APPLIES TO THE FOLLOWING PILES -

       1


 ******************************************************************************
```

AECOM

Job	Maurepaus Swamp		Project No.	60632162		
Description	Storage Monolith		Computed by	JMH	Date	Dec-20
	River Road Storage Monolith					
	CPGA Input & Output Files (Concrete Design)		Checked by	ND	Date	Dec-20

PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM	X FT	Y FT	Z FT	BATTER	ANGLE	LENGTH FT	FIXITY
1	3.00	-22.50	0.00	6.00	0.00	43.08	P
2	3.00	-13.50	0.00	6.00	0.00	43.08	P
3	3.00	-4.50	0.00	6.00	0.00	43.08	P
4	3.00	4.50	0.00	6.00	0.00	43.08	P
5	3.00	13.50	0.00	6.00	0.00	43.08	P
6	3.00	22.50	0.00	6.00	0.00	43.08	P
7	-3.00	-22.50	0.00	6.00	180.00	43.08	P
8	-3.00	-13.50	0.00	6.00	180.00	43.08	P
9	-3.00	-4.50	0.00	6.00	180.00	43.08	P
10	-3.00	4.50	0.00	6.00	180.00	43.08	P
11	-3.00	13.50	0.00	6.00	180.00	43.08	P
12	-3.00	22.50	0.00	6.00	180.00	43.08	P

516.91							

****

APPLIED LOADS

LOAD CASE	PX K	PY K	PZ K	MX FT-K	MY FT-K	MZ FT-K
1	0.0	0.0	725.0	0.0	270.2	0.0
2	-195.8	0.0	493.3	0.0	1094.0	0.0
3	-195.8	0.0	493.3	0.0	904.4	0.0

****

ORIGINAL PILE GROUP STIFFNESS MATRIX

0.87174E+03	-0.72155E-05	0.90949E-12	-0.14552E-10	-0.14172E+06	0.25976E-03
-0.72155E-05	0.27875E+03	0.47902E-04	0.00000E+00	0.17245E-02	-0.48885E-11
0.90949E-12	0.47902E-04	0.23836E+05	0.11642E-09	0.29104E-10	-0.17245E-02
0.14552E-10	0.00000E+00	0.00000E+00	0.81090E+09	-0.37253E-08	-0.22352E-07
-0.14172E+06	0.17245E-02	0.29104E-10	0.00000E+00	0.30891E+08	-0.62081E-01
0.25976E-03	-0.51159E-11	-0.17245E-02	-0.14901E-07	-0.62081E-01	0.30018E+08

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	ND	Date	Dec-20

```
                    12 PILES    3 LOAD CASES

LOAD CASE    1.  NUMBER OF FAILURES =  12.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    2.  NUMBER OF FAILURES =   6.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    3.  NUMBER OF FAILURES =   6.  NUMBER OF PILES IN TENSION =   0.


*******************************************************************************

         PILE CAP DISPLACEMENTS

LOAD
CASE       DX          DY          DZ          RX          RY          RZ
           IN          IN          IN          RAD         RAD         RAD

   1   0.6714E-01 -0.6044E-08  0.3042E-01  0.6924E-21  0.4130E-03  0.2020E-11
   2  -0.6119E+00 -0.4658E-08  0.2070E-01  0.3657E-22 -0.2382E-02  0.1557E-11
   3  -0.6590E+00 -0.4085E-08  0.2070E-01 -0.4493E-21 -0.2672E-02  0.1365E-11


*******************************************************************************
              ELASTIC CENTER INFORMATION


ELASTIC CENTER IN PLANE X-Z          X             Z
                                    FT            FT
                                   0.00          0.00


*******************************************************************************

         PILE FORCES IN LOCAL GEOMETRY

             M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
             * INDICATES PILE FAILURE
             # INDICATES CBF BASED ON MOMENTS DUE TO
                         (F3*EMIN) FOR CONCRETE PILES
             B INDICATES BUCKLING CONTROLS
```

Job	Maurepaus Swamp		Project No.	60632162		
Description	Storage Monolith		Computed by	JMH	Date	Dec-20
	River Road Storage Monolith					
	CPGA Input & Output Files (Concrete Design)		Checked by	ND	Date	Dec-20

LOAD CASE - 1

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF	
1	1.1	0.0	53.8	0.0	-34.8	0.0	1.08	0.14	*
2	1.1	0.0	53.8	0.0	-34.8	0.0	1.08	0.14	*
3	1.1	0.0	53.8	0.0	-34.8	0.0	1.08	0.14	*
4	1.1	0.0	53.8	0.0	-34.8	0.0	1.08	0.14	*
5	1.1	0.0	53.8	0.0	-34.8	0.0	1.08	0.14	*
6	1.1	0.0	53.8	0.0	-34.8	0.0	1.08	0.14	*
7	-1.3	0.0	68.6	0.0	40.3	0.0	1.37	0.18	*
8	-1.3	0.0	68.6	0.0	40.3	0.0	1.37	0.18	*
9	-1.3	0.0	68.6	0.0	40.3	0.0	1.37	0.18	*
10	-1.3	0.0	68.6	0.0	40.3	0.0	1.37	0.18	*
11	-1.3	0.0	68.6	0.0	40.3	0.0	1.37	0.18	*
12	-1.3	0.0	68.6	0.0	40.3	0.0	1.37	0.18	*

LOAD CASE - 2

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF	
1	-11.2	0.0	9.0	0.0	339.4	0.0	0.18	0.36	
2	-11.2	0.0	9.0	0.0	339.4	0.0	0.18	0.36	
3	-11.2	0.0	9.0	0.0	339.4	0.0	0.18	0.36	
4	-11.2	0.0	9.0	0.0	339.4	0.0	0.18	0.36	
5	-11.2	0.0	9.0	0.0	339.4	0.0	0.18	0.36	
6	-11.2	0.0	9.0	0.0	339.4	0.0	0.18	0.36	
7	11.0	0.0	74.3	0.0	-335.7	0.0	1.49	0.49	*
8	11.0	0.0	74.3	0.0	-335.7	0.0	1.49	0.49	*
9	11.0	0.0	74.3	0.0	-335.7	0.0	1.49	0.49	*
10	11.0	0.0	74.3	0.0	-335.7	0.0	1.49	0.49	*
11	11.0	0.0	74.3	0.0	-335.7	0.0	1.49	0.49	*
12	11.0	0.0	74.3	0.0	-335.7	0.0	1.49	0.49	*

Job	Maurepaus Swamp		Project No.	60632162		
Description	Storage Monolith		Computed by	JMH	Date	Dec-20
	River Road Storage Monolith					
	CPGA Input & Output Files (Concrete Design)		Checked by	ND	Date	Dec-20

LOAD CASE - 3

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF	
1	-12.0	0.0	14.2	0.0	365.7	0.0	0.28	0.40	
2	-12.0	0.0	14.2	0.0	365.7	0.0	0.28	0.40	
3	-12.0	0.0	14.2	0.0	365.7	0.0	0.28	0.40	
4	-12.0	0.0	14.2	0.0	365.7	0.0	0.28	0.40	
5	-12.0	0.0	14.2	0.0	365.7	0.0	0.28	0.40	
6	-12.0	0.0	14.2	0.0	365.7	0.0	0.28	0.40	
7	11.9	0.0	69.1	0.0	-362.0	0.0	1.38	0.50	*
8	11.9	0.0	69.1	0.0	-362.0	0.0	1.38	0.50	*
9	11.9	0.0	69.1	0.0	-362.0	0.0	1.38	0.50	*
10	11.9	0.0	69.1	0.0	-362.0	0.0	1.38	0.50	*
11	11.9	0.0	69.1	0.0	-362.0	0.0	1.38	0.50	*
12	11.9	0.0	69.1	0.0	-362.0	0.0	1.38	0.50	*

****

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	10.0	0.0	52.9	0.0	0.0	0.0
2	10.0	0.0	52.9	0.0	0.0	0.0
3	10.0	0.0	52.9	0.0	0.0	0.0
4	10.0	0.0	52.9	0.0	0.0	0.0
5	10.0	0.0	52.9	0.0	0.0	0.0
6	10.0	0.0	52.9	0.0	0.0	0.0
7	-10.0	0.0	67.9	0.0	0.0	0.0
8	-10.0	0.0	67.9	0.0	0.0	0.0
9	-10.0	0.0	67.9	0.0	0.0	0.0
10	-10.0	0.0	67.9	0.0	0.0	0.0
11	-10.0	0.0	67.9	0.0	0.0	0.0
12	-10.0	0.0	67.9	0.0	0.0	0.0

Job	Maurepaus Swamp		Project No.	60632162		
Description	Storage Monolith		Computed by	JMH	Date	Dec-20
	River Road Storage Monolith					
	CPGA Input & Output Files (Concrete Design)		Checked by	ND	Date	Dec-20

LOAD CASE - 2

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-9.5	0.0	10.7	0.0	0.0	0.0
2	-9.5	0.0	10.7	0.0	0.0	0.0
3	-9.5	0.0	10.7	0.0	0.0	0.0
4	-9.5	0.0	10.7	0.0	0.0	0.0
5	-9.5	0.0	10.7	0.0	0.0	0.0
6	-9.5	0.0	10.7	0.0	0.0	0.0
7	-23.1	0.0	71.5	0.0	0.0	0.0
8	-23.1	0.0	71.5	0.0	0.0	0.0
9	-23.1	0.0	71.5	0.0	0.0	0.0
10	-23.1	0.0	71.5	0.0	0.0	0.0
11	-23.1	0.0	71.5	0.0	0.0	0.0
12	-23.1	0.0	71.5	0.0	0.0	0.0

LOAD CASE - 3

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-9.5	0.0	16.0	0.0	0.0	0.0
2	-9.5	0.0	16.0	0.0	0.0	0.0
3	-9.5	0.0	16.0	0.0	0.0	0.0
4	-9.5	0.0	16.0	0.0	0.0	0.0
5	-9.5	0.0	16.0	0.0	0.0	0.0
6	-9.5	0.0	16.0	0.0	0.0	0.0
7	-23.1	0.0	66.2	0.0	0.0	0.0
8	-23.1	0.0	66.2	0.0	0.0	0.0
9	-23.1	0.0	66.2	0.0	0.0	0.0
10	-23.1	0.0	66.2	0.0	0.0	0.0
11	-23.1	0.0	66.2	0.0	0.0	0.0
12	-23.1	0.0	66.2	0.0	0.0	0.0

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Summary of Shear & Moment	Checked by	ND	Date	Dec-20
					References

Load Case	$V_{u,max}$ (kip/ft)	$M_{u,max}$ (kip/ft)
LC1	0.00	0.00
LC2	1.59	2.98
LC3	1.59	2.98

*Note: LC 1 only has vertical forces, so there is no shear or moment on the wall.

The following calculations are the max shear (Vu) and moment (Mu) on the wall form LC 2 and LC 3:

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JOB TITLE Maurepas WSLP Structures – River Road
PROJECT/JOB NO. CALCULATION NO.
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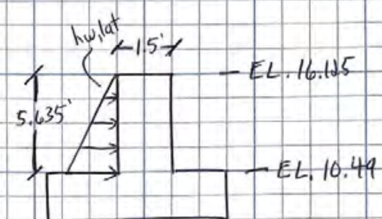
SCALE SHEET NO. 1 OF

Wall Calculations:

Assumptions:

* These calculations only show the loading condition for water to TOW (LC 2 & 3)

$t = 1.5' = 18''$
cover $= 3''$
$d = 18'' - 3'' - .75''$ → Assume #6 bars
$b = 12''$
$\phi_{shear} = .75$
$\phi_{moment} = .9$
$F_y = 60$ ksi
$f'_c = 4$ ksi



(1) Shear Calculations:

hw,lat

$$V_u = \frac{1}{2}(\gamma_{water})(H^2) = \frac{1}{2}(.0624\ K/ft^3)(5.635')^2$$

$$V_u = .991\ kip/ft$$

$$1.6\,V_u = \boxed{1.59\ kip/ft = V_u \text{ on } 1' \text{ of wall}}$$

(2) Moment Calculations:

$$M_u = V_u\left(\frac{H}{3}\right) = (1.59)\left(\frac{5.635'}{3}\right) = \boxed{2.98\ \frac{k\text{-}ft}{ft} = M_u \text{ on } 1' \text{ of wall}}$$

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Shear & Moment Check for Wall	Checked by	ND	Date	Dec-20
					References

*** Given Information:**

Wall Thickness:	1.50	ft
Clear Cover:	0.25	ft
Diameter Bar to Start:	0.06	ft
Maximum Shear (V_u):	1.59	kips per foot
Maximum Moment (M_u):	2.98	kip-ft per foot
φ_{shear} =	0.75	(ACI 318)
φ_{moment} =	0.9	(ACI 318)
$f_{y,\ rebar}$ =	60	ksi
f'_c =	4	ksi

*** Shear Calculations:**

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u) (ACI Eq. 11-1)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75	
f'_c =	4	ksi
b =	1	ft strip
d =	1.22	ft

φV_c =	16649.4	lbs	
	16.65	kips	** φVc=16.6 ≥ Vu=1.6, Shear Capacity OK

*** Reinforcement Calculations:**

Limit of Maximum Reinforcement: 0.25 x ρ_b (Design Criteria, EM 1110-2-2104, 3-5)

where ρ_b =	0.0285	for f'_c = 4,000psi, fy = 60,000psi
Max Rebar =	0.00713	*b * d

Maximum Reinforcement:	0.0071	* b * d =	1.25	in^2	per 1ft strip

A_{gross} = 1.5 ft * 12 in/ft * 12 in strip = 216.00 in^2

Limits of Minimum Reinforcement:	0.005 x Agross =	1.08	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
	$(3*\sqrt{(f'_c)}*b*d)/f_y$ =	0.55	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)
	$(200*b*d)/f_y$ =	0.59	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)

Min Reinforcement, temp & shrinkage:	0.54	in^2	per 1ft strip, per face
Min Reinforcement, flexural:	0.59	in^2	per 1ft strip, per face

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Shear & Moment Check for Wall	Checked by	ND	Date	Dec-20
				References	

*** Moment Calculations:**

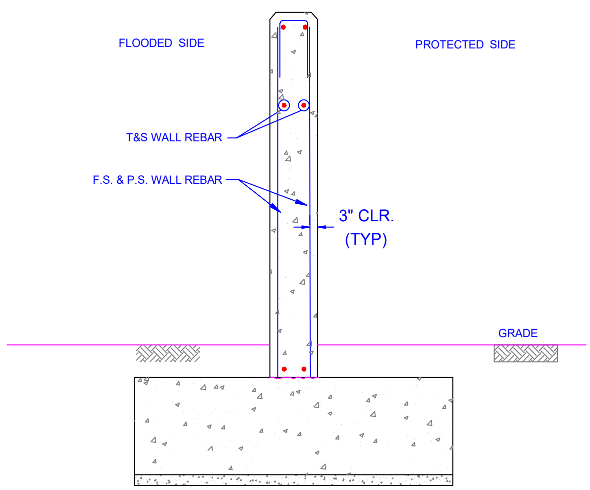
* $T = A_s \times f_y$
* $C = 0.85 \times f'_c \times a \times b$
* Assuming Tension = Compression $\longrightarrow$ $A_s \times f_y = 0.85 \times f'_c \times a \times b$
* $\varphi Mn = \varphi \times T \times (d - (a / 2))$
$= \varphi \times A_s \times f_y \times (d - (a / 2))$

* Capacity of Min Flexural Reinforcement:

A_s =	0.585	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	1.21875	
φ_{moment} =	0.9	

$a = (A_s \times f_y) / (0.85 \times f'_c \times b)$
= 0.860 in

φM_n =	448.4	kip-in
=	37.37	kip-ft



* Capacity of Maximum Reinforcement:

A_s =	1.250	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	1.22	
φ_{moment} =	0.9	

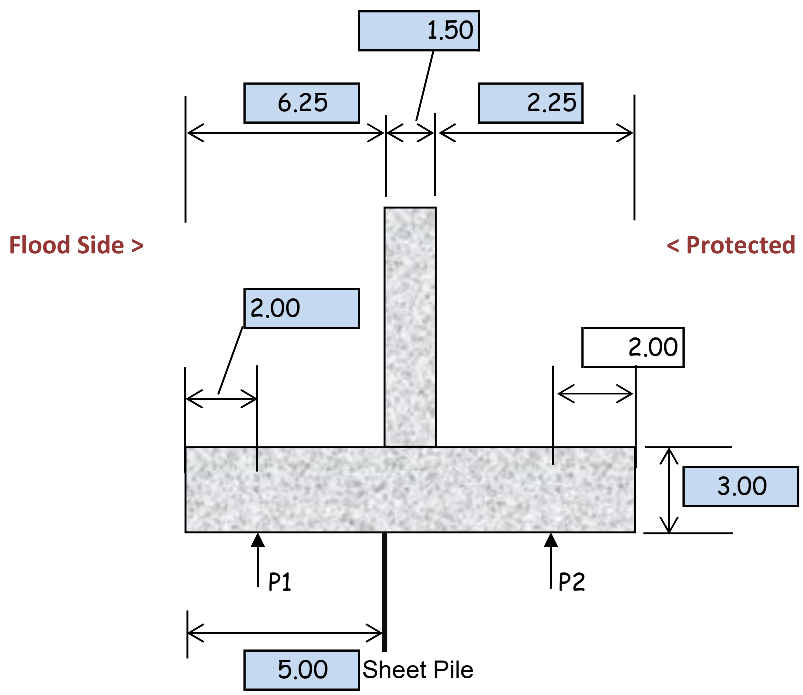
$a = (A_s \times f_y) / (0.85 \times f'_c \times b)$
= 1.839 in

φMn =	925.4	kip-in
=	77.12	kip-ft

**** φMn=77.1 ≥ Mu=3, Section OK**

The minimum proposed reinforcement for T&S Wall Rebar is #6 @ 9" (A = 0.59 in^2) and the minimum proposed reinforcement for F.S. & P.S. Wall Rebar is #6 @ 9"(A=0.59 in^2).

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Slab	Checked by	ND	Date	Dec-20
					References



Tributary width (pile spacing): 9 ft Referred to as "width" in calculations

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Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Slab Calculations	Checked by	ND	Date	Dec-20
					References

*Note: The following calculations represent the total shear (Vu) and moment (Mu) on both sides of the slab for all load cases. Capacity calculations for the slab can be found in the "Slab Conc Check" tab. All reactions are taken from the pinned or fixed results from CPGA.

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JOB TITLE Maurepas WSLP Structures - River Road
PROJECT/JOB NO. CALCULATION NO.
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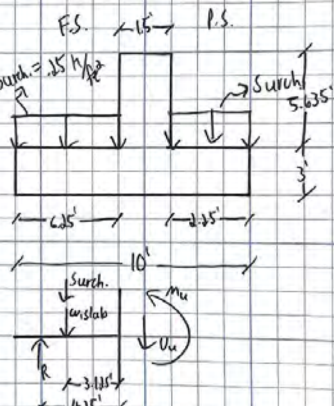
SCALE SHEET NO. 2 OF

Slab Calculations:

① Construction Surcharge

→ Concrete wt.
→ Surcharge = .25 k/ft²
→ Assume 9' of trib. length between piles
→ $\gamma_{conc.}$ = .15 k/ft³



Flood Side:

↗ from pinned results, less compression produces higher shear

V_u → R = ~~[illegible]~~ 33.1 kip from CPGA

w, slab = (6.25')(9')(3')(.15 kcf)

w, slab = 25.31 kip

Surcharge = (.25 ksf)(6.25')(9')

Surcharge = 14.06 kip

V_u = 14.06 + 25.31 − ~~[illegible]~~ 33.1

V_u = 6.27 kip

$1.6 V_u = \frac{10.03 \text{ kip}}{9'}$ = 1.115 kip/ft = V_u

9' → trib. length

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Slab Calculations	Checked by	ND	Date	Dec-20
					References

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JOB TITLE

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SCALE SHEET NO. 3 OF

$M_u \rightarrow$ R = 33.1 kip @ 4.25' ⊖

w,slab = 25.31 kip @ 3.125' ⊕

Surch. = 14.06 kip @ 3.125' ⊕

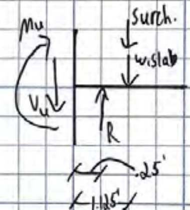
$M_u = (14.06)(3.125) + (25.31)(3.125) - (33.1)(4.25)$

$M_u = -17.64$ kip-ft

$1.6 M_u = \frac{-28.23 \text{ k-ft}}{9'} = -3.14 \frac{\text{k-ft}}{\text{ft}} = M_u$

9' → trib length

Protected Side:



$V_u \rightarrow$ R = 42.5 kip from CPGA

w,slab = (2.25')(9')(3')(.15 kcf)

w,slab = 9.11 kip

Surcharge = (.25 ksf)(9')(2.25')

Surcharge = 5.06 kip

$V_u = 9.11 + 5.06 - 42.5$

$V_u = -28.33$ kip

$1.6 V_u = \frac{-45.32 \text{ kip}}{9'} = -5.04 \text{ kip/ft} = V_u$

9' → trib. length

$M_u \rightarrow$ R = 42.5 kip @ .25' ⊖

w,slab = 9.11 kip @ 1.125' ⊕

Surch. = 5.06 kip @ 1.125' ⊕

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Slab Calculations	Checked by	ND	Date	Dec-20
					References

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JOB TITLE
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SCALE SHEET NO. 4 OF

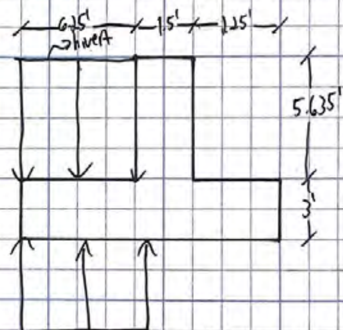
$M_u = (9.11)(1.125) + (5.06)(1.125) - (42.5)(.25)$

$M_u = 5.32$ kip-ft

$1.6 M_u = \frac{8.51 \text{ kip-ft}}{9'} = .95 \frac{\text{kip-ft}}{\text{ft}} = M_u$

9' → trib. length

2. Water to TOW (impervious)
→ concrete wt.
→ h,lat can be ignored
→ h,vert
→ uplift, impervious (assume sheet pile to be at middle of slab)
→ assume 9' of trib. length between piles



Flood Side:

V_u → R = −1.3 kip from CPGA

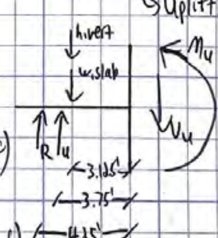
w,slab = 25.31 kip (see LC1 calcs)

h,vert = (5.635')(9')(6.25')(.0624 kcf)

h,vert = 19.76 kip

uplift = (8.635')(9')(5')(.0624 kcf)

Uplift = 24.25 kip



4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Slab Calculations	Checked by	ND	Date	Dec-20
					References

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JOB TITLE
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SCALE SHEET NO. 5 OF

$V_u = 1.3 + 25.31 + 19.78 - 24.25$

$V_u = 22.14$ Kip

$1.6V_u = \frac{35.42 \text{ kip}}{9'} = 3.94 \text{ K/ft} = V_u$

9' → trib. length

$M_u \longrightarrow R = -1.3k$ @ 4.25' (+)

$w_{slab} = 25.31$ Kip @ 3.125' (+)

$h_{vert} = 19.78$ Kip @ 3.125' (+)

uplift = 24.25 Kip @ 3.75' (−)

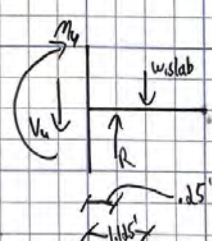
$M_u = (1.3)(4.25) + (25.31)(3.125) + (19.78)(3.125) - (24.25)(3.75)$

$M_u = 55.49$ kip-ft

$1.6M_u = \frac{88.79 \text{ kip-ft}}{9'} = 9.87 \frac{\text{k-ft}}{\text{ft}} = M_u$

9' → trib. length

Protected Side:



$V_u \rightarrow R = 52.7$ Kip from CPGA

$w_{slab} = 9.11$ Kip (see LC I calcs)

$V_u = 9.11 - 52.7$

$V_u = -43.59$ Kip

$1.6V_u = \frac{-69.74 \text{ Kip}}{9'} = -7.75 \text{ Kip/ft} = V_u$

9' → trib. length

4x4 = 1 in

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Slab Calculations	Checked by	ND	Date	Dec-20
					References

JOB TITLE
PROJECT/JOB NO. CALCULATION NO.
COMPUTED BY JH DATE
VERIFIED BY DATE
SCALE SHEET NO. 6 OF

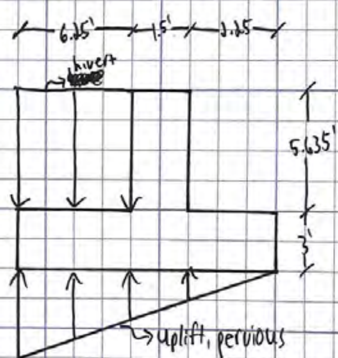
$M_u \rightarrow R = 52.7$ kip @ $.25'$ ⊖
$w_{,slab} = 9.11$ kip @ $1.125'$ ⊕

$M_u = (9.11)(1.125) - (52.7)(.25)$

$M_u = -2.93$ kip-ft

$1.6 M_u = \frac{-4.68 \text{ kip-ft}}{9'} = -.52 \frac{\text{k-ft}}{\text{ft}} = M_u$

9' → trib. length



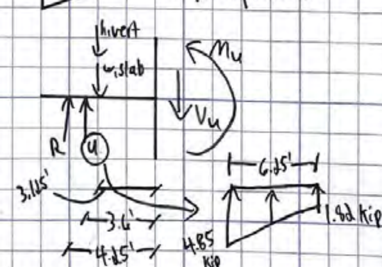
3. Water to TOW (pervious)

→ conc. wt.
→ h,lat can be ignored
→ h,vert
→ uplift, pervious
→ Assume 9' of trib. length between piles

Flood Side:

$V_u \rightarrow R = 1.3$ kip from CPGA
$w_{,slab} = 25.31$ kip (see LC1 calcs)
$h_{,vert} = 19.78$ kip (see LC2 calcs)
$\text{Uplift} = \left(\frac{4.45 + 1.42}{2}\right) 6.25'$

$\text{Uplift} = 20.84$ kip



4x4 = 1 in

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Slab Calculations	Checked by	ND	Date	Dec-20
					References

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SCALE SHEET NO. 7 OF

$V_u = 25.31 + 19.78 - 1.3 - 20.84$

$V_u = 22.95$ kip

$1.6V_u = \dfrac{36.72 \text{ kip}}{9'} = 4.08$ kip/ft $= V_u$

9' → trib. length

M_u → R = 1.3 kip @ 4.25' (−)

w_{slab} = 25.31 kip @ 3.125' (+)

h_{vert} = 19.78 kip @ 3.125' (+)

Uplift = 20.84 kip @ 3.6' (−)

$M_u = (25.31)(3.125) + (19.78)(3.125) - (1.3)(4.25) - (20.84)(3.6)$

$M_u = 60.36$ kip-ft

$1.6M_u = \dfrac{96.57 \text{ k-ft}}{9'} = 10.73 \dfrac{\text{kip-ft}}{\text{ft}} = M_u$

9' → trib. length

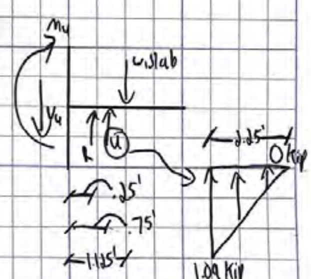
Protected Side:

V_u → R = 50.1 kip from CPGA

w_{slab} = 9.11 kip (see LC1 calcs)

Uplift $= \frac{1}{2}bh = \frac{1}{2}(1.09)(2.25)$

Uplift = 1.23 kip



$V_u = 9.11 - 50.1 - 1.23$

$V_u = -42.22$ kip

$1.6V_u = -67.55 \text{ kip}/9' = -7.51$ kip/ft $= V_u$

9' → trib. length

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Slab Calculations	Checked by	ND	Date	Dec-20
					References

AECOM Imagine it. Delivered.

JOB TITLE

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SCALE SHEET NO. 4 OF

$M_u \rightarrow R = 50.1\,k$ @ $.25'$ $\ominus$

$w_{slab} = 9.11$ kip @ $1.125'$ $\oplus$

$Uplift = 1.23$ kip @ $.75'$ $\ominus$

$M_u = (9.11)(1.125) - (50.1)(.25) - (1.23)(.75)$

$M_u = -3.20$ k-ft

$1.6M_u = \dfrac{-5.12 \text{ k-ft}}{9'} = -.57 \dfrac{\text{k-ft}}{\text{ft}}$

$9' \rightarrow$ trib. length

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Slab Conc. Check	Checked by	ND	Date	Dec-20
					References

*** Given Information:**

Slab Thickness:	3.00	ft				
Slab Width:	10.00	ft				
Clear Cover:	0.75	ft				
Diameter Bar to Start:	0.09	ft				
Diameter of Pile:	1.13	ft				
			Load Fact.			
Maximum Pile Reaction:	71.50	kips	1	71.50	kips	*From Factored CPGA Results
Maximum Shear:	7.75	kips				
Maximum Moment (Top):	10.73	kip-ft				
Maximum Moment (Bottom):	3.14	kip-ft				

φ_{shear} =	0.75	(ACI 318)
φ_{moment} =	0.9	(ACI 318)
$f_{y, rebar}$ =	60	ksi
f'_c =	4	ksi

*** Shear Calculations:**

1- Shear Capacity:

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75			
f'_c =	4	ksi		
b =	1	ft strip		
d =	2.20	ft	26.44	in

φV_c =	30095.3	lbs	
	30.10	kips	** φVc=30.1 ≥ Vu=7.8, **Shear Capacity OK**

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Slab Conc. Check	Checked by	ND	Date	Dec-20
					References

2- Punching Shear Capacity (ACI 318-14 Table 22.6.5.2):

Vc = minimum value = Eq. a: $4 \times \sqrt{f'_c} \times b_0 \times d$ for $\beta_c < 2.0$

Eq. b: $(2 + (4 / \beta_c)) \times \sqrt{f'_c} \times b_0 \times d$ for $\beta_c > 2.0$

Eq. c: $((\alpha_s \times d) / b_0 + 2) \times \sqrt{f'_c} \times b_0 \times d$ b_0 / d effect based on α_s

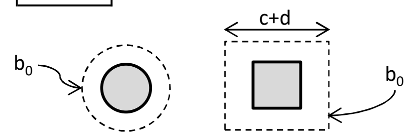
(interior column: α_s = 40, edge column: α_s = 30, corner column: α_s = 20)

d for piles = 26.436 in (Slab thickness - 9" pile embed - cover - $0.5d_{bar}$)

where β_c = Long side / Short side = 1

b_0 = Perimeter of Critical Section = $\pi*(D_{pile} + d)$ = 125.777

α_s = 20 (worst case - corner column)



Vc = minimum value = Eq. a: 841.17 kips

Eq. b: 1261.76 kips

Eq. c: 1304.59 kips

φV_c = 630.88 kips

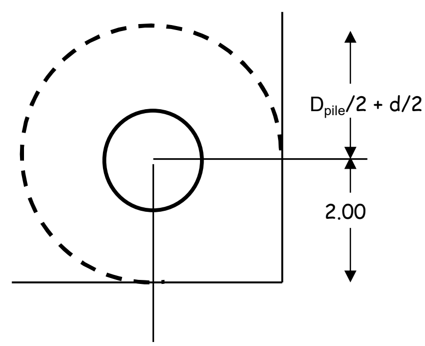
Check corner pile failure to edge of slab:

$D_{pile}/2+d/2$ = 1.67 ft

Diameter of corner failure = 1.668 + 2 ft

= 3.67 ft

Dia. punching shear calc above = 3.34



Diameter of punching shear calculation is smaller than the diameter of this corner failure area. Therefore, no re-check of corner punching failure is required.

φVc used in design = 30.10 kips

** φVc = 30.1k ≥ Vu = 7.8k, Shear Capacity OK

Maximum Pile Reaction = 71.50

** φVc=631k ≥ Vu=72k, Punching Shear Capacity OK

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Slab Conc. Check	Checked by	ND	Date	Dec-20
				References	

3- Deep Beam One-Way Shear Capacity (φV_{c1}):

For $(w/d) \geq 1.0$, a one-way (normal) shear investigation with loads outside the critical section (located at a distance d from the face of the column, b = footing width) and

$$v_c = 1.9\sqrt{f'_c} + 2500\rho_w\left(\frac{V_u d}{M_u}\right) \geq 2\sqrt{f'_c} \quad \text{(ACI Eq. 11-5)}$$

which reduces for $\rho_w \approx 0.002$ and 3,000 psi $\leq f'_c \leq$ 4,000 psi to $v_c = 1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}(V_u d/M_u) \geq 2\sqrt{f'_c}$.

For $(w/d) < 1.0$, $1.0 > M_u/V_u d > 0$; $\infty > V_u d/M_u \geq 1.0$ (no limits on M_u, $V_u d$, other than above)

$$v_c = \left(\frac{d}{w}\right)\left[3.5 - 2.5\left(\frac{M_u}{V_u d}\right)\right]\left[1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}\left(\frac{V_u d}{M_u}\right)\right] \leq 10\sqrt{f'_c} \quad \text{(ACI Eq. 13-2)}$$

w = 0.5 ft — Distance from CL pile to face of Wall + 3" lateral installation tolerance

M_u = 10.73 kip-ft
V_u = 7.75 kips

v_c = 1106.7 psi ≤ 10 x √f'c = 632.5 psi limit on shear strength
φV_{c1} = 150.48 kips — ** φVc=150.5 ≥ Vu=7.8, OK

Therefore, Slab is OK for shear forces found in slab analysis.

<u>* Reinforcement Calculations:</u>

Limit of Maximum Reinforcement: 0.25 x ρ_b (Design Criteria, EM 1110-2-2104, 3-5)
where ρ_b = 0.0285 for f'_c = 4,000psi, fy = 60,000psi
Max Rebar = 0.00713 *b * d

Maximum Reinforcement:	0.0071	* b * d =	2.26	in^2	per 1ft strip

A_{gross} = 3 ft * 12 in/ft * 12 in strip = 432.00 in^2

Limits of Minimum Reinforcement:			
0.005 x Agross =	2.16	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
$(3*\sqrt{(f'_c)}*b*d)/f_y$ =	1.00	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)
$(200*b*d)/f_y$ =	1.06	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)

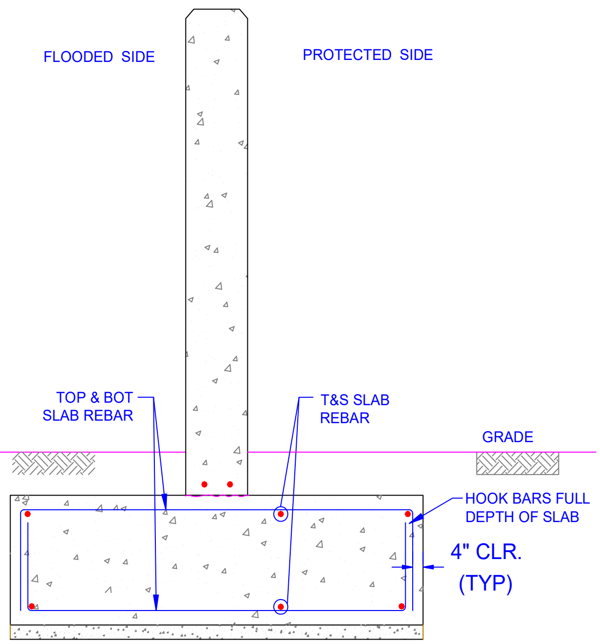
Min Reinforcement, temp & shrinkage:	1.08	in^2	per 1ft strip, per face
Min Reinforcement, flexural:	1.06	in^2	per 1ft strip, per face

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Storage Monolith	Computed by	JMH	Date	Dec-20
	River Road Storage Monolith				
	Slab Conc. Check	Checked by	ND	Date	Dec-20
					References

* Moment Calculations:

* $T = A_s \times f_y$
* $C = 0.85 \times f'_c \times a \times b$
* Assuming Tension = Compression ⟶ $A_s \times f_y = 0.85 \times f'_c \times a \times b$
* $\varphi Mn = \varphi \times T \times (d - (a / 2))$
 $= \varphi \times A_s \times f_y \times (d - (a / 2))$



* Capacity of Min Flexural Reinforcement:

A_s =	1.057	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	2.203	
φ_{moment} =	0.9	

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$
= 1.555 in

φM_n =	1465.1	kip-in
=	122.10	kip-ft

* Capacity of Maximum Reinforcement:

A_s =	2.260	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	2.20	
φ_{moment} =	0.9	

The minimum proposed reinforcement for to T&S Slab Rebar is #7 @ 6"(A =1.2in2) and the minimum proposed reinforcment for Top & Bot Slab Rebar is #7 @ 6"(A =1.2in2).

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$
= 3.324 in

φMn =	3023.8	kip-in
=	251.98	kip-ft

** $\varphi Mn=252 \geq Mu=10.7$, Section OK	TOP
** $\varphi Mn=252 \geq Mu=3.1$, Section OK	Bottom

Maurepaus Swamp

CN-02 (Represents CN-01)

CN Gate Storage Monolith

AECOM Project : 60632162

Foundation, Wall & Slab

AECOM

1555 Poydras Street

Suite 1200

New Orleans, LA 70112

(504) 586-8111

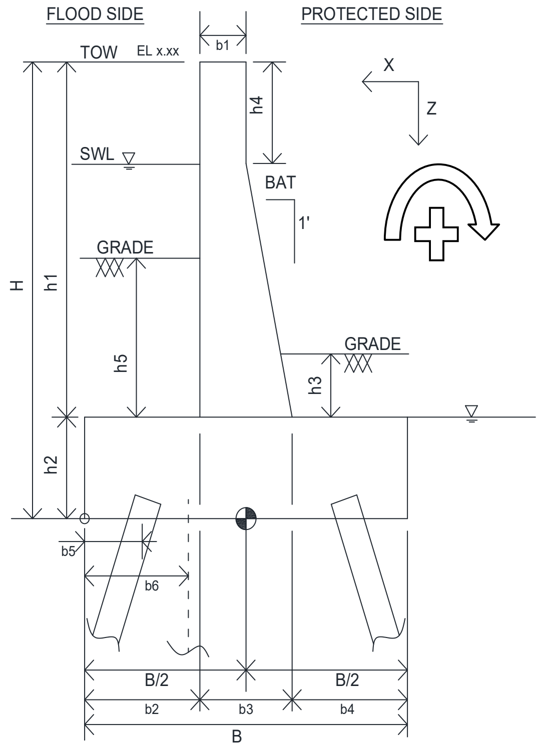
Computed by:	JMH	Checked by:	JRA
Date:	Dec-20	Date:	Dec-20

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	Wall Geometry	Checked by	JRA	Date	Dec-20

References

WALL GEOMETRY:

Top of Pilaster EL.	16.13	NAVD88
Top of Wall EL.	16.13	NAVD88
100 Yr. Water El.		NAVD88
10 Yr. Water El.		NAVD88
Top of Slab EL.	11.98	NAVD88
H=	7.15	ft.
h1=	4.15	ft.
h2=	3.00	ft. (Base Slab Height)
h3=	0.00	ft. (P.S. Soil Height)
h4=	0.00	ft.
h5=	0.00	ft. (F.S. Soil Height)
B=	10.00	ft. (Base Slab Width)
b1=	1.50	ft. (Wall Stem Width, top)
b2=	5.25	ft. (F.S. Slab Width)
b3=	1.50	ft. (Wall Stem Width, bottom)
b4=	3.25	ft. (P.S. Slab Width)
b5=	2.00	ft. (F.S. Pile Row Edge Space)
b6=	6.00	ft. (Sheet Pile Edge Space)
BAT=	0.00	(Wall Batter, N/A)
PS Grade =	11.98	NAVD88 (Average of PS soil for all)
Monolith Length =	46.00	ft
Bottom Of Slab =	8.98	NAVD88



T-WALL CROSS-SECTION

Notes: 1) positive 'Y' axis is into page

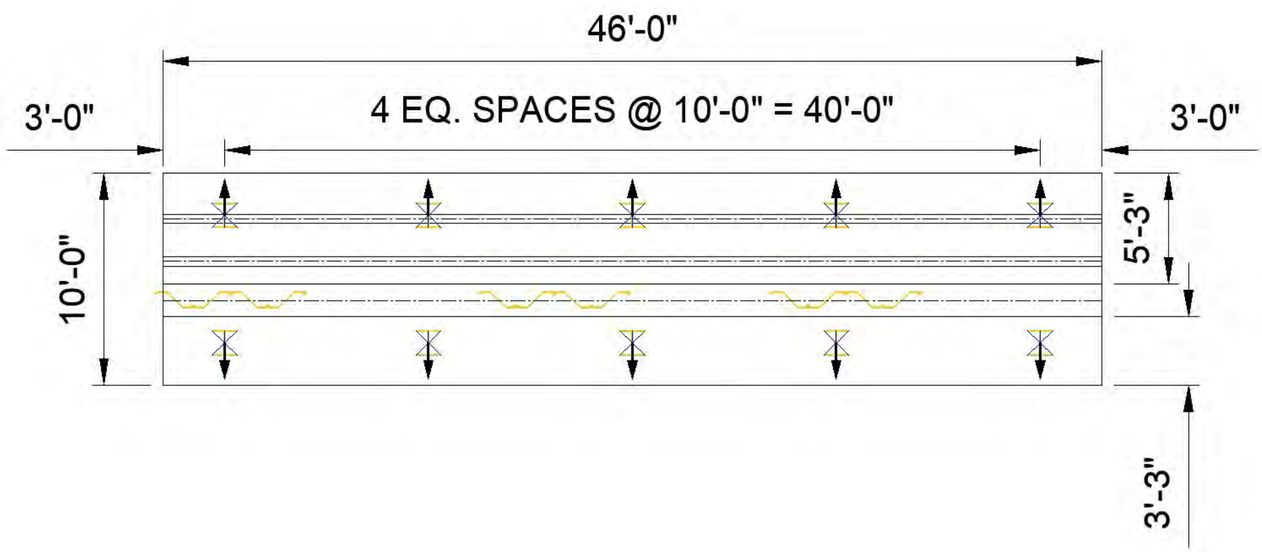
2) pile batters vary from those shown in diagram

Note: In this report, white boxes are for input data and colored boxes are calculated values.

Note: CN-01 and CN-02 have been deemed to be equal and opposite.

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	Applied Loads in SAP Model	Checked by	JRA	Date	Dec-20
					References

Pile and Pilaster Layout:



AECOM

Job	**Maurepaus Swamp**	**Project No.**	**60632162**		
Description	**CN-02 (Represents CN-01)**	**Computed by**	**JMH**	**Date**	**Dec-20**
	CN Gate Storage Monolith				
	Assumptions	**Checked by**	**JRA**	**Date**	**Dec-20**

References

Unit Weight of Storm Water =	0.0624	kcf	
Wet Unit Weight of Soil =	0.1200	kcf	
Sat Unit Weight of Soil =	0.0576	kcf	
Unit Weight of Concrete =	0.1500	kcf	
Impact Load =	0.0000	k/ft	
FS Wind force above SWL=	0.0500	ksf	
Construction Surcharge Pressure =	0.2500	ksf	
Unbalanced Load for Stability Analysis:			
F_{cap} (k/ft) =	0.00	(10y SWL Case; Force acts at bottom of slab)	
F_{cap} (k/ft) =	0.00	(100y SWL Case; Force acts at bottom of slab)	
F_{cap} (k/ft) =	0.00	(Water to TOW Case; Force acts at bottom of slab)	
K_0, Granular fill =	0.95	(for lateral soil forces)	
Assumed Wall Reinforcement Cover =	0.25	ft	
Assumed Wall d_{bar} =	0.06	ft	
Gate Length =	93.12	ft	
Gate Opening =	89.12	ft	*Tributary Length = 44.56'
Gate Weight =	22.35	kip	*Taken from similar roller gate from Hoboken project.

AECOM

Job Maurepaus Swamp — Project No. 60632162

Description CN-02 (Represents CN-01) — Computed by JMH — Date Dec-20

CN Gate Storage Monolith

Load Cases — Checked by JRA — Date Dec-20

References

No. of Load Cases	3	Update

No.	DCD LC No.	Description	FS Water El.	PS Water El.	Pile Design Over Stresses
1	1	Construction Surcharge	8.98	8.98	1.17
2	2a	Water to TOW (impervious cutoff)	16.13	8.98	1.33
3	2b	Water to TOW (pervious cutoff)	16.13	8.98	1.33

* Impact load is not applicable for this section, so it is excluded from the load combinations
* Forces induced by 10y water elevation are not applicable for this section, so they are excluded from the load combinations

*Earthquake and Wave Loads are to be determined and are excluded from these calculations

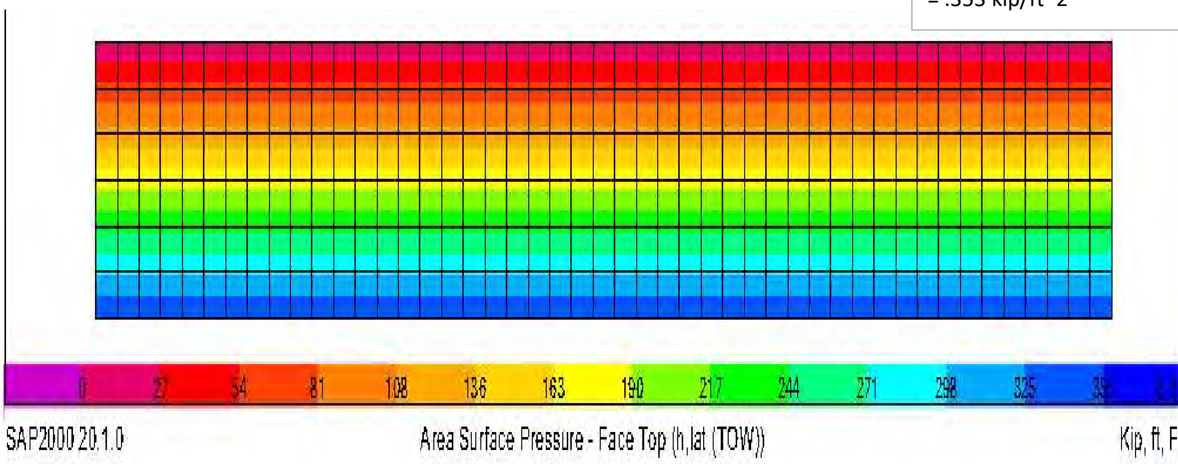
AECOM

Job	**Maurepaus Swamp**	**Project No.**	**60632162**		
Description	**CN-02 (Represents CN-01)**	**Computed by**	**JMH**	**Date**	**Dec-20**
	CN Gate Storage Monolith				
	Applied Loads in SAP Model	**Checked by**	**JRA**	**Date**	**Dec-20**

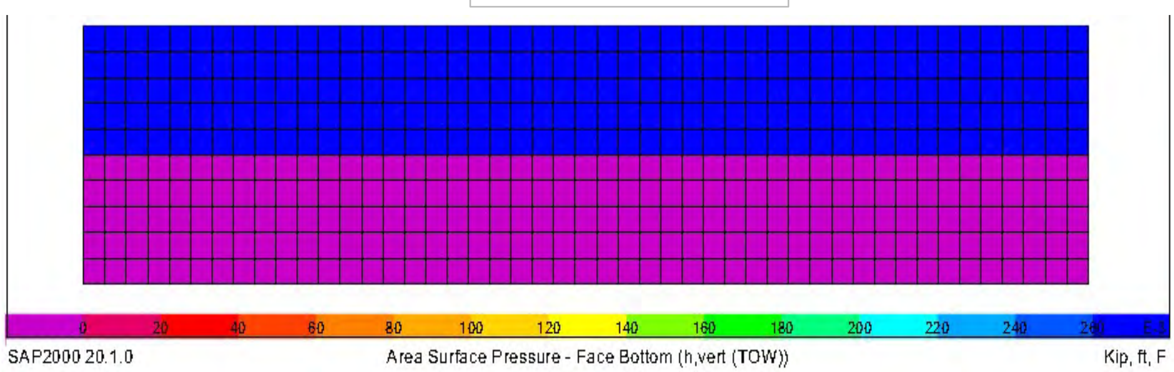
References

*The following diagrams represent the loads applied in the SAP Model; base reactions were taken from SAP to plug into CPGA to get the pile reactions of the

h,lat (TOW) =
(16.13-10.48)' * .0624k/ft^3
= .353 kip/ft^2



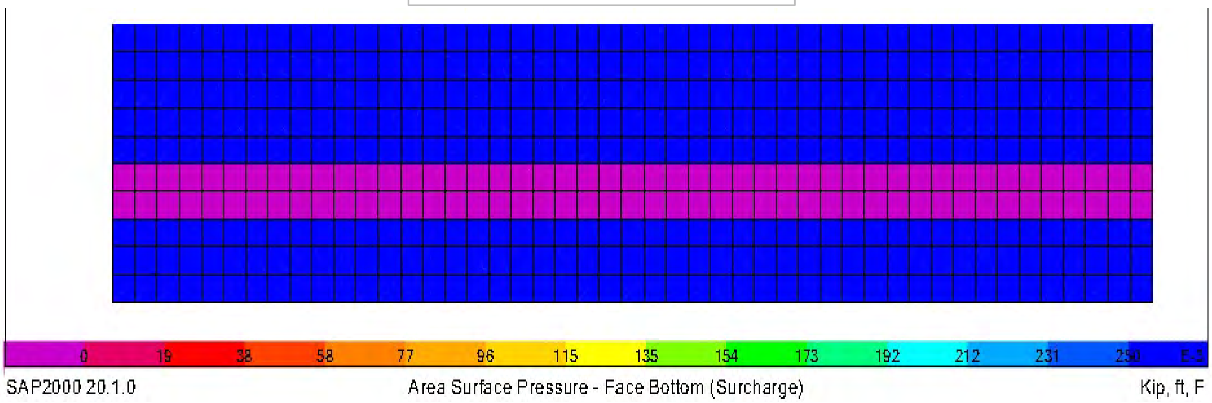
h,vert (TOW) =
(16.13-11.98)' * .0624k/ft^3 =
.260 kip/ft^2



Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	Applied Loads in SAP Model	Checked by	JRA	Date	Dec-20

References

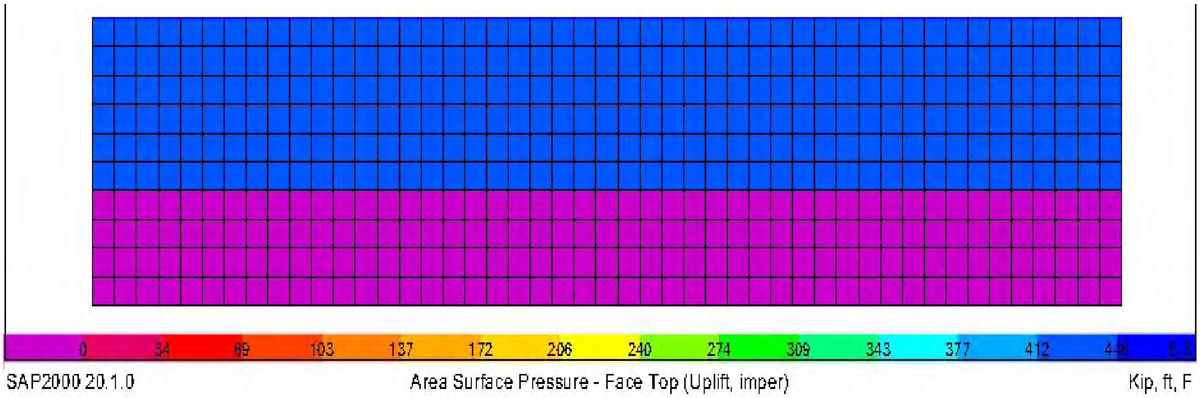
A surcharge of .25 kip/ft^2 is applied to both protected and flood sides of slab. See Assumptions page



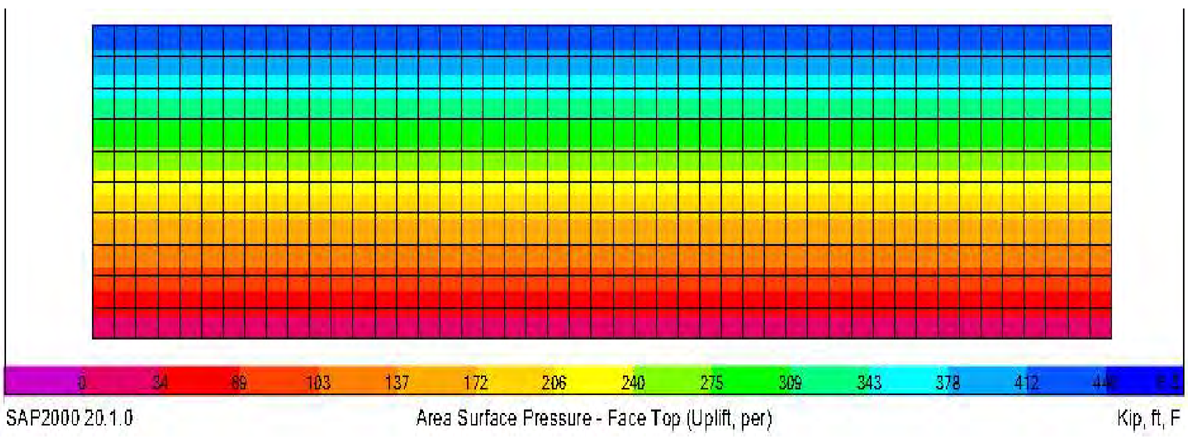
AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	Applied Loads in SAP Model	Checked by	JRA	Date	Dec-20

References



Impervious and Pervious Uplift =
(16.13' - 8.98') * .0624kcf = .446 ksf



AECOM

Job	Maurepaus Swamp	Project No.	60589133		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	Summary of Foundation Loads	Checked by	JRA	Date	Dec-20
					References

UNFACTORED LOADS FOR CPGA						
Load Case	Fx (kips)	Fy (kips)	Fz (kips)	Mx (kip-ft)	My (kip-ft)	Mz (kip-ft)
LC1	0.00	0.00	348.19	0.00	25.76	0.00
LC2	-73.37	0.00	192.69	0.00	320.62	0.00
LC3	-73.37	0.00	213.19	0.00	245.36	0.00

This table represents the base reactions taken from SAP. The moments were taken from the centroid of the structure with positive-x facing the flood side and positive-z facing downwards.

*Loads exported from SAP 2000 are within 5% on the conservative side of the actual loads on the monolith; OK to use for this submittal.

*Forces from the gate and the construction surcharge will not act simultaneously; for the construction case, surcharge governs over the gate weight so that the gate weight is excluded from these calculations.

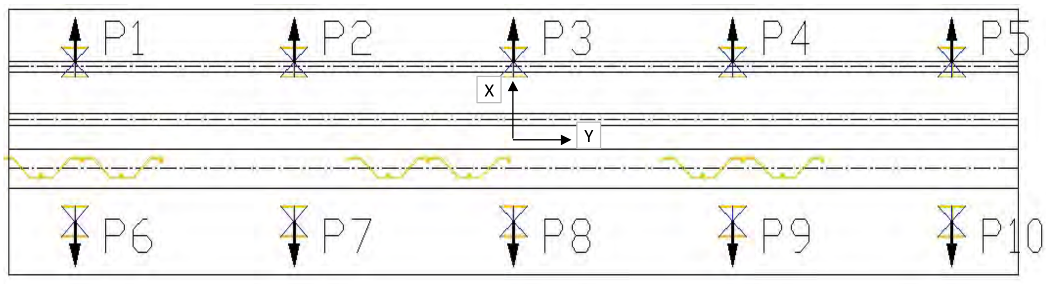
FACTORED LOADS FOR CPGA						
Load Case	Fx (kips)	Fy (kips)	Fz (kips)	Mx (kip-ft)	My (kip-ft)	Mz (kip-ft)
LC1	0.00	0.00	557.10	0.00	41.22	0.00
LC2	-117.40	0.00	308.30	0.00	512.99	0.00
LC3	-117.40	0.00	341.11	0.00	392.58	0.00

AECOM

Job	Maurepaus Swamp	Project No.	60632162
Description	CN-02 (Represents CN-01)	Computed by JMH	Date Dec-20
	CN Gate Storage Monolith		
	Soil & Pile Information Required for CPGA	Checked by JRA	Date Dec-20
			References

Pile Layout: 14 HP Piles

Row 1 pile no.	x	y	Row 2 pile no.	x	y
1	3.00	-20.00	6	-3.00	-20.00
2	3.00	-10.00	7	-3.00	-10.00
3	3.00	0.00	8	-3.00	0.00
4	3.00	10.00	9	-3.00	10.00
5	3.00	20.00	10	-3.00	20.00



Tip Elevation: (For CPGA, need Tip Elevation as a function of CPGA Axis at B.O. Slab, +Z points downward)

B.O.S. Elevation = 8.98 NAVD88
Pile Tip El. = -32 NAVD89
"TIP" in CPGA = 40.98 ft

Pile Properties & Attributes

E =	29000000.00	psi	
A =	21.40	in^2	HP14X73
I_x =	729.00	in^4	
I_y =	261.00	in^4	
C_{33} =	1.70	(factor for method of axial load transfer from pile to soil; = 1 full tip bearing, = 2 full skin friction)	
S_x =	107.00	in^3	
S_y =	35.80	in^3	
F_y =	50.00	ksi	

*Note: All soil properties and pile capacities are taken from 95% submittal for Maurepas intake structure.

Allowable Compression (AC) =	40.00	kips
Allowable Tension (AT) =	25.00	kips
ACC =	492.66	kips
ATT =	535.00	kips
AM1 =	2972.22	kip-in
AM2 =	994.44	kip-in

AECOM

Job	Maurepaus Swamp	Project No.	60632162
Description	CN-02 (Represents CN-01)	Computed by	JMH
	CN Gate Storage Monolith	Date	Dec-20
	Soil & Pile Information Required for CPGA	Checked by	JRA
		Date	Dec-20

References

Es Value for CPGA Run:

Monolith width = 46 ft

E_s = 540.40 psi = 0.5404 ksi

GROUP FACTORS	
Pile Spacing in Direction of Loading	From EM1110-2-2906
	D
3B	0.33
4B	0.38
5B	0.45
6B	0.56
7B	0.71
8B	1

Group reduction is based on distance between piles in direction of loading. This includes distance due to battering and is taken over the distance 10 x d_{pile} (point of fixety).

Assume a batter of 6.00

B = d_{pile} = 13.6 in = 1.133 ft

Distance between piles at B.O. Slab = 6.00 ft

Average distance between piles over 10*dpile = 7.89 ft

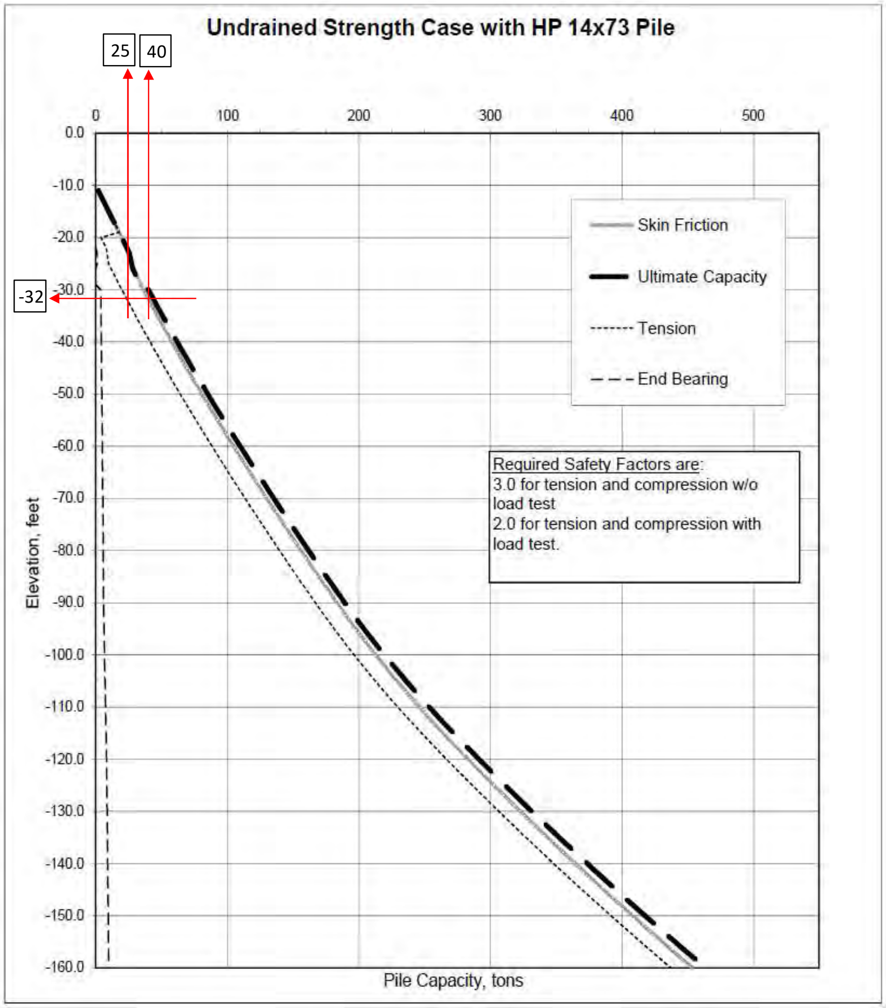
Average distance between piles in terms of pile width B = 6.96 B

Group Reduction "D" value for this distance = 0.70

Therefore, Es including group reduction = 0.38 ksi

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	Soil & Pile Information Required for CPGA	Checked by	JRA	Date	Dec-20
					References



Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

Input file:

```
100 MONOLITH, TOW EL. 16.13, TOS EL.11.98; HP 14X73  PILES
200 PROP 29000 729 261 21.4 1.7 0 ALL
300 SOIL ES 0.3805 TIP 40.98 0 ALL
400 PIN ALL
500 ALLOW H 40 25 492.7 535 2972.2 994.4 ALL
600 FOVSTR 1.17 1.17 1
700 FOVSTR 1.33 1.33 2 3
800 BATTER 6 All
1200 ANGLE 180 6 TO 10
1300 PILE 1 3 -20 0
1400 PILE 2 3 -10 0
1500 PILE 3 3 0 0
1600 PILE 4 3 10 0
1700 PILE 5 3 20 0
1800 PILE 6 -3 -20 0
1900 PILE 7 -3 -10 0
2000 PILE 8 -3 0 0
2100 PILE 9 -3 10 0
2200 PILE 10 -3 20 0
4500 LOAD 1 0 0 348.2 0 25.8 0
4600 LOAD 2 -73.4 0 192.7 0 320.6 0
4700 LOAD 3 -73.4 0 213.2 0 245.4 0
9000 FOUT 1 2 3 4 5 6 7 CN01P.DOC
9100 PFO ALL
9200 PLB ALL
```

Job	Maurepaus Swamp		Project No.	60632162		
Description	CN-02 (Represents CN-01)		Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	JRA	Date	Dec-20

CPGA RESULTS without Load Factors (pinned connection)

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 21-DEC-20     RUN TIME: 09:18:29



    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.10.0; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE  10 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                    X          Y          Z
                                  -----      -----      -----
WITH DIAGONAL COORDINATES = (     -3.00 ,   -20.00 ,     0.00 )
                            (      3.00 ,    20.00 ,     0.00 )


******************************************************************************

         PILE PROPERTIES AS INPUT


      E           I1           I2            A           C33          B66
     KSI         IN**4        IN**4        IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


******************************************************************************

         SOIL DESCRIPTIONS AS INPUT
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

```
    ES     ESOIL      LENGTH       L           LU
         K/IN**2                   FT          FT
        0.38050E+00    T      0.40980E+02   0.00000E+00

  ESOIL(ORIGINAL)     RGROUP     RCYCLIC
    K/IN**2
   0.38050E+00       0.1000E+01 0.1000E+01

 THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

     ALL


 ********************************************************************************

          PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


  0.17968E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.23229E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.21162E+04  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


 THIS MATRIX APPLIES TO THE FOLLOWING PILES -

       1


 ********************************************************************************

          PILE GEOMETRY AS INPUT AND/OR GENERATED

 NUM        X          Y          Z     BATTER   ANGLE   LENGTH  FIXITY
           FT         FT         FT                        FT

   1       3.00     -20.00       0.00     6.00     0.00    41.55    P
   2       3.00     -10.00       0.00     6.00     0.00    41.55    P
   3       3.00       0.00       0.00     6.00     0.00    41.55    P
   4       3.00      10.00       0.00     6.00     0.00    41.55    P
   5       3.00      20.00       0.00     6.00     0.00    41.55    P
   6      -3.00     -20.00       0.00     6.00   180.00    41.55    P
   7      -3.00     -10.00       0.00     6.00   180.00    41.55    P
   8      -3.00       0.00       0.00     6.00   180.00    41.55    P
   9      -3.00      10.00       0.00     6.00   180.00    41.55    P
  10      -3.00      20.00       0.00     6.00   180.00    41.55    P
                                                          ------
  415.45


 ********************************************************************************

                          APPLIED LOADS

 LOAD      PX         PY         PZ          MX          MY          MZ  OVERSTRESS
 CASE       K          K          K         FT-K        FT-K        FT-K  COM   TEN

   1        0.0        0.0      348.2         0.0        25.8         0.0 1.17 1.17
   2      -73.4        0.0      192.7         0.0       320.6         0.0 1.33 1.33
   3      -73.4        0.0      213.2         0.0       245.4         0.0 1.33 1.33
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

```
********************************************************************************

        ORIGINAL PILE GROUP STIFFNESS MATRIX

 0.74678E+03 -0.62602E-05  0.79581E-12  0.00000E+00 -0.12249E+06  0.22537E-03
-0.62602E-05  0.23229E+03  0.41402E-04  0.00000E+00  0.14905E-02 -0.55707E-11
 0.79581E-12  0.41402E-04  0.20595E+05  0.58208E-10  0.00000E+00 -0.14905E-02
 0.00000E+00  0.00000E+00  0.58208E-10  0.59314E+09  0.00000E+00 -0.11176E-07
-0.12249E+06  0.14905E-02  0.00000E+00 -0.37253E-08  0.26691E+08 -0.53657E-01
 0.22537E-03 -0.56843E-11 -0.14905E-02 -0.74506E-08 -0.53657E-01  0.21808E+08



                    10 PILES   3 LOAD CASES

LOAD CASE    1.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    2.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    3.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.


********************************************************************************

        PILE CAP DISPLACEMENTS

LOAD
CASE       DX          DY          DZ          RX          RY          RZ
           IN          IN          IN          RAD         RAD         RAD

   1   0.7695E-02 -0.3107E-08  0.1691E-01 -0.1659E-20  0.4692E-04  0.1191E-11
   2  -0.3019E+00 -0.1839E-08  0.9357E-02 -0.9182E-21 -0.1241E-02  0.7051E-12
   3  -0.3244E+00 -0.1743E-08  0.1035E-01 -0.1016E-20 -0.1378E-02  0.6685E-12


********************************************************************************
             ELASTIC CENTER INFORMATION


ELASTIC CENTER IN PLANE X-Z         X             Z
                                   FT            FT
                                  0.00          0.00
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

```
*******************************************************************************

         PILE FORCES IN LOCAL GEOMETRY

             M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
             * INDICATES PILE FAILURE
             # INDICATES CBF BASED ON MOMENTS DUE TO
                         (F3*EMIN) FOR CONCRETE PILES
             B INDICATES BUCKLING CONTROLS



LOAD CASE -     1

PILE    F1      F2      F3        M1        M2        M3   ALF  CBF
         K       K       K       IN-K      IN-K      IN-K

  1     0.1     0.0    34.4       0.0      -2.8       0.0 0.74 0.06
  2     0.1     0.0    34.4       0.0      -2.8       0.0 0.74 0.06
  3     0.1     0.0    34.4       0.0      -2.8       0.0 0.74 0.06
  4     0.1     0.0    34.4       0.0      -2.8       0.0 0.74 0.06
  5     0.1     0.0    34.4       0.0      -2.8       0.0 0.74 0.06
  6    -0.2     0.0    36.1       0.0       5.8       0.0 0.77 0.07
  7    -0.2     0.0    36.1       0.0       5.8       0.0 0.77 0.07
  8    -0.2     0.0    36.1       0.0       5.8       0.0 0.77 0.07
  9    -0.2     0.0    36.1       0.0       5.8       0.0 0.77 0.07
 10    -0.2     0.0    36.1       0.0       5.8       0.0 0.77 0.07


LOAD CASE -     2

PILE    F1      F2      F3        M1        M2        M3   ALF  CBF
         K       K       K       IN-K      IN-K      IN-K

  1    -5.5     0.0     7.8       0.0     167.6       0.0 0.15 0.14
  2    -5.5     0.0     7.8       0.0     167.6       0.0 0.15 0.14
  3    -5.5     0.0     7.8       0.0     167.6       0.0 0.15 0.14
  4    -5.5     0.0     7.8       0.0     167.6       0.0 0.15 0.14
  5    -5.5     0.0     7.8       0.0     167.6       0.0 0.15 0.14
  6     5.5     0.0    31.3       0.0    -165.9       0.0 0.59 0.17
  7     5.5     0.0    31.3       0.0    -165.9       0.0 0.59 0.17
  8     5.5     0.0    31.3       0.0    -165.9       0.0 0.59 0.17
  9     5.5     0.0    31.3       0.0    -165.9       0.0 0.59 0.17
 10     5.5     0.0    31.3       0.0    -165.9       0.0 0.59 0.17
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

LOAD CASE - 3

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	-5.9	0.0	12.3	0.0	180.2	0.0	0.23	0.16
2	-5.9	0.0	12.3	0.0	180.2	0.0	0.23	0.16
3	-5.9	0.0	12.3	0.0	180.2	0.0	0.23	0.16
4	-5.9	0.0	12.3	0.0	180.2	0.0	0.23	0.16
5	-5.9	0.0	12.3	0.0	180.2	0.0	0.23	0.16
6	5.9	0.0	30.9	0.0	-178.4	0.0	0.58	0.18
7	5.9	0.0	30.9	0.0	-178.4	0.0	0.58	0.18
8	5.9	0.0	30.9	0.0	-178.4	0.0	0.58	0.18
9	5.9	0.0	30.9	0.0	-178.4	0.0	0.58	0.18
10	5.9	0.0	30.9	0.0	-178.4	0.0	0.58	0.18

****

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	5.8	0.0	34.0	0.0	0.0	0.0
2	5.8	0.0	34.0	0.0	0.0	0.0
3	5.8	0.0	34.0	0.0	0.0	0.0
4	5.8	0.0	34.0	0.0	0.0	0.0
5	5.8	0.0	34.0	0.0	0.0	0.0
6	-5.8	0.0	35.7	0.0	0.0	0.0
7	-5.8	0.0	35.7	0.0	0.0	0.0
8	-5.8	0.0	35.7	0.0	0.0	0.0
9	-5.8	0.0	35.7	0.0	0.0	0.0
10	-5.8	0.0	35.7	0.0	0.0	0.0

Job	Maurepaus Swamp		Project No.	60632162		
Description	CN-02 (Represents CN-01)		Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	JRA	Date	Dec-20

LOAD CASE - 2

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-4.2	0.0	8.6	0.0	0.0	0.0
2	-4.2	0.0	8.6	0.0	0.0	0.0
3	-4.2	0.0	8.6	0.0	0.0	0.0
4	-4.2	0.0	8.6	0.0	0.0	0.0
5	-4.2	0.0	8.6	0.0	0.0	0.0
6	-10.5	0.0	30.0	0.0	0.0	0.0
7	-10.5	0.0	30.0	0.0	0.0	0.0
8	-10.5	0.0	30.0	0.0	0.0	0.0
9	-10.5	0.0	30.0	0.0	0.0	0.0
10	-10.5	0.0	30.0	0.0	0.0	0.0

LOAD CASE - 3

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-3.8	0.0	13.1	0.0	0.0	0.0
2	-3.8	0.0	13.1	0.0	0.0	0.0
3	-3.8	0.0	13.1	0.0	0.0	0.0
4	-3.8	0.0	13.1	0.0	0.0	0.0
5	-3.8	0.0	13.1	0.0	0.0	0.0
6	-10.9	0.0	29.5	0.0	0.0	0.0
7	-10.9	0.0	29.5	0.0	0.0	0.0
8	-10.9	0.0	29.5	0.0	0.0	0.0
9	-10.9	0.0	29.5	0.0	0.0	0.0
10	-10.9	0.0	29.5	0.0	0.0	0.0

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

CPGA RESULTS without Load Factors (FIXED connection)

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 21-DEC-20     RUN TIME: 09:19:27



    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.10.0; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE  10 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                  X          Y           Z
                                -----      -----       -----
WITH DIAGONAL COORDINATES = (     -3.00 ,   -20.00 ,     0.00 )
                            (      3.00 ,    20.00 ,     0.00 )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AECOM

Job	Maurepaus Swamp	Project No.	60632162
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

```
         PILE PROPERTIES AS INPUT


      E           I1           I2            A           C33          B66
     KSI         IN**4        IN**4        IN**2
  0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

 THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

     ALL


 ******************************************************************************

         SOIL DESCRIPTIONS AS INPUT


   ES     ESOIL      LENGTH       L            LU
         K/IN**2                 FT            FT
        0.38050E+00    T      0.40980E+02   0.00000E+00

  ESOIL(ORIGINAL)      RGROUP     RCYCLIC
   K/IN**2
   0.38050E+00       0.1000E+01 0.1000E+01

 THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

     ALL


 ******************************************************************************
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AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

PILE STIFFNESSES AS CALCULATED FROM PROPERTIES

0.35937E+02	0.00000E+00	0.00000E+00	0.00000E+00	0.16971E+04	0.00000E+00
0.00000E+00	0.46458E+02	0.00000E+00	-0.28362E+04	0.00000E+00	0.00000E+00
0.00000E+00	0.00000E+00	0.21162E+04	0.00000E+00	0.00000E+00	0.00000E+00
0.00000E+00	-0.28362E+04	0.00000E+00	0.34630E+06	0.00000E+00	0.00000E+00
0.16971E+04	0.00000E+00	0.00000E+00	0.00000E+00	0.16028E+06	0.00000E+00
0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

THIS MATRIX APPLIES TO THE FOLLOWING PILES -

1

****

PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM	X FT	Y FT	Z FT	BATTER	ANGLE	LENGTH FT	FIXITY
1	3.00	-20.00	0.00	6.00	0.00	41.55	F
2	3.00	-10.00	0.00	6.00	0.00	41.55	F
3	3.00	0.00	0.00	6.00	0.00	41.55	F
4	3.00	10.00	0.00	6.00	0.00	41.55	F
5	3.00	20.00	0.00	6.00	0.00	41.55	F
6	-3.00	-20.00	0.00	6.00	180.00	41.55	F
7	-3.00	-10.00	0.00	6.00	180.00	41.55	F
8	-3.00	0.00	0.00	6.00	180.00	41.55	F
9	-3.00	10.00	0.00	6.00	180.00	41.55	F
10	-3.00	20.00	0.00	6.00	180.00	41.55	F

415.45

****

APPLIED LOADS

LOAD CASE	PX K	PY K	PZ K	MX FT-K	MY FT-K	MZ FT-K	OVERSTRESS COM	TEN
1	0.0	0.0	348.2	0.0	25.8	0.0	1.17	1.17
2	-73.4	0.0	192.7	0.0	320.6	0.0	1.33	1.33
3	-73.4	0.0	213.2	0.0	245.4	0.0	1.33	1.33

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

```
*******************************************************************************

         ORIGINAL PILE GROUP STIFFNESS MATRIX

  0.92160E+03 -0.55610E-05  0.34106E-12 -0.13673E-03 -0.10470E+06  0.14346E-03
 -0.55610E-05  0.46458E+03  0.41048E-04 -0.27976E+05  0.16144E-02 -0.45475E-11
  0.34106E-12  0.41048E-04  0.20600E+05  0.33948E-04 -0.29104E-10 -0.14777E-02
 -0.13673E-03 -0.27976E+05  0.33948E-04  0.59664E+09 -0.20273E-01 -0.14901E-07
 -0.10470E+06  0.16144E-02 -0.29104E-10 -0.20273E-01  0.28501E+08 -0.64953E-01
  0.14346E-03 -0.18190E-11 -0.14777E-02 -0.14901E-07 -0.64953E-01  0.27574E+08



                     10 PILES    3 LOAD CASES

 LOAD CASE    1.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    2.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    3.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.


*******************************************************************************

         PILE CAP DISPLACEMENTS

 LOAD
 CASE       DX           DY           DZ           RX           RY           RZ
            IN           IN           IN          RAD          RAD          RAD

    1   0.2118E-02 -0.1537E-08  0.1690E-01 -0.7192E-13  0.1864E-04  0.9388E-12
    2  -0.1104E+00 -0.1213E-08  0.9354E-02 -0.9190E-13 -0.2705E-03  0.4384E-12
    3  -0.1165E+00 -0.1186E-08  0.1035E-01 -0.9396E-13 -0.3248E-03  0.3958E-12


*******************************************************************************
              ELASTIC CENTER INFORMATION



 ELASTIC CENTER IN PLANE X-Z          X             Z
                                     FT            FT
                                    0.00          0.00


*******************************************************************************
```

Job	Maurepaus Swamp		Project No.	60632162		
Description	CN-02 (Represents CN-01)		Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	JRA	Date	Dec-20

PILE FORCES IN LOCAL GEOMETRY

M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
* INDICATES PILE FAILURE
# INDICATES CBF BASED ON MOMENTS DUE TO
(F3*EMIN) FOR CONCRETE PILES
B INDICATES BUCKLING CONTROLS

LOAD CASE - 1

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	0.0	0.0	34.6	0.0	2.0	0.0	0.74	0.06
2	0.0	0.0	34.6	0.0	2.0	0.0	0.74	0.06
3	0.0	0.0	34.6	0.0	2.0	0.0	0.74	0.06
4	0.0	0.0	34.6	0.0	2.0	0.0	0.74	0.06
5	0.0	0.0	34.6	0.0	2.0	0.0	0.74	0.06
6	-0.2	0.0	35.9	0.0	-11.4	0.0	0.77	0.07
7	-0.2	0.0	35.9	0.0	-11.4	0.0	0.77	0.07
8	-0.2	0.0	35.9	0.0	-11.4	0.0	0.77	0.07
9	-0.2	0.0	35.9	0.0	-11.4	0.0	0.77	0.07
10	-0.2	0.0	35.9	0.0	-11.4	0.0	0.77	0.07

LOAD CASE - 2

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	-4.5	0.0	1.5	0.0	-233.4	0.0	0.03	0.18
2	-4.5	0.0	1.5	0.0	-233.4	0.0	0.03	0.18
3	-4.5	0.0	1.5	0.0	-233.4	0.0	0.03	0.18
4	-4.5	0.0	1.5	0.0	-233.4	0.0	0.03	0.18
5	-4.5	0.0	1.5	0.0	-233.4	0.0	0.03	0.18
6	4.4	0.0	37.6	0.0	228.2	0.0	0.71	0.23
7	4.4	0.0	37.6	0.0	228.2	0.0	0.71	0.23
8	4.4	0.0	37.6	0.0	228.2	0.0	0.71	0.23
9	4.4	0.0	37.6	0.0	228.2	0.0	0.71	0.23
10	4.4	0.0	37.6	0.0	228.2	0.0	0.71	0.23

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

LOAD CASE - 3

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	-4.8	0.0	5.5	0.0	-253.3	0.0	0.10	0.20
2	-4.8	0.0	5.5	0.0	-253.3	0.0	0.10	0.20
3	-4.8	0.0	5.5	0.0	-253.3	0.0	0.10	0.20
4	-4.8	0.0	5.5	0.0	-253.3	0.0	0.10	0.20
5	-4.8	0.0	5.5	0.0	-253.3	0.0	0.10	0.20
6	4.7	0.0	37.7	0.0	247.5	0.0	0.71	0.24
7	4.7	0.0	37.7	0.0	247.5	0.0	0.71	0.24
8	4.7	0.0	37.7	0.0	247.5	0.0	0.71	0.24
9	4.7	0.0	37.7	0.0	247.5	0.0	0.71	0.24
10	4.7	0.0	37.7	0.0	247.5	0.0	0.71	0.24

****

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	5.7	0.0	34.1	0.0	2.0	0.0
2	5.7	0.0	34.1	0.0	2.0	0.0
3	5.7	0.0	34.1	0.0	2.0	0.0
4	5.7	0.0	34.1	0.0	2.0	0.0
5	5.7	0.0	34.1	0.0	2.0	0.0
6	-5.7	0.0	35.5	0.0	11.4	0.0
7	-5.7	0.0	35.5	0.0	11.4	0.0
8	-5.7	0.0	35.5	0.0	11.4	0.0
9	-5.7	0.0	35.5	0.0	11.4	0.0
10	-5.7	0.0	35.5	0.0	11.4	0.0

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

LOAD CASE - 2

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-4.2	0.0	2.2	0.0	-233.4	0.0
2	-4.2	0.0	2.2	0.0	-233.4	0.0
3	-4.2	0.0	2.2	0.0	-233.4	0.0
4	-4.2	0.0	2.2	0.0	-233.4	0.0
5	-4.2	0.0	2.2	0.0	-233.4	0.0
6	-10.5	0.0	36.4	0.0	-228.2	0.0
7	-10.5	0.0	36.4	0.0	-228.2	0.0
8	-10.5	0.0	36.4	0.0	-228.2	0.0
9	-10.5	0.0	36.4	0.0	-228.2	0.0
10	-10.5	0.0	36.4	0.0	-228.2	0.0

LOAD CASE - 3

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-3.8	0.0	6.2	0.0	-253.3	0.0
2	-3.8	0.0	6.2	0.0	-253.3	0.0
3	-3.8	0.0	6.2	0.0	-253.3	0.0
4	-3.8	0.0	6.2	0.0	-253.3	0.0
5	-3.8	0.0	6.2	0.0	-253.3	0.0
6	-10.8	0.0	36.5	0.0	-247.5	0.0
7	-10.8	0.0	36.5	0.0	-247.5	0.0
8	-10.8	0.0	36.5	0.0	-247.5	0.0
9	-10.8	0.0	36.5	0.0	-247.5	0.0
10	-10.8	0.0	36.5	0.0	-247.5	0.0

Job	Maurepaus Swamp		Project No.	60632162		
Description	CN-02 (Represents CN-01)		Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith					
	CPGA Input & Output Files (Concrete Design)		Checked by	JRA	Date	Dec-20

Input file:

```
100 MONOLITH, TOW EL. 16.13, TOS EL.10.49; HP 14X73  PILES
200 PROP 29000 729 261 21.4 1.7 0 ALL
300 SOIL ES 0.3805 TIP 40.98 0 ALL
400 PIN ALL
500 ALLOW H 40 25 492.7 535 2972.2 994.4 ALL
600 FOVSTR 1 1 1
700 FOVSTR 1 1 2 3
800 BATTER 6 All
1200 ANGLE 180 6 TO 10
1300 PILE 1 3 -20 0
1400 PILE 2 3 -10 0
1500 PILE 3 3 0 0
1600 PILE 4 3 10 0
1700 PILE 5 3 20 0
1800 PILE 6 -3 -20 0
1900 PILE 7 -3 -10 0
2000 PILE 8 -3 0 0
2100 PILE 9 -3 10 0
2200 PILE 10 -3 20 0
4500 LOAD 1 0 0 557.1 0 41.2 0
4600 LOAD 2 -117.4 0 308.3 0 513 0
4700 LOAD 3 -117.4 0 341.1 0 392.6 0
9000 FOUT 1 2 3 4 5 6 7 RR01S.DOC
9100 PFO ALL
9200 PLB ALL
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	JRA	Date	Dec-20

CPGA RESULTS with Load Factors

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 21-DEC-20     RUN TIME: 09:20:33




    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.10.49; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE  10 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                   X          Y          Z
                                 -----      -----      -----
WITH DIAGONAL COORDINATES = (     -3.00 ,    -20.00 ,     0.00 )
                            (      3.00 ,     20.00 ,     0.00 )


*******************************************************************************

         PILE PROPERTIES AS INPUT


      E           I1           I2           A           C33          B66
     KSI         IN**4        IN**4        IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	JRA	Date	Dec-20

```
********************************************************************************

         SOIL DESCRIPTIONS AS INPUT


   ES      ESOIL       LENGTH        L             LU
         K/IN**2                     FT            FT
        0.38050E+00     T      0.40980E+02   0.00000E+00

 ESOIL(ORIGINAL)      RGROUP     RCYCLIC
   K/IN**2
  0.38050E+00       0.1000E+01 0.1000E+01

THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

    ALL


********************************************************************************

         PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


 0.17968E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.23229E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.21162E+04  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


THIS MATRIX APPLIES TO THE FOLLOWING PILES -

      1


********************************************************************************
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	JRA	Date	Dec-20

PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM	X FT	Y FT	Z FT	BATTER	ANGLE	LENGTH FT	FIXITY
1	3.00	-20.00	0.00	6.00	0.00	41.55	P
2	3.00	-10.00	0.00	6.00	0.00	41.55	P
3	3.00	0.00	0.00	6.00	0.00	41.55	P
4	3.00	10.00	0.00	6.00	0.00	41.55	P
5	3.00	20.00	0.00	6.00	0.00	41.55	P
6	-3.00	-20.00	0.00	6.00	180.00	41.55	P
7	-3.00	-10.00	0.00	6.00	180.00	41.55	P
8	-3.00	0.00	0.00	6.00	180.00	41.55	P
9	-3.00	10.00	0.00	6.00	180.00	41.55	P
10	-3.00	20.00	0.00	6.00	180.00	41.55	P

415.45

****

APPLIED LOADS

LOAD CASE	PX K	PY K	PZ K	MX FT-K	MY FT-K	MZ FT-K
1	0.0	0.0	557.1	0.0	41.2	0.0
2	-117.4	0.0	308.3	0.0	513.0	0.0
3	-117.4	0.0	341.1	0.0	392.6	0.0

****

ORIGINAL PILE GROUP STIFFNESS MATRIX

0.74678E+03	-0.62602E-05	0.79581E-12	0.00000E+00	-0.12249E+06	0.22537E-03
-0.62602E-05	0.23229E+03	0.41402E-04	0.00000E+00	0.14905E-02	-0.55707E-11
0.79581E-12	0.41402E-04	0.20595E+05	0.58208E-10	0.00000E+00	-0.14905E-02
0.00000E+00	0.00000E+00	0.58208E-10	0.59314E+09	0.00000E+00	-0.11176E-07
-0.12249E+06	0.14905E-02	0.00000E+00	-0.37253E-08	0.26691E+08	-0.53657E-01
0.22537E-03	-0.56843E-11	-0.14905E-02	-0.74506E-08	-0.53657E-01	0.21808E+08

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	JRA	Date	Dec-20

```
                     10 PILES   3 LOAD CASES

LOAD CASE    1.  NUMBER OF FAILURES =  10.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    2.  NUMBER OF FAILURES =   5.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    3.  NUMBER OF FAILURES =   5.  NUMBER OF PILES IN TENSION =   0.


******************************************************************************

         PILE CAP DISPLACEMENTS

LOAD
CASE       DX          DY          DZ          RX          RY          RZ
           IN          IN          IN          RAD         RAD         RAD

   1   0.1229E-01 -0.4971E-08  0.2705E-01 -0.2655E-20  0.7492E-04  0.1906E-11
   2  -0.4828E+00 -0.2943E-08  0.1497E-01 -0.1469E-20 -0.1985E-02  0.1128E-11
   3  -0.5188E+00 -0.2789E-08  0.1656E-01 -0.1625E-20 -0.2204E-02  0.1070E-11


******************************************************************************
              ELASTIC CENTER INFORMATION


ELASTIC CENTER IN PLANE X-Z         X             Z
                                   FT            FT
                                  0.00          0.00


******************************************************************************
```

Job	Maurepaus Swamp		Project No.	60632162		
Description	CN-02 (Represents CN-01)		Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith					
	CPGA Input & Output Files (Concrete Design)		Checked by	JRA	Date	Dec-20

```
         PILE FORCES IN LOCAL GEOMETRY

             M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
             * INDICATES PILE FAILURE
             # INDICATES CBF BASED ON MOMENTS DUE TO
                         (F3*EMIN) FOR CONCRETE PILES
             B INDICATES BUCKLING CONTROLS



 LOAD CASE -     1

 PILE    F1      F2      F3        M1        M2        M3   ALF  CBF
          K       K       K       IN-K      IN-K      IN-K

   1     0.1     0.0    55.1       0.0      -4.4       0.0 1.38 0.12          *
   2     0.1     0.0    55.1       0.0      -4.4       0.0 1.38 0.12          *
   3     0.1     0.0    55.1       0.0      -4.4       0.0 1.38 0.12          *
   4     0.1     0.0    55.1       0.0      -4.4       0.0 1.38 0.12          *
   5     0.1     0.0    55.1       0.0      -4.4       0.0 1.38 0.12          *
   6    -0.3     0.0    57.8       0.0       9.3       0.0 1.45 0.13          *
   7    -0.3     0.0    57.8       0.0       9.3       0.0 1.45 0.13          *
   8    -0.3     0.0    57.8       0.0       9.3       0.0 1.45 0.13          *
   9    -0.3     0.0    57.8       0.0       9.3       0.0 1.45 0.13          *
  10    -0.3     0.0    57.8       0.0       9.3       0.0 1.45 0.13          *


 LOAD CASE -     2

 PILE    F1      F2      F3        M1        M2        M3   ALF  CBF
          K       K       K       IN-K      IN-K      IN-K

   1    -8.8     0.0    12.5       0.0     268.0       0.0 0.31 0.29
   2    -8.8     0.0    12.5       0.0     268.0       0.0 0.31 0.29
   3    -8.8     0.0    12.5       0.0     268.0       0.0 0.31 0.29
   4    -8.8     0.0    12.5       0.0     268.0       0.0 0.31 0.29
   5    -8.8     0.0    12.5       0.0     268.0       0.0 0.31 0.29
   6     8.7     0.0    50.0       0.0    -265.3       0.0 1.25 0.37          *
   7     8.7     0.0    50.0       0.0    -265.3       0.0 1.25 0.37          *
   8     8.7     0.0    50.0       0.0    -265.3       0.0 1.25 0.37          *
   9     8.7     0.0    50.0       0.0    -265.3       0.0 1.25 0.37          *
  10     8.7     0.0    50.0       0.0    -265.3       0.0 1.25 0.37          *
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	JRA	Date	Dec-20

LOAD CASE - 3

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF	
	K	K	K	IN-K	IN-K	IN-K			
1	-9.5	0.0	19.7	0.0	288.2	0.0	0.49	0.33	
2	-9.5	0.0	19.7	0.0	288.2	0.0	0.49	0.33	
3	-9.5	0.0	19.7	0.0	288.2	0.0	0.49	0.33	
4	-9.5	0.0	19.7	0.0	288.2	0.0	0.49	0.33	
5	-9.5	0.0	19.7	0.0	288.2	0.0	0.49	0.33	
6	9.4	0.0	49.4	0.0	-285.3	0.0	1.24	0.39	*
7	9.4	0.0	49.4	0.0	-285.3	0.0	1.24	0.39	*
8	9.4	0.0	49.4	0.0	-285.3	0.0	1.24	0.39	*
9	9.4	0.0	49.4	0.0	-285.3	0.0	1.24	0.39	*
10	9.4	0.0	49.4	0.0	-285.3	0.0	1.24	0.39	*

****

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	9.2	0.0	54.3	0.0	0.0	0.0
2	9.2	0.0	54.3	0.0	0.0	0.0
3	9.2	0.0	54.3	0.0	0.0	0.0
4	9.2	0.0	54.3	0.0	0.0	0.0
5	9.2	0.0	54.3	0.0	0.0	0.0
6	-9.2	0.0	57.1	0.0	0.0	0.0
7	-9.2	0.0	57.1	0.0	0.0	0.0
8	-9.2	0.0	57.1	0.0	0.0	0.0
9	-9.2	0.0	57.1	0.0	0.0	0.0
10	-9.2	0.0	57.1	0.0	0.0	0.0

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	JRA	Date	Dec-20

LOAD CASE - 2

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-6.6	0.0	13.7	0.0	0.0	0.0
2	-6.6	0.0	13.7	0.0	0.0	0.0
3	-6.6	0.0	13.7	0.0	0.0	0.0
4	-6.6	0.0	13.7	0.0	0.0	0.0
5	-6.6	0.0	13.7	0.0	0.0	0.0
6	-16.8	0.0	47.9	0.0	0.0	0.0
7	-16.8	0.0	47.9	0.0	0.0	0.0
8	-16.8	0.0	47.9	0.0	0.0	0.0
9	-16.8	0.0	47.9	0.0	0.0	0.0
10	-16.8	0.0	47.9	0.0	0.0	0.0

LOAD CASE - 3

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-6.1	0.0	21.0	0.0	0.0	0.0
2	-6.1	0.0	21.0	0.0	0.0	0.0
3	-6.1	0.0	21.0	0.0	0.0	0.0
4	-6.1	0.0	21.0	0.0	0.0	0.0
5	-6.1	0.0	21.0	0.0	0.0	0.0
6	-17.4	0.0	47.2	0.0	0.0	0.0
7	-17.4	0.0	47.2	0.0	0.0	0.0
8	-17.4	0.0	47.2	0.0	0.0	0.0
9	-17.4	0.0	47.2	0.0	0.0	0.0
10	-17.4	0.0	47.2	0.0	0.0	0.0

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	Summary of Shear & Moment	Checked by	JRA	Date	Dec-20
					References

Load Case	$V_{u,max}$ (kip/ft)	$M_{u,max}$ (kip/ft)
LC1	0.00	0.00
LC2	0.86	1.19
LC3	0.86	1.19

*Note: LC 1 only has vertical forces, so there is no shear or moment on the wall.

The following calculations are the max shear (Vu) and moment (Mu) on the wall form LC 2 and LC 3:

AECOM Imagine it. Delivered.

JOB TITLE Maurepas WSLP Structures – CN Gate Mono
PROJECT/JOB NO. CALCULATION NO.
COMPUTED BY JH DATE
VERIFIED BY DATE
SCALE SHEET NO. 1 OF

Wall Calculations:

Assumptions:

$t = 1.5' = 18''$

$cover = 3''$

$d = 18'' - 3'' - \frac{.75''}{2} = 14.625''$ → Assume #6 bars

$b = 12''$

$\phi_{shear} = .75$

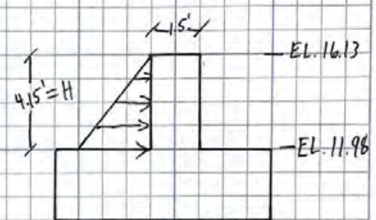
$\phi_{moment} = .9$

$F_y = 60$ ksi

$f'_c = 4$ ksi

$\gamma_{water} = .0624\ k/ft^3$

★ These calculations only show the loading condition for water to TOW (LC2 & 3)



① Shear Calculations:

→ $h_{w,lat} = \frac{1}{2}(\gamma_{water})(H^2) = \frac{1}{2}(.0624\ k/ft^3)(4.15')^2$

$V_u = .54\ k/ft$

$1.6V_u = \boxed{.86\ k/ft = V_u}$

② Moment Calculations:

→ $M_u = (V_u)\left(\frac{H}{3}\right) = (.86)\left(\frac{4.15'}{3}\right)$

$\boxed{M_u = 1.19\ \frac{k\text{-}ft}{ft}}$

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	Shear & Moment Check for Wall	Checked by	JRA	Date	Dec-20
					References

*** Given Information:**

Wall Thickness:	1.50	ft
Clear Cover:	0.25	ft
Diameter Bar to Start:	0.06	ft
Maximum Shear (V_u):	0.86	kips per foot
Maximum Moment (M_u):	1.19	kip-ft per foot
φ_{shear} =	0.75	(ACI 318)
φ_{moment} =	0.9	(ACI 318)
$f_{y,\ rebar}$ =	60	ksi
f'_c =	4	ksi

*** Shear Calculations:**

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u) (ACI Eq. 11-1)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75	
f'_c =	4	ksi
b =	1	ft strip
d =	1.22	ft

φV_c =	16649.4	lbs	
	16.65	kips	** φVc=16.6 ≥ Vu=0.9, **Shear Capacity OK**

*** Reinforcement Calculations:**

Limit of Maximum Reinforcement: 0.25 x ρ_b (Design Criteria, EM 1110-2-2104, 3-5)

where ρ_b =	0.0285	for f'_c = 4,000psi, fy = 60,000psi
Max Rebar =	0.00713	*b * d

Maximum Reinforcement:	0.0071	* b * d =	1.25	in^2	per 1ft strip

A_{gross} = 1.5 ft * 12 in/ft * 12 in strip = 216.00 in^2

Limits of Minimum Reinforcement:	0.005 x Agross =	1.08	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
	$(3*\sqrt{(f'_c)}*b*d)/f_y$ =	0.55	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)
	$(200*b*d)/f_y$ =	0.59	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)

Min Reinforcement, temp & shrinkage:	0.54	in^2	per 1ft strip, per face
Min Reinforcement, flexural:	0.59	in^2	per 1ft strip, per face

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	Shear & Moment Check for Wall	Checked by	JRA	Date	Dec-20
					References

*** Moment Calculations:**

* $T = A_s \times f_y$

* $C = 0.85 \times f'_c \times a \times b$

* Assuming Tension = Compression ⟶ $A_s \times f_y = 0.85 \times f'_c \times a \times b$

* $\varphi Mn = \varphi \times T \times (d - (a / 2))$

$= \varphi \times A_s \times f_y \times (d - (a / 2))$

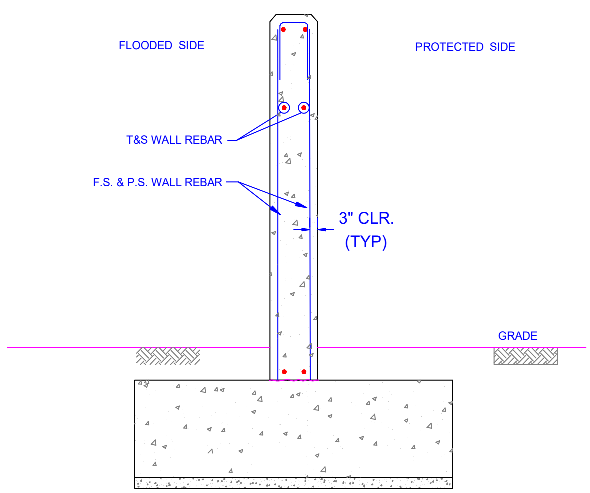
* Capacity of Min Flexural Reinforcement:

A_s =	0.585	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	1.21875	
φ_{moment} =	0.9	

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$

= 0.860 in

φM_n =	448.4	kip-in
=	37.37	kip-ft



* Capacity of Maximum Reinforcement:

A_s =	1.250	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	1.22	
φ_{moment} =	0.9	

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$

= 1.839 in

φMn =	925.4	kip-in
=	77.12	kip-ft

**** $\varphi Mn=77.1 \geq Mu=1.2$, Section OK**

The minimum proposed reinforcement for T&S Wall Rebar is #6 @ 9" (A = 0.59 in^2) and the minimum proposed reinforcement for F.S. & P.S. Wall Rebar is #6 @ 9"(A=0.59 in^2).

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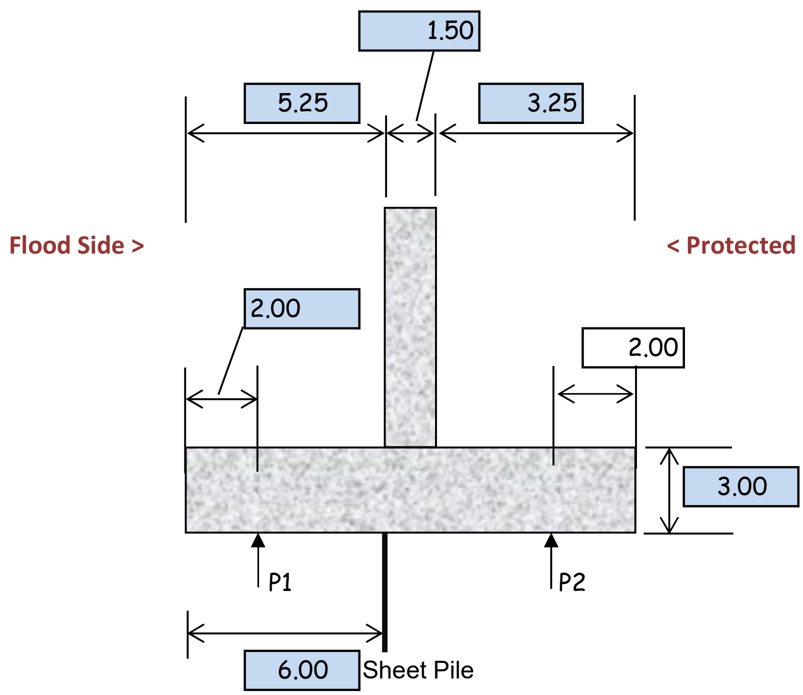

Tributary width (pile spacing): 9 ft   Referred to as "width" in calculations

AECOM

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*Note: The following calculations represent the total shear (Vu) and moment (Mu) on both sides of the slab for all load cases. Capacity calculations for the slab can be found in the "Slab Conc Check" tab. All reactions are taken from the pinned or fixed results from CPGA.

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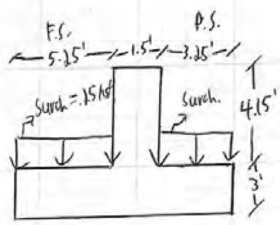
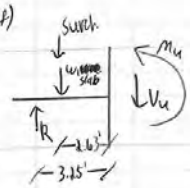
Slab Calculations:

① Construction Surcharge
→ conc. wt.
→ surcharge = .25 k/ft²
→ Assume 10' of trib. length between piles
→ $\gamma_{conc.}$ = .15 kcf



Flood Side:

$V_u \rightarrow R =$ 34.1 kip from CPGA
$w_{slab} = (3')(10')(5.25')(.15\text{ kcf})$
$= 23.63$ kip
Surch $= (.25\text{ ksf})(10')(5.25')$
$= 13.125$ kip



$V_u = 23.63 + 13.125 -$ 34.1

$V_u =$ 2.66 kip

$1.6 V_u = \frac{4.25\text{ k}}{10'} =$ .425 kip/ft $= V_u$

$M_u \rightarrow R =$ 34.1 k @ 5.25' ⊖
$w_{slab} =$ 23.63 k @ 2.63' ⊕
Surch. = 13.125 k @ 2.63' ⊕

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Job	Maurepaus Swamp	Project No.	60632162		
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$$M_u = (3.63)(2.63) + (13.125)(2.63) - (\boxed{34.1})(3.25)$$

$$M_u = \boxed{-14.16} \text{ kip-ft}$$

$$1.6 M_u = \frac{\boxed{-22.65} \text{ kip-ft}}{10'} = \boxed{-2.27} \ \frac{\text{k-ft}}{\text{ft}} = M_u$$

Protected Side:

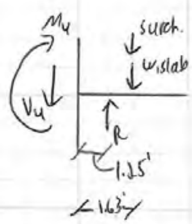
$V_u \rightarrow R = 35.7$ kip from CPGA

$w_{slab} = (3')(10')(3.25')(.15 \text{ kcf})$

$= 14.63$ kip

$Surch. = (.25 \text{ ksf})(10')(3.25')$

$= 8.13$ kip



$$V_u = 14.63 + 8.13 - 35.7$$

$$V_u = -12.94$$

$$1.6 V_u = \frac{-20.7 \text{ kip}}{10'} = -2.07 \ k/ft = V_u$$

$M_u \rightarrow R = 35.7$ k @ 1.25' ⊖

$w_{slab} = 14.63$ k @ 1.63' ⊕

Surch. = 8.13 k @ 1.63' ⊕

$$M_u = (14.63)(1.63) + (8.13)(1.63) - (35.7)(1.25)$$

$$M_u = -7.53 \text{ k-ft}$$

$$1.6 M_u = \frac{-12.04 \text{ k-ft}}{10'} = -1.204 \ \frac{\text{k-ft}}{\text{ft}} = M_u$$

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(2) Water to TOW (impervious)

→ conc. wt

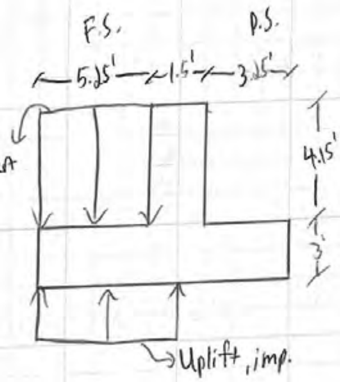
→ h,lat can be ignored

→ h,vert

→ uplift, imp.

(Assume sheet pile to be @ middle of wall)

→ 10' trib. length between piles



Flood Side:

V_u → R = 2.2 kip from CPGA

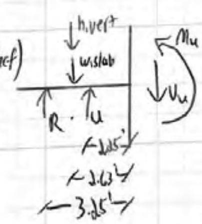
w,slab = 23.63 k (see LC1 calcs)

h,vert = (4.15')(5.25')(10')(.0624 kcf)

= 13.6 kip

Uplift = (7.15')(6')(10')(.0624)

= 26.77 kip



$V_u = 23.63 + 13.6 - 2.2 - 26.77$

$V_u = 8.26$ kip

$1.6V_u = \frac{13.22 \text{ kip}}{10'} = 1.322 \text{ k/ft} = V_u$

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
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$M_u \rightarrow$ R = 2.2 k @ 3.25' ⊖
$w_{,slab}$ = 23.63 k @ 2.63' ⊕
$h_{,vert}$ = 13.6 k @ 2.63' ⊕
Uplift = 26.77 k @ 2.25' ⊖

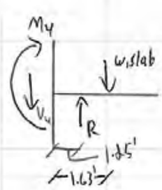
$M_u = (23.63)(2.63) + (13.6)(2.63) - (2.2)(3.25) - (26.77)(2.25)$

$M_u = 30.53$ k-ft

$1.6M_u = \frac{48.85 \text{ k-ft}}{10'} = 4.89 \frac{\text{k-ft}}{\text{ft}} = M_u$

Protected Side:

$V_u \rightarrow$ ~~BQA~~
R = 36.4 k from CPGA
$w_{,slab}$ = 14.63 k (see LC1 calcs)



$V_u = 14.63 - 36.4$

$V_u = -21.77$ k

$1.6V_u = \frac{-34.83 \text{ k}}{10'} = -3.483 \text{ k/ft} = V_u$

$M_u \rightarrow$ R = 36.4 k @ 1.25' ⊖
$w_{,slab}$ = 14.63 k @ 1.63' ⊕

$M_u = (14.63)(1.63) - (36.4)(1.25)$

$M_u = -21.65$ k-ft $\rightarrow 1.6\, M_u = \frac{-34.64 \text{ k-ft}}{10'} = -3.46 \frac{\text{k-ft}}{\text{ft}} = M_u$

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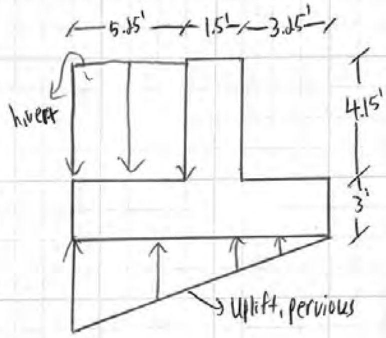
③ Water to TOW (Pervious)
→ conc. wt.
→ h, lat can be ignored
→ h, vert
→ Uplift, pervious
→ 10' of trib. length between piles



Flood side:

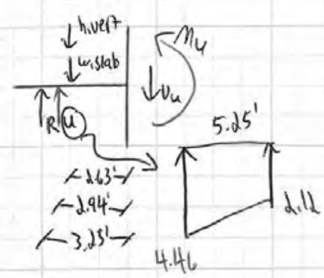
$V_u \rightarrow R = 13.1\ k$ from CPGA

$w, slab = 23.63\ k$ (see LC1 calcs)

$h, vert = 13.6\ k$ (see LC2 calcs)

$uplift = \left(\frac{4.46 + 2.12}{2}\right) 5.25'$

$= 17.27\ kip$



$V_u = 23.63 + 13.6 - 17.27 - 13.1$

$V_u = 6.86\ kip$

$1.6 V_u = \frac{10.98\ kip}{10'} = 1.098\ k/ft = V_u$

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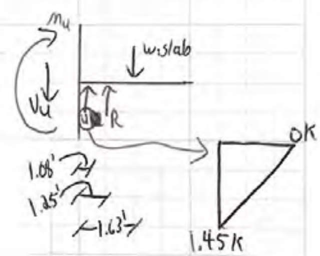
$M_u \rightarrow R = 13.1\ k$ @ $3.25'$ ⊖
$w_{slab} = 23.63\ k$ @ $2.63'$ ⊕
$h_{vert} = 13.6\ k$ @ $2.63'$ ⊕
$Uplift = 17.27\ k$ @ $2.94'$ ⊖

$M_u = (23.63)(2.63) + (13.6)(2.63) - (13.1)(3.25) - (17.27)(2.94)$

$M_u = 4.57\ k\text{-}ft$

$1.6M_u = \dfrac{7.3\ k\text{-}ft}{10'} = .73\ \dfrac{k\text{-}ft}{ft} = M_u$

Protected Side:



$V_u \rightarrow R = 36.5\ k$ from CPGA
$w_{slab} = 14.63\ k$ (see LCI calcs)
$Uplift = \frac{1}{2}(1.45)(3.25)$
$= 2.36\ kip$

$V_u = 14.63 - 36.5 - 2.36$

$V_u = -24.23\ k$

$1.6V_u = \dfrac{-38.77\ k}{10'} = -3.88\ k/ft = V_u$

$M_u \rightarrow R = 36.5\ k$ @ $1.25'$ ⊖
$w_{slab} = 14.63\ k$ @ $1.63'$ ⊕
$Uplift = 2.36\ k$ @ $1.08'$ ⊖

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	CN Gate Storage Monolith				
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$M_u = (14.63)(1.63) - (36.5)(1.25) - (2.36)(1.08)$

$M_u = -24.33$ k-ft

$1.6M_u = \frac{-38.92 \text{ k-ft}}{10'} = -3.89 \frac{\text{k-ft}}{\text{ft}} = M_u$

AECOM

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Description	CN-02 (Represents CN-01)	Computed by	JMH	Date	Dec-20
	CN Gate Storage Monolith				
	Slab Conc. Check	Checked by	JRA	Date	Dec-20
				References	

* Given Information:

Slab Thickness:	3.00	ft				
Slab Width:	10.00	ft				
Clear Cover:	0.75	ft				
Diameter Bar to Start:	0.09	ft				
Diameter of Pile:	1.13	ft	Load Fact.			
Maximum Pile Reaction:	57.10	kips	1	57.10	kips	*From Factored CPGA Results
Maximum Shear:	3.88	kips				
Maximum Moment (Top):	4.89	kip-ft				
Maximum Moment (Bottom):	3.89	kip-ft				

φ_{shear} =	0.75	(ACI 318)
φ_{moment} =	0.9	(ACI 318)
$f_{y,\ rebar}$ =	60	ksi
f'_c =	4	ksi

* Shear Calculations:

1- Shear Capacity:

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75			
f'_c =	4	ksi		
b =	1	ft strip		
d =	2.20	ft	26.44	in

φV_c =	30095.3	lbs	
	30.10	kips	** φVc=30.1 ≥ Vu=3.9, **Shear Capacity OK**

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2- Punching Shear Capacity (ACI 318-14 Table 22.6.5.2):

Vc = minimum value = Eq. a: $4 \times \sqrt{f'_c} \times b_0 \times d$ for $\beta_c < 2.0$

Eq. b: $(2 + (4 / \beta_c)) \times \sqrt{f'_c} \times b_0 \times d$ for $\beta_c > 2.0$

Eq. c: $((\alpha_s \times d) / b_0 + 2) \times \sqrt{f'_c} \times b_0 \times d$ b_0 / d effect based on α_s

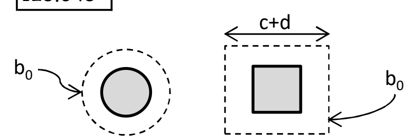
(interior column: α_s = 40, edge column: α_s = 30, corner column: α_s = 20)

d for piles = 26.203 in (Slab thickness - 9" pile embed - cover - $0.5d_{bar}$)

where β_c = Long side / Short side = 1

b_0 = Perimeter of Critical Section = $\pi*(D_{pile} + d)$ = 125.045

α_s = 20 (worst case - corner column)



Vc = minimum value = Eq. a: 828.91 kips

Eq. b: 1243.36 kips

Eq. c: 1282.94 kips

φV_c = 621.68 kips

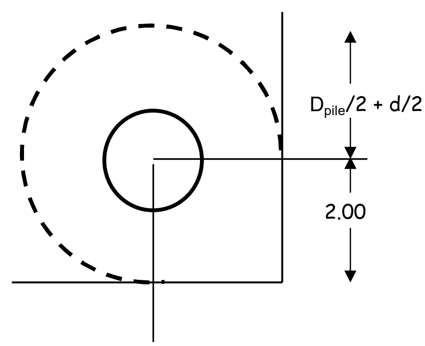
Check corner pile failure to edge of slab:

$D_{pile}/2+d/2$ = 1.66 ft

Diameter of corner failure = 1.658 + 2 ft

= 3.66 ft

Dia. punching shear calc above = 3.32



Diameter of punching shear calculation is smaller than the diameter of this corner failure area. Therefore, no re-check of corner punching failure is required.

φVc used in design = 30.10 kips

** φVc = 30.1k ≥ Vu = 3.9k, Shear Capacity OK

Maximum Pile Reaction = 57.10

** φVc=622k ≥ Vu=57k, Punching Shear Capacity OK

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	Slab Conc. Check	Checked by	JRA	Date	Dec-20
					References

3- Deep Beam One-Way Shear Capacity (φV_{c1}):

For $(w/d) \geq 1.0$, a one-way (normal) shear investigation with loads outside the critical section (located at a distance d from the face of the column, b = footing width) and

$$v_c = 1.9\sqrt{f'_c} + 2500\rho_w\left(\frac{V_u d}{M_u}\right) \geq 2\sqrt{f'_c} \quad \text{(ACI Eq. 11-5)}$$

which reduces for $\rho_w \approx 0.002$ and 3,000 psi $\leq f'_c \leq$ 4,000 psi to $v_c = 1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}(V_u d/M_u) \geq 2\sqrt{f'_c}$.

For $(w/d) < 1.0$, $1.0 > M_u/V_u d > 0$; $\infty > V_u d/M_u \geq 1.0$ (no limits on M_u, $V_u d$, other than above)

$$v_c = \left(\frac{d}{w}\right)\left[3.5 - 2.5\left(\frac{M_u}{V_u d}\right)\right]\left[1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}\left(\frac{V_u d}{M_u}\right)\right] \leq 10\sqrt{f'_c} \quad \text{(ACI Eq. 13-2)}$$

w = 1.5 ft   Distance from CL pile to face of Wall + 3" lateral installation tolerance

M_u = 4.89 kip-ft
V_u = 3.88 kips

v_c = 398.9 psi   ≤ 10 x √f'c = 632.5 psi limit on shear strength
φV_{c1} = 94.91 kips   ** φVc=94.9 ≥ Vu=3.9, OK

Therefore, Slab is OK for shear forces found in slab analysis.

<u>* Reinforcement Calculations:</u>

Limit of Maximum Reinforcement: 0.25 x ρ_b (Design Criteria, EM 1110-2-2104, 3-5)
where ρ_b = 0.0285 for f'_c = 4,000psi, fy = 60,000psi
Max Rebar = 0.00713 *b * d

Maximum Reinforcement:	0.0071	* b * d =	2.26	in^2	per 1ft strip

A_{gross} = 3 ft * 12 in/ft * 12 in strip = 432.00 in^2

Limits of Minimum Reinforcement:

0.005 x Agross =	2.16	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
$(3\sqrt{f'_c} \cdot b \cdot d)/f_y$ =	1.00	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)
$(200 \cdot b \cdot d)/f_y$ =	1.06	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)

Min Reinforcement, temp & shrinkage:	1.08	in^2	per 1ft strip, per face
Min Reinforcement, flexural:	1.06	in^2	per 1ft strip, per face

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	CN Gate Storage Monolith				
	Slab Conc. Check	Checked by	JRA	Date	Dec-20
					References

*** Moment Calculations:**

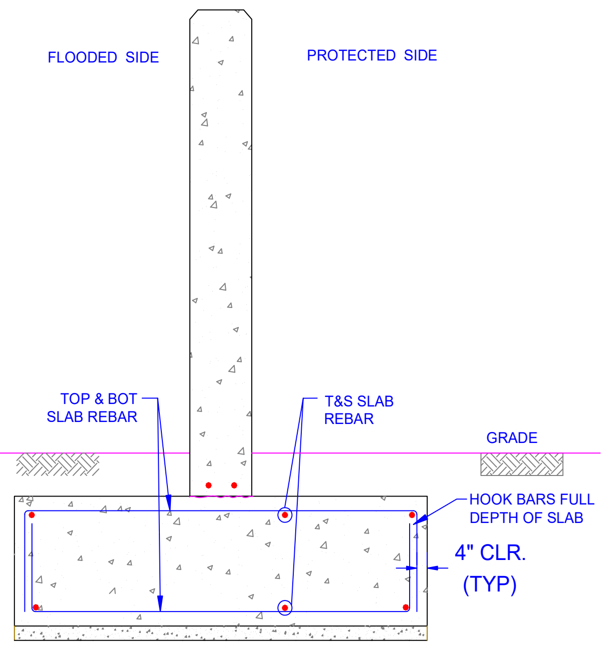
* $T = A_s \times f_y$

* $C = 0.85 \times f'_c \times a \times b$

* Assuming Tension = Compression ⟶ $A_s \times f_y = 0.85 \times f'_c \times a \times b$

* $\varphi Mn = \varphi \times T \times (d - (a / 2))$

$= \varphi \times A_s \times f_y \times (d - (a / 2))$



* Capacity of Min Flexural Reinforcement:

A_s =	1.057	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	2.203	
φ_{moment} =	0.9	

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$

= 1.555 in

φM_n =	1465.1	kip-in
=	122.10	kip-ft

* Capacity of Maximum Reinforcement:

A_s =	2.260	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	2.20	
φ_{moment} =	0.9	

The minimum proposed reinforcement for to T&S Slab Rebar is #7 @ 6"(A =1.2in2) and the minimum proposed reinforcment for Top & Bot Slab Rebar is #7 @ 6"(A =1.2in2).

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$

= 3.324 in

φMn =	3023.8	kip-in
=	251.98	kip-ft

** φMn=252 ≥ Mu=4.9, Section OK	TOP
** φMn=252 ≥ Mu=3.9, Section OK	Bottom

Maurepaus Swamp

CN-03 (Represents CN-04)

CN Gate Monolith

AECOM Project : 60632162

Foundation, Wall & Slab

AECOM

1555 Poydras Street

Suite 1200

New Orleans, LA 70112

(504) 586-8111

Computed by:	JMH	Checked by:	JRA
Date:	Dec-20	Date:	Dec-20

AECOM

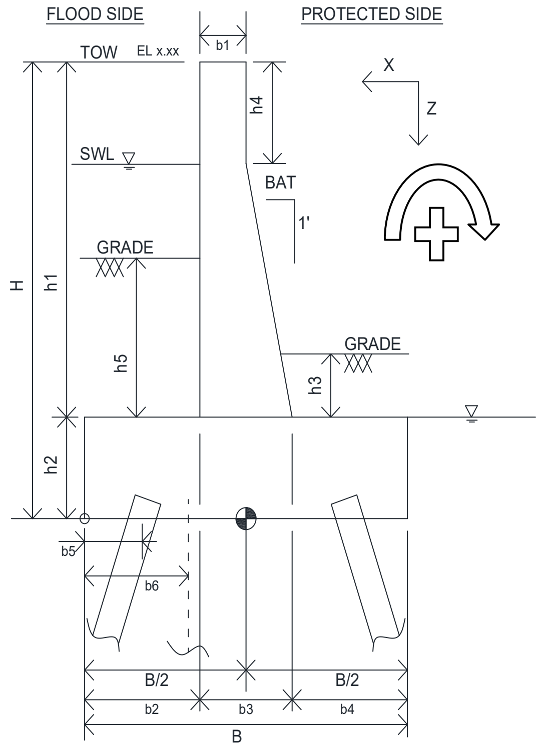
Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Wall Geometry	Checked by	JRA	Date	Dec-20

References

WALL GEOMETRY:

Top of Pilaster EL.	16.13	NAVD88
Top of Wall EL.	16.13	NAVD88
100 Yr. Water El.		NAVD88
10 Yr. Water El.		NAVD88
Top of Slab EL.	11.98	NAVD88
H=	8.65	ft.
h1=	4.15	ft.
h2=	4.50	ft. (Base Slab Height)
h3=	0.00	ft. (P.S. Soil Height)
h4=	0.00	ft.
h5=	0.00	ft. (F.S. Soil Height)
B=	12.00	ft. (Base Slab Width)
b1=	1.50	ft. (Wall Stem Width, top)
b2=	6.25	ft. (F.S. Slab Width)
b3=	1.50	ft. (Wall Stem Width, bottom)
b4=	4.25	ft. (P.S. Slab Width)
b5=	2.00	ft. (F.S. Pile Row Edge Space)
b6=	7.00	ft. (Sheet Pile Edge Space)
BAT=	0.00	(Wall Batter, N/A)
PS Grade =	11.98	NAVD88 (Average of PS soil for all)

Monolith Length =	58.92	ft
Bottom Of Slab =	7.48	NAVD88



T-WALL CROSS-SECTION

Notes: 1) positive 'Y' axis is into page

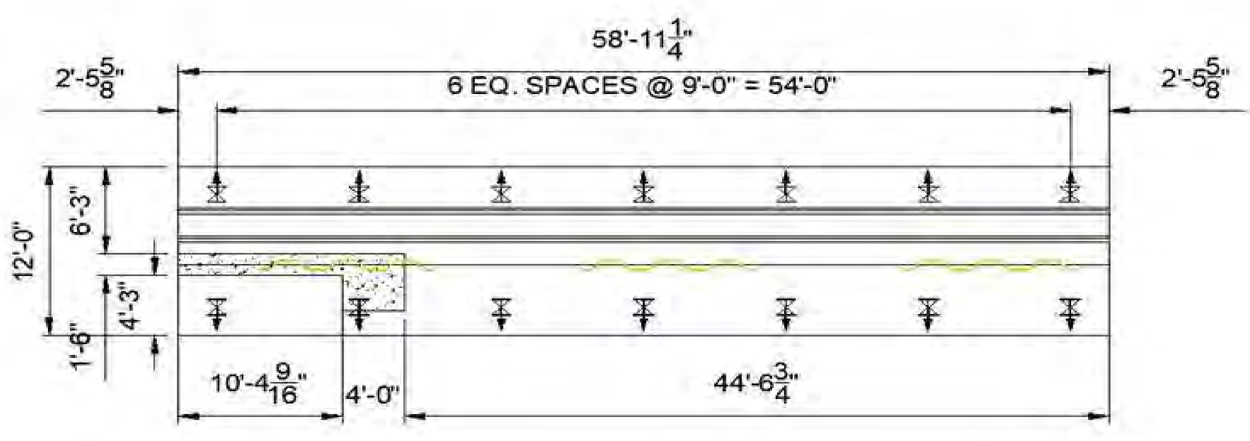
2) pile batters vary from those shown in diagram

Note: In this report, white boxes are for input data and colored boxes are calculated values.

Note: CN-03 and CN-04 have been deemed to be equal and opposite.

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Applied Loads in SAP Model	Checked by	JRA	Date	Dec-20
					References

Pile and Pilaster Layout:



AECOM

Job	**Maurepaus Swamp**	**Project No.**	**60632162**		
Description	**CN-03 (Represents CN-04)**	**Computed by**	**JMH**	**Date**	**Dec-20**
	CN Gate Monolith				
	Assumptions	**Checked by**	**JRA**	**Date**	**Dec-20**

References

Unit Weight of Storm Water =	0.0624	kcf
Wet Unit Weight of Soil =	0.1200	kcf
Sat Unit Weight of Soil =	0.0576	kcf
Unit Weight of Concrete =	0.1500	kcf
Impact Load =	0.0000	k/ft
FS Wind force above SWL=	0.0500	ksf
Construction Surcharge Pressure =	0.2500	ksf
Unbalanced Load for Stability Analysis:		
F_{cap} (k/ft) =	0.00	(10y SWL Case; Force acts at bottom of slab)
F_{cap} (k/ft) =	0.00	(100y SWL Case; Force acts at bottom of slab)
F_{cap} (k/ft) =	0.00	(Water to TOW Case; Force acts at bottom of slab)
K_0, Granular fill =	0.95	(for lateral soil forces)
Assumed Wall Reinforcement Cover =	0.25	ft
Assumed Wall d_{bar} =	0.06	ft
Gate Length =	93.12	ft
Gate Opening =	89.12	ft *Tributary Length = 44.56'
Gate Weight =	22.35	kip *Taken from similar roller gate from Hoboken project.

***NOTE:** Gate calculations show a gate weight of 31.03 kip:
(31.03 - 22.35) / 14 piles = .62 kip/pile
By inspection, gate weight will not drastically affect the design and the new gate weight passes with the pile capacities along with the shear and moment capacities on the slab. The gate weight will be updated and analyzed for the next submittal.

AECOM

Job	Maurepaus Swamp	Project No.	60632162
Description	CN-03 (Represents CN-04)	Computed by	JMH
	CN Gate Monolith	Date	Dec-20
	Load Cases	Checked by	JRA
		Date	Dec-20
			References

No. of Load Cases	3	Update

No.	DCD LC No.	Description	FS Water El.	PS Water El.	Pile Design Over Stresses
1	1	Construction Surcharge	7.48	7.48	1.17
2	2a	Water to TOW (impervious cutoff)	16.13	7.48	1.33
3	2b	Water to TOW (pervious cutoff)	16.13	7.48	1.33
4		Dead + Cooper E80	7.48	7.48	1.00

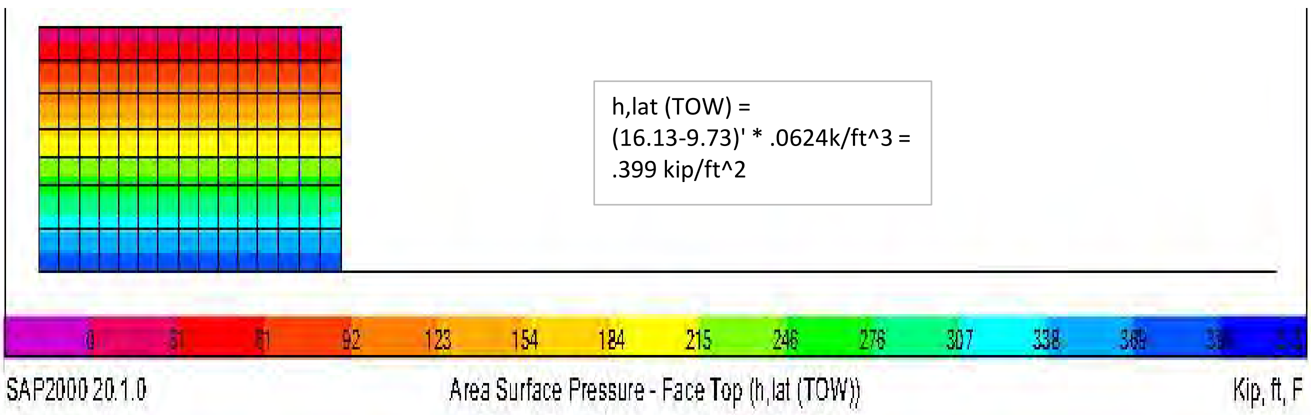
* Impact load is not applicable for this section, so it is excluded from the load combinations
* Forces induced by 10y water elevation are not applicable for this section, so they are excluded from the load combinations

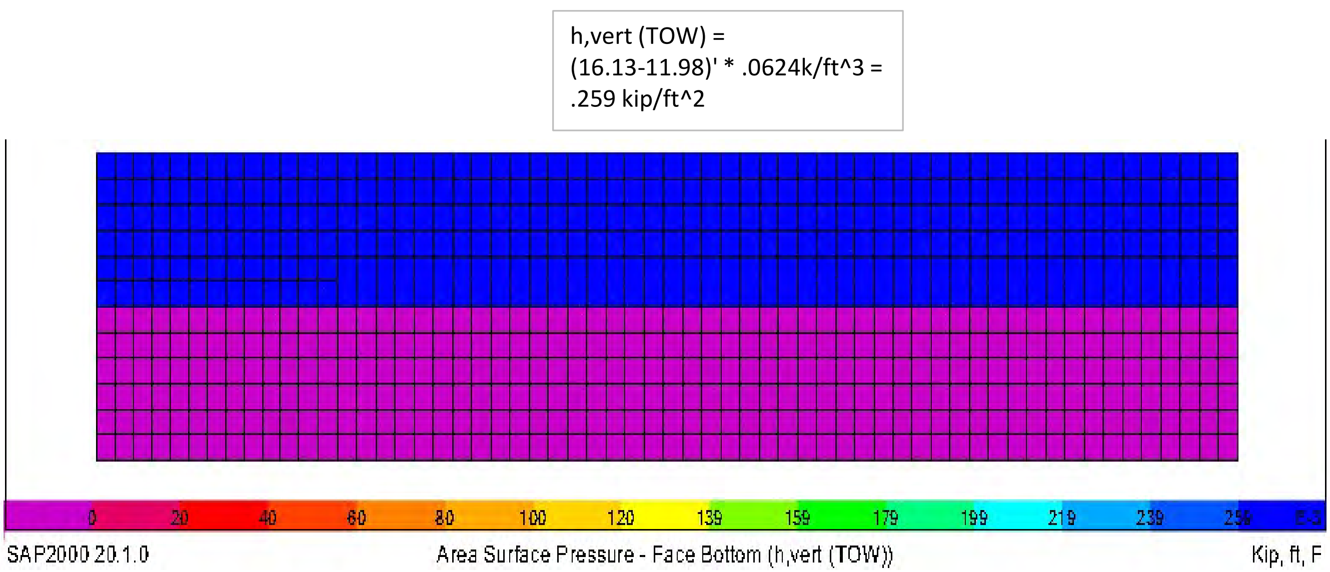
*Earthquake and Wave Loads are to be determined and are excluded from these calculations

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Applied Loads in SAP Model	Checked by	JRA	Date	Dec-20

References

*The following diagrams represent the loads applied in the SAP Model; base reactions were taken from SAP to plug into CPGA to get the pile reactions of the structure.



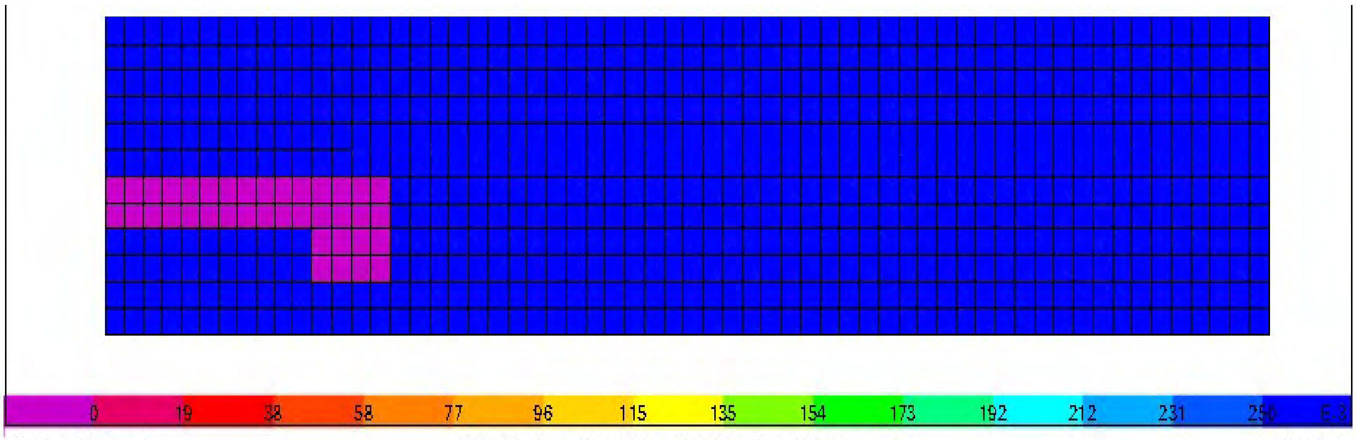


AECOM

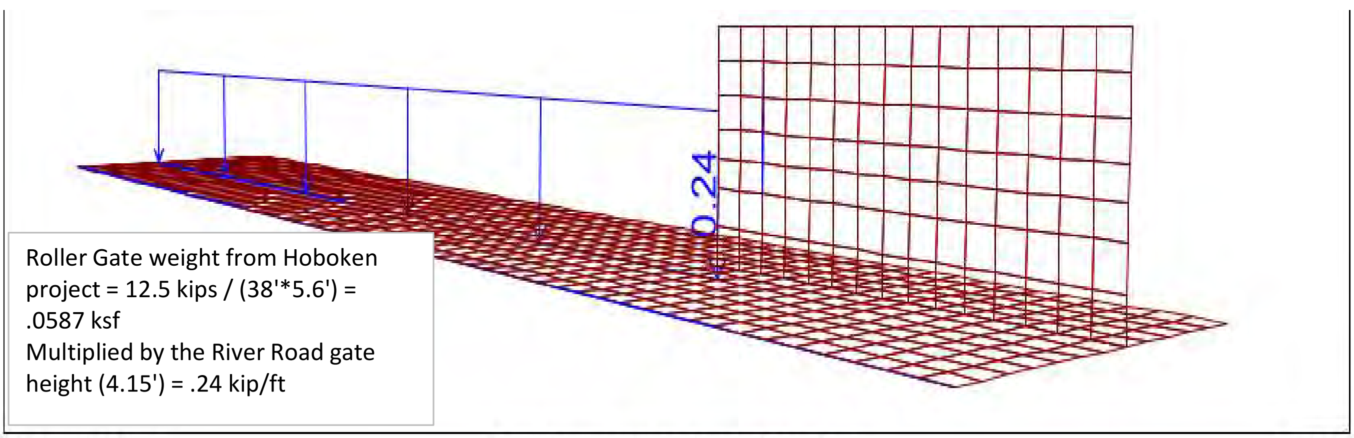
Job	**Maurepaus Swamp**	**Project No.**	**60632162**		
Description	**CN-03 (Represents CN-04)**	**Computed by**	**JMH**	**Date**	**Dec-20**
	CN Gate Monolith				
	Applied Loads in SAP Model	**Checked by**	**JRA**	**Date**	**Dec-20**

References

A surcharge of .25 kip/ft^2 is applied to both protected and flood sides of slab. See Assumptions page



SAP2000 20.1.0 Area Surface Pressure - Face Bottom (Surcharge) Kip, ft, F

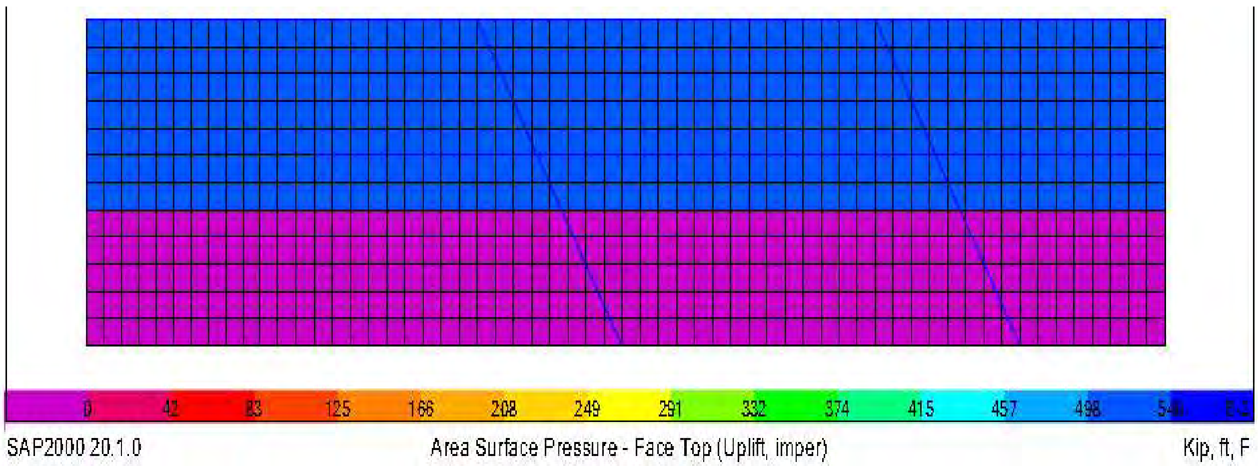


SAP2000 20.1.0 Frame Span Loads (gate) (GLOBAL CSys) Kip, ft, F

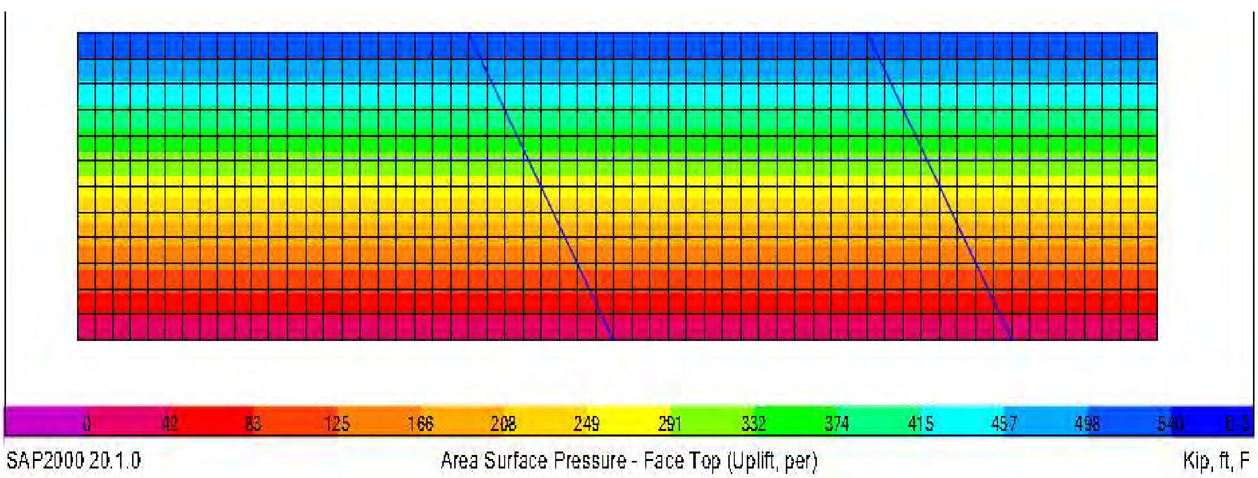
AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Applied Loads in SAP Model	Checked by	JRA	Date	Dec-20

References



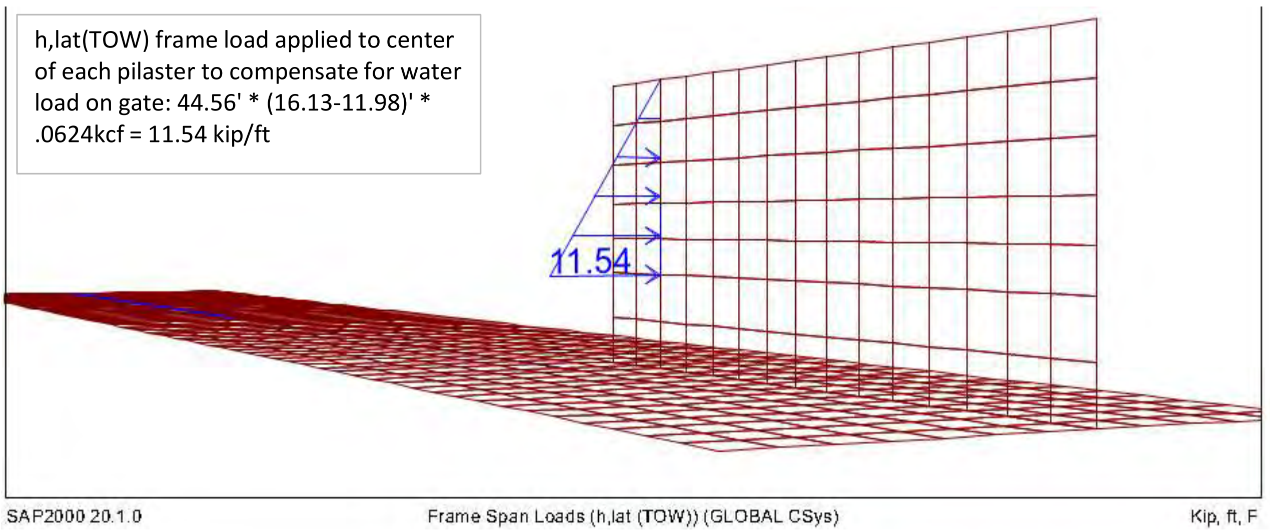
Impervious and Pervious Uplift =
(16.13' - 7.48') * .0624kcf = .54 ksf



AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Applied Loads in SAP Model	Checked by	JRA	Date	Dec-20

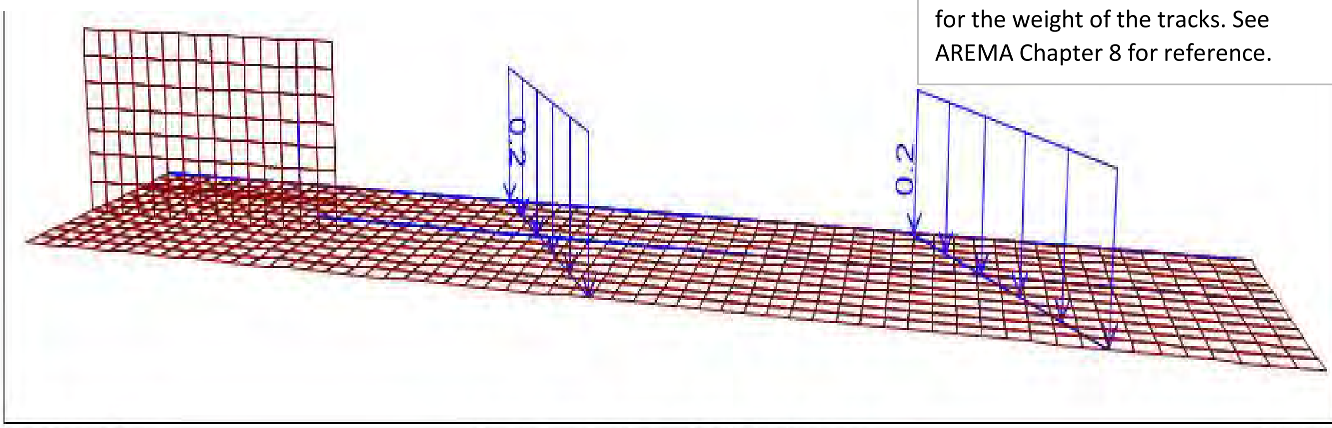
References



Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Applied Loads in SAP Model	Checked by	JRA	Date	Dec-20

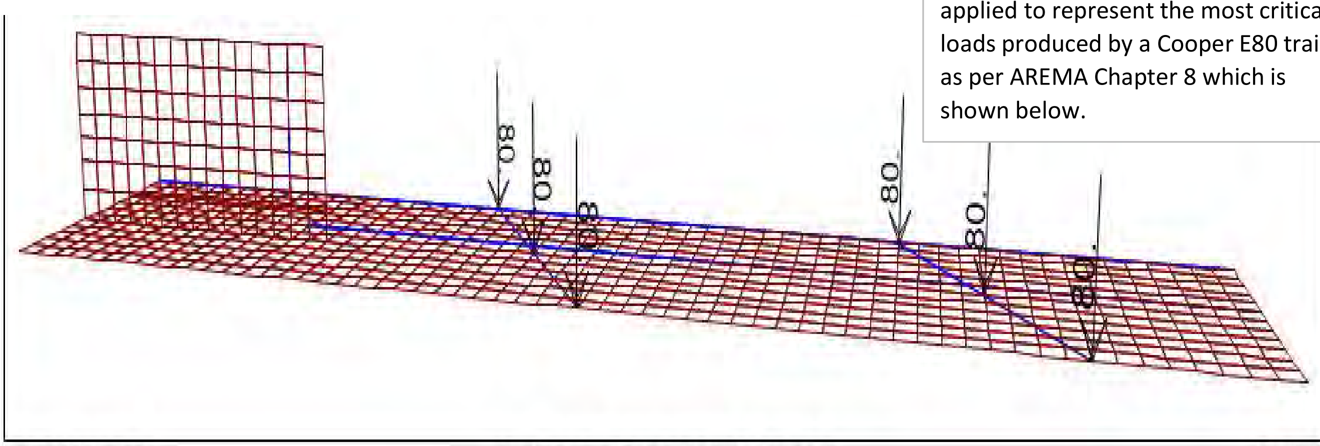
References

Train tracks - Two distributed frame loads of .2 kip/ft is applied to the center of both rail tracks to account for the weight of the tracks. See AREMA Chapter 8 for reference.



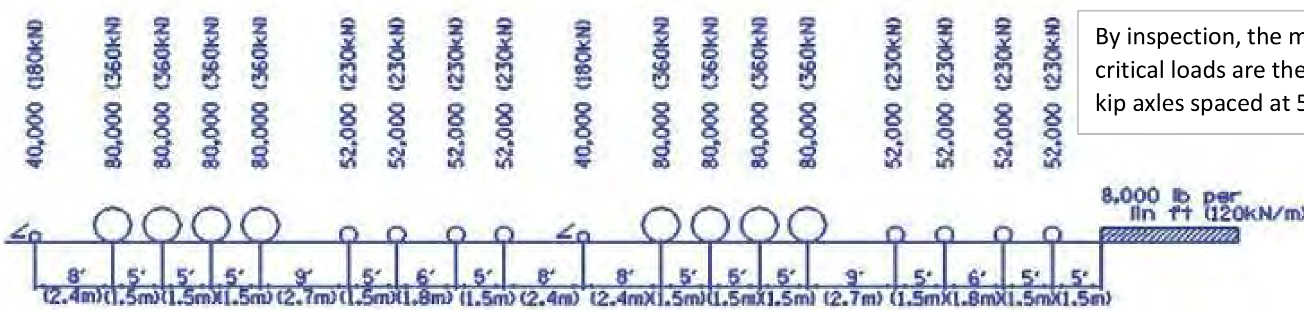
SAP2000 20.1.0 Frame Span Loads (tracks) (GLOBAL CSys) Kip, ft, F

Train Load - six 80 kip joint loads are applied to represent the most critical loads produced by a Cooper E80 train as per AREMA Chapter 8 which is shown below.



SAP2000 20.1.0 Joint Loads (Cooper E80) (As Defined) Kip, ft, F

By inspection, the most critical loads are the 80 kip axles spaced at 5'.



AECOM

Job	Maurepaus Swamp	Project No.	60589133		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Summary of Foundation Loads	Checked by	JRA	Date	Dec-20
					References

UNFACTORED LOADS FOR CPGA						
Load Case	Fx (kips)	Fy (kips)	Fz (kips)	Mx (kip-ft)	My (kip-ft)	Mz (kip-ft)
LC1	0.00	0.00	664.46	-211.24	6.48	0.00
LC2	-137.46	0.00	390.05	-335.30	655.25	-580.63
LC3	-137.46	0.00	420.02	-335.31	490.45	-580.63
LC4	0.00	0.00	1031.24	3182.52	19.69	0.00

This table represents the base reactions taken from SAP. The moments were taken from the centroid of the structure with positive-x facing the flood side and positive-z facing downwards.

Note: Loads exported from SAP 2000 are within 5% on the conservative side of the actual loads on the monolith; OK to use for this submittal.

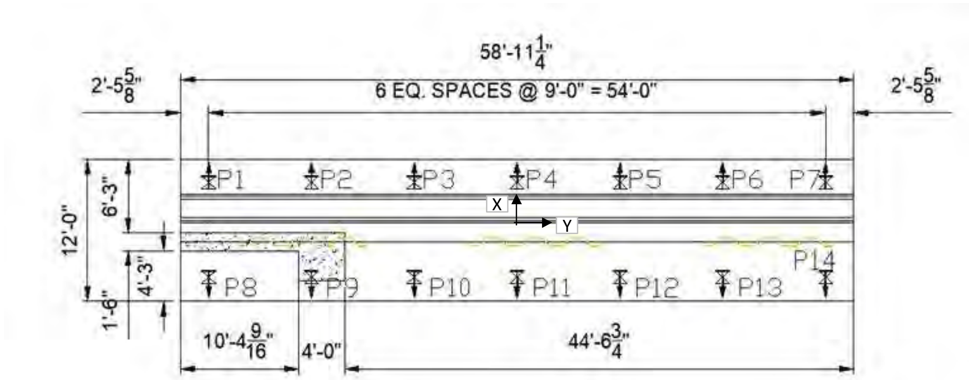
FACTORED LOADS FOR CPGA						
Load Case	Fx (kips)	Fy (kips)	Fz (kips)	Mx (kip-ft)	My (kip-ft)	Mz (kip-ft)
LC1	0.00	0.00	1063.13	-337.99	10.37	0.00
LC2	-219.94	0.00	624.09	-536.48	1048.40	-929.01
LC3	-219.94	0.00	672.03	-536.49	784.72	-929.01
LC4	0.00	0.00	2268.73	7001.54	43.32	0.00

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Soil & Pile Information Required for CPGA	Checked by	JRA	Date	Dec-20
					References

Pile Layout: 14 HP Piles

Row 1			Row 2		
pile no.	x	y	pile no.	x	y
1	4.00	-27.00	8	-4.00	-27.00
2	4.00	-18.00	9	-4.00	-18.00
3	4.00	-9.00	10	-4.00	-9.00
4	4.00	0.00	11	-4.00	0.00
5	4.00	9.00	12	-4.00	9.00
6	4.00	18.00	13	-4.00	18.00
7	4.00	27.00	14	-4.00	27.00



Tip Elevation: (For CPGA, need Tip Elevation as a function of CPGA Axis at B.O. Slab, +Z points downward)

B.O.S. Elevation =	7.48	NAVD88
Pile Tip El. =	-60	NAVD89
"TIP" in CPGA =	**67.48**	**ft**

Pile Properties & Attributes

E =	29000000.0	psi
A =	21.40	in^2 HP14X73
I_x =	729.00	in^4
I_y =	261.00	in^4
C_{33} =	1.70	(factor for method of axial load transfer from pile to soil; = 1 full tip bearing, = 2 full skin friction)
S_x =	107.00	in^3
S_y =	35.80	in^3
F_y =	50.00	ksi

*Note: All soil properties and pile capacities are taken from 95% submittal for Maurepas intake structure.

Allowable Compression (AC) =	110.00	kips
Allowable Tension (AT) =	87.50	kips
ACC =	492.66	kips
ATT =	535.00	kips
AM1 =	2972.22	kip-in
AM2 =	994.44	kip-in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Soil & Pile Information Required for CPGA	Checked by	JRA	Date	Dec-20
					References

Es Value for CPGA Run:

Monolith width = 59 ft

E_s = 540.40 psi = 0.5404 ksi

GROUP FACTORS	
Pile Spacing in Direction of Loading	From EM1110-2-2906
	D
3B	0.33
4B	0.38
5B	0.45
6B	0.56
7B	0.71
8B	1

Group reduction is based on distance between piles in direction of loading. This includes distance due to battering and is taken over the distance 10 x d_{pile} (point of fixety).

Assume a batter of 6.00

B = d_{pile} = 13.6 in = 1.133 ft

Distance between piles at B.O. Slab = 8.00 ft

Average distance between piles over 10*dpile = 9.89 ft

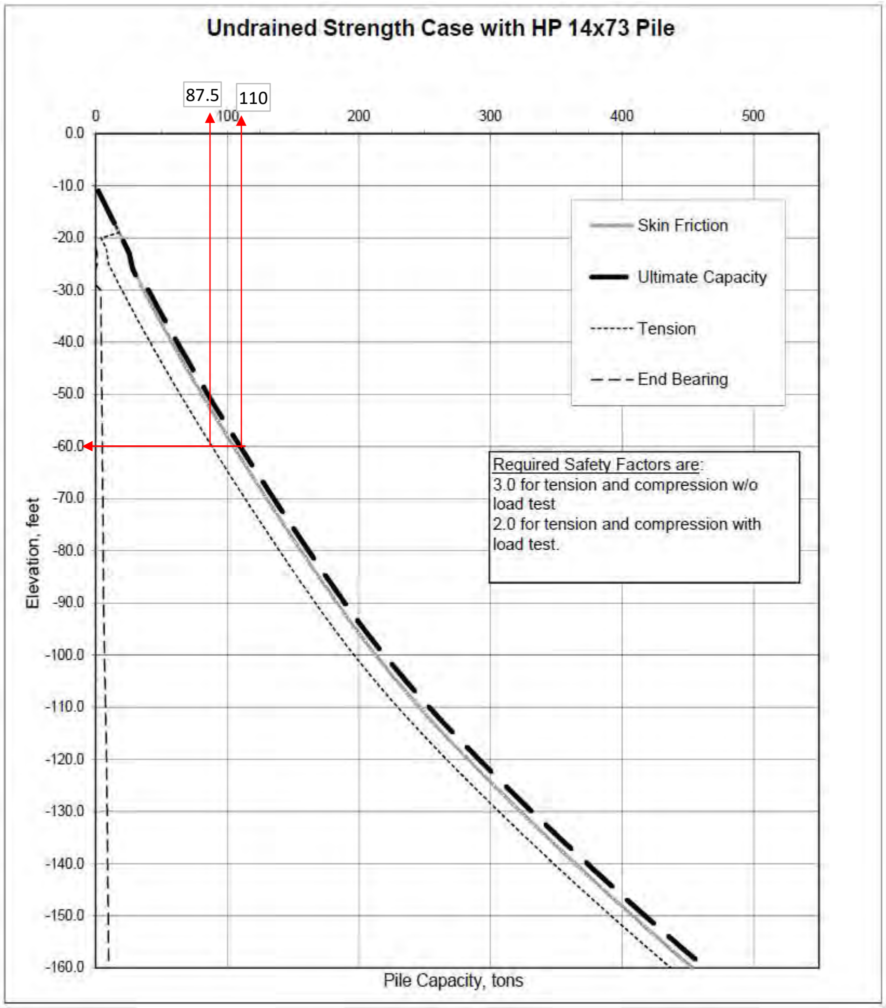
Average distance between piles in terms of pile width B = 8.73 B

Group Reduction "D" value for this distance = 1.00

Therefore, Es including group reduction = 0.54 ksi

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Soil & Pile Information Required for CPGA	Checked by	JRA	Date	Dec-20
					References



Job	Maurepaus Swamp		Project No.	60632162		
Description	CN-03 (Represents CN-04)		Computed by	JMH	Date	Dec-20
	CN Gate Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	JRA	Date	Dec-20

Input file:

```
100 MONOLITH, TOW EL. 16.13, TOS EL.10.0; HP 14X73  PILES
200 PROP 29000 729 261 21.4 1.7 0 ALL
300 SOIL ES 0.5404 TIP 67.48 0 ALL
400 PIN ALL
500 ALLOW H 110 88 492.7 535 2972.2 994.4 ALL
600 FOVSTR 1.17 1.17 1
700 FOVSTR 1.33 1.33 2 3
800 FOVSTR 1 1 4
900 BATTER 6 All
1200 ANGLE 180 8 TO 14
1300 PILE 1 4 -27 0
1400 PILE 2 4 -18 0
1500 PILE 3 4 -9 0
1600 PILE 4 4 0 0
1700 PILE 5 4 9 0
1800 PILE 6 4 18 0
1900 PILE 7 4 27 0
2000 PILE 8 -4 -27 0
2100 PILE 9 -4 -18 0
2200 PILE 10 -4 -9 0
2300 PILE 11 -4 0 0
2400 PILE 12 -4 9 0
2500 PILE 13 -4 18 0
2600 PILE 14 -4 27 0
4500 LOAD 1 0 0 664.5 -211.2 6.5 0
4600 LOAD 2 -137.5 0 390.1 -335.3 655.2 -580.6
4700 LOAD 3 -137.5 0 420 -335.3 490.5 -580.6
4800 LOAD 4 0 0 1031.2 3182.5 19.7 0
9000 FOUT 1 2 3 4 5 6 7 CN01P.DOC
9100 PFO ALL
9200 PLB ALL
```

CPGA RESULTS without Load Factors (pinned connection)

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 22-DEC-20     RUN TIME: 12:01:50



    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.10.0; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE  14 PILES AND
            4 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                   X          Y          Z
                                 -----      -----      -----
WITH DIAGONAL COORDINATES = (     -4.00 ,   -27.00 ,     0.00 )
                            (      4.00 ,    27.00 ,     0.00 )


*******************************************************************************

         PILE PROPERTIES AS INPUT


      E           I1           I2           A           C33          B66
     KSI         IN**4        IN**4        IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         SOIL DESCRIPTIONS AS INPUT
```

Job	Maurepaus Swamp		Project No.	60632162		
Description	CN-03 (Represents CN-04)		Computed by	JMH	Date	Dec-20
	CN Gate Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	JRA	Date	Dec-20

```
   ES     ESOIL      LENGTH       L           LU
        K/IN**2                  FT           FT
       0.54040E+00    T      0.67480E+02   0.00000E+00

  ESOIL(ORIGINAL)      RGROUP     RCYCLIC
    K/IN**2
   0.54040E+00       0.1000E+01 0.1000E+01

 THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

     ALL


 ********************************************************************************

          PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


  0.23377E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.30221E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.12852E+04  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


 THIS MATRIX APPLIES TO THE FOLLOWING PILES -

       1


 ********************************************************************************
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM	X FT	Y FT	Z FT	BATTER	ANGLE	LENGTH FT	FIXITY
1	4.00	-27.00	0.00	6.00	0.00	68.41	P
2	4.00	-18.00	0.00	6.00	0.00	68.41	P
3	4.00	-9.00	0.00	6.00	0.00	68.41	P
4	4.00	0.00	0.00	6.00	0.00	68.41	P
5	4.00	9.00	0.00	6.00	0.00	68.41	P
6	4.00	18.00	0.00	6.00	0.00	68.41	P
7	4.00	27.00	0.00	6.00	0.00	68.41	P
8	-4.00	-27.00	0.00	6.00	180.00	68.41	P
9	-4.00	-18.00	0.00	6.00	180.00	68.41	P
10	-4.00	-9.00	0.00	6.00	180.00	68.41	P
11	-4.00	0.00	0.00	6.00	180.00	68.41	P
12	-4.00	9.00	0.00	6.00	180.00	68.41	P
13	-4.00	18.00	0.00	6.00	180.00	68.41	P
14	-4.00	27.00	0.00	6.00	180.00	68.41	P

957.75

****

APPLIED LOADS

LOAD CASE	PX K	PY K	PZ K	MX FT-K	MY FT-K	MZ FT-K	OVERSTRESS COM	 TEN
1	0.0	0.0	664.5	-211.2	6.5	0.0	1.17	1.17
2	-137.5	0.0	390.1	-335.3	655.2	-580.6	1.33	1.33
3	-137.5	0.0	420.0	-335.3	490.5	-580.6	1.33	1.33
4	0.0	0.0	1031.2	3182.5	19.7	0.0		

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

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*******************************************************************************

         ORIGINAL PILE GROUP STIFFNESS MATRIX

  0.80470E+03 -0.46435E-05  0.85265E-12  0.14552E-10 -0.13750E+06  0.22289E-03
 -0.46435E-05  0.42309E+03  0.34856E-04  0.00000E+00  0.16731E-02 -0.52296E-11
  0.85265E-12  0.34856E-04  0.17515E+05  0.00000E+00 -0.29104E-10 -0.16731E-02
  0.00000E+00  0.21684E-18  0.00000E+00  0.81717E+09  0.37253E-08 -0.22352E-07
 -0.13750E+06  0.16731E-02 -0.29104E-10  0.37253E-08  0.40354E+08 -0.80308E-01
  0.22289E-03 -0.63665E-11 -0.16731E-02 -0.29802E-07 -0.80308E-01  0.38519E+08



                     14 PILES    4 LOAD CASES

 LOAD CASE    1.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    2.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    3.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    4.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.


*******************************************************************************

         PILE CAP DISPLACEMENTS

 LOAD
 CASE       DX          DY          DZ          RX          RY          RZ
            IN          IN          IN          RAD         RAD         RAD

    1   0.7905E-03 -0.3135E-08  0.3794E-01 -0.3101E-05  0.4627E-05  0.1653E-11
    2  -0.3293E+00 -0.1782E-08  0.2227E-01 -0.4924E-05 -0.9272E-03 -0.1809E-03
    3  -0.3493E+00 -0.1679E-08  0.2398E-01 -0.4924E-05 -0.1044E-02 -0.1809E-03
    4   0.2396E-02 -0.4880E-08  0.5888E-01  0.4673E-04  0.1402E-04  0.2573E-11


*******************************************************************************
              ELASTIC CENTER INFORMATION



 ELASTIC CENTER IN PLANE X-Z          X             Z
                                     FT            FT
                                    0.00          0.00
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

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******************************************************************************

         PILE FORCES IN LOCAL GEOMETRY

             M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
             * INDICATES PILE FAILURE
             # INDICATES CBF BASED ON MOMENTS DUE TO
                       (F3*EMIN) FOR CONCRETE PILES
             B INDICATES BUCKLING CONTROLS



LOAD CASE -    1

PILE    F1      F2      F3        M1        M2        M3   ALF  CBF
         K       K       K      IN-K      IN-K      IN-K

  1    -0.1     0.0    49.3       0.0       3.6       0.0 0.38 0.09
  2    -0.1     0.0    48.8       0.0       3.6       0.0 0.38 0.09
  3    -0.1     0.0    48.4       0.0       3.6       0.0 0.38 0.09
  4    -0.1     0.0    48.0       0.0       3.5       0.0 0.37 0.09
  5    -0.1     0.0    47.6       0.0       3.5       0.0 0.37 0.09
  6    -0.1     0.0    47.1       0.0       3.5       0.0 0.37 0.08
  7    -0.1     0.0    46.7       0.0       3.4       0.0 0.36 0.08
  8    -0.2     0.0    49.5       0.0       4.7       0.0 0.38 0.09
  9    -0.2     0.0    49.1       0.0       4.7       0.0 0.38 0.09
 10    -0.2     0.0    48.6       0.0       4.6       0.0 0.38 0.09
 11    -0.2     0.0    48.2       0.0       4.6       0.0 0.37 0.09
 12    -0.2     0.0    47.8       0.0       4.6       0.0 0.37 0.09
 13    -0.2     0.0    47.4       0.0       4.5       0.0 0.37 0.09
 14    -0.2     0.0    46.9       0.0       4.5       0.0 0.36 0.09


LOAD CASE -    2

PILE    F1      F2      F3        M1        M2        M3   ALF  CBF
         K       K       K      IN-K      IN-K      IN-K

  1    -9.2    -0.3     4.7      -9.4     256.5       0.0 0.03 0.20
  2    -8.8    -0.3     8.2      -9.4     243.9       0.0 0.06 0.20
  3    -8.3    -0.3    11.6      -9.4     231.3       0.0 0.08 0.20
  4    -7.8    -0.3    15.1      -9.4     218.7       0.0 0.10 0.19
  5    -7.4    -0.3    18.5      -9.4     206.1       0.0 0.13 0.19
  6    -6.9    -0.3    22.0      -9.4     193.5       0.0 0.15 0.18
  7    -6.5    -0.3    25.4      -9.4     180.9       0.0 0.17 0.18
  8     9.0    -0.3    55.8      -9.4    -251.4       0.0 0.38 0.28
  9     8.6    -0.3    51.0      -9.4    -238.9       0.0 0.35 0.26
 10     8.1    -0.3    46.2      -9.4    -226.4       0.0 0.32 0.24
 11     7.7    -0.3    41.4      -9.4    -213.9       0.0 0.28 0.23
 12     7.2    -0.3    36.6      -9.4    -201.4       0.0 0.25 0.21
 13     6.8    -0.3    31.8      -9.4    -188.9       0.0 0.22 0.19
 14     6.3    -0.3    27.0      -9.4    -176.4       0.0 0.18 0.18
```

Job	Maurepaus Swamp		Project No.	60632162		
Description	CN-03 (Represents CN-04)		Computed by	JMH	Date	Dec-20
	CN Gate Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	JRA	Date	Dec-20

LOAD CASE - 3

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	-9.7	-0.3	9.8	-9.4	270.2	0.0	0.07	0.22
2	-9.2	-0.3	13.2	-9.4	257.5	0.0	0.09	0.22
3	-8.8	-0.3	16.7	-9.4	244.9	0.0	0.11	0.21
4	-8.3	-0.3	20.1	-9.4	232.3	0.0	0.14	0.21
5	-7.9	-0.3	23.6	-9.4	219.7	0.0	0.16	0.20
6	-7.4	-0.3	27.1	-9.4	207.1	0.0	0.18	0.20
7	-7.0	-0.3	30.5	-9.4	194.5	0.0	0.21	0.20
8	9.5	-0.3	55.1	-9.4	-264.7	0.0	0.38	0.29
9	9.1	-0.3	50.3	-9.4	-252.2	0.0	0.34	0.27
10	8.6	-0.3	45.5	-9.4	-239.7	0.0	0.31	0.25
11	8.2	-0.3	40.7	-9.4	-227.2	0.0	0.28	0.24
12	7.7	-0.3	35.9	-9.4	-214.7	0.0	0.25	0.22
13	7.3	-0.3	31.1	-9.4	-202.2	0.0	0.21	0.20
14	6.8	-0.3	26.2	-9.4	-189.7	0.0	0.18	0.19

LOAD CASE - 4

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	-0.1	0.0	55.1	0.0	3.1	0.0	0.50	0.11
2	-0.1	0.0	61.5	0.0	3.6	0.0	0.56	0.13
3	-0.1	0.0	67.9	0.0	4.2	0.0	0.62	0.14
4	-0.2	0.0	74.3	0.0	4.7	0.0	0.68	0.16
5	-0.2	0.0	80.7	0.0	5.2	0.0	0.73	0.17
6	-0.2	0.0	87.1	0.0	5.8	0.0	0.79	0.18
7	-0.2	0.0	93.5	0.0	6.3	0.0	0.85	0.20
8	-0.2	0.0	55.8	0.0	6.3	0.0	0.51	0.12
9	-0.2	0.0	62.2	0.0	6.8	0.0	0.57	0.13
10	-0.3	0.0	68.6	0.0	7.4	0.0	0.62	0.15
11	-0.3	0.0	75.0	0.0	7.9	0.0	0.68	0.16
12	-0.3	0.0	81.4	0.0	8.5	0.0	0.74	0.17
13	-0.3	0.0	87.8	0.0	9.0	0.0	0.80	0.19
14	-0.3	0.0	94.2	0.0	9.5	0.0	0.86	0.20

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Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	8.0	0.0	48.6	0.0	0.0	0.0
2	7.9	0.0	48.2	0.0	0.0	0.0
3	7.8	0.0	47.8	0.0	0.0	0.0
4	7.8	0.0	47.3	0.0	0.0	0.0
5	7.7	0.0	46.9	0.0	0.0	0.0
6	7.6	0.0	46.5	0.0	0.0	0.0
7	7.6	0.0	46.1	0.0	0.0	0.0
8	-8.0	0.0	48.8	0.0	0.0	0.0
9	-7.9	0.0	48.4	0.0	0.0	0.0
10	-7.8	0.0	48.0	0.0	0.0	0.0
11	-7.8	0.0	47.6	0.0	0.0	0.0
12	-7.7	0.0	47.2	0.0	0.0	0.0
13	-7.6	0.0	46.7	0.0	0.0	0.0
14	-7.6	0.0	46.3	0.0	0.0	0.0

LOAD CASE - 2

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-8.3	-0.3	6.2	0.0	0.0	0.0
2	-7.3	-0.3	9.5	0.0	0.0	0.0
3	-6.3	-0.3	12.8	0.0	0.0	0.0
4	-5.3	-0.3	16.2	0.0	0.0	0.0
5	-4.3	-0.3	19.5	0.0	0.0	0.0
6	-3.2	-0.3	22.8	0.0	0.0	0.0
7	-2.2	-0.3	26.2	0.0	0.0	0.0
8	-18.1	0.3	53.6	0.0	0.0	0.0
9	-16.8	0.3	48.9	0.0	0.0	0.0
10	-15.6	0.3	44.2	0.0	0.0	0.0
11	-14.4	0.3	39.6	0.0	0.0	0.0
12	-13.1	0.3	34.9	0.0	0.0	0.0
13	-11.9	0.3	30.2	0.0	0.0	0.0
14	-10.7	0.3	25.6	0.0	0.0	0.0

AECOM

Job	Maurepaus Swamp		Project No.	60632162		
Description	CN-03 (Represents CN-04)		Computed by	JMH	Date	Dec-20
	CN Gate Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	JRA	Date	Dec-20

LOAD CASE - 3

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	-8.0	-0.3	11.2	0.0	0.0	0.0
2	-6.9	-0.3	14.6	0.0	0.0	0.0
3	-5.9	-0.3	17.9	0.0	0.0	0.0
4	-4.9	-0.3	21.2	0.0	0.0	0.0
5	-3.9	-0.3	24.6	0.0	0.0	0.0
6	-2.9	-0.3	27.9	0.0	0.0	0.0
7	-1.9	-0.3	31.2	0.0	0.0	0.0
8	-18.4	0.3	52.7	0.0	0.0	0.0
9	-17.2	0.3	48.1	0.0	0.0	0.0
10	-16.0	0.3	43.4	0.0	0.0	0.0
11	-14.7	0.3	38.8	0.0	0.0	0.0
12	-13.5	0.3	34.1	0.0	0.0	0.0
13	-12.3	0.3	29.4	0.0	0.0	0.0
14	-11.0	0.3	24.8	0.0	0.0	0.0

LOAD CASE - 4

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	8.9	0.0	54.4	0.0	0.0	0.0
2	10.0	0.0	60.7	0.0	0.0	0.0
3	11.0	0.0	67.0	0.0	0.0	0.0
4	12.0	0.0	73.3	0.0	0.0	0.0
5	13.1	0.0	79.6	0.0	0.0	0.0
6	14.1	0.0	85.9	0.0	0.0	0.0
7	15.1	0.0	92.2	0.0	0.0	0.0
8	-8.9	0.0	55.1	0.0	0.0	0.0
9	-10.0	0.0	61.4	0.0	0.0	0.0
10	-11.0	0.0	67.7	0.0	0.0	0.0
11	-12.0	0.0	74.0	0.0	0.0	0.0
12	-13.1	0.0	80.3	0.0	0.0	0.0
13	-14.1	0.0	86.6	0.0	0.0	0.0
14	-15.1	0.0	93.0	0.0	0.0	0.0

Job	Maurepaus Swamp		Project No.	60632162		
Description	CN-03 (Represents CN-04)		Computed by	JMH	Date	Dec-20
	CN Gate Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	JRA	Date	Dec-20

CPGA RESULTS without Load Factors (FIXED connection)

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CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 22-DEC-20     RUN TIME: 12:03:30




    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.10.0; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE  14 PILES AND
            4 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                   X          Y          Z
                                 -----      -----      -----
WITH DIAGONAL COORDINATES = (     -4.00 ,   -27.00 ,     0.00 )
                            (      4.00 ,    27.00 ,     0.00 )


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AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

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         PILE PROPERTIES AS INPUT


      E           I1           I2            A           C33          B66
     KSI         IN**4        IN**4        IN**2
  0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

 THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

     ALL


 ******************************************************************************

         SOIL DESCRIPTIONS AS INPUT


    ES     ESOIL      LENGTH       L            LU
         K/IN**2                   FT           FT
        0.54040E+00    T      0.67480E+02   0.00000E+00

  ESOIL(ORIGINAL)      RGROUP     RCYCLIC
    K/IN**2
   0.54040E+00       0.1000E+01 0.1000E+01

 THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

     ALL


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Job	Maurepaus Swamp		Project No.	60632162		
Description	CN-03 (Represents CN-04)		Computed by	JMH	Date	Dec-20
	CN Gate Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	JRA	Date	Dec-20

PILE STIFFNESSES AS CALCULATED FROM PROPERTIES

0.46753E+02	0.00000E+00	0.00000E+00	0.00000E+00	0.20224E+04	0.00000E+00
0.00000E+00	0.60441E+02	0.00000E+00	-0.33800E+04	0.00000E+00	0.00000E+00
0.00000E+00	0.00000E+00	0.12852E+04	0.00000E+00	0.00000E+00	0.00000E+00
0.00000E+00	-0.33800E+04	0.00000E+00	0.37804E+06	0.00000E+00	0.00000E+00
0.20224E+04	0.00000E+00	0.00000E+00	0.00000E+00	0.17497E+06	0.00000E+00
0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

THIS MATRIX APPLIES TO THE FOLLOWING PILES -

1

****

PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM	X FT	Y FT	Z FT	BATTER	ANGLE	LENGTH FT	FIXITY
1	4.00	-27.00	0.00	6.00	0.00	68.41	F
2	4.00	-18.00	0.00	6.00	0.00	68.41	F
3	4.00	-9.00	0.00	6.00	0.00	68.41	F
4	4.00	0.00	0.00	6.00	0.00	68.41	F
5	4.00	9.00	0.00	6.00	0.00	68.41	F
6	4.00	18.00	0.00	6.00	0.00	68.41	F
7	4.00	27.00	0.00	6.00	0.00	68.41	F
8	-4.00	-27.00	0.00	6.00	180.00	68.41	F
9	-4.00	-18.00	0.00	6.00	180.00	68.41	F
10	-4.00	-9.00	0.00	6.00	180.00	68.41	F
11	-4.00	0.00	0.00	6.00	180.00	68.41	F
12	-4.00	9.00	0.00	6.00	180.00	68.41	F
13	-4.00	18.00	0.00	6.00	180.00	68.41	F
14	-4.00	27.00	0.00	6.00	180.00	68.41	F

957.75

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Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

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                         APPLIED LOADS

 LOAD      PX         PY         PZ          MX          MY          MZ  OVERSTRESS
 CASE       K          K          K         FT-K        FT-K        FT-K  COM   TEN

   1       0.0        0.0      664.5      -211.2         6.5         0.0 1.17 1.17
   2    -137.5        0.0      390.1      -335.3       655.2      -580.6 1.33 1.33
   3    -137.5        0.0      420.0      -335.3       490.5      -580.6 1.33 1.33
   4       0.0        0.0     1031.2      3182.5        19.7         0.0


 ******************************************************************************

          ORIGINAL PILE GROUP STIFFNESS MATRIX

  0.11231E+04 -0.33699E-05  0.39790E-12 -0.22812E-03 -0.10702E+06  0.67097E-04
 -0.33699E-05  0.84618E+03  0.34210E-04 -0.46677E+05  0.18702E-02  0.45475E-11
  0.39790E-12  0.34210E-04  0.17524E+05  0.56640E-04  0.14552E-10 -0.16421E-02
 -0.22812E-03 -0.46677E+05  0.56640E-04  0.82273E+09 -0.30133E-01 -0.18626E-07
 -0.10702E+06  0.18702E-02  0.14552E-10 -0.30133E-01  0.43271E+08 -0.10021E+00
  0.67097E-04  0.45475E-11 -0.16421E-02 -0.29802E-07 -0.10021E+00  0.55240E+08



                      14 PILES    4 LOAD CASES

 LOAD CASE    1.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    2.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    3.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    4.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.


 ******************************************************************************

          PILE CAP DISPLACEMENTS

 LOAD
 CASE       DX          DY          DZ          RX          RY          RZ
            IN          IN          IN          RAD         RAD         RAD

    1   0.2247E-03 -0.1705E-03  0.3792E-01 -0.3090E-05  0.2358E-05  0.1131E-11
    2  -0.1375E+00 -0.2706E-03  0.2226E-01 -0.4906E-05 -0.1584E-03 -0.1261E-03
    3  -0.1432E+00 -0.2706E-03  0.2397E-01 -0.4906E-05 -0.2182E-03 -0.1261E-03
    4   0.6811E-03  0.2569E-02  0.5885E-01  0.4656E-04  0.7148E-05  0.1761E-11


 ******************************************************************************
               ELASTIC CENTER INFORMATION



 ELASTIC CENTER IN PLANE X-Z          X              Z
                                      FT             FT
                                     0.00           0.00
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Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

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******************************************************************************

         PILE FORCES IN LOCAL GEOMETRY

             M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
             * INDICATES PILE FAILURE
             # INDICATES CBF BASED ON MOMENTS DUE TO
                       (F3*EMIN) FOR CONCRETE PILES
             B INDICATES BUCKLING CONTROLS
```

LOAD CASE - 1

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	-0.3	0.0	49.2	-0.6	-12.0	0.0	0.38	0.10
2	-0.3	0.0	48.8	-0.6	-11.9	0.0	0.38	0.10
3	-0.3	0.0	48.4	-0.6	-11.8	0.0	0.38	0.09
4	-0.3	0.0	48.0	-0.6	-11.7	0.0	0.37	0.09
5	-0.3	0.0	47.6	-0.6	-11.6	0.0	0.37	0.09
6	-0.3	0.0	47.1	-0.6	-11.5	0.0	0.37	0.09
7	-0.3	0.0	46.7	-0.6	-11.4	0.0	0.36	0.09
8	-0.3	0.0	49.4	0.6	-13.8	0.0	0.38	0.10
9	-0.3	0.0	49.0	0.6	-13.7	0.0	0.38	0.10
10	-0.3	0.0	48.6	0.6	-13.6	0.0	0.38	0.10
11	-0.3	0.0	48.2	0.6	-13.5	0.0	0.37	0.10
12	-0.3	0.0	47.7	0.6	-13.4	0.0	0.37	0.09
13	-0.3	0.0	47.3	0.6	-13.3	0.0	0.37	0.09
14	-0.3	0.0	46.9	0.6	-13.2	0.0	0.36	0.09

LOAD CASE - 2

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	-8.8	-0.4	2.2	27.4	-394.1	0.0	0.01	0.31
2	-8.2	-0.4	4.4	27.4	-366.7	0.0	0.03	0.29
3	-7.5	-0.4	6.6	27.4	-339.4	0.0	0.05	0.27
4	-6.9	-0.4	8.8	27.4	-312.0	0.0	0.06	0.26
5	-6.3	-0.4	11.0	27.4	-284.7	0.0	0.08	0.24
6	-5.6	-0.4	13.2	27.4	-257.3	0.0	0.09	0.22
7	-5.0	-0.4	15.4	27.4	-230.0	0.0	0.11	0.20
8	8.4	-0.4	58.3	29.2	378.2	0.0	0.40	0.38
9	7.8	-0.4	54.7	29.2	351.2	0.0	0.37	0.36
10	7.2	-0.4	51.2	29.2	324.2	0.0	0.35	0.33
11	6.5	-0.4	47.6	29.2	297.2	0.0	0.33	0.30
12	5.9	-0.4	44.1	29.2	270.2	0.0	0.30	0.28
13	5.3	-0.4	40.5	29.2	243.2	0.0	0.28	0.25
14	4.7	-0.4	37.0	29.2	216.2	0.0	0.25	0.23

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

LOAD CASE - 3

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	-9.2	-0.4	6.8	27.4	-417.4	0.0	0.05	0.33
2	-8.6	-0.4	9.0	27.4	-390.0	0.0	0.06	0.32
3	-7.9	-0.4	11.2	27.4	-362.7	0.0	0.08	0.30
4	-7.3	-0.4	13.4	27.4	-335.3	0.0	0.09	0.28
5	-6.7	-0.4	15.6	27.4	-308.0	0.0	0.11	0.26
6	-6.0	-0.4	17.8	27.4	-280.6	0.0	0.12	0.25
7	-5.4	-0.4	20.0	27.4	-253.3	0.0	0.14	0.23
8	8.8	-0.4	58.0	29.2	400.4	0.0	0.40	0.40
9	8.2	-0.4	54.5	29.2	373.4	0.0	0.37	0.37
10	7.6	-0.4	50.9	29.2	346.4	0.0	0.35	0.35
11	6.9	-0.4	47.4	29.2	319.4	0.0	0.32	0.32
12	6.3	-0.4	43.8	29.2	292.4	0.0	0.30	0.30
13	5.7	-0.4	40.3	29.2	265.4	0.0	0.28	0.27
14	5.1	-0.4	36.7	29.2	238.4	0.0	0.25	0.24

LOAD CASE - 4

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	-0.3	0.0	55.2	8.7	-11.8	0.0	0.50	0.13
2	-0.3	0.0	61.6	8.7	-13.5	0.0	0.56	0.14
3	-0.4	0.0	67.9	8.7	-15.2	0.0	0.62	0.16
4	-0.4	0.0	74.3	8.7	-16.8	0.0	0.68	0.17
5	-0.4	0.0	80.7	8.7	-18.5	0.0	0.73	0.19
6	-0.5	0.0	87.1	8.7	-20.2	0.0	0.79	0.20
7	-0.5	0.0	93.4	8.7	-21.9	0.0	0.85	0.21
8	-0.4	0.0	55.8	-8.7	-17.3	0.0	0.51	0.13
9	-0.4	0.0	62.1	-8.7	-18.9	0.0	0.56	0.15
10	-0.5	0.0	68.5	-8.7	-20.6	0.0	0.62	0.16
11	-0.5	0.0	74.9	-8.7	-22.3	0.0	0.68	0.18
12	-0.5	0.0	81.3	-8.7	-24.0	0.0	0.74	0.19
13	-0.6	0.0	87.6	-8.7	-25.6	0.0	0.80	0.21
14	-0.6	0.0	94.0	-8.7	-27.3	0.0	0.85	0.22

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Job	Maurepaus Swamp		Project No.	60632162		
Description	CN-03 (Represents CN-04)		Computed by	JMH	Date	Dec-20
	CN Gate Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	JRA	Date	Dec-20

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	7.8	0.0	48.6	-0.6	-12.0	0.1
2	7.7	0.0	48.2	-0.6	-11.9	0.1
3	7.7	0.0	47.8	-0.6	-11.8	0.1
4	7.6	0.0	47.4	-0.6	-11.7	0.1
5	7.5	0.0	46.9	-0.6	-11.6	0.1
6	7.5	0.0	46.5	-0.6	-11.5	0.1
7	7.4	0.0	46.1	-0.6	-11.4	0.1
8	-7.8	0.0	48.8	-0.6	13.8	-0.1
9	-7.7	0.0	48.4	-0.6	13.7	-0.1
10	-7.7	0.0	48.0	-0.6	13.6	-0.1
11	-7.6	0.0	47.6	-0.6	13.5	-0.1
12	-7.5	0.0	47.1	-0.6	13.4	-0.1
13	-7.5	0.0	46.7	-0.6	13.3	-0.1
14	-7.4	0.0	46.3	-0.6	13.2	-0.1

LOAD CASE - 2

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	-8.3	-0.4	3.6	27.0	-394.1	-4.5
2	-7.3	-0.4	5.7	27.0	-366.7	-4.5
3	-6.3	-0.4	7.7	27.0	-339.4	-4.5
4	-5.4	-0.4	9.8	27.0	-312.0	-4.5
5	-4.4	-0.4	11.9	27.0	-284.7	-4.5
6	-3.4	-0.4	14.0	27.0	-257.3	-4.5
7	-2.4	-0.4	16.0	27.0	-230.0	-4.5
8	-17.9	0.4	56.1	-28.8	-378.2	-4.8
9	-16.7	0.4	52.7	-28.8	-351.2	-4.8
10	-15.5	0.4	49.3	-28.8	-324.2	-4.8
11	-14.3	0.4	45.9	-28.8	-297.2	-4.8
12	-13.1	0.4	42.5	-28.8	-270.2	-4.8
13	-11.9	0.4	39.1	-28.8	-243.2	-4.8
14	-10.7	0.4	35.7	-28.8	-216.2	-4.8

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JRA	Date	Dec-20

LOAD CASE - 3

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	-8.0	-0.4	8.2	27.0	-417.4	-4.5
2	-7.0	-0.4	10.3	27.0	-390.0	-4.5
3	-6.0	-0.4	12.3	27.0	-362.7	-4.5
4	-5.0	-0.4	14.4	27.0	-335.3	-4.5
5	-4.0	-0.4	16.5	27.0	-308.0	-4.5
6	-3.0	-0.4	18.6	27.0	-280.6	-4.5
7	-2.0	-0.4	20.6	27.0	-253.3	-4.5
8	-18.2	0.4	55.8	-28.8	-400.4	-4.8
9	-17.0	0.4	52.4	-28.8	-373.4	-4.8
10	-15.8	0.4	49.0	-28.8	-346.4	-4.8
11	-14.6	0.4	45.6	-28.8	-319.4	-4.8
12	-13.4	0.4	42.2	-28.8	-292.4	-4.8
13	-12.2	0.4	38.8	-28.8	-265.4	-4.8
14	-11.0	0.4	35.4	-28.8	-238.4	-4.8

LOAD CASE - 4

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	8.8	0.0	54.5	8.6	-11.8	-1.4
2	9.8	0.0	60.8	8.6	-13.5	-1.4
3	10.8	0.0	67.1	8.6	-15.2	-1.4
4	11.8	0.0	73.4	8.6	-16.8	-1.4
5	12.8	0.0	79.7	8.6	-18.5	-1.4
6	13.8	0.0	86.0	8.6	-20.2	-1.4
7	14.8	0.0	92.2	8.6	-21.9	-1.4
8	-8.8	0.0	55.1	8.6	17.3	1.4
9	-9.8	0.0	61.4	8.6	18.9	1.4
10	-10.8	0.0	67.7	8.6	20.6	1.4
11	-11.8	0.0	74.0	8.6	22.3	1.4
12	-12.8	0.0	80.2	8.6	24.0	1.4
13	-13.8	0.0	86.5	8.6	25.6	1.4
14	-14.8	0.0	92.8	8.6	27.3	1.4

Job	Maurepaus Swamp		Project No.	60632162		
Description	CN-03 (Represents CN-04)		Computed by	JMH	Date	Dec-20
	CN Gate Monolith					
	CPGA Input & Output Files (Concrete Design)		Checked by	JRA	Date	Dec-20

Input file:

```
100 MONOLITH, TOW EL. 16.13, TOS EL.10.49; HP 14X73  PILES
200 PROP 29000 729 261 21.4 1.7 0 ALL
300 SOIL ES 0.5404 TIP 67.48 0 ALL
400 PIN ALL
500 ALLOW H 110 88 492.7 535 2972.2 994.4 ALL
600 FOVSTR 1 1 1
700 FOVSTR 1 1 2 3 4
800 BATTER 6 All
1200 ANGLE 180 8 TO 14
1300 PILE 1 4 -27 0
1400 PILE 2 4 -18 0
1500 PILE 3 4 -9 0
1600 PILE 4 4 0 0
1700 PILE 5 4 9 0
1800 PILE 6 4 18 0
1900 PILE 7 4 27 0
2000 PILE 8 -4 -27 0
2100 PILE 9 -4 -18 0
2200 PILE 10 -4 -9 0
2300 PILE 11 -4 0 0
2400 PILE 12 -4 9 0
2500 PILE 13 -4 18 0
2600 PILE 14 -4 27 0
4500 LOAD 1 0 0 1063.1 -338 10.4 0
4600 LOAD 2 -219.9 0 624.1 -536.5 1048.4 -929
4700 LOAD 3 -219.9 0 672 -536.5 784.7 -929
4800 LOAD 4 0 0 2268.7 7001.5 43.3 0
9000 FOUT 1 2 3 4 5 6 7 RR01S.DOC
9100 PFO ALL
9200 PLB ALL
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	JRA	Date	Dec-20

CPGA RESULTS with Load Factors

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 22-DEC-20     RUN TIME: 12:04:49




    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.10.49; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE  14 PILES AND
            4 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                    X          Y           Z
                                  -----      -----       -----
WITH DIAGONAL COORDINATES = (      -4.00 ,    -27.00 ,      0.00 )
                            (       4.00 ,     27.00 ,      0.00 )


******************************************************************************

         PILE PROPERTIES AS INPUT


      E           I1            I2            A            C33           B66
     KSI         IN**4         IN**4         IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


******************************************************************************

         SOIL DESCRIPTIONS AS INPUT
```

Job	Maurepaus Swamp		Project No.	60632162		
Description	CN-03 (Represents CN-04)		Computed by	JMH	Date	Dec-20
	CN Gate Monolith					
	CPGA Input & Output Files (Concrete Design)		Checked by	JRA	Date	Dec-20

```
   ES      ESOIL       LENGTH        L            LU
         K/IN**2                    FT            FT
        0.54040E+00     T       0.67480E+02   0.00000E+00

 ESOIL(ORIGINAL)      RGROUP      RCYCLIC
   K/IN**2
  0.54040E+00        0.1000E+01 0.1000E+01

THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

    ALL


******************************************************************************

         PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


 0.23377E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.30221E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.12852E+04  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


THIS MATRIX APPLIES TO THE FOLLOWING PILES -

      1


******************************************************************************
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Job	Maurepaus Swamp		Project No.	60632162		
Description	CN-03 (Represents CN-04)		Computed by	JMH	Date	Dec-20
	CN Gate Monolith					
	CPGA Input & Output Files (Concrete Design)		Checked by	JRA	Date	Dec-20

PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM	X FT	Y FT	Z FT	BATTER	ANGLE	LENGTH FT	FIXITY
1	4.00	-27.00	0.00	6.00	0.00	68.41	P
2	4.00	-18.00	0.00	6.00	0.00	68.41	P
3	4.00	-9.00	0.00	6.00	0.00	68.41	P
4	4.00	0.00	0.00	6.00	0.00	68.41	P
5	4.00	9.00	0.00	6.00	0.00	68.41	P
6	4.00	18.00	0.00	6.00	0.00	68.41	P
7	4.00	27.00	0.00	6.00	0.00	68.41	P
8	-4.00	-27.00	0.00	6.00	180.00	68.41	P
9	-4.00	-18.00	0.00	6.00	180.00	68.41	P
10	-4.00	-9.00	0.00	6.00	180.00	68.41	P
11	-4.00	0.00	0.00	6.00	180.00	68.41	P
12	-4.00	9.00	0.00	6.00	180.00	68.41	P
13	-4.00	18.00	0.00	6.00	180.00	68.41	P
14	-4.00	27.00	0.00	6.00	180.00	68.41	P

957.75

****

APPLIED LOADS

LOAD CASE	PX K	PY K	PZ K	MX FT-K	MY FT-K	MZ FT-K
1	0.0	0.0	1063.1	-338.0	10.4	0.0
2	-219.9	0.0	624.1	-536.5	1048.4	-929.0
3	-219.9	0.0	672.0	-536.5	784.7	-929.0
4	0.0	0.0	2268.7	7001.5	43.3	0.0

****

ORIGINAL PILE GROUP STIFFNESS MATRIX

0.80470E+03	-0.46435E-05	0.85265E-12	0.14552E-10	-0.13750E+06	0.22289E-03
-0.46435E-05	0.42309E+03	0.34856E-04	0.00000E+00	0.16731E-02	-0.52296E-11
0.85265E-12	0.34856E-04	0.17515E+05	0.00000E+00	-0.29104E-10	-0.16731E-02
0.00000E+00	0.21684E-18	0.00000E+00	0.81717E+09	0.37253E-08	-0.22352E-07
-0.13750E+06	0.16731E-02	-0.29104E-10	0.37253E-08	0.40354E+08	-0.80308E-01
0.22289E-03	-0.63665E-11	-0.16731E-02	-0.29802E-07	-0.80308E-01	0.38519E+08

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	JRA	Date	Dec-20

```
                    14 PILES    4 LOAD CASES

 LOAD CASE    1.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    2.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    3.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    4.  NUMBER OF FAILURES =  14.  NUMBER OF PILES IN TENSION =   0.


 ******************************************************************************

          PILE CAP DISPLACEMENTS

 LOAD
 CASE       DX          DY          DZ          RX          RY          RZ
            IN          IN          IN          RAD         RAD         RAD

    1   0.1265E-02 -0.5016E-08  0.6070E-01 -0.4963E-05  0.7402E-05  0.2645E-11
    2  -0.5266E+00 -0.2852E-08  0.3563E-01 -0.7878E-05 -0.1482E-02 -0.2894E-03
    3  -0.5587E+00 -0.2688E-08  0.3837E-01 -0.7878E-05 -0.1670E-02 -0.2894E-03
    4   0.5266E-02 -0.1074E-07  0.1295E+00  0.1028E-03  0.3082E-04  0.5660E-11


 ******************************************************************************
               ELASTIC CENTER INFORMATION



 ELASTIC CENTER IN PLANE X-Z         X             Z
                                    FT            FT
                                   0.00          0.00


 ******************************************************************************
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AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	JRA	Date	Dec-20

PILE FORCES IN LOCAL GEOMETRY

M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
* INDICATES PILE FAILURE
# INDICATES CBF BASED ON MOMENTS DUE TO
(F3*EMIN) FOR CONCRETE PILES
B INDICATES BUCKLING CONTROLS

LOAD CASE - 1

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	-0.2	0.0	78.8	0.0	5.8	0.0	0.72	0.17
2	-0.2	0.0	78.1	0.0	5.8	0.0	0.71	0.16
3	-0.2	0.0	77.4	0.0	5.7	0.0	0.70	0.16
4	-0.2	0.0	76.8	0.0	5.6	0.0	0.70	0.16
5	-0.2	0.0	76.1	0.0	5.6	0.0	0.69	0.16
6	-0.2	0.0	75.4	0.0	5.5	0.0	0.69	0.16
7	-0.2	0.0	74.7	0.0	5.5	0.0	0.68	0.16
8	-0.3	0.0	79.2	0.0	7.5	0.0	0.72	0.17
9	-0.3	0.0	78.5	0.0	7.5	0.0	0.71	0.17
10	-0.3	0.0	77.8	0.0	7.4	0.0	0.71	0.17
11	-0.3	0.0	77.1	0.0	7.3	0.0	0.70	0.16
12	-0.3	0.0	76.4	0.0	7.3	0.0	0.69	0.16
13	-0.3	0.0	75.8	0.0	7.2	0.0	0.69	0.16
14	-0.3	0.0	75.1	0.0	7.2	0.0	0.68	0.16

LOAD CASE - 2

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	-14.7	-0.4	7.5	-15.1	410.2	0.0	0.07	0.43
2	-14.0	-0.4	13.1	-15.1	390.0	0.0	0.12	0.42
3	-13.3	-0.4	18.6	-15.1	369.9	0.0	0.17	0.41
4	-12.6	-0.4	24.1	-15.1	349.7	0.0	0.22	0.41
5	-11.8	-0.4	29.6	-15.1	329.5	0.0	0.27	0.40
6	-11.1	-0.4	35.2	-15.1	309.4	0.0	0.32	0.39
7	-10.4	-0.4	40.7	-15.1	289.2	0.0	0.37	0.38
8	14.4	-0.4	89.3	-15.1	-402.0	0.0	0.81	0.59
9	13.7	-0.4	81.6	-15.1	-382.0	0.0	0.74	0.55
10	13.0	-0.4	73.9	-15.1	-362.0	0.0	0.67	0.52
11	12.3	-0.4	66.2	-15.1	-342.1	0.0	0.60	0.48
12	11.6	-0.4	58.5	-15.1	-322.1	0.0	0.53	0.45
13	10.8	-0.4	50.9	-15.1	-302.1	0.0	0.46	0.41
14	10.1	-0.4	43.2	-15.1	-282.1	0.0	0.39	0.38

AECOM

Job	**Maurepaus Swamp**	**Project No.**	**60632162**		
Description	**CN-03 (Represents CN-04)**	**Computed by**	**JMH**	**Date**	**Dec-20**
	CN Gate Monolith				
	CPGA Input & Output Files (Concrete Design)	**Checked by**	**JRA**	**Date**	**Dec-20**

LOAD CASE - 3

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	-15.5	-0.4	15.7	-15.1	432.1	0.0	0.14	0.47
2	-14.8	-0.4	21.2	-15.1	411.9	0.0	0.19	0.46
3	-14.1	-0.4	26.7	-15.1	391.7	0.0	0.24	0.45
4	-13.3	-0.4	32.2	-15.1	371.6	0.0	0.29	0.44
5	-12.6	-0.4	37.8	-15.1	351.4	0.0	0.34	0.44
6	-11.9	-0.4	43.3	-15.1	331.2	0.0	0.39	0.43
7	-11.2	-0.4	48.8	-15.1	311.0	0.0	0.44	0.42
8	15.2	-0.4	88.1	-15.1	-423.3	0.0	0.80	0.61
9	14.5	-0.4	80.4	-15.1	-403.3	0.0	0.73	0.57
10	13.8	-0.4	72.7	-15.1	-383.3	0.0	0.66	0.54
11	13.0	-0.4	65.0	-15.1	-363.3	0.0	0.59	0.50
12	12.3	-0.4	57.4	-15.1	-343.3	0.0	0.52	0.47
13	11.6	-0.4	49.7	-15.1	-323.4	0.0	0.45	0.43
14	10.9	-0.4	42.0	-15.1	-303.4	0.0	0.38	0.40

LOAD CASE - 4

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF	
	K	K	K	IN-K	IN-K	IN-K			
1	-0.2	0.0	121.2	0.0	6.8	0.0	1.10	0.25	*
2	-0.3	0.0	135.3	0.0	7.9	0.0	1.23	0.28	*
3	-0.3	0.0	149.4	0.0	9.1	0.0	1.36	0.31	*
4	-0.4	0.0	163.4	0.0	10.3	0.0	1.49	0.34	*
5	-0.4	0.0	177.5	0.0	11.5	0.0	1.61	0.37	*
6	-0.5	0.0	191.6	0.0	12.7	0.0	1.74	0.40	*
7	-0.5	0.0	205.7	0.0	13.9	0.0	1.87	0.43	*
8	-0.5	0.0	122.7	0.0	13.8	0.0	1.12	0.26	*
9	-0.5	0.0	136.8	0.0	15.0	0.0	1.24	0.29	*
10	-0.6	0.0	150.9	0.0	16.2	0.0	1.37	0.32	*
11	-0.6	0.0	165.0	0.0	17.4	0.0	1.50	0.35	*
12	-0.7	0.0	179.0	0.0	18.6	0.0	1.63	0.38	*
13	-0.7	0.0	193.1	0.0	19.8	0.0	1.76	0.41	*
14	-0.8	0.0	207.2	0.0	21.0	0.0	1.88	0.44	*

****

Job	Maurepaus Swamp		Project No.	60632162		
Description	CN-03 (Represents CN-04)		Computed by	JMH	Date	Dec-20
	CN Gate Monolith					
	CPGA Input & Output Files (Concrete Design)		Checked by	JRA	Date	Dec-20

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	12.7	0.0	77.8	0.0	0.0	0.0
2	12.6	0.0	77.1	0.0	0.0	0.0
3	12.5	0.0	76.4	0.0	0.0	0.0
4	12.4	0.0	75.7	0.0	0.0	0.0
5	12.3	0.0	75.1	0.0	0.0	0.0
6	12.2	0.0	74.4	0.0	0.0	0.0
7	12.1	0.0	73.7	0.0	0.0	0.0
8	-12.7	0.0	78.1	0.0	0.0	0.0
9	-12.6	0.0	77.5	0.0	0.0	0.0
10	-12.5	0.0	76.8	0.0	0.0	0.0
11	-12.4	0.0	76.1	0.0	0.0	0.0
12	-12.3	0.0	75.5	0.0	0.0	0.0
13	-12.2	0.0	74.8	0.0	0.0	0.0
14	-12.1	0.0	74.1	0.0	0.0	0.0

LOAD CASE - 2

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	-13.3	-0.4	9.9	0.0	0.0	0.0
2	-11.7	-0.4	15.2	0.0	0.0	0.0
3	-10.0	-0.4	20.5	0.0	0.0	0.0
4	-8.4	-0.4	25.9	0.0	0.0	0.0
5	-6.8	-0.4	31.2	0.0	0.0	0.0
6	-5.2	-0.4	36.5	0.0	0.0	0.0
7	-3.5	-0.4	41.9	0.0	0.0	0.0
8	-28.9	0.4	85.7	0.0	0.0	0.0
9	-26.9	0.4	78.2	0.0	0.0	0.0
10	-25.0	0.4	70.8	0.0	0.0	0.0
11	-23.0	0.4	63.3	0.0	0.0	0.0
12	-21.0	0.4	55.8	0.0	0.0	0.0
13	-19.1	0.4	48.4	0.0	0.0	0.0
14	-17.1	0.4	40.9	0.0	0.0	0.0

Job	Maurepaus Swamp		Project No.	60632162		
Description	CN-03 (Represents CN-04)		Computed by	JMH	Date	Dec-20
	CN Gate Monolith					
	CPGA Input & Output Files (Concrete Design)		Checked by	JRA	Date	Dec-20

LOAD CASE - 3

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	-12.7	-0.4	18.0	0.0	0.0	0.0
2	-11.1	-0.4	23.3	0.0	0.0	0.0
3	-9.5	-0.4	28.7	0.0	0.0	0.0
4	-7.9	-0.4	34.0	0.0	0.0	0.0
5	-6.2	-0.4	39.3	0.0	0.0	0.0
6	-4.6	-0.4	44.6	0.0	0.0	0.0
7	-3.0	-0.4	50.0	0.0	0.0	0.0
8	-29.5	0.4	84.4	0.0	0.0	0.0
9	-27.5	0.4	76.9	0.0	0.0	0.0
10	-25.5	0.4	69.5	0.0	0.0	0.0
11	-23.6	0.4	62.0	0.0	0.0	0.0
12	-21.6	0.4	54.6	0.0	0.0	0.0
13	-19.6	0.4	47.1	0.0	0.0	0.0
14	-17.6	0.4	39.6	0.0	0.0	0.0

LOAD CASE - 4

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	19.7	0.0	119.6	0.0	0.0	0.0
2	22.0	0.0	133.5	0.0	0.0	0.0
3	24.2	0.0	147.4	0.0	0.0	0.0
4	26.5	0.0	161.3	0.0	0.0	0.0
5	28.8	0.0	175.2	0.0	0.0	0.0
6	31.0	0.0	189.1	0.0	0.0	0.0
7	33.3	0.0	203.0	0.0	0.0	0.0
8	-19.7	0.0	121.1	0.0	0.0	0.0
9	-22.0	0.0	135.0	0.0	0.0	0.0
10	-24.2	0.0	148.9	0.0	0.0	0.0
11	-26.5	0.0	162.8	0.0	0.0	0.0
12	-28.8	0.0	176.7	0.0	0.0	0.0
13	-31.0	0.0	190.6	0.0	0.0	0.0
14	-33.3	0.0	204.5	0.0	0.0	0.0

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Summary of Shear & Moment	Checked by	JRA	Date	Dec-20
					References

Load Case	$V_{u,max}$ (kip/ft)	$M_{u,max}$ (kip/ft)
LC1	0.00	0.00
LC2	0.86	1.19
LC3	0.86	1.19
LC4	0.00	0.00

*Note: LC 1 and 4 only have vertical forces, so there is no shear or moment on the wall.

The following calculations are the max shear (Vu) and moment (Mu) on the wall form LC 2 and LC 3:

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JOB TITLE Maurepas WSLP Structures – CN Gate Mono
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SCALE SHEET NO. 1 OF

Wall Calculations:

☆ These calculations only show the loading condition for water to TOW (LC2 & 3)

Assumptions:

$t = 1.5' = 18''$

cover = 3''

$d = 18'' - 3'' - \frac{.75''}{2} = 14.625''$ → Assume #6 bars

$b = 12''$

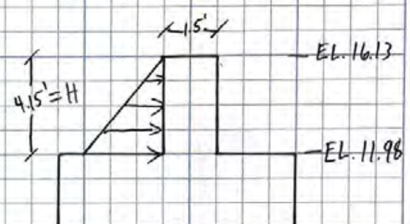
$\phi_{shear} = .75$

$\phi_{moment} = .9$

$F_y = 60$ ksi

$f'_c = 4$ ksi

$\gamma_{water} = .0624\ k/ft^3$



① Shear Calculations:

→ $h_{w,lat} = \frac{1}{2}(\gamma_{water})(H^2) = \frac{1}{2}(.0624\ k/ft^3)(4.15')^2$

$V_u = .54\ k/ft$

$1.6 V_u = \boxed{.86\ k/ft = V_u}$

② Moment Calculations:

→ $M_u = (V_u)\left(\frac{H}{3}\right) = (.86)\left(\frac{4.15'}{3}\right)$

$\boxed{M_u = 1.19\ \frac{k\text{-}ft}{ft}}$

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Shear & Moment Check for Wall	Checked by	JRA	Date	Dec-20
					References

*** Given Information:**

Wall Thickness:	1.50	ft
Clear Cover:	0.25	ft
Diameter Bar to Start:	0.06	ft
Maximum Shear (V_u):	0.86	kips per foot
Maximum Moment (M_u):	1.19	kip-ft per foot
φ_{shear} =	0.75	(ACI 318)
φ_{moment} =	0.9	(ACI 318)
$f_{y,\ rebar}$ =	60	ksi
f'_c =	4	ksi

*** Shear Calculations:**

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u) (ACI Eq. 11-1)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75	
f'_c =	4	ksi
b =	1	ft strip
d =	1.22	ft

φV_c =	16649.4	lbs	
	16.65	kips	** φVc=16.6 ≥ Vu=0.9, **Shear Capacity OK**

*** Reinforcement Calculations:**

Limit of Maximum Reinforcement: 0.25 x ρ_b (Design Criteria, EM 1110-2-2104, 3-5)

where ρ_b =	0.0285	for f'_c = 4,000psi, fy = 60,000psi
Max Rebar =	0.00713	*b * d

Maximum Reinforcement:	0.0071	* b * d =	1.25	in^2	per 1ft strip

A_{gross} = 1.5 ft * 12 in/ft * 12 in strip = 216.00 in^2

Limits of Minimum Reinforcement:	0.005 x Agross =	1.08	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
	$(3*\sqrt{(f'_c)}*b*d)/f_y$ =	0.55	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)
	$(200*b*d)/f_y$ =	0.59	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)

Min Reinforcement, temp & shrinkage:	0.54	in^2	per 1ft strip, per face
Min Reinforcement, flexural:	0.59	in^2	per 1ft strip, per face

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Shear & Moment Check for Wall	Checked by	JRA	Date	Dec-20
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*** Moment Calculations:**

* $T = A_s \times f_y$

* $C = 0.85 \times f'_c \times a \times b$

* Assuming Tension = Compression ⟶ $A_s \times f_y = 0.85 \times f'_c \times a \times b$

* $\varphi Mn = \varphi \times T \times (d - (a / 2))$

$= \varphi \times A_s \times f_y \times (d - (a / 2))$

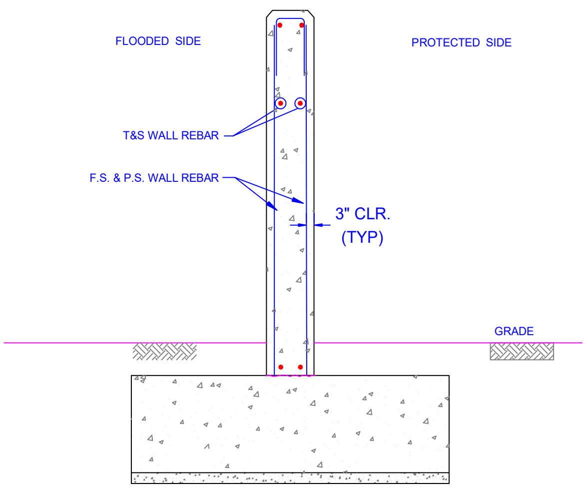
* Capacity of Min Flexural Reinforcement:

A_s =	0.585	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	1.21875	
φ_{moment} =	0.9	

$a = (A_s \times f_y) / (0.85 \times f'_c \times b)$

= 0.860 in

φM_n =	448.4	kip-in
=	37.37	kip-ft



* Capacity of Maximum Reinforcement:

A_s =	1.250	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	1.22	
φ_{moment} =	0.9	

$a = (A_s \times f_y) / (0.85 \times f'_c \times b)$

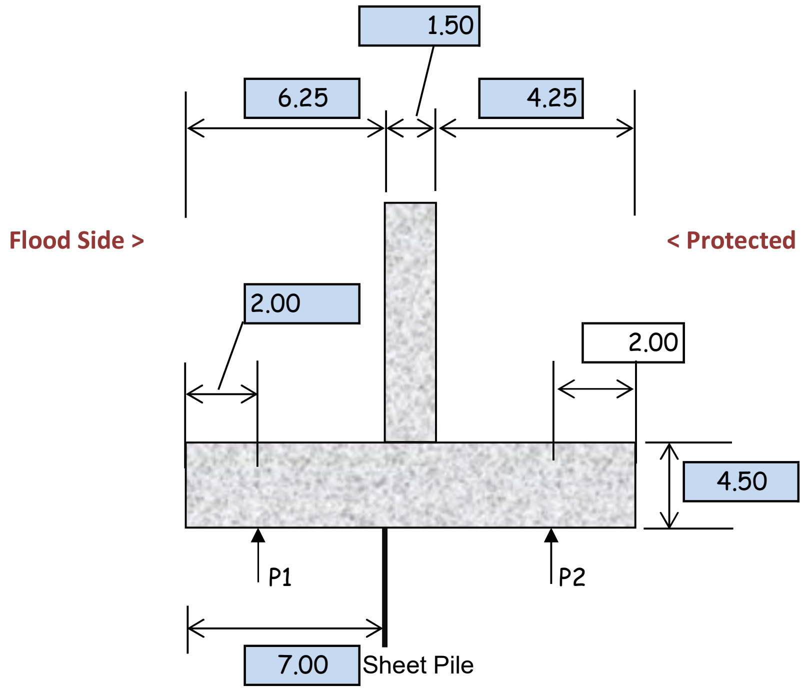
= 1.839 in

φMn =	925.4	kip-in
=	77.12	kip-ft

**** φMn=77.1 ≥ Mu=1.2, Section OK**

The minimum proposed reinforcement for T&S Wall Rebar is #6 @ 9" (A = 0.59 in^2) and the minimum proposed reinforcement for F.S. & P.S. Wall Rebar is #6 @ 9"(A=0.59 in^2).

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Slab	Checked by	JRA	Date	Dec-20
					References



Tributary width (pile spacing): 9 ft   Referred to as "width" in calculations

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Slab Calculations	Checked by	JRA	Date	Dec-20
					References

*Note: The following calculations represent the total shear (Vu) and moment (Mu) on both sides of the slab for all load cases. Capacity calculations for the slab can be found in the "Slab Conc Check" tab. All reactions are taken from the pinned or fixed results from CPGA.

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JOB TITLE
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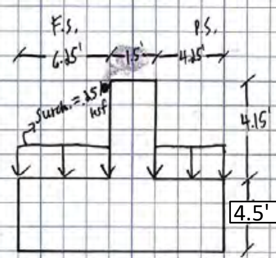
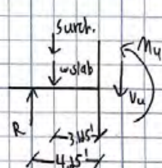
Slab Calculations

① Construction Surcharge
→ conc. wt
→ Surcharge = .25 ksf
→ Assume 9' of trib. length between piles
→ $\gamma_{conc} = .15$ kcf



Flood Side:



$V_u \rightarrow R = 48.6$ k from CPGA

$w_{slab} = 4.5'(9')(6.25')(.15\text{ kcf})$

$w_{slab} = 37.97$ kip

$Surch = (.25\text{ ksf})(6.25')(9')$

$Surch. = 14.06$ kip

$V_u = 37.97 + 14.06 - 48.6$

$V_u = 3.43$ kip

$1.6V_u = \dfrac{5.5 \text{ kip}}{9'} = .61 \text{ kip/ft} = V_u$

9' → trib. length

4x4 = 1 in

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Slab Calculations	Checked by	JRA	Date	Dec-20
					References

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JOB TITLE
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SCALE SHEET NO. 3 OF

$M_u \rightarrow R =$ 48.6 kip @ 4.25' (−)
w,slab = 37.97 kip @ 3.125' (+)
Surch. = 14.06 kip @ 3.125 (+)

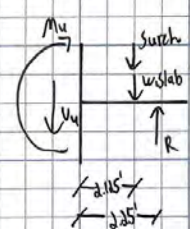
$M_u = (37.97)(3.125) + (14.06)(3.125) - (48.6)(4.25)$

$M_u =$ -43.96 k-ft

$1.6 M_u = \frac{-70.33 \text{ k-ft}}{9'} = -7.81 \frac{\text{k-ft}}{\text{ft}} = M_u$

9' → trib. length

Protected Side:



$V_u \rightarrow R =$ 48.8 kip from CP&A
w,slab = (4.25')(4.5')(9')(.15 kcf)
w,slab = 25.82 kip
Surch. = (.25 ksf)(4.25')(9')
Surch. = 9.56 kip

$V_u = 25.82 + 9.56 - 48.8$

$V_u = -13.42$

$1.6 V_u = \frac{-21.47 \text{ kip}}{9'} = -2.39 \text{ kip/ft} = V_u$

9' → trib. length

$M_u \rightarrow R =$ 48.8 kip @ 2.25' (−)
w,slab = 25.82 kip @ 2.125' (+)
Surch. = 9.56 kip @ 2.125' (+)

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Slab Calculations	Checked by	JRA	Date	Dec-20
					References

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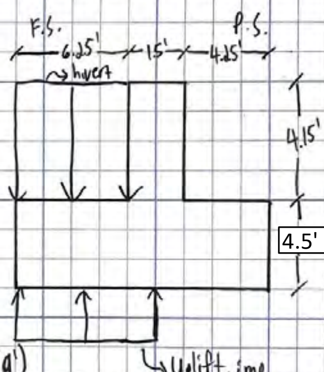
$M_u = (\boxed{25.82})(2.125) + (9.56)(2.125) - (\boxed{48.8})(2.25)$

$M_u = \boxed{-34.62}$ k-ft

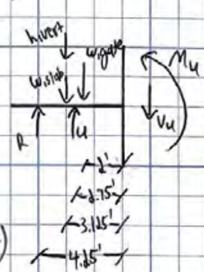
$1.6 M_u = \dfrac{\boxed{-55.4}\ \text{k-ft}}{9'} = \boxed{-6.15}\ \dfrac{\text{k-ft}}{\text{ft}} = M_u$

2. Water to TOW (impervious)

→ conc. wt
→ $h_{,lat}$ can be ignored
→ $h_{,vert}$
→ Uplift, impervious (assume sheet pile to be @ middle of wall)
→ Assume 9' of trib. length between piles
→ gate wt = (.24 k/ft) (9')
= 2.16 k



Flood Side:



V_u → R = $\boxed{3.6}$ kip from CPGA
$w_{,slab}$ = $\boxed{37.97}$ k (see LC1 calcs)
$w_{,gate}$ = 2.16 kip
$h_{,vert}$ = (4.15')(6.25')(9')(.0624 kcf)
$h_{,vert}$ = 14.57 kip
Uplift = ($\boxed{8.65}$)(7')(9')(.0624 kcf)
Uplift = $\boxed{34}$ kips

4x4 = 1 in

AECOM

Job	**Maurepaus Swamp**	**Project No.**	**60632162**		
Description	**CN-03 (Represents CN-04)**	**Computed by**	**JMH**	**Date**	**Dec-20**
	CN Gate Monolith				
	Slab Calculations	**Checked by**	**JRA**	**Date**	**Dec-20**
					References

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$V_u = -3.6 + 37.97 + 2.16 + 14.57 - 34$

$V_u = 17.1\ k$

$1.6V_u = \dfrac{27.36\ k}{9'} = 3.04\ k/ft = V_u$

9' → trib. length

$M_u \rightarrow R = 3.6$ Kip @ 4.25' (−)

$w_{,slab} = 37.97$ kip @ 3.125' (+)

$h_{,vert} = 14.57$ kip @ 3.125' (+)

$w_{,gate} = 2.16$ kip @ 2' (+)

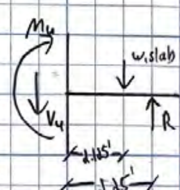
$Uplift = 34$ kip @ 2.75' (−)

$M_u = -3.6(4.25) + (37.97)(3.125) + (14.57)(3.125) + (2.16)(2) - (34)(2.75)$

$M_u = 59.71\ k\text{-}ft$

$1.6M_u = \dfrac{95.53\ k\text{-}ft}{9'} = 10.61\ \dfrac{Kip\text{-}ft}{ft} = M_u$

Protected Side:



$V_u \rightarrow R = 56.1$ kip from CPGA

$w_{,slab} = 25.82$ kip (see LC1 calcs)

$V_u = 25.82 - 56.1 = -30.25$ kip

$1.6V_u = \dfrac{-48.4\ Kip}{9'} = -5.38\ k/ft = V_u$

9' → trib. length

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Slab Calculations	Checked by	JRA	Date	Dec-20
					References

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JOB TITLE
PROJECT/JOB NO. CALCULATION NO.
COMPUTED BY JH DATE
VERIFIED BY DATE
SCALE SHEET NO. 6 OF

$M_u \rightarrow R = \boxed{56.1}\ k$ @ $2.25'$ ⊖

$w_{slab} = \boxed{25.82}\ k$ @ $2.125'$ ⊕

$M_u = (\boxed{25.82})(2.125) - (\boxed{56.1})(2.25)$

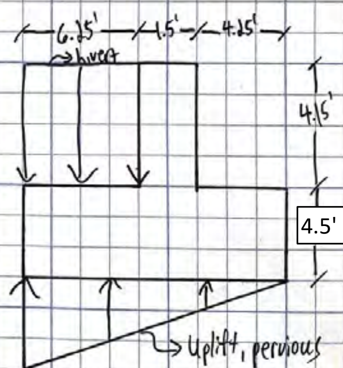
$M_u = \boxed{-71.36}\ k\text{-}ft$

$1.6 M_u = \dfrac{\boxed{-114.17}\ k\text{-}ft}{9'} = \boxed{-12.69}\ \dfrac{k\text{-}ft}{ft} = M_u$

9' → trib length

3. Water to TOW (pervious)

→ conc. wt
→ h,lat can be ignored
→ h,vert
→ Uplift, pervious
→ Assume 9' of trib. length between piles
→ gate wt = 2.16 k for 9'



Flood Side:

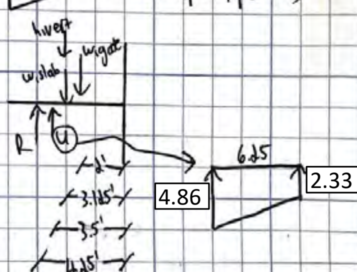
$V_u \rightarrow R = \boxed{8.2}\ k$ from CPGA

$w_{slab} = \boxed{37.97}\ k$ (see LC1 calcs)

$w_{gate} = 2.16$ kip

$h_{vert} = 14.57$ kip (see LC2 calcs)

$\text{Uplift} = \left(\dfrac{\boxed{4.86 + 2.33}}{2}\right) 6.25 = \boxed{22.47}$ kip



4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Slab Calculations	Checked by	JRA	Date	Dec-20
					References

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JOB TITLE
PROJECT/JOB NO. CALCULATION NO.
COMPUTED BY JH DATE
VERIFIED BY DATE
SCALE SHEET NO. 7 OF

$V_u = 37.97 + 2.16 + 14.57 - 8.2 - 22.47$

$V_u = 24.03$ kip

$1.6 V_u = \frac{38.45}{9'} = 4.27 \ k/ft = V_u$

9' → trib length

$M_u \rightarrow R = 8.2$ kip @ 4.25' (−)

w,slab = 37.97 kip @ 3.125 (+)

h,vert = 14.57 kip @ 3.125' (+)

w,gate = 2.16 kip @ 2' (+)

Uplift = 22.47 kip @ 3.5' (−)

$M_u = (37.97)(3.125) + (14.57)(3.125) + (2.16)(2) - (8.2)(4.25) - (22.47)(3.5)$

$M_u = 55$ k-ft

$1.6 M_u = \frac{88 \ k\text{-}ft}{9'} = 9.78 \ \frac{k\text{-}ft}{ft} = M_u$

9' → trib. length

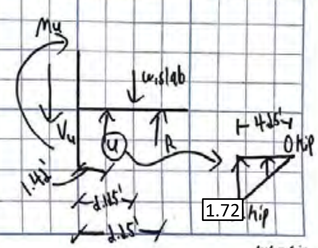
Protected Side:

$V_u \rightarrow R = 55.8$ kip from CP&A

w,slab = 25.82 kip (see LC1 calcs)

Uplift = ½ (1.72)(4.25)

= 3.66 kip



4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Slab Calculations	Checked by	JRA	Date	Dec-20
					References

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JOB TITLE
PROJECT/JOB NO. CALCULATION NO.
COMPUTED BY JH DATE
VERIFIED BY DATE
SCALE SHEET NO. 8 OF

$V_u = 25.82 - 55.8 - 3.66$

$V_u = -33.64$ kip

$\dfrac{1.6V_u = -53.82 \text{ kip}}{9'} = -5.98 \ \text{kip/ft} = V_u$

9' → trib. length

$M_u \rightarrow R = 55.8$ kip @ 2.25' ⊖

$w, slab = 25.82$ kip @ 2.125' ⊕

$Uplift = 3.66$ kip @ 1.42' ⊖

$M_u = (25.82)(2.125) - (55.8)(2.25) - (3.66)(1.42)$

$M_u = -75.88$ k-ft

$\dfrac{1.6M_u = -121.41 \text{ k-ft}}{9'} = -13.49 \ \text{k-ft/ft} = M_u$

9' → trib. length

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Slab Calculations	Checked by	JRA	Date	Dec-20
					References

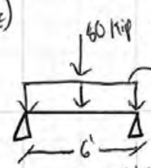
AECOM

Job ______ Project No. ______ Page ___ of ___
Description ______ Computed by JH Sheet ___ of ___
Checked by ______ Date ______
Reference

(4) Dead + Cooper E80

→ assume 6' span between piles with a simple beam analysis
→ assume $b = 4.71' =$ width of rail
→ assume $t = 4.5'$
→ wt. of concrete
→ wt of one axle of Cooper E80 (80 kip)
→ Load Factor = 2.2 for Usual Case
→ wt. of rails (.2 k/ft)

*NOTE: The shear and moment capacities shown in this report are for b=1' of slab; the calcs on this page show the loading for b=4.71' of slab, so the capacities are multiplied by 4.71'.



→ Dead wt
– concrete = (4.5')(4.71')(.15kcf) = 3.18 k/ft
– rails = .2 k/ft
Total uniform load = 3.38 k/ft

V_u → Dead wt → Concrete $= (4.5')(4.71')(6')(.15\ kcf)$
$= 19.08$ kip

→ Rails $= (.2\ k/ft)(6')$
$= 1.2$ kip

→ Cooper E80 Axle = 80 kip

$V_u = 80 + 19.08 + 1.2 = 100.3$ kip

$2.2 V_u = 220.62$ kip $= V_u$ < ϕVc = 4.71*50.6 =238.33 kip -- OK

M,train = P*L/4 = (80*6)/4 = 120 k-ft
M,uniform = wL^2/8 = (3.38*6^2)/8 = 15.21 k-ft

M,total = 2.2*135.21 k-ft = 297.45 k -ft < ϕMn = 4.71*344.97 =1624.81 kip-ft -- OK

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Slab Conc. Check	Checked by	JRA	Date	Dec-20
				References	

* Given Information:

Slab Thickness:	4.50	ft				
Slab Width:	12.00	ft				
Clear Cover:	0.75	ft				
Diameter Bar to Start:	0.09	ft				
Diameter of Pile:	1.13	ft	Load Fact.			
Maximum Pile Reaction:	204.50	kips	1	204.50	kips	*From Factored CPGA Results
Maximum Shear:	5.98	kips				
Maximum Moment (Top):	10.61	kip-ft				
Maximum Moment (Bottom):	13.49	kip-ft				

φ_{shear} =	0.75	(ACI 318)
φ_{moment} =	0.9	(ACI 318)
$f_{y,\ rebar}$ =	60	ksi
f'_c =	4	ksi

* Shear Calculations:

1- Shear Capacity:

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75			
f'_c =	4	ksi		
b =	1	ft strip		
d =	3.70	ft	44.44	in

φV_c =	50586.8	lbs	
	50.59	kips	** φVc=50.6 ≥ Vu=6, **Shear Capacity OK**

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Slab Conc. Check	Checked by	JRA	Date	Dec-20
					References

2- Punching Shear Capacity (ACI 318-14 Table 22.6.5.2):

Vc = minimum value = Eq. a: $4 \times \sqrt{f'_c} \times b_0 \times d$ for $\beta_c < 2.0$

Eq. b: $(2 + (4 / \beta_c)) \times \sqrt{f'_c} \times b_0 \times d$ for $\beta_c > 2.0$

Eq. c: $((\alpha_s \times d) / b_0 + 2) \times \sqrt{f'_c} \times b_0 \times d$ b_0 / d effect based on α_s

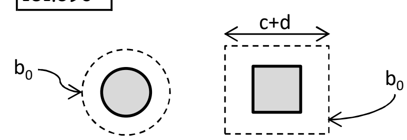
(interior column: α_s = 40, edge column: α_s = 30, corner column: α_s = 20)

d for piles = 44.203 in (Slab thickness - 9" pile embed - cover - $0.5d_{bar}$)

where β_c = Long side / Short side = 1

b_0 = Perimeter of Critical Section = $\pi*(D_{pile} + d)$ = 181.593

α_s = 20 (worst case - corner column)



Vc = minimum value = Eq. a: 2030.68 kips

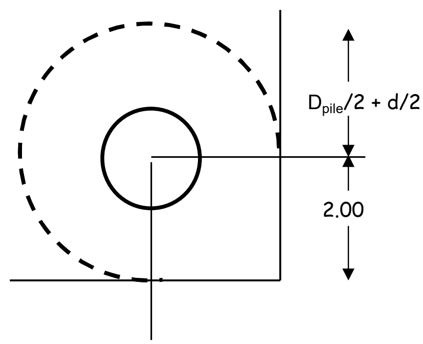
Eq. b: 3046.02 kips

Eq. c: 3486.86 kips

φV_c = 1523.01 kips

Check corner pile failure to edge of slab:

$D_{pile}/2+d/2$ = 2.41 ft



Diameter of corner failure = 2.408 + 2 ft

= 4.41 ft

Dia. punching shear calc above = 4.82

Diameter of punching shear calculation is smaller than the diameter of this corner failure area. Therefore, no re-check of corner punching failure is required.

φVc used in design = 50.59 kips

** φVc = 50.6k ≥ Vu = 6k, Shear Capacity OK

Maximum Pile Reaction = 204.50

** φVc=1523k ≥ Vu=205k, Punching Shear Capacity OK

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Slab Conc. Check	Checked by	JRA	Date	Dec-20
				References	

3- Deep Beam One-Way Shear Capacity (φV_{c1}):

For $(w/d) \geq 1.0$, a one-way (normal) shear investigation with loads outside the critical section (located at a distance d from the face of the column, b = footing width) and

$$v_c = 1.9\sqrt{f'_c} + 2500\rho_w\left(\frac{V_u d}{M_u}\right) \geq 2\sqrt{f'_c} \quad \text{(ACI Eq. 11-5)}$$

which reduces for $\rho_w \approx 0.002$ and 3,000 psi $\leq f'_c \leq$ 4,000 psi to $v_c = 1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}\,(V_u d/M_u) \geq 2\sqrt{f'_c}$.

For $(w/d) < 1.0$, $1.0 > M_u/V_u d > 0$; $\infty > V_u d/M_u \geq 1.0$ (no limits on M_u, $V_u d$, other than above)

$$v_c = \left(\frac{d}{w}\right)\left[3.5 - 2.5\left(\frac{M_u}{V_u d}\right)\right]\left[1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}\left(\frac{V_u d}{M_u}\right)\right] \leq 10\sqrt{f'_c} \quad \text{(ACI Eq. 13-2)}$$

w = 2.5 ft — Distance from CL pile to face of Wall + 3" lateral installation tolerance

M_u = 13.49 kip-ft

V_u = 5.98 kips

v_c = 382.3 psi ≤ 10 x √f'c = 632.5 psi limit on shear strength

φV_{c1} = 152.89 kips — ** φVc=152.9 ≥ Vu=6, OK

Therefore, Slab is OK for shear forces found in slab analysis.

<u>* Reinforcement Calculations:</u>

Limit of Maximum Reinforcement: 0.25 x ρ_b (Design Criteria, EM 1110-2-2104, 3-5)

where ρ_b = 0.0285 for f'_c = 4,000psi, fy = 60,000psi

Max Rebar = 0.00713 *b * d

Maximum Reinforcement:	0.0071	* b * d =	3.80	in^2	per 1ft strip

A_{gross} = 4.5 ft * 12 in/ft * 12 in strip = 648.00 in^2

Limits of Minimum Reinforcement:	0.005 x Agross =	3.24	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
	$(3*\sqrt{(f'_c)}*b*d)/f_y$ =	1.69	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)
	$(200*b*d)/f_y$ =	1.78	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)

Min Reinforcement, temp & shrinkage:	1.62	in^2	per 1ft strip, per face
Min Reinforcement, flexural:	1.78	in^2	per 1ft strip, per face

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Slab Conc. Check	Checked by	JRA	Date	Dec-20
					References

*** Moment Calculations:**

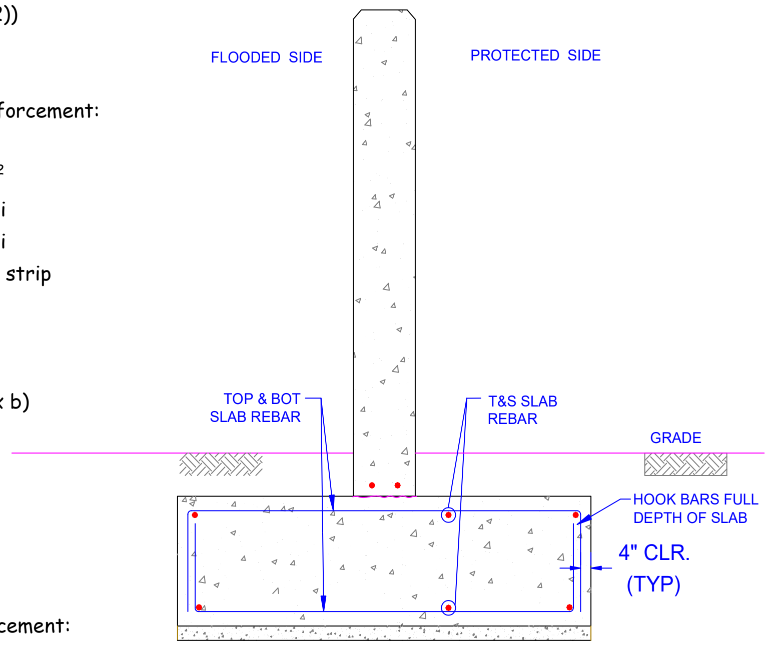
* $T = A_s \times f_y$

* $C = 0.85 \times f'_c \times a \times b$

* Assuming Tension = Compression ⟶ $A_s \times f_y = 0.85 \times f'_c \times a \times b$

* $\varphi Mn = \varphi \times T \times (d - (a / 2))$

$= \varphi \times A_s \times f_y \times (d - (a / 2))$



* Capacity of Min Flexural Reinforcement:

A_s =	1.777	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	3.703	
φ_{moment} =	0.9	

$a = (A_s \times f_y) / (0.85 \times f'_c \times b)$

= 2.614 in

φM_n =	4139.6	kip-in
=	344.97	kip-ft

* Capacity of Maximum Reinforcement:

A_s =	3.799	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	3.70	
φ_{moment} =	0.9	

The minimum proposed reinforcement for to T&S Slab Rebar is #9 @ 6"(A = 2.0 in2) and the minimum proposed reinforcment for Top & Bot Slab Rebar is #9 @ 6"(A =2.0 in2).

$a = (A_s \times f_y) / (0.85 \times f'_c \times b)$

= 5.587 in

φMn =	8543.4	kip-in
=	711.95	kip-ft

** φMn=711.9 ≥ Mu=10.6, Section OK	TOP
** φMn=711.9 ≥ Mu=13.5, Section OK	Bottom

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	CN-03 (Represents CN-04)	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
	Slab Calculations	Checked by	JRA	Date	Dec-20
				References	

*Note: The following calculations represent the total shear (Vu) and moment (Mu) on both sides of the slab for all load cases. Capacity calculations for the slab can be found in the "Slab Conc Check" tab.

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JOB TITLE
PROJECT/JOB NO. CALCULATION NO.
COMPUTED BY JH DATE
VERIFIED BY DATE
SCALE SHEET NO. 9 OF

• Shear & Moment on Pilaster

→ Assume gate opening is 89.12' wide (trib. length = 44.56')
→ Pilasters are 4' x 4'
→ wall stem height = 4.15' = H

① $V_u \rightarrow \frac{1}{2}(\gamma_{water})(H^2)(\text{trib. length})$

$= \frac{1}{2}(.0624 \text{ kcf})(4.15')^2(44.56')$

$= (23.94 \text{ kip})\,1.6$

$V_u = 38.31 \text{ kip}$

② $M_u \rightarrow V_u(H/3) = (38.31 \text{ K})(4.15'/3)$

$M_u = 52.99 \text{ k-ft}$

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	GATE SUPPORT STRUCTURES CN Gate Monolith	Computed by	JMH	Date	Dec-20
S, M & T Check for Pilaster River Road Gate		Checked by	JRA	Date	Dec-20
				References	

*** Given Information:**

Pilaster Width:	4.00	ft			
Pilaster Thickness:	4.00	ft			
Clear Cover:	0.33	ft	=	4.00	in
Diameter Bar to Start:	0.08	ft	=	1.00	in
Stirup Bar Dia:	0.05	ft	=	0.625	in

Maximum Shear (V_u):	38.31	kips per foot
Maximum Moment (M_u):	52.99	kip-ft per foot
Gate Wt. Induced Moment ($M_{u,gate}$):	N/A	kip-ft per foot
Maximum Torsion (T_u):	0	kip-ft *Center line of latches are at center of pilaster, so Tu = 0

φ_{shear} =	0.75	(ACI 318)
φ_{moment} =	0.9	(ACI 318)
$\varphi_{torsion}$ =	0.75	(ACI 318)
$f_{y,\ rebar}$ =	60	ksi
f'_c =	4	ksi

*** Shear Calculations:**

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u) (ACI Eq. 11-1)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75			
f'_c =	4	ksi		
b =	4	ft strip		
d =	3.63	ft	43.50	in

φV_c =	198085.1	lbs	
	198.09	kips	** φVc=198.1 ≥ Vu=38.3, **Shear Capacity OK**

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	GATE SUPPORT STRUCTURES	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
S, M & T Check for Pilaster River Road Gate		Checked by	JRA	Date	Dec-20
				References	

*** Reinforcement Calculations:**

Limit of Maximum Reinforcement: $0.25 \times \rho_b$ (Design Criteria, EM 1110-2-2104, 3-5)

where ρ_b = 0.0285 for f'_c = 4,000psi, fy = 60,000psi

Max Rebar = 0.00713 *b * d

Maximum Reinforcement: 0.0071 * b * d = 14.88 in^2 per 2ft strip

A_{gross} = 4 ft * 12 in/ft * 48 in strip = 2304.00 in^2

Limits of Minimum Reinforcement:			
$0.003 \times Agross$ =	6.91	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
$(3*\sqrt{(f'_c)}*b*d)/f_y$ =	6.60	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)
$(200*b*d)/f_y$ =	6.96	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)

Min Reinforcement, temp & shrinkage:	3.46	in^2	per 2ft strip, per face
Min Reinforcement, flexural:	6.96	in^2	per 2ft strip, per face

*** Moment Calculations:**

- * $T = A_s \times f_y$
- * $C = 0.85 \times f'_c \times a \times b$
- * Assuming Tension = Compression $\longrightarrow$ $A_s \times f_y = 0.85 \times f'_c \times a \times b$
- * $\varphi Mn = \varphi \times T \times (d - (a / 2))$

  $= \varphi \times A_s \times f_y \times (d - (a / 2))$

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	GATE SUPPORT STRUCTURES	Computed by	JMH	Date	Dec-20
	CN Gate Monolith				
S, M & T Check for Pilaster River Road Gate		Checked by	JRA	Date	Dec-20
				References	

* Capacity of Min Flexural Reinforcement:

A_s =	6.960	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	4	ft strip
d =	3.63	
φ_{moment} =	0.9	

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$

= 2.559 in

φM_n =	15868.2	kip-in
=	1322.35	kip-ft

Min reinforcement is sufficient.

* Capacity of Maximum Reinforcement:

A_s =	14.877	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	4	ft strip
d =	3.625	
φ_{moment} =	0.9	

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$

= 5.469 in

φMn =	32749.1	kip-in
=	2729.09	kip-ft

** φMn=2729.1 ≥ Mu=53, Section OK

Maurepas Swamp

PI-WALL SECTIONS

KCS-1

AECOM Project : 60632162

Foundation, Wall & Slab

AECOM

1555 Poydras Street

Suite 1200

New Orleans, LA 70112

(504) 586-8111

Computed by:	AML	Checked by:	JMH
Date:	Dec-20	Date:	Dec-20

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Wall Gemetry	Checked by	JMH	Date	Dec-20

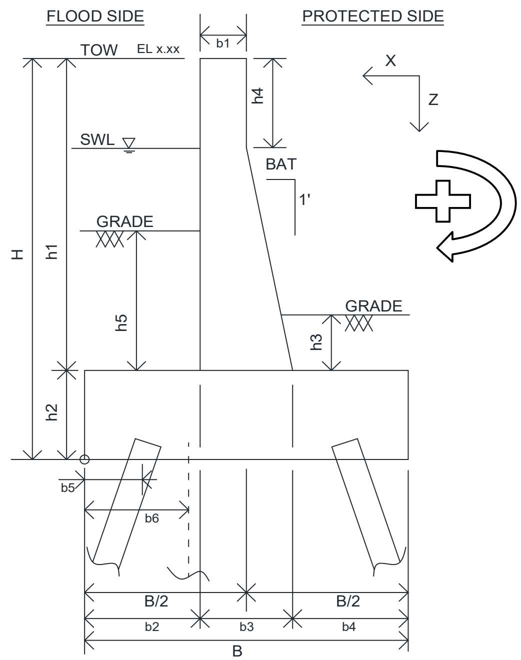
References

WALL GEOMETRY:

Top of Wall EL.	16.13	NAVD88
100 Yr. Water El.		NAVD88
10 Yr. Water El.		NAVD88
Top of Slab EL.	12.89	NAVD88
H=	6.24	ft.
h1=	3.24	ft.
h2=	3.00	ft. (Base Slab Height)
h3=	3.24	ft. (P.S. Soil Height)
h4=	0.00	ft.
h5=	3.24	ft. (F.S. Soil Height)
B=	10.00	ft. (Base Slab Width)
b1=	1.50	ft. (Wall Stem Width, top)
b2=	5.75	ft. (F.S. Slab Width)
b3=	1.50	ft. (Wall Stem Width, bottom)
b4=	2.75	ft. (P.S. Slab Width)
b5=	2.00	ft. (F.S. Pile Row Edge Space)
b6=	6.50	ft. (Sheet Pile Edge Space)
BAT=	0.00	(Wall Batter, N/A)
PS Grade =	16.13	NAVD88 (Average of PS soil for all)

Monolith Length =	20.3	ft

Bottom Of Slab =	9.89	NAVD88



PI-WALL CROSS-SECTION

Notes: 1) positive 'Y' axis is into page

2) pile batters vary from those shown in diagram

In this report, white boxes are for input data, and colored boxes are calculated values.

AECOM

Job	**Maurepas Swamp**	**Project No.**	**60632162**		
Description	**PI-WALL SECTIONS**	**Computed by**	**AML**	**Date**	**Dec-20**
	KCS-1				
	Assumptions	**Checked by**	**JMH**	**Date**	**Dec-20**

References

Unit Weight of Storm Water =	0.0624	kcf
Wet Unit Weight of Soil =	0.1200	kcf
Sat Unit Weight of Soil =	0.0576	kcf
Unit Weight of Concrete =	0.1500	kcf
Impact Load =	0.0000	k/ft
FS Wind force above SWL=	0.0500	ksf
Construction Surcharge Pressure =	0.2500	ksf

Unbalanced Load for Stability Analysis:

F_{cap} (k/ft) =	0.00	(100y SWL Case; Force acts at bottom of slab)
F_{cap} (k/ft) =	0.00	(Water to TOW Case; Force acts at bottom of slab)
K_0, Granular fill =	0.95	(for lateral soil forces)
Assumed Reinforcement Cover =	0.33	ft
Assumed Wall d_{bar} =	0.08	ft

AECOM

Job	Maurepas Swamp	Project No.	60632162
Description	PI-WALL SECTIONS	Computed by	AML
	KCS-1	Date	Dec-20
	Load Cases	Checked by	JMH
		Date	Dec-20

References

No. of Load Cases	3

Update

No.	DCD LC No.	Description	FS Water El.	PS Water El.	Pile design Over Stresses
1	1a	Construction Surcharge	9.89	9.89	1.17
2	2a	Water to TOW(impervious cutoff)	16.13	9.89	1.33
3	2b	Water to TOW(pervious cutoff)	16.13	9.89	1.33

Note: Impact load is not applicable for this section, so it is excluded from the load combinations.

Note: Forces induced by 10y water elevation are not applicable for this section, so they are excluded from the load combinations.

Note: After inspection, it is discovered that OBE does not govern and can be eliminated from load combinations

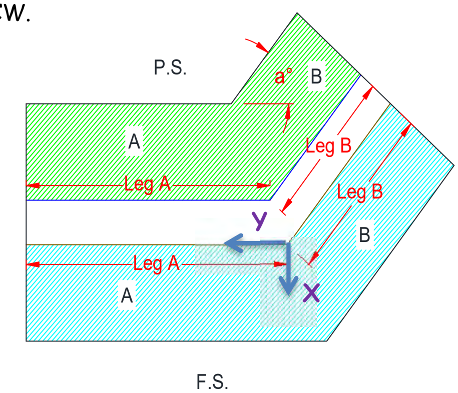
AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Foundation Load Calculation	Checked by	JMH	Date	Dec-20
					References

PI Areas & Lengths

* Input all areas, lengths & coordinates from the CAD file for the specific PI wall section. The center of the coordinate system is the corner of the flood side wall. Positive angle's direction is CCW.

	A (ft^2)	X_{cen}	Y_{cen}
Wall	30.59	1.41	-3.83
Slab	197.14	2.70	-3.53
FS Slab	107.85	4.90	-3.04
PS Slab	58.71	-0.68	-4.30
Imp. Uplift	123.10	4.51	-3.12
Per. Uplift	197.14	4.47	-3.13



PI angle (α) = -25.00 deg.

	L (ft)	X_{cen}	Y_{cen}
Leg A-FS	5.88	0.00	2.94
Leg A-PS	6.22	-1.50	2.77
Leg B-FS	14.17	3.04	-6.40
Leg B-PS	14.51	1.61	-6.89

Weight:

Wall stem weight = $A_{Wall} \times H_{Wall} \times \gamma_{conc.}$

Wall stem weight = 14.86 (kips)

X_{cen} = 1.41

Y_{cen} = -3.83

Base slab weight = $A_{Slab} \times H_{Slab} \times \gamma_{conc.}$

Base slab weight = 88.71 (kips)

X_{cen} = 2.70

Y_{cen} = -3.53

AECOM

Job	Maurepas Swamp	Project No.	60632162
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1		
	Foundation Load Calculation	Checked by	JMH	Date	Dec-20

References

Soil Force (Dry & Sat.):

	Water EL.	FS Soil EL.	PS Soil EL.
Dry	9.89	16.13	16.13
Top of Wall EL.	16.13	16.13	16.13

F.S. soil weight = $A_{FS,Slab} \times H_{FS,Soil} \times \gamma_{soil}$

F.S. soil weight = 41.93 (kips) **Dry**

20.13 (kips) **TOW**

X_{cen} = 4.90 **Dry** Y_{cen} = -3.04

4.90 **TOW** -3.04

P.S. soil weight = $A_{PS,Slab} \times H_{PS,Soil} \times \gamma_{soil}$

P.S. soil weight = 22.83 (kips) **Dry**

22.83 (kips) **TOW**

X_{cen} = -0.68 **Dry** Y_{cen} = -4.30

-0.68 **TOW** -4.30

F.S. soil lat. force/ft = $0.5\ K_0\ \gamma_{soil}\ H_{Soil}^2$

F.S. soil lat. force/ft = -2.22 (kip/ft) **Dry**

-1.07 **TOW**

	Side A		Side B				Both sides Z_{cen}	M_x	M_y	M_z
	F_x side A (kips)	Side A Y_{cen}	F_x side B (kips)	F_y side B (kips)	Side B X_{cen}	Side B Y_{cen}				
Dry	-13.05	2.94	-28.50	-13.29	3.04	-6.40	-2.08	-27.65	86.43	-184.46
TOW	-6.26	2.94	-13.68	-6.38	3.04	-6.40	-2.08	-13.27	41.49	-88.54

P.S. soil lat. force/ft = $0.5\ K_0\ \gamma_{soil}\ H_{Soil}^2$

P.S. soil lat. force/ft = 2.22 (kip/ft) **Dry**

2.22 (kip/ft) **TOW**

	Side A		Side B				Both sides Z_{cen}	M_x	M_y	M_z
	F_x side A (kips)	Side A Y_{cen}	F_x side B (kips)	F_y side B (kips)	Side B X_{cen}	Side B Y_{cen}				
Dry	13.80	2.77	29.19	13.61	1.61	-6.89	-2.08	28.31	-89.42	184.77
TOW	13.80	2.77	29.19	13.61	1.61	-6.89	-2.08	28.31	-89.42	184.77

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Foundation Load Calculation	Checked by	JMH	Date	Dec-20
					References

Soil Force (SWL):

	Water EL.	FS Soil EL.	PS Soil
10 Yr. Water El.	0	16.13	16.13
100 Yr. Water El.	0	16.13	16.13

F.S. soil weight = $A_{FS,Slab} \times H_{FS,Soil} \times \gamma_{soil}$

F.S. soil weight = 41.93 (kips) 10y

41.93 (kips) 100y

X_{cen} = 4.90 Y_{cen} = -3.04

P.S. soil weight = $A_{PS,Slab} \times H_{PS,Soil} \times \gamma_{soil}$

P.S. soil weight = 22.83 (kips) 10y

22.83 (kips) 100y

X_{cen} = -0.68 Y_{cen} = -4.30

F.S. soil lat. force/ft = $0.5\ K_0\ \gamma_{soil}\ H_{Soil}^2$

F.S. soil lat. force/ft = -2.22 (kip/ft) **100y**

(kip/ft) **10y**

	Side A		Side B				Both			
	F_x side A (kips)	Side A Y_{cen}	F_x side B (kips)	F_y side B (kips)	Side B X_{cen}	Side B Y_{cen}	sides Z_{cen}	M_x	M_y	M_z
100y	-13.05	2.94	-28.50	-13.29	3.04	-6.40	-2.08	-27.65	86.43	-184.46
10y										

P.S. soil lat. force/ft = $0.5\ K_0\ \gamma_{soil}\ H_{Soil}^2$

P.S. soil lat. force/ft = 2.22 (kip/ft) **100y**

(kip/ft) **10y**

	Side A		Side B				Both			
	F_x side A (kips)	Side A Y_{cen}	F_x side B (kips)	F_y side B (kips)	Side B X_{cen}	Side B Y_{cen}	sides Z_{cen}	M_x	M_y	M_z
100y	13.80	2.77	29.19	13.61	1.61	-6.89	-2.08	28.31	-89.42	184.77
10y										

Water Force (SWL & TOW):

10 Yr. Water El.	0
100 Yr. Water El.	0
Top of Wall EL.	16.13

F.S. water weight = $A_{FS,Slab} \times H_w \times \gamma_{water}$

F.S. water weight = (kips) **10y**

0.00 (kips) **100y**

21.80 (kips) **TOW**

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Foundation Load Calculation	Checked by	JMH	Date	Dec-20
					References

X_{cen} = 0.00 — 10y & 100y — Y_{cen} = -3.04

4.90 — TOW — -3.04

F.S. water lat. force = $0.5\ \gamma_{water}\ H_w^2$

		(kip/ft)	10y
F.S. water lat. force =	0.00	(kip/ft)	100y
	-1.21	(kip/ft)	TOW

	Side A		Side B							
	F_x side A (kips)	Side A Y_{cen}	F_x side B (kips)	F_y side B (kips)	Side B X_{cen}	Side B Y_{cen}	Both sides Z_{cen}	M_x	M_y	M_z
10y										
100y	0.00	2.94	0.00	0.00	3.04	-6.40	3.30	0.00	0.00	0.00
TOW	-7.14	2.94	-15.60	-7.28	3.04	-6.40	-2.08	-15.13	47.31	-100.97

Wind Force:

Wind force = 0.05 ksf x monolith height

	Side A		Side B							
	F_x side A (kips)	Side A Y_{cen}	F_x side B (kips)	F_y side B (kips)	Side B X_{cen}	Side B Y_{cen}	Both sides Z_{cen}	M_x	M_y	M_z
Const.	1.94	2.77	4.10	1.91	1.61	-6.89	-3.12	5.97	-18.86	25.97
Dry	0.00	2.94	0.00	0.00	3.04	-6.40	-6.24	0.00	0.00	0.00
100y	-4.74	2.94	-10.36	-4.83	3.04	-6.40	1.83	8.81	-27.56	-67.03
10y										

Wave Force:

	Side A		Side B							
	F_x side A (kips)	Side A Y_{cen}	F_x side B (kips)	F_y side B (kips)	Side B X_{cen}	Side B Y_{cen}	Both sides Z_{cen}	M_x	M_y	M_z
10y										
100y	-0.69	2.94	-1.51	-0.70	3.04	-6.40	-0.35	-0.25	0.77	-9.77
TOW	-0.77	2.94	-1.68	-0.78	3.04	-6.40	-1.44	-1.13	3.54	-10.88

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Foundation Load Calculation	Checked by	JMH	Date	Dec-20
					References

Surcharge Force:

Surcharge force = 0.25 ksf * F.S./P.S. area

	F_z (kips)	X_{cen}	Y_{cen}	M_x	M_y
F.S.	26.96	4.90	-3.04	-81.96	-132.11
P.S.	14.68	-0.68	-4.30	-63.11	9.98

Unbalanced Force:

	Side A		Side B				Both sides Z_{cen}	M_x	M_y	M_z
	F_x side A (kips)	Side A Y_{cen}	F_x side B (kips)	F_y side B (kips)	Side B X_{cen}	Side B Y_{cen}				
10y										
100y	0.00	0.00	0.00	0.00	3.04	-6.40		0.00	0.00	0.00
TOW	0.00	0.00	0.00	0.00	3.04	-6.40		0.00	0.00	0.00

Impact Force:

Impact force = 0 ksf x monolith length

Side A		Side B				Both sides Z_{cen}	M_x	M_y	M_z
F_x side A (kips)	Side A Y_{cen}	F_x side B (kips)	F_y side B (kips)	Side B X_{cen}	Side B Y_{cen}				
0.00	2.94	0.00	0.00	3.04	-6.40	-6.24	0.00	0.00	0.00

Uplift Force:

Impervious

Uplift force = $A_{uplift} \times H_w \times \gamma_{water}$

	F_z (kips)	X_{cen}	Y_{cen}	M_x	M_y
10y					
100y	75.97	4.51	-3.12	-237.03	-342.63
TOW	-47.93	4.51	-3.12	149.55	216.18

Pervious

Uplift force = $A_{uplift} \times H_w \times \gamma_{water}$

	F_z (kips)	X_{cen}	Y_{cen}	M_x	M_y
10y					
100y	60.83	4.47	-3.13	-190.40	-271.91
TOW	-38.38	4.47	-3.13	120.13	171.56

AECOM

Job	Maurepas Swamp	Project No.	60632162
Description	PI-WALL SECTIONS	Computed by AML	Date Dec-20
	KCS-1		
	Shear & Moment Calculation on Wall	Checked by JMH	Date Dec-20

References

Note: Shear is calculated at distance d from the bottom of the wall

d = wall thickness - cover - (1/2)d_{bar} = 1.13 ft

Elevation of distance d = 14.02 NAVD 88

Soil Force (Dry & Sat.):

	Water EL.	FS Soil EL.	PS Soil EL.
Dry	9.89	16.13	16.13
Top of Wall EL.	16.13	16.13	16.13

F.S. soil lat. force = 0.5 K_0 γ_{soil} $(H_{Soil})^2$

F.S. soil lat. force at d = -0.25 (kip/ft) Dry

-0.12 (kip/ft) TOW

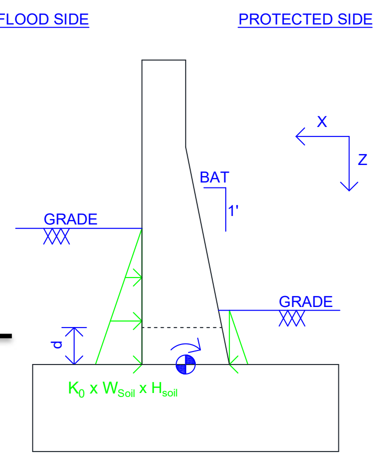
F.S. soil lat. force at bottom of the wall = -0.60 (kip/ft) Dry

-0.29 (kip/ft) TOW

M = F_{Soil} x H_{Soil}/3

M = 0.65 (k-ft/ft) Dry

0.31 (k-ft/ft) TOW



P.S. soil lat. force = 0.5 K_0 γ_{soil} $(H_{Soil})^2$

P.S. soil lat. force at d = 0.25 (kip/ft) Dry

0.25 (kip/ft) TOW

P.S. soil lat. force at bottom of the wall = 0.60 (kip/ft) Dry

0.60 (kip/ft) TOW

M = F_{Soil} x H_{Soil}/3

M = -0.65 (k-ft/ft) Dry

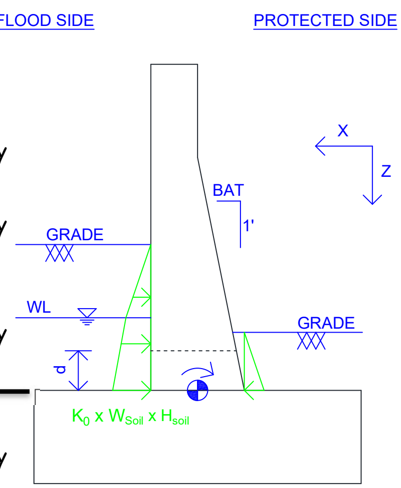
-0.65 (k-ft/ft) TOW

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Shear & Moment Calculation on Wall	Checked by	JMH	Date	Dec-20
					References

Soil Force (SWL):

	Water EL.	FS Soil EL.	PS Soil EL.
100 Yr. Water El.	0	16.13	16.13
10 Yr. Water El.	0	16.13	16.13



F.S. soil lat. force = $0.5\ K_0\ \gamma_{soil}\ (H_{Soil})^2$

F.S. soil lat. force at d =	-0.25	(kip/ft)	100y
	-0.25	(kip/ft)	10y
F.S. soil lat. force at bottom of the wall =	-0.60	(kip/ft)	100y
	-0.60	(kip/ft)	10y

$M = F_{Soil} \times H_{Soil}/3$

M =	0.65	(k-ft/ft)	100y
	0.65	(k-ft/ft)	10y

P.S. soil lat. force = $0.5\ K_0\ \gamma_{soil}\ (H_{Soil})^2$

P.S. soil lat. force at d =	0.25	(kip/ft)	100y
	0.25	(k-ft/ft)	10y
P.S. soil lat. force at bottom of the wall =	0.60	(kip/ft)	100y
	0.60	(k-ft/ft)	10y

$M = F_{Soil} \times H_{Soil}/3$

M =	-0.65	(k-ft/ft)	100y
	-0.65	(k-ft/ft)	10y

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Shear & Moment Calculation on Wall	Checked by	JMH	Date	Dec-20
				References	

Water Force (SWL & TOW):

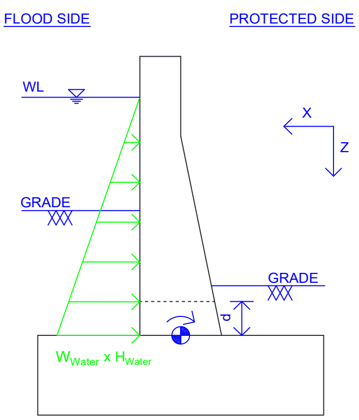
	Water EL.
10 Yr. Water El.	0
100 Yr. Water El.	0
Top of Wall EL.	16.13

F.S. water lat. force = $0.5\ \gamma_{water}\ Hw^2$

F.S. water lat. force at d =		(kip/ft)	10y
	0.00	(kip/ft)	100y
	-0.14	(kip/ft)	TOW
F.S. water force at bottom of the wall =		(kip/ft)	10y
	0.00	(kip/ft)	100y
	-0.33	(kip/ft)	TOW

$M = F_{Water} \times H_{Water}/3$

M =		(k-ft/ft)	10y
	0.00	(k-ft/ft)	100y
	0.35	(k-ft/ft)	TOW



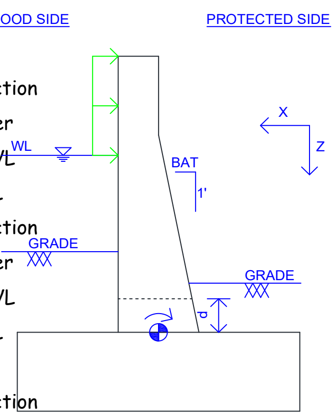
Wind Force:

F.S. wind force = $P_{Wind} \times Area$

F.S. wind force at d =	0.11	(kip/ft)	Construction
	0.00	(kip/ft)	No Water
	-0.11	(kip/ft)	100y SWL
		(kip/ft)	10y SWL
F.S. wind force at bottom of the wall =	0.16	(kip/ft)	Construction
	0.00	(kip/ft)	No Water
	-0.16	(kip/ft)	100y SWL
		(kip/ft)	10y SWL

$M = F_{Wind} \times Z_{Cent}$

M =	-0.26	(k-ft/ft)	Construction
	0.00	(k-ft/ft)	No Water
	0.26	(k-ft/ft)	100y SWL
	0.26	(k-ft/ft)	10y SWL



AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	LC1	Checked by	JMH	Date	Dec-20
					References

LC1: Construction Surcharge

Loads

Deselect All

Dead Loads:

- [x] Wall Stem Wt.
- [x] Base Slab Wt.

Soil Forces:

Dry	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
10 Yr. Water El.	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
100 Yr. Water El.	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
Top of Wall EL.	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force

Water Forces:

10 Yr. Water El.	☐ F.S. Water	☐ F.S. Lat. Water
100 Yr. Water El.	☐ F.S. Water	☐ F.S. Lat. Water
Top of Wall EL.	☐ F.S. Water	☐ F.S. Lat. Water

Wind Force:

Construction	☐ P.S. Lat. Wind Force
No Water	☐ F.S. Lat. Wind
100 Yr. Water El.	☐ F.S. Lat. Wind
10 Yr. Water El.	☐ F.S. Lat. Wind

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	LC1	Checked by	JMH	Date	Dec-20

References

Wave Force:

10 Yr. Water El.	☐ F.S. Lat. Wave
100 Yr. Water El.	☐ F.S. Lat. Wave
Top of Wall EL.	☐ F.S. Lat. Wave

Earthquake Force:

MDE	☐ Soil Ver. MDE	☐ Soil Lat. MDE	☐ Conc. Ver. MDE	☐ Conc. Lat. MDE
OBE	☐ Soil Ver. OBE	☐ Soil Lat. OBE	☐ Conc. Ver. OBE	☐ Conc. Lat. OBE

Surcharge Forces:

☑ F.S. Surcharge Force ☑ P.S. Surcharge Force

Unbalanced Load:

10 Yr. Water El.	☐ Lat. Unbalance
100 Yr. Water El.	☐ Lat. Unbalance
Top of Wall EL.	☐ Lat. Unbalance

Impact Load:

☐ Lat. Impact force

Uplift Loads:

Impervious	☐ 10y SWL Uplift Pressure
	☐ 100y SWL Uplift
	☐ TOW Uplift Pressure
Pervious	☐ 10y SWL Uplift Pressure
	☐ 100y SWL Uplift
	☐ TOW Uplift Pressure

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	LC1	Checked by	JMH	Date	Dec-20
					References

Fx	Fy	Fz	'X' Centroid	'Y' Centroid	'Z' Centroid	Mx	My	Mz	NOTES:
(kips)	(kips)	(kips)	(ft)	(ft)	(ft)	(kip-ft)	(kip-ft)	(kip-ft)	
0.00	0.00	14.86	1.41	-3.83	0.00	-56.93	-20.96	0.00	Wall stem weight
0.00	0.00	88.71	2.70	-3.53	0.00	-313.16	-239.53	0.00	Base slab weight
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	F.S. soil weight
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	P.S. soil weight
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	F.S. lateral soil force
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	P.S. lateral soil force
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Vertical water force
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Lateral water force
						0.00	0.00	0.00	Wind load
						0.00	0.00	0.00	FS wave load
						0.00	0.00	0.00	Soil Vertical EQ force
						0.00	0.00	0.00	Soil Lateral EQ force
						0.00	0.00	0.00	Con. Vertical EQ force
						0.00	0.00	0.00	Con. Lateral EQ force
0.00	0.00	26.96		0.00	0.00	-81.96	-132.11	0.00	F.S. Surcharge load
0.00	0.00	14.68		0.00	0.00	-63.11	9.98	0.00	P.S. Surcharge load
						0.00	0.00	0.00	Unbalanced load
						0.00	0.00	0.00	Impact load
						0.00	0.00	0.00	Hydrostatic uplift
0.000	**0.000**	**145.217**				**-515.167**	**-382.616**	**0.000**	**SUM.**

Job	Maurepas Swamp	Project No.	60632162
Description	PI-WALL SECTIONS	Computed by	AML
	KCS-1	Date	Dec-20
	LC1	Checked by	JMH
		Date	Dec-20

References

Shear and Moment on the Wall

Note: enter load factors

Update

V_u	0.00	(kips/ft)
M_u	0.00	(kips-ft/ft)

Soil Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6		
PS	1.6		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Water Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6		

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Wind Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6		

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Wave Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6		

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Earthquake Force:

Load Factor		Unfact. V	Unfact. M
PS	1.6		

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Impact Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6		

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	LC2	Checked by	JMH	Date	Dec-20
					References

LC2: Water to TOW(impervious cutoff)

Loads

Deselect All

Dead Loads:

☑ Wall Stem Wt. ☑ Base Slab Wt.

Soil Forces:

Dry	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
10 Yr. Water El.	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
100 Yr. Water El.	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
Top of Wall EL.	☑ F.S. Soil Wt.	☑ P.S. Soil Wt.	☑ F.S. Lat. Soil Force	☑ P.S. Lat. Soil Force

Water Forces:

10 Yr. Water El.	☐ F.S. Water	☐ F.S. Lat. Water
100 Yr. Water El.	☐ F.S. Water	☐ F.S. Lat. Water
Top of Wall EL.	☑ F.S. Water	☑ F.S. Lat. Water

Wind Force:

Construction	☐ P.S. Lat. Wind Force
No Water	☐ F.S. Lat. Wind
100 Yr. Water El.	☐ F.S. Lat. Wind
10 Yr. Water El.	☐ F.S. Lat. Wind

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	LC2	Checked by	JMH	Date	Dec-20
				References	

Wave Force:

10 Yr. Water El. — ☐ F.S. Lat. Wave

100 Yr. Water El. — ☐ F.S. Lat. Wave

Top of Wall EL. — ☐ F.S. Lat. Wave

Earthquake Force:

MDE — ☐ Soil Ver. MDE ☐ Soil Lat. MDE ☐ Conc. Ver. MDE ☐ Conc. Lat. MDE

OBE — ☐ Soil Ver. OBE ☐ Soil Lat. OBE ☐ Conc. Ver. OBE ☐ Conc. Lat. OBE

Surcharge Forces:

☐ F.S. Surcharge Force ☐ P.S. Surcharge Force

Unbalanced Load:

10 Yr. Water El. — ☐ Lat. Unbalance

100 Yr. Water El. — ☐ Lat. Unbalance

Top of Wall EL. — ☐ Lat. Unbalance

Impact Load:

☐ Lat. Impact force

Uplift Loads:

Impervious
- ☐ 10y SWL Uplift Pressure
- ☐ 100y SWL Uplift
- ☑ TOW Uplift Pressure

Pervious
- ☐ 10y SWL Uplift Pressure
- ☐ 100y SWL Uplift
- ☐ TOW Uplift Pressure

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	LC2	Checked by	JMH	Date	Dec-20
				References	

Fx	Fy	Fz	'X' Centroid	'Y' Centroid	'Z' Centroid	Mx	My	Mz	NOTES:
(kips)	(kips)	(kips)	(ft)	(ft)	(ft)	(kip-ft)	(kip-ft)	(kip-ft)	
0.00	0.00	14.86	1.41	-3.83	0.00	-56.93	-20.96	0.00	Wall stem weight
0.00	0.00	88.71	2.70	-3.53	0.00	-313.16	-239.53	0.00	Base slab weight
0.00	0.00	20.13	4.90	-3.04	0.00	-61.19	-98.62	0.00	F.S. soil weight
0.00	0.00	22.83	-0.68	-4.30	0.00	-98.15	15.52	0.00	P.S. soil weight
-19.95	-6.38	0.00				-13.27	41.49	-88.54	F.S. lateral soil force
42.99	13.61	0.00				28.31	-89.42	184.77	P.S. lateral soil force
0.00	0.00	21.80	4.90	-3.04	0.00	-66.28	-106.84	0.00	Vertical water force
-22.74	-7.28	0.00				-15.13	47.31	-100.97	Lateral water force
						0.00	0.00	0.00	Wind load
						0.00	0.00	0.00	FS wave load
						0.00	0.00	0.00	Soil Vertical EQ force
						0.00	0.00	0.00	Soil Lateral EQ force
						0.00	0.00	0.00	Con. Vertical EQ force
						0.00	0.00	0.00	Con. Lateral EQ force
						0.00	0.00	0.00	F.S. Surcharge load
						0.00	0.00	0.00	P.S. Surcharge load
						0.00	0.00	0.00	Unbalanced load
						0.00	0.00	0.00	Impact load
0.00	0.00	-47.93		0.00	0.00	149.55	216.18	0.00	Hydrostatic uplift
0.301	**-0.045**	**120.402**				**-446.253**	**-234.869**	**-4.734**	**SUM.**

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	LC2	Checked by	JMH	Date	Dec-20

References

Shear and Moment on the Wall

Note: enter load factors

Update

V_u	-0.01	(kips/ft)
M_u	0.03	(kips-ft/ft)

Soil Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6	-0.122	0.310
PS	1.6	0.254	-0.646

Factored V & M

V_u =	0.211	(kips/ft)
M_u =	-0.538	(kips-ft/ft)

Water Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6	-0.139	0.354

V_u =	-0.223	(kips/ft)
M_u =	0.566	(kips-ft/ft)

Wind Force:

Load Factor		Unfact. V	Unfact. M
FS			

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Wave Force:

Load Factor		Unfact. V	Unfact. M
FS	0		

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Earthquake Force:

Load Factor		Unfact. V	Unfact. M
PS			

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Impact Force:

Load Factor		Unfact. V	Unfact. M
FS			

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	LC3	Checked by	JMH	Date	Dec-20
					References

LC3: Water to TOW(pervious cutoff)

Loads

Deselect All

Dead Loads:

- [x] Wall Stem Wt.
- [x] Base Slab Wt.

Soil Forces:

Dry	[ ] F.S. Soil Wt.	[ ] P.S. Soil Wt.	[ ] F.S. Lat. Soil Force	[ ] P.S. Lat. Soil Force
10 Yr. Water El.	[ ] F.S. Soil Wt.	[ ] P.S. Soil Wt.	[ ] F.S. Lat. Soil Force	[ ] P.S. Lat. Soil Force
100 Yr. Water El.	[ ] F.S. Soil Wt.	[ ] P.S. Soil Wt.	[ ] F.S. Lat. Soil Force	[ ] P.S. Lat. Soil Force
Top of Wall EL.	[x] F.S. Soil Wt.	[x] P.S. Soil Wt.	[x] F.S. Lat. Soil Force	[x] P.S. Lat. Soil Force

Water Forces:

10 Yr. Water El.	[ ] F.S. Water	[ ] F.S. Lat. Water
100 Yr. Water El.	[ ] F.S. Water	[ ] F.S. Lat. Water
Top of Wall EL.	[x] F.S. Water	[x] F.S. Lat. Water

Wind Force:

Construction	[ ] P.S. Lat. Wind Force
No Water	[ ] F.S. Lat. Wind
100 Yr. Water El.	[ ] F.S. Lat. Wind
10 Yr. Water El.	[ ] F.S. Lat. Wind

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	LC3	Checked by	JMH	Date	Dec-20
				References	

Wave Force:

10 Yr. Water El. — ☐ F.S. Lat. Wave

100 Yr. Water El. — ☐ F.S. Lat. Wave

Top of Wall EL. — ☐ F.S. Lat. Wave

Earthquake Force:

MDE — ☐ Soil Ver. MDE ☐ Soil Lat. MDE ☐ Conc. Ver. MDE ☐ Conc. Lat. MDE

OBE — ☐ Soil Ver. OBE ☐ Soil Lat. OBE ☐ Conc. Ver. OBE ☐ Conc. Lat. OBE

Surcharge Forces:

☐ F.S. Surcharge Force ☐ P.S. Surcharge Force

Unbalanced Load:

10 Yr. Water El. — ☐ Lat. Unbalance

100 Yr. Water El. — ☐ Lat. Unbalance

Top of Wall EL. — ☐ Lat. Unbalance

Impact Load:

☐ Lat. Impact force

Uplift Loads:

Impervious
- ☐ 10y SWL Uplift Pressure
- ☐ 100y SWL Uplift
- ☐ TOW Uplift Pressure

Pervious
- ☐ 10y SWL Uplift Pressure
- ☐ 100y SWL Uplift
- ☑ TOW Uplift Pressure

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	LC3	Checked by	JMH	Date	Dec-20
					References

Fx	Fy	Fz	'X' Centroid	'Y' Centroid	'Z' Centroid	Mx	My	Mz	NOTES:
(kips)	(kips)	(kips)	(ft)	(ft)	(ft)	(kip-ft)	(kip-ft)	(kip-ft)	
0.00	0.00	14.86	1.41	-3.83	0.00	-56.93	-20.96	0.00	Wall stem weight
0.00	0.00	88.71	2.70	-3.53	0.00	-313.16	-239.53	0.00	Base slab weight
0.00	0.00	20.13	4.90	-3.04	0.00	-61.19	-98.62	0.00	F.S. soil weight
0.00	0.00	22.83	-0.68	-4.30	0.00	-98.15	15.52	0.00	P.S. soil weight
-19.95	-6.38	0.00				-13.27	41.49	-88.54	F.S. lateral soil force
42.99	13.61	0.00				28.31	-89.42	184.77	P.S. lateral soil force
0.00	0.00	21.80	4.90	-3.04	0.00	-66.28	-106.84	0.00	Vertical water force
-22.74	-7.28	0.00				-15.13	47.31	-100.97	Lateral water force
						0.00	0.00	0.00	Wind load
						0.00	0.00	0.00	FS wave load
						0.00	0.00	0.00	Soil Vertical EQ force
						0.00	0.00	0.00	Soil Lateral EQ force
						0.00	0.00	0.00	Con. Vertical EQ force
						0.00	0.00	0.00	Con. Lateral EQ force
						0.00	0.00	0.00	F.S. Surcharge load
						0.00	0.00	0.00	P.S. Surcharge load
						0.00	0.00	0.00	Unbalanced load
						0.00	0.00	0.00	Impact load
0.00	0.00	-38.38		0.00	0.00	120.13	171.56	0.00	Hydrostatic uplift
0.301	**-0.045**	**129.955**				**-475.675**	**-279.488**	**-4.734**	**SUM.**

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	LC3	Checked by	JMH	Date	Dec-20

References

Shear and Moment on the Wall

Note: enter load factors

Update

V_u	-0.01	(kips/ft)
M_u	0.03	(kips-ft/ft)

Soil Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6	-0.122	0.310
PS	1.6	0.254	-0.646

Factored V & M

V_u =	0.211	(kips/ft)
M_u =	-0.538	(kips-ft/ft)

Water Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6	-0.139	0.354

V_u =	-0.223	(kips/ft)
M_u =	0.566	(kips-ft/ft)

Wind Force:

Load Factor		Unfact. V	Unfact. M
FS			

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Wave Force:

Load Factor		Unfact. V	Unfact. M
FS			

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Earthquake Force:

Load Factor		Unfact. V	Unfact. M
PS			

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Impact Force:

Load Factor		Unfact. V	Unfact. M
FS			

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

AECOM

Job	Maurepas Swamp	Project No.	60560480		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Summary of Foundation Loads	Checked by	JMH	Date	Dec-20
					References

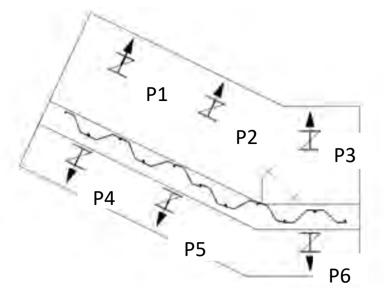
Load Case	Fx (kips)	Fy (kips)	Fz (kips)	Mx (kip-ft)	My (kip-ft)	Mz (kip-ft)
LC1	0.00	0.00	145.22	-515.17	-382.62	0.00
LC2	0.30	-0.04	120.40	-446.25	-234.87	-4.73
LC3	0.30	-0.04	129.95	-475.68	-279.49	-4.73

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Soil & Pile Information Required for CPGA	Checked by	JMH	Date	Dec-20
					References

Pile Layout: 6 HP Piles

pile no.	x	y	pile no.	x	y
1	8.2	-8.5	4	2.78	-11.05
2	5.6	-3.05	5	0.2	-5.63
3	3.75	2.88	6	-2.25	2.88



Tip Elevation: (For CPGA, need Tip Elevation as a function of CPGA Axis at B.O. Slab, +Z points downward)

B.O.S. Elevation =	9.89	NAVD88
TIP Elevation =	-30	NAVD89
"TIP" in CPGA =	39.89	**ft**

Pile Properties & Attributes

E =	29,000,000	psi	
A =	21.4	in^2	HP14x73
I_x =	729	in^4	
I_y =	261	in^4	
C_{33} =	1.7	(factor for method of axial load transfer from pile to soil; = 1 full tip bearing, = 2 full skin friction)	
S_x =	107	in^3	
S_y =	35.8	in^3	
F_y =	50	ksi	

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Soil & Pile Information Required for CPGA	Checked by	JMH	Date	Dec-20
					References

*NOTE: All soil properties and pile capacities are taken from the 95% submittal for Maurepas Intake Structure

Allowable Compression (AC) =	35.00	kips
Allowable Tension (AT) =	20.00	kips
ACC =	492.66	kips
ATT =	535.00	kips
AM1 =	2972.22	kip-in
AM2 =	994.44	kip-in

Es Value for CPGA Run:

Monolith width = 20.33 ft

E_s = 540.4 psi = 0.54 ksi

GROUP FACTORS	
Pile Spacing in Direction of Loading	From EM1110-2-2906
	D
3B	0.33
4B	0.38
5B	0.45
6B	0.56
7B	0.71
8B	1

Group reduction is based on distance between piles in direction of loading. This includes distance due to battering and is taken over the distance 10 x d_{pile} (point of fixety).

Assume a batter of 6

B = d_{pile} = 13.60 in = 1.1333333 ft

Distance between piles at B.O. Slab = 6.00 ft

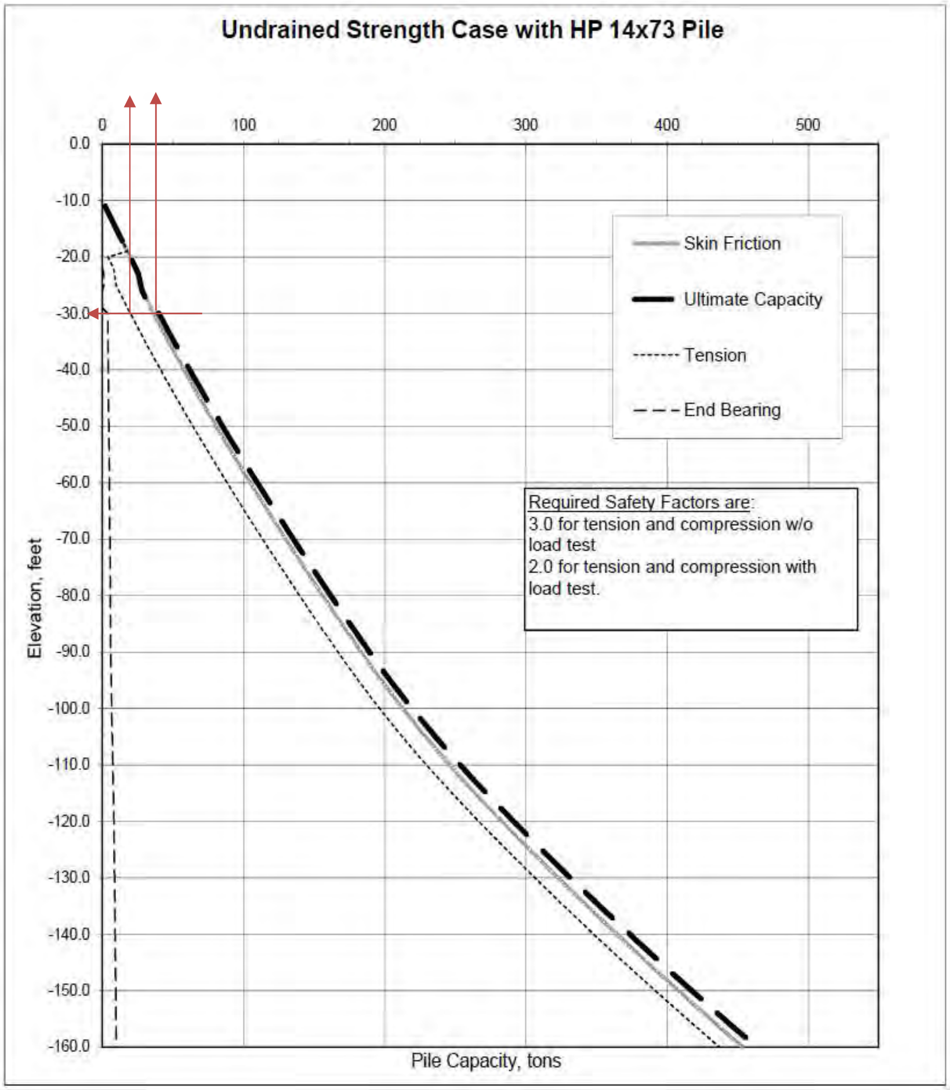
Average distance between piles over 10*dpile = 7.89 ft

Average distance between piles in terms of pile width B = 6.96 B

Group Reduction "D" value for this distance = 0.70

Therefore, Es including group reduction = 0.38 ksi

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Soil & Pile Information Required for CPGA	Checked by	JMH	Date	Dec-20
					References



AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	CPGA Input & Output Files	Checked by	JMH	Date	Dec-20

Input file to pile analysis (Unfactored Loads):

```
100 MONOLITH, TOW EL. 16.13, TOS EL. 12.89; HP14x73 PILES
200 PROP 29000 729 261 21.4 1.7 0 ALL
300 SOIL ES 0.3805 TIP 39.89 0 ALL
400 PIN ALL
500 ALLOW H 35 20 492.7 535 2972.2 994.4 ALL
600 FOVSTR 1.17 1.17 1
700 FOVSTR 1.33 1.33 2 TO 3
900 BATTER 6 1 TO 6
1200 ANGLE 25 1 TO 2
1300 ANGLE 180 6
1400 ANGLE 205 4 TO 5
1400 PILE 1 8.2 -8.5 0
1500 PILE 2 5.6 -3.05 0
1600 PILE 3 3.75 2.88 0
1700 PILE 4 2.78 -11.05 0
1800 PILE 5 0.2 -5.63 0
1900 PILE 6 -2.25 2.88 0
4500 LOAD 1 0 0 145.2 -515.2 -382.6 0
4600 LOAD 2 0.3 0 120.4 -446.3 -234.9 -4.7
4700 LOAD 3 0.3 0 130 -475.7 -279.5 -4.7
9000 FOUT 1 2 3 4 5 6 7 KCS1P.DOC
9100 PFO ALL
9200 PLB ALL
```

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	CPGA Input & Output Files	Checked by	JMH	Date	Dec-20

Input file to concrete design (Factored Loads):

```
100 MONOLITH, TOW EL. 16.13, TOS EL. 12.89; HP14x73 PILES
200 PROP 29000 729 261 21.4 1.7 0 ALL
300 SOIL ES 0.3805 TIP 39.89 0 ALL
400 PIN ALL
500 ALLOW H 35 20 492.7 535 2972.2 994.4 ALL
600 FOVSTR 1 1 1
700 FOVSTR 1 1 2 TO 3
900 BATTER 6 1 TO 6
1200 ANGLE 25 1 TO 2
1300 ANGLE 180 6
1400 ANGLE 205 4 TO 5
1400 PILE 1 8.2 -8.5 0
1500 PILE 2 5.6 -3.05 0
1600 PILE 3 3.75 2.88 0
1700 PILE 4 2.78 -11.05 0
1800 PILE 5 0.2 -5.63 0
1900 PILE 6 -2.25 2.88 0
4500 LOAD 1 0.00 0.00 232.35 -824.27 -612.19 0.00
4600 LOAD 2 0.48 -0.07 192.64 -714.01 -375.79 -7.57
4700 LOAD 3 0.48 -0.07 207.93 -761.08 -447.18 -7.57
9000 FOUT 1 2 3 4 5 6 7 KCS1SC.DOC
9100 PFO ALL
9200 PLB ALL
```

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	CPGA Input & Output Files	Checked by	JMH	Date	Dec-20

CPGA RESULTS (Unfactored Loads) ***(PIN CONNECTIONS)***

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 15-DEC-20     RUN TIME: 15:28:39



    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL. 12.89; HP14X73 PILES
DATA UNKNOWN - REJECTED.



THERE ARE   6 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                    X          Y          Z
                                  -----      -----      -----
WITH DIAGONAL COORDINATES = (     -2.25 ,   -11.05 ,     0.00 )
                            (      8.20 ,     2.88 ,     0.00 )


*******************************************************************************

         PILE PROPERTIES AS INPUT


      E           I1           I2           A           C33          B66
     KSI         IN**4        IN**4        IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         SOIL DESCRIPTIONS AS INPUT
```

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	CPGA Input & Output Files	Checked by	JMH	Date	Dec-20

```
    ES      ESOIL       LENGTH        L            LU
          K/IN**2                    FT            FT
         0.38050E+00    T      0.39890E+02   0.00000E+00

  ESOIL(ORIGINAL)     RGROUP      RCYCLIC
    K/IN**2
   0.38050E+00       0.1000E+01 0.1000E+01

 THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

     ALL


 ******************************************************************************

          PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


  0.17968E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.23229E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.21740E+04  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


 THIS MATRIX APPLIES TO THE FOLLOWING PILES -

      1


 ******************************************************************************

          PILE GEOMETRY AS INPUT AND/OR GENERATED

 NUM        X          Y          Z      BATTER   ANGLE   LENGTH  FIXITY
           FT         FT         FT                        FT

   1       8.20      -8.50       0.00     6.00    25.00    40.44     P
   2       5.60      -3.05       0.00     6.00    25.00    40.44     P
   3       3.75       2.88       0.00     6.00     0.00    40.44     P
   4       2.78     -11.05       0.00     6.00   205.00    40.44     P
   5       0.20      -5.63       0.00     6.00   205.00    40.44     P
   6      -2.25       2.88       0.00     6.00   180.00    40.44     P
                                                          ------
 242.64
```

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	CPGA Input & Output Files	Checked by	JMH	Date	Dec-20

```
******************************************************************************

                        APPLIED LOADS

LOAD     PX         PY         PZ          MX          MY          MZ  OVERSTRESS
CASE      K          K          K         FT-K        FT-K        FT-K  COM   TEN

  1       0.0        0.0      145.2      -515.2      -382.6         0.0 1.17 1.17
  2       0.3        0.0      120.4      -446.3      -234.9        -4.7 1.33 1.33
  3       0.3        0.0      130.0      -475.7      -279.5        -4.7 1.33 1.33


******************************************************************************
         ORIGINAL PILE GROUP STIFFNESS MATRIX

 0.41957E+03  0.81218E+02 -0.71918E-05  0.19507E+05 -0.66316E+05  0.21439E+05
 0.81218E+02  0.17725E+03  0.23931E-04  0.90962E+04 -0.19185E+05  0.13880E+05
-0.71918E-05  0.23931E-04  0.12695E+05 -0.57049E+06 -0.46411E+06 -0.32151E+03
 0.19507E+05  0.90962E+04 -0.57049E+06  0.76759E+08  0.34825E+08  0.21277E+07
-0.66316E+05 -0.19185E+05 -0.46411E+06  0.34825E+08  0.38234E+08 -0.35694E+07
 0.21439E+05  0.13880E+05 -0.32151E+03  0.21277E+07 -0.35694E+07  0.37036E+07



                      6 PILES    3 LOAD CASES

LOAD CASE    1.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    2.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    3.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.


******************************************************************************
```

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	CPGA Input & Output Files	Checked by	JMH	Date	Dec-20

```
         PILE CAP DISPLACEMENTS

 LOAD
 CASE       DX          DY          DZ          RX          RY          RZ
            IN          IN          IN          RAD         RAD         RAD

    1   0.2104E-01  0.6127E-02  0.1450E-01 -0.3836E-04  0.1309E-03  0.4635E-05
    2   0.5925E-01  0.1851E-01  0.1694E-01 -0.1202E-03  0.3518E-03 -0.1794E-04
    3   0.5169E-01  0.1626E-01  0.1680E-01 -0.1027E-03  0.3057E-03 -0.2039E-04


 ******************************************************************************
              ELASTIC CENTER INFORMATION



 ELASTIC CENTER IN PLANE X-Z          X             Z
                                      FT            FT
                                     0.00          0.00


 ******************************************************************************

         PILE FORCES IN LOCAL GEOMETRY

             M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
             * INDICATES PILE FAILURE
             # INDICATES CBF BASED ON MOMENTS DUE TO
                         (F3*EMIN) FOR CONCRETE PILES
             B INDICATES BUCKLING CONTROLS



 LOAD CASE -    1

 PILE    F1      F2      F3       M1       M2       M3   ALF  CBF
          K       K       K       IN-K     IN-K     IN-K

   1     0.4    -0.1    19.8     -2.9    -11.5      0.0 0.48 0.05
   2     0.4    -0.1    23.1     -2.9    -11.2      0.0 0.56 0.05
   3     0.3     0.1    23.1      5.8    -10.6      0.0 0.56 0.05
   4    -0.4     0.1    24.7      3.2     13.4      0.0 0.60 0.06
   5    -0.4     0.1    28.1      3.2     13.3      0.0 0.69 0.06
   6    -0.4    -0.1    28.4     -5.5     12.8      0.0 0.69 0.06


 LOAD CASE -    2

 PILE    F1      F2      F3       M1       M2       M3   ALF  CBF
          K       K       K       IN-K     IN-K     IN-K

   1     1.1    -0.2     9.5     -8.3    -32.4      0.0 0.20 0.04
   2     1.1    -0.2    16.7     -8.3    -32.8      0.0 0.36 0.05
   3     1.1     0.4    14.9     16.2    -32.5      0.0 0.32 0.05
   4    -1.1     0.2    24.2      7.1     33.8      0.0 0.52 0.06
   5    -1.1     0.2    30.4      7.1     34.7      0.0 0.65 0.07
   6    -1.1    -0.4    26.4    -17.3     34.3      0.0 0.57 0.07
```

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	CPGA Input & Output Files	Checked by	JMH	Date	Dec-20

LOAD CASE - 3

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	0.9	-0.2	12.2	-7.3	-27.7	0.0	0.26	0.04
2	0.9	-0.2	18.8	-7.3	-28.3	0.0	0.40	0.05
3	0.9	0.4	17.7	14.0	-28.3	0.0	0.38	0.05
4	-1.0	0.2	25.1	6.0	29.3	0.0	0.54	0.06
5	-1.0	0.2	30.6	6.0	30.3	0.0	0.66	0.07
6	-1.0	-0.4	27.4	-15.4	30.2	0.0	0.59	0.07

****

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	3.3	1.5	19.5	0.0	0.0	0.0
2	3.8	1.7	22.7	0.0	0.0	0.0
3	4.1	0.1	22.7	0.0	0.0	0.0
4	-3.2	-1.6	24.4	0.0	0.0	0.0
5	-3.8	-1.8	27.8	0.0	0.0	0.0
6	-4.2	0.1	28.0	0.0	0.0	0.0

LOAD CASE - 2

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	2.5	0.9	9.2	0.0	0.0	0.0
2	3.5	1.4	16.3	0.0	0.0	0.0
3	3.5	0.4	14.5	0.0	0.0	0.0
4	-2.5	-1.4	24.1	0.0	0.0	0.0
5	-3.4	-1.8	30.1	0.0	0.0	0.0
6	-3.2	0.4	26.2	0.0	0.0	0.0

LOAD CASE - 3

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	2.7	1.1	11.9	0.0	0.0	0.0
2	3.7	1.5	18.4	0.0	0.0	0.0
3	3.8	0.4	17.3	0.0	0.0	0.0
4	-2.8	-1.5	25.0	0.0	0.0	0.0
5	-3.6	-1.8	30.3	0.0	0.0	0.0
6	-3.5	0.4	27.2	0.0	0.0	0.0

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	CPGA Input & Output Files	Checked by	JMH	Date	Dec-20

CPGA RESULTS (Unfactored Loads) ***(FIX CONNECTIONS)***

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 15-DEC-20     RUN TIME: 15:29:15



    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL. 12.89; HP14X73 PILES
DATA UNKNOWN - REJECTED.



THERE ARE   6 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                   X          Y          Z
                                 -----      -----      -----
WITH DIAGONAL COORDINATES = (     -2.25 ,   -11.05 ,     0.00 )
                            (      8.20 ,     2.88 ,     0.00 )


*******************************************************************************

         PILE PROPERTIES AS INPUT


      E           I1           I2           A           C33          B66
     KSI         IN**4        IN**4        IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         SOIL DESCRIPTIONS AS INPUT


   ES     ESOIL      LENGTH       L            LU
         K/IN**2                  FT           FT
        0.38050E+00    T      0.39890E+02   0.00000E+00

 ESOIL(ORIGINAL)     RGROUP     RCYCLIC
   K/IN**2
  0.38050E+00       0.1000E+01 0.1000E+01

THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

    ALL
```

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	CPGA Input & Output Files	Checked by	JMH	Date	Dec-20

```
*******************************************************************************

         PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


 0.35937E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.16971E+04  0.00000E+00
 0.00000E+00  0.46458E+02  0.00000E+00 -0.28362E+04  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.21740E+04  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00 -0.28362E+04  0.00000E+00  0.34630E+06  0.00000E+00  0.00000E+00
 0.16971E+04  0.00000E+00  0.00000E+00  0.00000E+00  0.16028E+06  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


THIS MATRIX APPLIES TO THE FOLLOWING PILES -

     1


*******************************************************************************

         PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM        X          Y          Z      BATTER   ANGLE   LENGTH  FIXITY
          FT         FT         FT                         FT

  1       8.20      -8.50       0.00     6.00    25.00    40.44    F
  2       5.60      -3.05       0.00     6.00    25.00    40.44    F
  3       3.75       2.88       0.00     6.00     0.00    40.44    F
  4       2.78     -11.05       0.00     6.00   205.00    40.44    F
  5       0.20      -5.63       0.00     6.00   205.00    40.44    F
  6      -2.25       2.88       0.00     6.00   180.00    40.44    F
                                                          ------
242.64


*******************************************************************************

                        APPLIED LOADS

LOAD     PX         PY         PZ          MX           MY           MZ  OVERSTRESS
CASE      K          K          K         FT-K         FT-K         FT-K  COM    TEN

  1       0.0        0.0      145.2      -515.2       -382.6         0.0 1.17 1.17
  2       0.3        0.0      120.4      -446.3       -234.9        -4.7 1.33 1.33
  3       0.3        0.0      130.0      -475.7       -279.5        -4.7 1.33 1.33


*******************************************************************************
```

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	CPGA Input & Output Files	Checked by	JMH	Date	Dec-20

```
         ORIGINAL PILE GROUP STIFFNESS MATRIX

 0.52857E+03  0.72414E+02 -0.71319E-05  0.21066E+05 -0.54917E+05  0.26057E+05
 0.72414E+02  0.31252E+03  0.23732E-04 -0.69627E+04 -0.20747E+05  0.18024E+05
-0.71319E-05  0.23732E-04  0.12697E+05 -0.57062E+06 -0.46422E+06 -0.31883E+03
 0.21066E+05 -0.69627E+04 -0.57062E+06  0.78686E+08  0.35073E+08  0.16825E+07
-0.54917E+05 -0.20747E+05 -0.46422E+06  0.35073E+08  0.39436E+08 -0.31069E+07
 0.26057E+05  0.18024E+05 -0.31883E+03  0.16825E+07 -0.31069E+07  0.49588E+07



                      6 PILES    3 LOAD CASES

LOAD CASE    1.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    2.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    3.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.


*******************************************************************************

         PILE CAP DISPLACEMENTS

LOAD
CASE       DX          DY          DZ          RX          RY          RZ
           IN          IN          IN          RAD         RAD         RAD

   1   0.5726E-02  0.1999E-02  0.1297E-01 -0.1013E-04  0.5431E-04  0.9461E-06
   2   0.1708E-01  0.5490E-02  0.1276E-01 -0.4248E-04  0.1418E-03 -0.1700E-04
   3   0.1500E-01  0.4975E-02  0.1316E-01 -0.3524E-04  0.1233E-03 -0.1822E-04


*******************************************************************************
              ELASTIC CENTER INFORMATION


ELASTIC CENTER IN PLANE X-Z          X             Z
                                    FT            FT
                                   0.00          0.00


*******************************************************************************

         PILE FORCES IN LOCAL GEOMETRY

             M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
             * INDICATES PILE FAILURE
             # INDICATES CBF BASED ON MOMENTS DUE TO
                         (F3*EMIN) FOR CONCRETE PILES
             B INDICATES BUCKLING CONTROLS
```

AECOM

Job	Maurepas Swamp		Project No.	60632162		
Description	PI-WALL SECTIONS		Computed by	AML	Date	Dec-20
	KCS-1					
	CPGA Input & Output Files		Checked by	JMH	Date	Dec-20

LOAD CASE - 1

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	0.3	-0.1	20.8	6.3	16.5	0.0	0.51	0.05
2	0.2	-0.1	23.0	6.3	16.1	0.0	0.56	0.06
3	0.2	0.1	23.8	-9.3	15.4	0.0	0.58	0.06
4	-0.4	0.1	24.6	-6.6	-22.4	0.0	0.60	0.06
5	-0.4	0.1	26.8	-6.6	-22.5	0.0	0.65	0.07
6	-0.4	-0.1	28.2	9.0	-22.2	0.0	0.69	0.07

LOAD CASE - 2

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	0.8	-0.2	12.3	16.9	48.6	0.0	0.26	0.06
2	0.8	-0.2	16.2	16.8	50.2	0.0	0.35	0.07
3	0.8	0.3	16.8	-26.9	50.9	0.0	0.36	0.07
4	-0.9	0.1	23.7	-11.5	-53.3	0.0	0.51	0.08
5	-0.9	0.1	26.8	-11.4	-55.8	0.0	0.58	0.09
6	-1.0	-0.4	26.1	32.4	-56.5	0.0	0.56	0.09

LOAD CASE - 3

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	0.7	-0.2	14.7	15.5	41.2	0.0	0.31	0.06
2	0.7	-0.2	18.4	15.5	43.0	0.0	0.40	0.06
3	0.7	0.3	19.3	-22.8	44.1	0.0	0.41	0.07
4	-0.8	0.1	24.7	-9.7	-46.3	0.0	0.53	0.08
5	-0.8	0.1	27.5	-9.7	-48.9	0.0	0.59	0.08
6	-0.9	-0.4	27.2	28.6	-50.2	0.0	0.58	0.09

****

PILE FORCES IN GLOBAL GEOMETRY

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	CPGA Input & Output Files	Checked by	JMH	Date	Dec-20

LOAD CASE - 1

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	3.4	1.5	20.4	-1.4	17.5	-1.0
2	3.7	1.6	22.6	-1.2	17.2	-1.0
3	4.2	0.1	23.5	-9.2	15.4	1.5
4	-3.3	-1.6	24.3	-3.6	23.0	1.1
5	-3.6	-1.8	26.5	-3.7	23.2	1.1
6	-4.3	0.1	27.8	-8.9	22.2	-1.5

LOAD CASE - 2

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	2.6	1.0	12.0	-5.5	51.1	-2.8
2	3.2	1.3	15.9	-6.2	52.5	-2.8
3	3.6	0.3	16.5	-26.6	50.9	4.4
4	-2.7	-1.4	23.6	-12.3	53.1	1.9
5	-3.1	-1.6	26.6	-13.3	55.3	1.9
6	-3.3	0.4	25.9	-31.9	56.5	-5.3

LOAD CASE - 3

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	2.9	1.1	14.3	-3.6	43.8	-2.5
2	3.4	1.4	18.1	-4.3	45.4	-2.5
3	3.9	0.3	18.9	-22.5	44.1	3.7
4	-2.9	-1.5	24.5	-10.9	46.0	1.6
5	-3.3	-1.7	27.3	-12.0	48.4	1.6
6	-3.6	0.4	26.9	-28.2	50.2	-4.7

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	CPGA Input & Output Files	Checked by	JMH	Date	Dec-20

CPGA RESULTS (Factored Loads) ***(SLAB CHECK)***

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 15-DEC-20     RUN TIME: 15:30:26



    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL. 12.89; HP14X73 PILES
DATA UNKNOWN - REJECTED.



THERE ARE   6 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                   X          Y          Z
                                 -----      -----      -----
WITH DIAGONAL COORDINATES = (     -2.25 ,   -11.05 ,     0.00 )
                            (      8.20 ,     2.88 ,     0.00 )


*******************************************************************************

         PILE PROPERTIES AS INPUT


      E           I1           I2            A           C33          B66
     KSI         IN**4        IN**4        IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         SOIL DESCRIPTIONS AS INPUT


   ES     ESOIL      LENGTH       L            LU
         K/IN**2                  FT           FT
        0.38050E+00    T      0.39890E+02   0.00000E+00

 ESOIL(ORIGINAL)      RGROUP     RCYCLIC
   K/IN**2
  0.38050E+00       0.1000E+01 0.1000E+01
```

Job	Maurepas Swamp		Project No.	60632162		
Description	PI-WALL SECTIONS		Computed by	AML	Date	Dec-20
	KCS-1					
	CPGA Input & Output Files		Checked by	JMH	Date	Dec-20

```
THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


 0.17968E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.23229E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.21740E+04  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


THIS MATRIX APPLIES TO THE FOLLOWING PILES -

     1


*******************************************************************************

         PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM        X          Y          Z     BATTER   ANGLE   LENGTH  FIXITY
          FT         FT         FT                        FT

  1       8.20      -8.50       0.00     6.00    25.00    40.44    P
  2       5.60      -3.05       0.00     6.00    25.00    40.44    P
  3       3.75       2.88       0.00     6.00     0.00    40.44    P
  4       2.78     -11.05       0.00     6.00   205.00    40.44    P
  5       0.20      -5.63       0.00     6.00   205.00    40.44    P
  6      -2.25       2.88       0.00     6.00   180.00    40.44    P
                                                         ------
242.64


*******************************************************************************

                        APPLIED LOADS

LOAD     PX         PY         PZ          MX           MY           MZ
CASE      K          K          K         FT-K         FT-K         FT-K

  1      0.0        0.0      232.3      -824.3       -612.2          0.0
  2      0.5       -0.1      192.6      -714.0       -375.8         -7.6
  3      0.5       -0.1      207.9      -761.1       -447.2         -7.6
```

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	CPGA Input & Output Files	Checked by	JMH	Date	Dec-20

```
*******************************************************************************

         ORIGINAL PILE GROUP STIFFNESS MATRIX

  0.41957E+03  0.81218E+02 -0.71918E-05  0.19507E+05 -0.66316E+05  0.21439E+05
  0.81218E+02  0.17725E+03  0.23931E-04  0.90962E+04 -0.19185E+05  0.13880E+05
 -0.71918E-05  0.23931E-04  0.12695E+05 -0.57049E+06 -0.46411E+06 -0.32151E+03
  0.19507E+05  0.90962E+04 -0.57049E+06  0.76759E+08  0.34825E+08  0.21277E+07
 -0.66316E+05 -0.19185E+05 -0.46411E+06  0.34825E+08  0.38234E+08 -0.35694E+07
  0.21439E+05  0.13880E+05 -0.32151E+03  0.21277E+07 -0.35694E+07  0.37036E+07



                      6 PILES   3 LOAD CASES

LOAD CASE    1.  NUMBER OF FAILURES =   5.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    2.  NUMBER OF FAILURES =   3.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    3.  NUMBER OF FAILURES =   3.  NUMBER OF PILES IN TENSION =   0.


*******************************************************************************

         PILE CAP DISPLACEMENTS

LOAD
CASE       DX          DY          DZ          RX          RY          RZ
           IN          IN          IN          RAD         RAD         RAD

   1   0.3367E-01  0.9803E-02  0.2320E-01 -0.6134E-04  0.2094E-03  0.7401E-05
   2   0.9470E-01  0.2904E-01  0.2710E-01 -0.1921E-03  0.5623E-03 -0.2696E-04
   3   0.8255E-01  0.2543E-01  0.2685E-01 -0.1640E-03  0.4880E-03 -0.3087E-04


*******************************************************************************
              ELASTIC CENTER INFORMATION


ELASTIC CENTER IN PLANE X-Z          X             Z
                                    FT            FT
                                   0.00          0.00


*******************************************************************************

         PILE FORCES IN LOCAL GEOMETRY

             M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
             * INDICATES PILE FAILURE
             # INDICATES CBF BASED ON MOMENTS DUE TO
                         (F3*EMIN) FOR CONCRETE PILES
             B INDICATES BUCKLING CONTROLS
```

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	CPGA Input & Output Files	Checked by	JMH	Date	Dec-20

LOAD CASE - 1

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF	
	K	K	K	IN-K	IN-K	IN-K			
1	0.6	-0.1	31.7	-4.6	-18.4	0.0	0.91	0.08	
2	0.6	-0.1	36.9	-4.6	-17.9	0.0	1.06	0.09	*
3	0.6	0.2	36.9	9.3	-17.0	0.0	1.06	0.10	*
4	-0.7	0.1	39.5	5.1	21.4	0.0	1.13	0.10	*
5	-0.7	0.1	45.0	5.1	21.3	0.0	1.29	0.11	*
6	-0.7	-0.2	45.4	-8.8	20.4	0.0	1.30	0.12	*

LOAD CASE - 2

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF	
	K	K	K	IN-K	IN-K	IN-K			
1	1.7	-0.3	15.3	-13.6	-51.7	0.0	0.44	0.09	
2	1.7	-0.3	26.6	-13.6	-52.3	0.0	0.76	0.11	
3	1.7	0.6	23.8	25.4	-52.0	0.0	0.68	0.11	
4	-1.8	0.3	38.7	11.9	54.0	0.0	1.11	0.14	*
5	-1.8	0.3	48.6	11.9	55.5	0.0	1.39	0.16	*
6	-1.8	-0.7	42.3	-27.2	54.8	0.0	1.21	0.15	*

LOAD CASE - 3

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF	
	K	K	K	IN-K	IN-K	IN-K			
1	1.5	-0.3	19.6	-12.1	-44.3	0.0	0.56	0.09	
2	1.5	-0.3	30.0	-12.1	-45.1	0.0	0.86	0.11	
3	1.5	0.6	28.2	22.0	-45.1	0.0	0.81	0.11	
4	-1.5	0.3	40.2	10.1	46.8	0.0	1.15	0.13	*
5	-1.6	0.3	48.9	10.1	48.4	0.0	1.40	0.15	*
6	-1.6	-0.6	43.8	-24.0	48.2	0.0	1.25	0.15	*

****

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	5.3	2.4	31.2	0.0	0.0	0.0
2	6.1	2.7	36.3	0.0	0.0	0.0
3	6.6	0.2	36.4	0.0	0.0	0.0
4	-5.2	-2.6	39.1	0.0	0.0	0.0
5	-6.0	-3.0	44.5	0.0	0.0	0.0
6	-6.8	0.2	44.9	0.0	0.0	0.0

Job	Maurepas Swamp	Project No.	60632162
Description	PI-WALL SECTIONS	Computed by	AML
	KCS-1	Date	Dec-20
	CPGA Input & Output Files	Checked by	JMH
		Date	Dec-20

LOAD CASE - 2

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	3.9	1.5	14.8	0.0	0.0	0.0
2	5.7	2.3	26.0	0.0	0.0	0.0
3	5.6	0.6	23.2	0.0	0.0	0.0
4	-4.1	-2.2	38.5	0.0	0.0	0.0
5	-5.5	-2.9	48.2	0.0	0.0	0.0
6	-5.2	0.7	42.0	0.0	0.0	0.0

LOAD CASE - 3

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	4.3	1.7	19.1	0.0	0.0	0.0
2	5.9	2.4	29.4	0.0	0.0	0.0
3	6.1	0.6	27.6	0.0	0.0	0.0
4	-4.5	-2.4	39.9	0.0	0.0	0.0
5	-5.8	-3.0	48.5	0.0	0.0	0.0
6	-5.6	0.6	43.5	0.0	0.0	0.0

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Summary of Shear & Moment	Checked by	JMH	Date	Dec-20
					References

Load Case	$V_{u,max}$ (kip/ft)	$M_{u,max}$ (kip/ft)
LC1	0.00	0.00
LC2	-0.01	0.03
LC3	-0.01	0.03

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS KCS-1	Computed by	AML	Date	Dec-20
	Shear & Moment Check for Wall	Checked by	JMH	Date	Dec-20
				References	

*** Given Information:**

Wall Thickness:	1.50	ft
Clear Cover:	0.25	ft
Diameter Bar to Start:	0.0625	ft
Maximum Shear (V_u):	0.01	kip per foot
Maximum Moment (M_u):	0.03	kip-ft per foot
φ_{shear} =	0.75	(ACI 318)
φ_{moment} =	0.9	(ACI 318)
$f_{y,\,rebar}$ =	60	ksi
f'_c =	4	ksi

*** Shear Calculations:**

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u) (ACI Eq. 11-1)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75		
f'_c =	4	ksi	
b =	1	ft strip	
d =	1.22	ft	14.625

φV_c =	16649.4	lbs	
	16.65	kips	** φVc=16.6 ≥ Vu=0, **Shear Capacity OK**

*** Reinforcement Calculations:**

Limit of Maximum Reinforcement: 0.25 x ρ_b (Design Criteria, EM 1110-2-2104, 3-5)

where ρ_b =	0.0285	for f'_c = 4,000psi, fy = 60,000psi
Max Rebar =	0.00713	*b * d

Maximum Reinforcement:	0.0071	* b * d =	1.25	in^2	per 1ft strip

A_{gross} = 1.5 ft * 12 in/ft * 12 in strip = 216.00 in^2

Limits of Minimum Reinforcement:	0.003 x Agross =	0.65	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
	$(3*\sqrt{(f'_c)}*b*d)/f_y$ =	0.55	in^2	ACI 318-14, 9.6.1.2, min for flexural members)
	$(200*b*d)/f_y$ =	0.59	in^2	ACI 318-14, 9.6.1.2, min for flexural members)

Min Reinforcement, temp & shrinkage:	0.32	in^2	per 1ft strip, per face
Min Reinforcement, flexural:	0.59	in^2	per 1ft strip, per face

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS KCS-1	Computed by	AML	Date	Dec-20
	Shear & Moment Check for Wall	Checked by	JMH	Date	Dec-20
					References

*** Moment Calculations:**

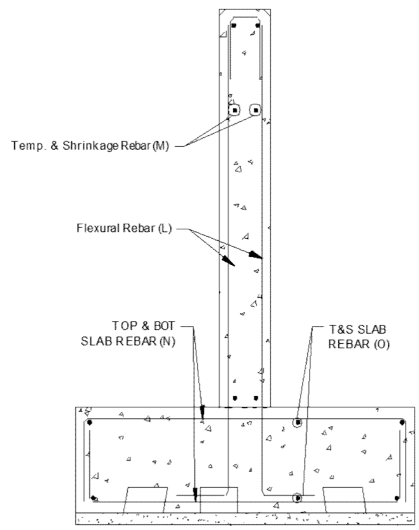
* $T = A_s \times f_y$
* $C = 0.85 \times f'_c \times a \times b$
* Assuming Tension = Compression ⟶ $A_s \times f_y = 0.85 \times f'_c \times a \times b$
* $\varphi Mn = \varphi \times T \times (d - (a / 2))$
$= \varphi \times A_s \times f_y \times (d - (a / 2))$

* Capacity of Min Flexural Reinforcement:

A_s =	0.585	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	1.21875	
φ_{moment} =	0.9	

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$
= 0.860 in

φM_n =	448.4	kip-in
=	37.37	kip-ft



* Capacity of Maximum Reinforcement:

*** #6 rebar is used for flexural reinforcement for wall, spacing varies**

*** #6 rebar is used for temp. & shrinkage reinforcement for wall, spacing varies**

A_s =	1.250	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	1.22	
φ_{moment} =	0.9	

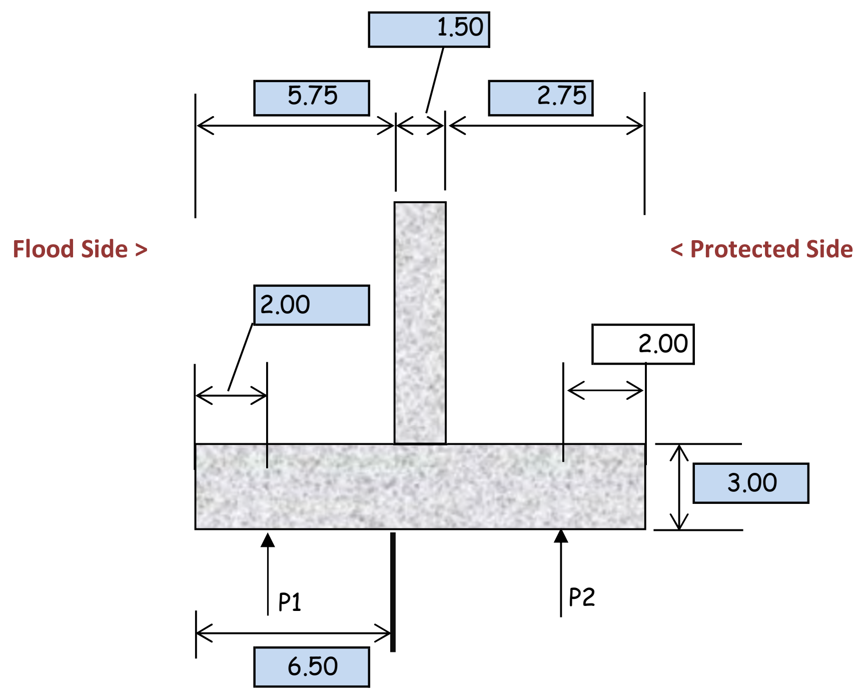
Proposed flexural reinforcement: #6@9 (A= 0.59 in^2)
Proposed temp. & shrinkage reinforcement: #6@9 (A= 0.59 in^2)

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$
= 1.839 in

φMn =	925.4	kip-in
=	77.12	kip-ft

**** φMn=77.1 ≥ Mu=0, Section OK**

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
Slab		Checked by	JMH	Date	Dec-20
					References



Tributary width (pile spacing): 6 ft Referred to as "width" in calculations

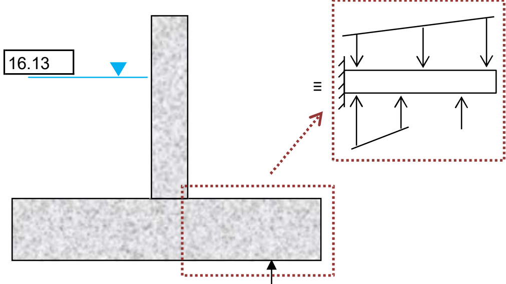
AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

Load Case: 3

Analysis of Protected Side of Slab:

F.S. WL = 16.13



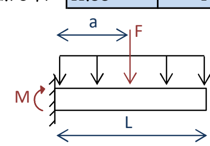
P2 (kips) = 48.5

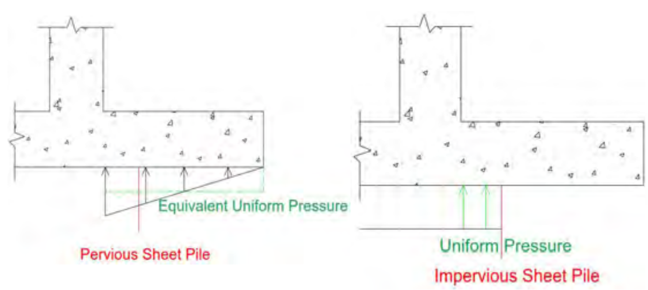
(+) Compression
(-) Tension

* Here the shear and moment diagrams for the protected side of the slab are presented. The protected side of the slab is considered as a cantilever beam fixed at the face of the wall in protected side.

Allowable Overstress: %

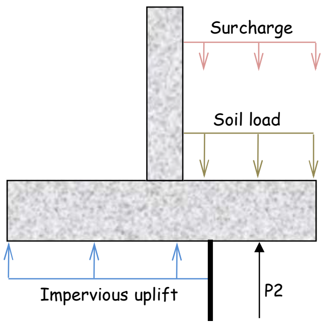
			Load Fac.			L	F (kips)	F x a = M (k-ft)
Self Weight:	$\gamma_{concrete} \times H_{slab} \times$ Width =	2.70 x	1.6	4.32	kips/ft	x 2.75 ft =	11.88	16.34
Soil Load:	$\gamma_{soil} \times H_{soil} \times$ Width =	2.33 x	1.6	3.73	kips/ft	x 2.75 ft =	10.26	14.11
Const. Surcharge Load:	Surcharge pressure x Width =	1.50 x	0	0.00	kips/ft	x 2.75 ft =	0.00	0.00
Uplift: ☑ Pervious ☐ Impervious	$\gamma_{water} \times H_{water\ w/slab} \times$ Width =	0.32 x	1.6	0.51	kips/ft	x 2.75 ft =	1.41	1.29
Conc. Earthquake Load:	EQ area pressure x Width =	1.85 x		0.00	kips/ft	x 2.75 ft =	0.00	0.00
Pile P2	P =	48.50 x	1	48.50	kips		48.50	36.38

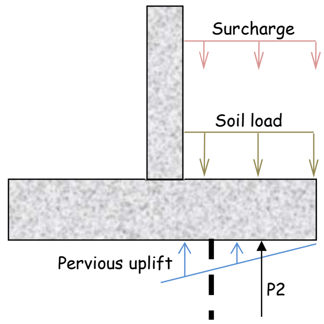




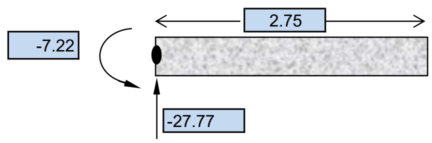
AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Slab Calculation	Checked by	JMH	Date	Dec-20
					References





Reactions Calculations:



Find Reactions at face of wall (assumed to be a fixed support):

R_z = Self Weight + Soil Load - Pile Reaction 2 + (Surch.) - (Uplift)

R_z = -27.77 kips

M_y = -7.22 kips-ft

Shear and Moment Calculations:

1) Sign Convention: ↑ → ↺ +

2) Find Equations for each loading to use in shear and moment calculations:
(Moving a distance "X" from the protected side to the wall stem across the slab)

Self Weight:
w_{weight} = -4.32 kips/ft
V_{weight} = -4.32 X
M_{weight} = -4.32 X² / 2

Soil Load:
w_{soil} = -3.73 kips/ft
V_{soil} = -3.73 X
M_{soil} = -3.73 X² / 2

Const. Surcharge:
w_{EQ} = -0 kips/ft
V_{EQ} = -0 X
M_{EQ} = -0 X² / 2

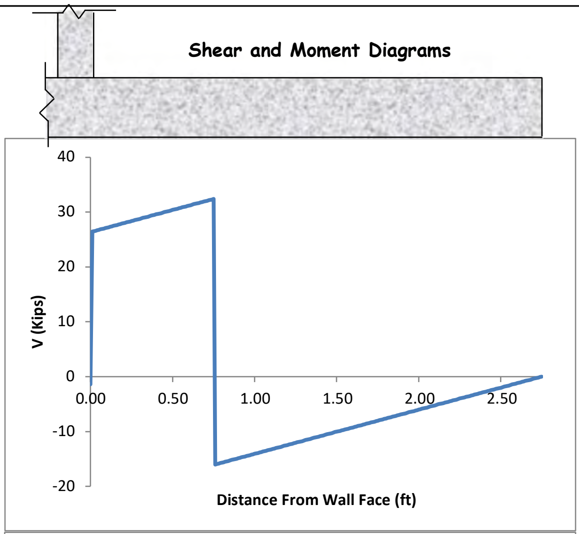
Uplift Load:
w_{uplift} = 0.37 X Kips/ft
V_{uplift} = 0.37 X² / 2
M_{uplift} = 0.37 X^3 / 6

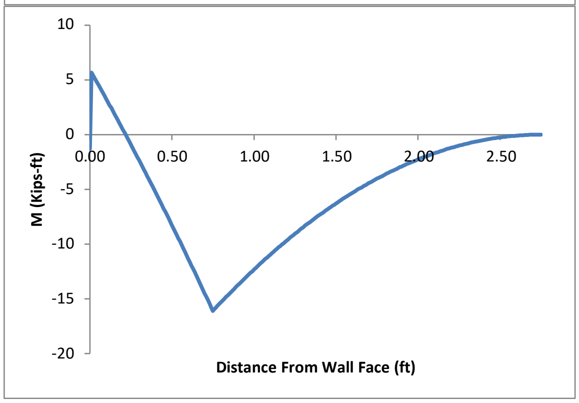
Conc. EQ:
w_{EQ} = -0 kips/ft
V_{EQ} = -0 X
M_{EQ} = -0 X² / 2

Pile P2:
V_{pile} = 48.5 Kips (after x = 2ft)
M_{pile} = 48.5 (X - 2 ft)

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Slab Calculation	Checked by	JMH	Date	Dec-20
					References

Shear and Moment Diagrams





Max Shear	
32.40	kips / tributary width / allowable OS =
5.40 Kips	

Max Top Moment	
-16.105	kips / tributary width / allowable OS =
-2.68 Kips	

Max Bottom Moment	
29.1805	kips / tributary width / allowable OS =
4.86 Kips	

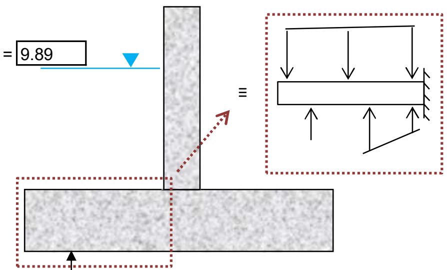
AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

Load Case: 1

Analysis of Protected Side of Slab:

F.S. WL = 9.89



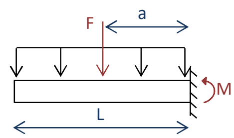
* Here the shear and moment diagrams for the flood side of the slab are presented. The flood side of the slab is considered as a cantilever beam fixed at the face of the wall in flood side.

P1 (kips) = 36.4

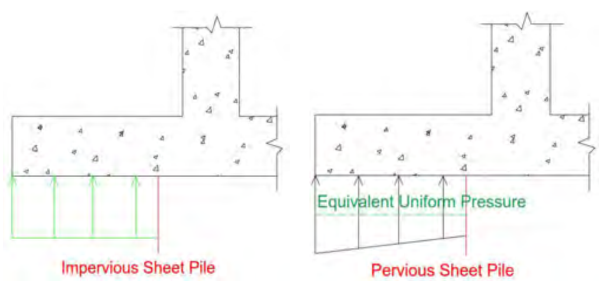
(+) Compression
(-) Tension

Allowable Overstress: 0 %

				Load Fac.			L	F (kips)	F x a = M (k-ft)
Self Weight:	$\gamma_{concrete} \times H_{slab} \times$ Width =	2.70	x	1.6	4.32	kips/ft	x 5.75 ft =	24.84	71.42



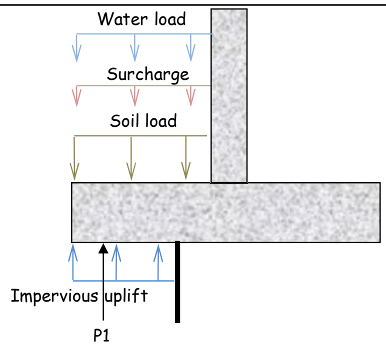
Soil Load:	$\gamma_{soil} \times H_{soil} \times$ Width =	2.33	x	0	0.00	kips/ft	x 5.75 ft =	0.00	0.00
Const. Surcharge Load:	Surcharge pressure x Width =	1.50	x	1.6	2.40	kips/ft	x 5.75 ft =	13.80	39.68
Uplift: ☐ Pervious ☐ Impervious	$\gamma_{water} \times H_{water\ w/slab} \times$ Width =	0.00	x	1.6	0.00	kips/ft	x 5.75 ft =	0.00	0.00

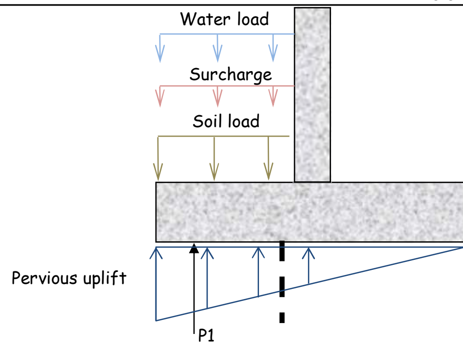


Conc. Earthquake Load:	EQ area pressure x Width =	1.85	x		0.00	kips/ft	x 5.75 ft =	0.00	0.00
Pile P1	P =	36.40	x	1	36.40	kips		36.40	136.50
Water Weight:	$\gamma_{water} \times H_{water} \times$ Width =	-1.12	x	0	0.00	kips/ft	x 5.75 ft =	0.00	0.00

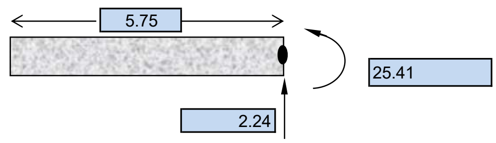
AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	





Reactions Calculations:



Find Reactions at face of wall (assumed to be a fixed support):

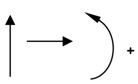
R_z = Self Weight + Soil Load + Surch. - Pile Reaction 1 - Uplift

R_z = 2.24 kips

M_y = 25.41 kips-ft

Shear and Moment Calculations:

1) Sign Convention:



2) Find Equations for each loading to use in shear and moment calculations:
(Moving a distance "X" from the flood side to the wall stem across the slab)

Self Weight: w_{weight} = -4.32 kips/ft
V_{weight} = -4.32 X
M_{weight} = -4.32 X² / 2

Soil Load: w_{soil} = -0 kips/ft
V_{soil} = -0 X
M_{soil} = -0 X² / 2

Const. Surcharge: w_{EQ} = -2.4 kips/ft
V_{EQ} = -2.4 X
M_{EQ} = -2.4 X² / 2

Uplift Load: w_{uplift} = 0
V_{uplift} = 0
M_{uplift} = 0

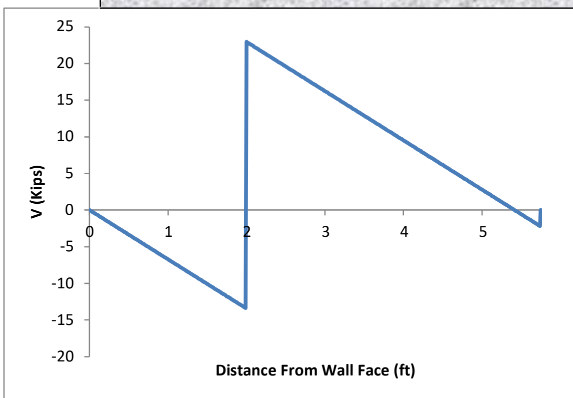
Water Load: w_{uplift} = -0 kips/ft
V_{uplift} = -0 X
M_{uplift} = -0 X² / 2

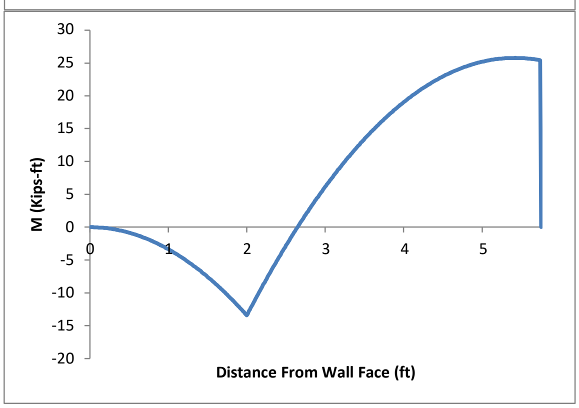
Conc. EQ: w_{EQ} = -0 kips/ft
V_{EQ} = -0 X
M_{EQ} = -0 X² / 2

Pile P2: V_{pile} = 36.4 Kips (after x = 2ft)
M_{pile} = 36.4 (X - 2 ft)

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

Shear and Moment Diagrams





Max Shear	
22.96	kips / tributary width / allowable OS =
3.83 Kips	

Max Top Moment	
-13.44	kips / tributary width / allowable OS =
-2.24 Kips	

Max Bottom Moment	
25.7833	kips / tributary width / allowable OS =
4.30 Kips	

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS KCS-1	Computed by	AML	Date	Dec-20
	Slab Conc. Check	Checked by	JMH	Date	Dec-20
				References	

*** Given Information:**

Slab Thickness:	3.00	ft			
Slab Width:	10.00	ft			
Clear Cover:	0.75	ft			
Diameter Bar to Start:	0.09	ft			
Diameter of Pile:	1.15	ft	Load Fact.		
Maximum Pile Reaction:	48.50	kips	1	48.50	kips
Maximum Shear:	5.40	kips			
Maximum Moment (Top):	2.68	kip-ft			
Maximum Moment (Bottom):	4.86	kip-ft			

φ_{shear} =	0.75	(ACI 318)
φ_{moment} =	0.9	(ACI 318)
$f_{y,\ rebar}$ =	60	ksi
f'_c =	4	ksi

*** Shear Calculations:**

1- Shear Capacity:

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75	
f'_c =	4	ksi
b =	1	ft strip
d =	2.20	ft

φV_c =	30095.3	lbs	
	30.10	kips	** φVc=30.1 ≥ Vu=5.4, **Shear Capacity OK**

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Slab Conc. Check	Checked by	JMH	Date	Dec-20
					References

2- Punching Shear Capacity (ACI 318-14 Table 22.6.5.2):

Vc = minimum value = Eq. a: $4 \times \sqrt{f'_c} \times b_0 \times d$ for $\beta_c < 2.0$

Eq. b: $(2 + (4 / \beta_c)) \times \sqrt{f'_c} \times b_0 \times d$ for $\beta_c > 2.0$

Eq. c: $((\alpha_s \times d) / b_0 + 2) \times \sqrt{f'_c} \times b_0 \times d$ b_0 / d effect based on α_s

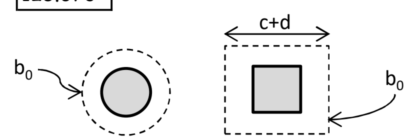
(interior column: α_s = 40, edge column: α_s = 30, corner column: α_s = 20)

d for piles = 26.203 in (Slab thickness - 9" pile embed - cover - $0.5d_{bar}$)

where β_c = Long side / Short side = 1

b_0 = Perimeter of Critical Section = $\pi*(D_{pile} + d)$ = 125.673

α_s = 20 (worst case - corner column)



* For HP piles this b0 gives a conservative results

Vc = minimum value = Eq. a: 833.07 kips

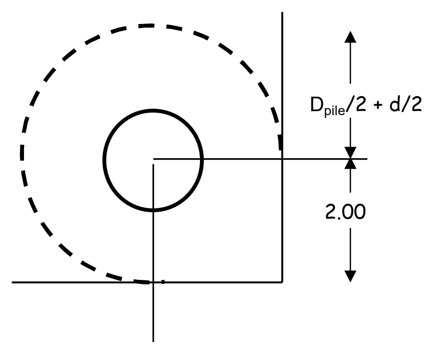
Eq. b: 1249.61 kips

Eq. c: 1285.02 kips

φV_c = 624.81 kips

Check corner pile failure to edge of slab:

$D_{pile}/2+d/2$ = 1.67 ft



Diameter of corner failure = 1.667 + 2 ft

= 3.67 ft

Dia. punching shear calc above = 3.33

Diameter of punching shear calculation is smaller than the diameter of this corner failure area. Therefore, no re-check of corner punching failure is required.

φVc used in design = 30.10 kips

** φVc = 30.1k ≥ Vu = 5.4k, Shear Capacity OK

Maximum Pile Reaction = 48.50

** φVc=625k ≥ Vu=49k, Punching Shear Capacity OK

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS	Computed by	AML	Date	Dec-20
	KCS-1				
	Slab Conc. Check	Checked by	JMH	Date	Dec-20
					References

3- Deep Beam One-Way Shear Capacity (φV_{c1}):

For $(w/d) \geq 1.0$, a one-way (normal) shear investigation with loads outside the critical section (located at a distance d from the face of the column, b = footing width) and

$$v_c = 1.9\sqrt{f'_c} + 2500\rho_w\left(\frac{V_u d}{M_u}\right) \geq 2\sqrt{f'_c} \quad \text{(ACI Eq. 11-5)}$$

which reduces for $\rho_w \approx 0.002$ and 3,000 psi $\leq f'_c \leq$ 4,000 psi to $v_c = 1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}\,(V_u d/M_u) \geq 2\sqrt{f'_c}$.

For $(w/d) < 1.0$, $1.0 > M_u/V_u d > 0$; $\infty > V_u d/M_u \geq 1.0$ (no limits on $M_u, V_u d$, other than above)

$$v_c = \left(\frac{d}{w}\right)\left[3.5 - 2.5\left(\frac{M_u}{V_u d}\right)\right]\left[1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}\left(\frac{V_u d}{M_u}\right)\right] \leq 10\sqrt{f'_c} \quad \text{(ACI Eq. 13-2)}$$

w = 1.0 ft Distance from CL pile to face of Wall + 3" lateral installation tolerance

M_u = 4.86 kip-ft
V_u = 5.40 kips

v_c = 740.7 psi ≤ 10 x √f'c = 632.5 psi limit on shear strength
φV_{c1} = 150.48 kips ** φVc=150.5 ≥ Vu=5.4, OK

Therefore, Slab is OK for shear forces found in slab analysis.

<u>* Reinforcement Calculations:</u>

Limit of Maximum Reinforcement: 0.25 x ρ_b (Design Criteria, EM 1110-2-2104, 3-5)
where ρ_b = 0.0285 for f'$_c$ = 4,000psi, fy = 60,000psi
Max Rebar = 0.00713 *b * d

Maximum Reinforcement: 0.0071 * b * d = 2.26 in^2 per 1ft strip

A_{gross} = 3 ft * 12 in/ft * 12 in strip = 432.00 in^2

Limits of Minimum Reinforcement: 0.003 x Agross =	1.30	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
(3*√(f'$_c$) *b*d)/f$_y$ =	1.00	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)
(200*b*d)/f$_y$ =	1.06	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)

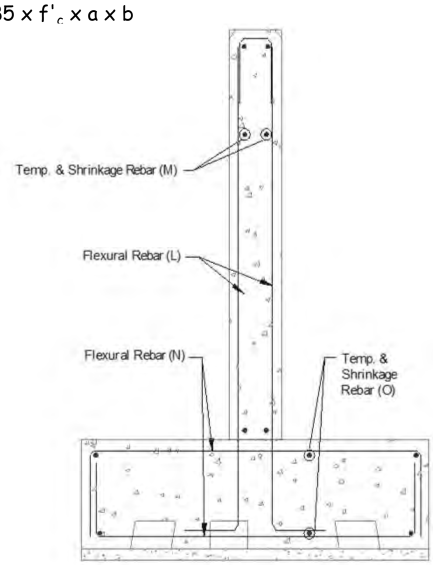
Min Reinforcement, temp & shrinkage:	0.65	in^2	per 1ft strip, per face
Min Reinforcement, flexural:	1.06	in^2	per 1ft strip, per face

AECOM

Job	Maurepas Swamp	Project No.	60632162		
Description	PI-WALL SECTIONS KCS-1	Computed by	AML	Date	Dec-20
	Slab Conc. Check	Checked by	JMH	Date	Dec-20
				References	

* Moment Calculations:

* $T = A_s \times f_y$
* $C = 0.85 \times f'_c \times a \times b$
* Assuming Tension = Compression $\longrightarrow A_s \times f_y = 0.85 \times f'_c \times a \times b$
* $\varphi Mn = \varphi \times T \times (d - (a / 2))$
$= \varphi \times A_s \times f_y \times (d - (a / 2))$



* Capacity of Min Flexural Reinforcement:

A_s =	1.057	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	2.203	
φ_{moment} =	0.9	

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$
= 1.555 in

φM_n =	1465.1	kip-in
=	122.10	kip-ft

* Capacity of Maximum Reinforcement:

*** #7 rebar is used for flexural reinforcement for slab, spacing varies**
*** #7 rebar is used for temp. & shrinkage reinforcement for slab, spacing varies**

A_s =	2.260	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	2.20	
φ_{moment} =	0.9	

Proposed flexural reinforcement: #6@6 (A=0.88 in^2)
Proposed temp. & shrinkage reinforcement: #7@6 (A= 1.20 in^2)

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$
= 3.324 in

φMn =	3023.8	kip-in
=	251.98	kip-ft

** $\varphi Mn=252 \geq Mu=2.7$, Section OK	TOP
** $\varphi Mn=252 \geq Mu=4.9$, Section OK	Bottom

Maurepaus Swamp

T-WALL SECTION

KCS-2 (Represents KCS-4)

AECOM Project : 60632162

Foundation, Wall & Slab

AECOM

1555 Poydras Street

Suite 1200

New Orleans, LA 70112

(504) 586-8111

Computed by:	AML	Checked by:	JMH
Date:	Dec-20	Date:	Dec-20

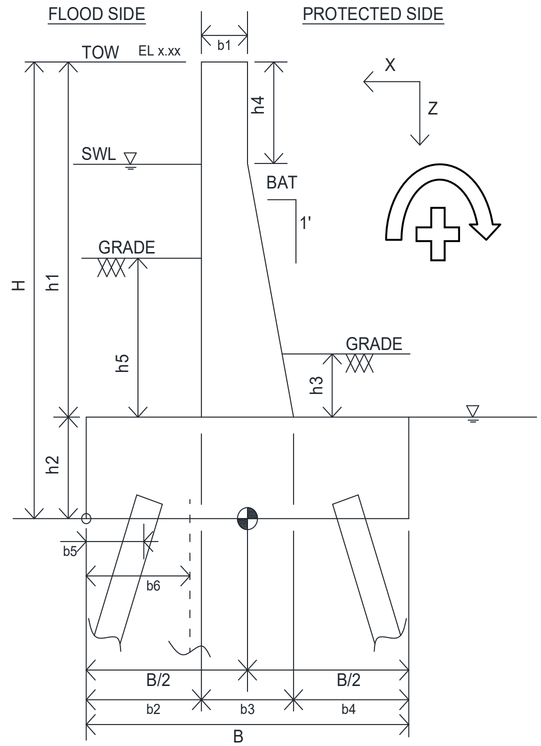
AECOM

Job	Maurepaus Swamp		Project No.	60632162		
Description	T-WALL SECTION		Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)					
	Wall Geometry		Checked by	JMH	Date	Dec-20

References

WALL GEOMETRY:

Top of Wall EL.	16.13	NAVD88
100 Yr. Water El.		NAVD88
10 Yr. Water El.		NAVD88
Top of Slab EL.	10.89	NAVD88
H=	8.24	ft.
h1=	5.24	ft.
h2=	3.00	ft. (Base Slab Height)
h3=	1.90	ft. (P.S. Soil Height)
h4=	0.00	ft.
h5=	1.90	ft. (F.S. Soil Height)
B=	10.00	ft. (Base Slab Width)
b1=	1.50	ft. (Wall Stem Width, top)
b2=	5.75	ft. (F.S. Slab Width)
b3=	1.50	ft. (Wall Stem Width, bottom)
b4=	2.75	ft. (P.S. Slab Width)
b5=	2.00	ft. (F.S. Pile Row Edge Space)
b6=	6.50	ft. (Sheet Pile Edge Space)
BAT=	0.00	(Wall Batter, N/A)
PS Grade =	12.79	NAVD88 (Average of PS soil for all)



T-WALL CROSS-SECTION

Notes: 1) positive 'Y' axis is into page

2) pile batters vary from those shown in diagram

Monolith Length =	18.0	ft
Bottom Of Slab =	7.89	NAVD88

Note: In this report, white boxes are for input data and colored boxes are calculated values.

KCS-2 and KCS-4 have been deemed to be equal and opposite.

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Assumptions	Checked by	JMH	Date	Dec-20

References

Unit Weight of Storm Water =	0.0624	kcf
Wet Unit Weight of Soil =	0.1200	kcf
Sat Unit Weight of Soil =	0.0576	kcf
Unit Weight of Concrete =	0.1500	kcf
Impact Load =	0.0000	k/ft
FS Wind force above SWL=	0.0500	ksf
Construction Surcharge Pressure =	0.2500	ksf
Unbalanced Load for Stability Analysis:		
F_{cap} (k/ft) =	0.00	(10y SWL Case; Force acts at bottom of slab)
F_{cap} (k/ft) =	0.00	(100y SWL Case; Force acts at bottom of slab)
F_{cap} (k/ft) =	0.00	(Water to TOW Case; Force acts at bottom of slab)
K_0, Granular fill =	0.95	(for lateral soil forces)
Assumed Reinforcement Cover =	0.25	ft
Assumed Wall d_{bar} =	0.08	ft

AECOM

Job	**Maurepaus Swamp**	**Project No.**	**60632162**		
Description	**T-WALL SECTION**	**Computed by**	**AML**	**Date**	**Dec-20**
	KCS-2 (Represents KCS-4)				
	Load Cases	**Checked by**	**JMH**	**Date**	**Dec-20**
					References

No. of Load Cases	3	Update

No.	DCD LC No.	Description	FS Water El.	PS Water El.	Pile Design Over Stresses
1	1	Construction Surcharge	7.89	7.89	1.17
2	2a	Water to TOW (impervious cutoff)	16.13	7.89	1.33
3	2b	Water to TOW (pervious cutoff)	16.13	7.89	1.33

* Impact load is not applicable for this section, so it is excluded from the load combinations
* Forces induced by 10y water elevation are not applicable for this section, so they are excluded from the load combinations

*Earthquake and Wave Loads are to be determined and are excluded from these calculations

AECOM

Job Maurepaus Swamp | Project No. 60632162

Description T-WALL SECTION | Computed by AML | Date Dec-20

KCS-2 (Represents KCS-4)

Foundation Load Calculation | Checked by JMH | Date Dec-20

References

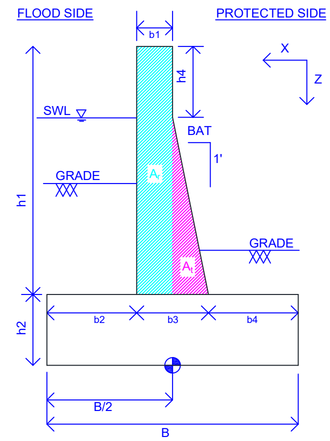
Weight:

Wall stem weight = $[(b_1 \times h_1) + 0.5(h_1-h_4)(b_3-b_1)]\ \gamma_{conc.}$

Wall stem weight = 1.18 (kip/ft)

$X_{cen} = [(A_r \times X_{cen\text{-}Ar}) + (A_t \times X_{cen\text{-}At})]/(A_r + A_t)$

X_{cen} = -1.5



Base slab weight = $h_2 \times B \times \gamma_{conc.}$ =

Base slab weight = 4.5 (kip/ft)

X_{cen} = 0

Soil Force (Dry & Sat.):

	Water EL.	FS Soil EL.	PS Soil EL.
Dry	7.89	12.79	12.79
Top of Wall EL.	16.13	12.79	12.79

F.S. soil weight = $(b_2 \times h_5)\ \gamma_{soil.}$

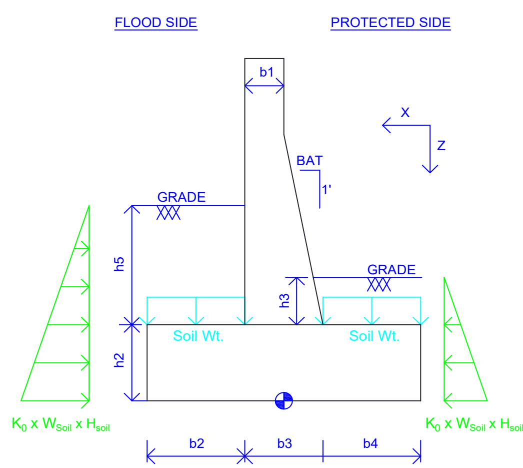
F.S. soil weight = 1.31 (kip/ft) **Dry**

0.63 (kip/ft) **TOW**

$X_{cen} = B/2 - b_2/2$

X_{cen} = 2.13 **Dry**

2.13 **TOW**



P.S. soil weight = $[(b_4 \times h_3) + (BAT \times h_3^2)/2]\ \gamma_{soil.}$

P.S. soil weight = 0.63 (kip/ft) **Dry**

0.63 (kip/ft) **TOW**

$X_{cen} = [(A_r \times X_{cen\text{-}Ar}) + (A_t \times X_{cen\text{-}At})]/(A_r + A_t)$

X_{cen} = -3.63 **Dry**

-3.63 **TOW**

AECOM

Job: Maurepaus Swamp

Project No. 60632162

Description: T-WALL SECTION

KCS-2 (Represents KCS-4)

Foundation Load Calculation

Computed by: AML — Date: Dec-20

Checked by: JMH — Date: Dec-20

References

F.S. soil lat. force = $0.5\ K_0\ \gamma_{soil}\ (h_2 + h_5)^2$

F.S. soil lat. force =	-1.37	(kip/ft)	Dry
	-0.66	(kip/ft)	TOW

$Z_{cen} = (h_2+h_5)/3$

Z_{cen} =	-1.63	Dry
	-1.63	TOW

P.S. soil lat. force = $0.5\ K_0\ \gamma_{soil}\ (h_2 + h_3)^2$

P.S. soil lat. force =	1.37	(kip/ft)	Dry
	1.37	(kip/ft)	TOW

$Z_{cen} = (h_2+h_5)/3$

Z_{cen} =	-1.63	Dry
	-1.63	TOW

Soil Force (SWL):

	Water EL.	FS Soil EL.	PS Soil EL.
100 Yr. Water El.	0	12.79	12.79
10 Yr. Water El.	0	12.79	12.79

F.S. soil weight = $(b_2 \times h_5)\ \gamma_{soil.}$

F.S. soil weight =	1.31	(kip/ft)	100y
		(kip/ft)	10y

$X_{cen} = B/2 - b_2/2$

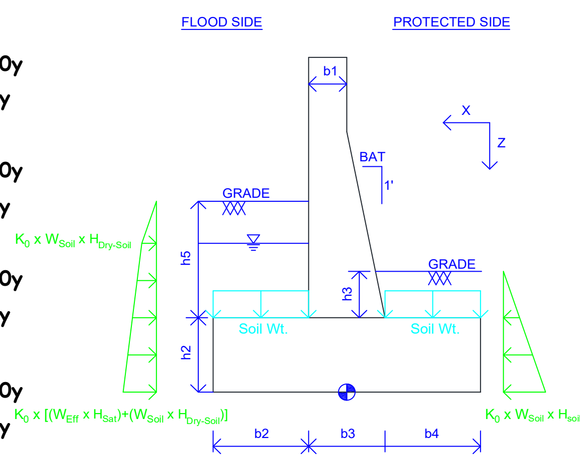
X_{cen} =	2.13	100y
		10y

P.S. soil weight = $[(b_4 \times h_3) + (BAT \times h_3^2)/2]\ \gamma_{soil.}$

P.S. soil weight =	0.63	(kip/ft)	100y
		(kip/ft)	10y

$X_{cen} = [(A_r \times X_{cen\text{-}Ar}) + (A_t \times X_{cen\text{-}At})]/(A_r + A_t)$

X_{cen} =	-3.63	100y
		10y



F.S. soil lat. force = $0.5\ K_0\ \gamma_{soil}\ (h_2 + h_5)^2$

F.S. soil lat. force =	-1.37	(kip/ft)	100y
			10y

$Z_{cen} = (h_2+h_5)/3$

Z_{cen} =	-1.63	100y
		10y

AECOM

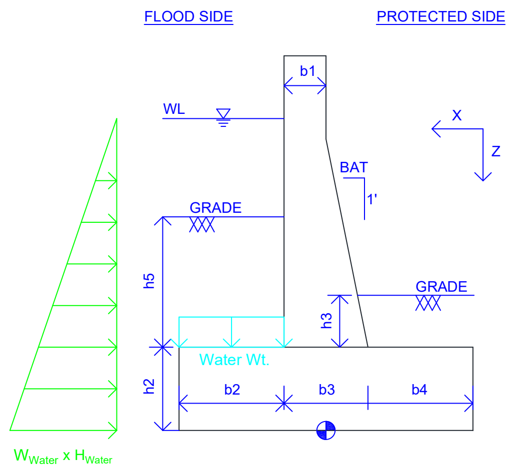
Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Foundation Load Calculation	Checked by	JMH	Date	Dec-20
				References	

P.S. soil lat. force = 0.5 K_0 γ_{soil} $(h_2 + h_3)^2$

P.S. soil lat. force =	1.37	(kip/ft)	100y
		(kip/ft)	10y

Z_{cen} = $(h_2+h_5)/3$

Z_{cen} =	-1.63	100y
		10y



Water Force (SWL & TOW):

	Water EL.
10 Yr. Water El.	0
100 Yr. Water El.	0
Top of Wall EL.	16.13

F.S. water weight = $(b_2 \times H_w)$ γ_{water}

F.S. water weight =		(kip/ft)	10y
	0.00	(kip/ft)	100y
	1.88	(kip/ft)	TOW

X_{cen} = $B/2 - b_2/2$

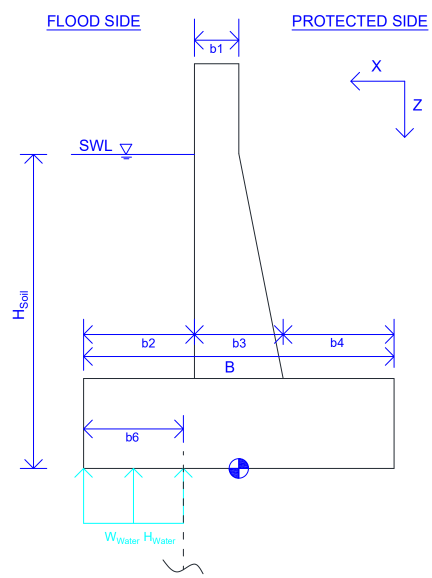
X_{cen} =		10y
	0.00	100y
	2.13	TOW

F.S. water lat. force = 0.5 γ_{water} Hw^2

F.S. water lat. force =		(kip/ft)	10y
	0.00	(kip/ft)	100y
	-2.12	(kip/ft)	TOW

Z_{cen} = $H_w/3$

Z_{cen} =		10y
	2.63	100y
	-2.75	TOW



Impervious uplift Force = $(b_6 \times H_w)$ γ_{water}

Impervious uplift Force =		(kip/ft)	10y
	3.20	(kip/ft)	100y
	-3.34	(kip/ft)	TOW

X_{cen} = $B/2 - b_6/2$

X_{cen} =		10y
	1.75	100y
	1.75	TOW

AECOM

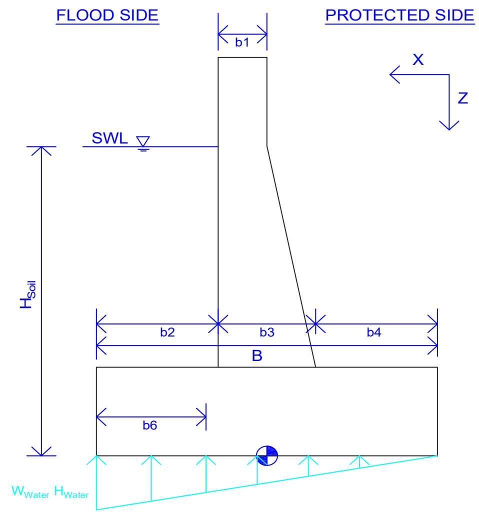
Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Foundation Load Calculation	Checked by	JMH	Date	Dec-20
				References	

Pervious uplift Force = $(b_6 \times H_w)\ \gamma_{water}$

Pervious uplift Force =			10y
	2.46	(kip/ft)	100y
	-2.57	(kip/ft)	TOW

X_{cen} = B/2 - B/3

X_{cen} =	1.67	10y
	1.67	100y
	1.67	TOW



AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Foundation Loads	Checked by	JMH	Date	Dec-20

References

Foundation Loads

Dead Loads:

			X-Cent.
Wall stem weight =	1.18	(kip/ft)	-1.50
Base slab weight =	4.5	(kip/ft)	0.00

Soil Forces:

	Water EL.	FS Soil EL.	PS Soil EL.	Wt. of FS Soil (k/ft)	X-Cent.	Wt. of PS Soil (k/ft)	X-Cent.	FS Soil Lateral Force (k/ft)	Z-Cent.	PS Soil Lateral Force (k/ft)	Z-Cent.
Dry	7.89	12.79	12.79	1.311	2.13	0.627	-3.63	-1.369	-1.63	1.369	-1.63
100 Yr. Water El.	0.0	12.79	12.79	1.311	2.13	0.627	-3.63	-1.369	-1.63	1.369	-1.63
Top of Wall EL.	16.1	12.79	12.79	0.629	2.13	0.627	-3.63	-0.657	-1.63	1.369	-1.63
10 Yr. Water El.	0.0	12.79	12.79	1.311	2.13	0.627	-3.63	-1.369	-1.63	1.369	-1.63

Water Forces:

	Water EL.	Wt. of FS Water (k/ft)	X-Cent.	FS Water Lateral Force (k/ft)	Z-Cent.
100 Yr. Water El.	0.0	0.000	0.00	0.000	2.63
Top of Wall EL.	16.1	1.880	2.13	-2.118	-2.75
10 Yr. Water El.	0.0	0.000	0.00	0.000	2.63

Wind Force:

				Z-Cent.	
0.05 ksf x monolith height =	0.412	k/ft	Construction	-4.12	(Apply to PS)
	-0.167	k/ft	No Water	-6.57	
	-0.807	k/ft	100y SWL	-0.17	
	-0.807	k/ft	10y SWL	-0.17	

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Foundation Loads	Checked by	JMH	Date	Dec-20
				References	

Surcharge Forces:

0.25 ksf * F.S. width =	1.438	k/ft	X_{Cen} =	2.13
0.25 ksf * P.S. width =	0.688	k/ft	X_{Cen} =	-3.63

Unbalanced Load:

100y SWL	0.00	k/ft in (+) X Direction, acting at bottom of slab (Z-coordinate = 0)	Z_{Cen} =	
TOW	0.00	k/ft in (+) X Direction, acting at bottom of slab (Z-coordinate = 0)	Z_{Cen} =	
10y SWL	0.00	k/ft in (+) X Direction, acting at bottom of slab (Z-coordinate = 0)	Z_{Cen} =	

Impact Load:

0.00	k/ft in (-) X Direction, acting at top of wall (Z-coordinate = TOW)	Z_{Cen} =	-8.24

Uplift Loads:

Impervious:

T.O.W. :	-3.34	k/ft	X_{Cen} =	1.75
100 Yr. Water El. :	3.20	k/ft		
10 Yr. Water El. :	3.20	k/ft		

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Foundation Loads	Checked by	JMH	Date	Dec-20

References

Pervious:

T.O.W.	-2.57	k/ft	X_{Cen} =	1.67
100 Yr. Water El.	2.46	k/ft		
10 Yr. Water El. :	2.46	k/ft		

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Shear & Moment Calculation on Wall	Checked by	JMH	Date	Dec-20
				References	

Note: Shear is calculated at distance d from the bottom of the wall

d = wall thickness - cover - (1/2)d_{bar} = 1.21 ft

Elevation of distance d = 12.10 NAVD 88

Soil Force (Dry & Sat.):

	Water EL.	FS Soil EL.	PS Soil EL.
Dry	7.89	12.79	12.79
Top of Wall EL.	16.13	12.79	12.79

F.S. soil lat. force = 0.5 K_0 γ_{soil} $(H_{Soil})^2$

F.S. soil lat. force at d = -0.03 (kip/ft) Dry

-0.01 (kip/ft) TOW

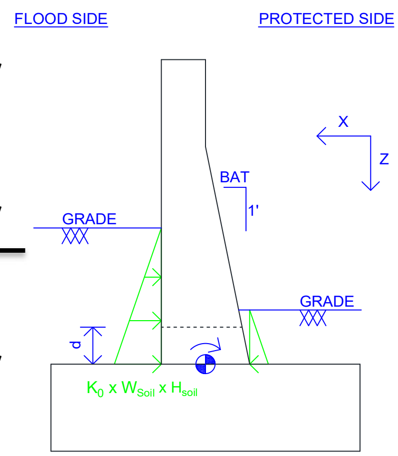
F.S. soil lat. force at bottom of the wall = -0.21 (kip/ft) Dry

-0.10 (kip/ft) TOW

$M = F_{Soil} \times H_{Soil}/3$

M = 0.13 (k-ft/ft) Dry

0.06 (k-ft/ft) TOW



P.S. soil lat. force = 0.5 K_0 γ_{soil} $(H_{Soil})^2$

P.S. soil lat. force at d = 0.03 (kip/ft) Dry

0.03 (kip/ft) TOW

P.S. soil lat. force at bottom of the wall = 0.21 (kip/ft) Dry

0.21 (kip/ft) TOW

$M = F_{Soil} \times H_{Soil}/3$

M = -0.13 (k-ft/ft) Dry

-0.13 (k-ft/ft) TOW

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Shear & Moment Calculation on Wall	Checked by	JMH	Date	Dec-20
				References	

Water Force (SWL & TOW):

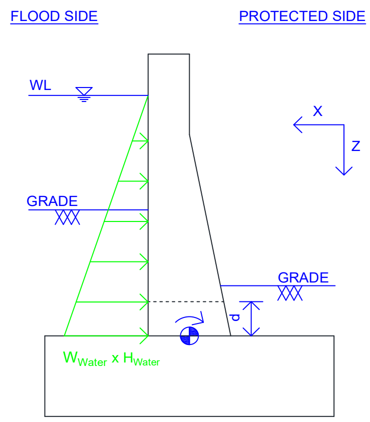
	Water EL.
10 Yr. Water El.	0
100 Yr. Water El.	0
Top of Wall EL.	16.13

F.S. water lat. force = 0.5 γ_{water} Hw^2

F.S. water lat. force at d =		(kip/ft)	10y
	0.00	(kip/ft)	100y
	-0.51	(kip/ft)	TOW
F.S. water force at bottom of the wall =	0.00	(kip/ft)	10y
	0.00	(kip/ft)	100y
	-0.86	(kip/ft)	TOW

$M = F_{Water} \times H_{Water}/3$

M =		(k-ft/ft)	10y
	0.00	(k-ft/ft)	100y
	1.50	(k-ft/ft)	TOW



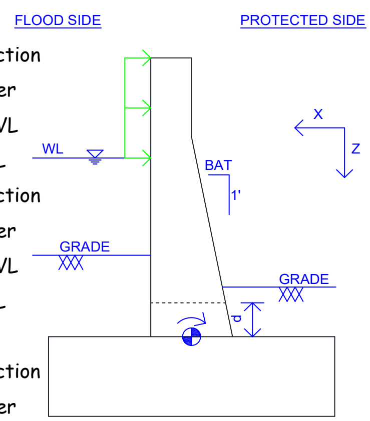
Wind Force:

F.S. wind force = P_{Wind} x Area

F.S. wind force at d =	0.20	(kip/ft)	Construction
	-0.17	(kip/ft)	No Water
	-0.20	(kip/ft)	100y SWL
	-0.20	(kip/ft)	10y SWL
F.S. wind force at bottom of the wall =	0.26	(kip/ft)	Construction
	-0.17	(kip/ft)	No Water
	-0.26	(kip/ft)	100y SWL
	-0.26	(kip/ft)	10y SWL

$M = F_{Wind} \times Z_{cent.}$

M =	-0.69	(k-ft/ft)	Construction
	0.60	(k-ft/ft)	No Water
	0.69	(k-ft/ft)	100y SWL
	0.69	(k-ft/ft)	10y SWL



AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	LC1	Checked by	JMH	Date	Dec-20
				References	

LC1: Construction Surcharge

Loads

Deselect All

Dead Loads:

☑ Wall Stem Wt. ☑ Base Slab Wt.

Soil Forces:

Dry	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
10 Yr. Water El.	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
100 Yr. Water El.	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
Top of Wall EL.	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force

Water Forces:

10 Yr. Water El.	☐ F.S. Water	☐ F.S. Lat. Water
100 Yr. Water El.	☐ F.S. Water	☐ F.S. Lat. Water
Top of Wall EL.	☐ F.S. Water	☐ F.S. Lat. Water

Wind Force:

Construction	☐ P.S. Lat. Wind
No Water	☐ F.S. Lat. Wind
10 Yr. Water El.	☐ F.S. Lat. Wind
100 Yr. Water El.	☐ F.S. Lat. Wind

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	LC1	Checked by	JMH	Date	Dec-20
				References	

Wave Force:

- 10 Yr. Water El. — ☐ F.S. Lat. Wave
- 100 Yr. Water El. — ☐ F.S. Lat. Wave
- Top of Wall EL. — ☐ F.S. Lat. Wave

Earthquake Force:

- MDE — ☐ Soil Ver. MDE ☐ Soil Lat. MDE ☐ Conc. Ver. MDE ☐ Conc. Lat. MDE
- OBE — ☐ Soil Ver. OBE ☐ Soil Lat. OBE ☐ Conc. Ver. OBE ☐ Conc. Lat. OBE

Surcharge Forces:

☑ F.S. Surcharge Force ☑ P.S. Surcharge Force

Unbalanced Load:

- 10 Yr. Water El. — ☐ Lat. Unbalance
- 100 Yr. Water El. — ☐ Lat. Unbalance
- Top of Wall EL. — ☐ Lat. Unbalance

Impact Load:

☐ Lat. Impact force

Uplift Loads:

Impervious
- ☐ 10y SWL Uplift Pressure
- ☐ 100y SWL Uplift
- ☐ TOW Uplift Pressure

Pervious
- ☐ 10y SWL Uplift Pressure
- ☐ 100y SWL Uplift
- ☐ TOW Uplift Pressure

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	LC1	Checked by	JMH	Date	Dec-20
				References	

Fx	Fy	Fz	'X' Centroid	'Y' Centroid	'Z' Centroid	Mx	My	Mz	NOTES:
(kip/ft)	(kip/ft)	(kip/ft)	(ft)	(ft)	(ft)	(kip-ft/ft)	(kip-ft/ft)	(kip-ft/ft)	
0.00	0.00	1.18	-1.50	0.00	0.00	0.00	1.77	0.00	Wall stem weight
0.00	0.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00	Base slab weight
						0.00	0.00	0.00	F.S. soil weight
						0.00	0.00	0.00	P.S. soil weight
						0.00	0.00	0.00	F.S. lateral soil force
						0.00	0.00	0.00	P.S. lateral soil force
						0.00	0.00	0.00	Vertical water force
						0.00	0.00	0.00	Lateral water force
						0.00	0.00	0.00	Wind load
						0.00	0.00	0.00	FS wave load
						0.00	0.00	0.00	Soil Vertical EQ force
						0.00	0.00	0.00	Soil Lateral EQ force
						0.00	0.00	0.00	Con. Vertical EQ force
						0.00	0.00	0.00	Con. Lateral EQ force
0.00	0.00	1.44	2.13	0.00	0.00	0.00	-3.06	0.00	F.S. Surcharge load
0.00	0.00	0.69	-3.63	0.00	0.00	0.00	2.49	0.00	P.S. Surcharge load
						0.00	0.00	0.00	Unbalanced load
						0.00	0.00	0.00	Impact load
						0.00	0.00	0.00	Hydrostatic uplift
0.000	**0.000**	**7.806**				**0.000**	**1.208**	**0.000**	**SUM.**

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	LC1	Checked by	JMH	Date	Dec-20
				References	

Shear and Moment on the Wall

Note: enter load factors

Update

V_u	0.00	(kips/ft)
M_u	0.00	(kips-ft/ft)

Soil Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6		
PS	1.6		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Water Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Wind Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Wave Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Earthquake Force:

Load Factor		Unfact. V	Unfact. M
PS	1.6		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Impact Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	LC2	Checked by	JMH	Date	Dec-20
				References	

LC2: Water to TOW (impervious cutoff)

Loads

Deselect All

Dead Loads:

	☑ Wall Stem Wt.	☑ Base Slab Wt.

Soil Forces:

Dry	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
10 Yr. Water El.	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
100 Yr. Water El.	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
Top of Wall EL.	☑ F.S. Soil Wt.	☑ P.S. Soil Wt.	☑ F.S. Lat. Soil Force	☑ P.S. Lat. Soil Force

Water Forces:

10 Yr. Water El.	☐ F.S. Water	☐ F.S. Lat. Water
100 Yr. Water El.	☐ F.S. Water	☐ F.S. Lat. Water
Top of Wall EL.	☑ F.S. Water	☑ F.S. Lat. Water

Wind Force:

Construction	☐ P.S. Lat. Wind Force
No Water	☐ F.S. Lat. Wind
10 Yr. Water El.	☐ F.S. Lat. Wind
100 Yr. Water El.	☐ F.S. Lat. Wind

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	LC2	Checked by	JMH	Date	Dec-20
				References	

Wave Force:

- 10 Yr. Water El. — ☐ F.S. Lat. Wave
- 100 Yr. Water El. — ☐ F.S. Lat. Wave
- Top of Wall EL. — ☐ F.S. Lat. Wave

Earthquake Force:

- MDE — ☐ Soil Ver. MDE ☐ Soil Lat. MDE ☐ Conc. Ver. MDE ☐ Conc. Lat. MDE
- OBE — ☐ Soil Ver. OBE ☐ Soil Lat. OBE ☐ Conc. Ver. OBE ☐ Conc. Lat. OBE

Surcharge Forces:

☐ F.S. Surcharge Force ☐ P.S. Surcharge Force

Unbalanced Load:

- 10 Yr. Water El. — ☐ Lat. Unbalance
- 100 Yr. Water El. — ☐ Lat. Unbalance
- Top of Wall EL. — ☐ Lat. Unbalance

Impact Load:

☐ Lat. Impact force

Uplift Loads:

Impervious
- ☐ 10y SWL Uplift Pressure
- ☐ 100y SWL Uplift
- ☑ TOW Uplift Pressure

Pervious
- ☐ 10y SWL Uplift Pressure
- ☐ 100y SWL Uplift
- ☐ TOW Uplift Pressure

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	LC2	Checked by	JMH	Date	Dec-20
				References	

Fx	Fy	Fz	'X' Centroid	'Y' Centroid	'Z' Centroid	Mx	My	Mz	NOTES:
(kip/ft)	(kip/ft)	(kip/ft)	(ft)	(ft)	(ft)	(kip-ft/ft)	(kip-ft/ft)	(kip-ft/ft)	
0.00	0.00	1.18	-1.50	0.00	0.00	0.00	1.77	0.00	Wall stem weight
0.00	0.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00	Base slab weight
0.00	0.00	0.63	2.13	0.00	0.00	0.00	-1.34	0.00	F.S. soil weight
0.00	0.00	0.63	-3.63	0.00	0.00	0.00	2.27	0.00	P.S. soil weight
-0.66	0.00	0.00	0.00	0.00	-1.63	0.00	1.07	0.00	F.S. lateral soil force
1.37	0.00	0.00	0.00	0.00	-1.63	0.00	-2.24	0.00	P.S. lateral soil force
0.00	0.00	1.88	2.13	0.00	0.00	0.00	-4.00	0.00	Vertical water force
-2.12	0.00	0.00	0.00	0.00	-2.75	0.00	5.82	0.00	Lateral water force
						0.00	0.00	0.00	Wind load
						0.00	0.00	0.00	FS wave load
						0.00	0.00	0.00	Soil Vertical EQ force
						0.00	0.00	0.00	Soil Lateral EQ force
						0.00	0.00	0.00	Con. Vertical EQ force
						0.00	0.00	0.00	Con. Lateral EQ force
						0.00	0.00	0.00	F.S. Surcharge load
						0.00	0.00	0.00	P.S. Surcharge load
						0.00	0.00	0.00	Unbalanced load
						0.00	0.00	0.00	Impact load
0.00	0.00	-3.34	1.75	0.00	0.00	0.00	5.85	0.00	Hydrostatic uplift
-1.407	**0.000**	**5.474**				**0.000**	**9.215**	**0.000**	**SUM.**

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	LC2	Checked by	JMH	Date	Dec-20
				References	

Shear and Moment on the Wall

Update

V_u	-0.79	(kips/ft)
M_u	2.29	(kips-ft/ft)

Note: enter load factors

Soil Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6	-0.013	0.063
PS	1.6	0.027	-0.130

Factored V & M

V_u =	0.023	(kips/ft)
M_u =	-0.108	(kips-ft/ft)

Water Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6	-0.507	1.496

Factored V & M

V_u =	-0.811	(kips/ft)
M_u =	2.394	(kips-ft/ft)

Wind Force:

Load Factor		Unfact. V	Unfact. M
FS	1		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Wave Force:

Load Factor		Unfact. V	Unfact. M
FS	1		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Earthquake Force:

Load Factor		Unfact. V	Unfact. M
PS	1		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Impact Force:

Load Factor		Unfact. V	Unfact. M
FS	1		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	LC3	Checked by	JMH	Date	Dec-20
					References

LC3: Water to TOW (pervious cutoff)

Loads

Deselect All

Dead Loads:

- [x] Wall Stem Wt.
- [x] Base Slab Wt.

Soil Forces:

Dry	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
10 Yr. Water El.	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
100 Yr. Water El.	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
Top of Wall EL.	☑ F.S. Soil Wt.	☑ P.S. Soil Wt.	☑ F.S. Lat. Soil Force	☑ P.S. Lat. Soil Force

Water Forces:

10 Yr. Water El.	☐ F.S. Water	☐ F.S. Lat. Water
100 Yr. Water El.	☐ F.S. Water	☐ F.S. Lat. Water
Top of Wall EL.	☑ F.S. Water	☑ F.S. Lat. Water

Wind Force:

Construction	☐ P.S. Lat. Wind Force
No Water	☐ F.S. Lat. Wind
10 Yr. Water El.	☐ F.S. Lat. Wind
100 Yr. Water El.	☐ F.S. Lat. Wind

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	LC3	Checked by	JMH	Date	Dec-20
				References	

Wave Force:

10 Yr. Water El. ☐ F.S. Lat. Wave

100 Yr. Water El. ☐ F.S. Lat. Wave

Top of Wall EL. ☐ F.S. Lat. Wave

Earthquake Force:

MDE ☐ Soil Ver. MDE ☐ Soil Lat. MDE ☐ Conc. Ver. MDE ☐ Conc. Lat. MDE

OBE ☐ Soil Ver. OBE ☐ Soil Lat. OBE ☐ Conc. Ver. OBE ☐ Conc. Lat. OBE

Surcharge Forces:

☐ F.S. Surcharge Force ☐ P.S. Surcharge Force

Unbalanced Load:

10 Yr. Water El. ☐ Lat. Unbalance

100 Yr. Water El. ☐ Lat. Unbalance

Top of Wall EL. ☐ Lat. Unbalance

Impact Load:

☐ Lat. Impact force

Uplift Loads:

Impervious
- ☐ 10y SWL Uplift Pressure
- ☐ 100y SWL Uplift
- ☐ TOW Uplift Pressure

Pervious
- ☐ 10y SWL Uplift Pressure
- ☐ 100y SWL Uplift
- ☑ TOW Uplift Pressure

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	LC3	Checked by	JMH	Date	Dec-20
				References	

Fx	Fy	Fz	'X' Centroid	'Y' Centroid	'Z' Centroid	Mx	My	Mz	NOTES:
(kip/ft)	(kip/ft)	(kip/ft)	(ft)	(ft)	(ft)	(kip-ft/ft)	(kip-ft/ft)	(kip-ft/ft)	
0.00	0.00	1.18	-1.50	0.00	0.00	0.00	1.77	0.00	Wall stem weight
0.00	0.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00	Base slab weight
0.00	0.00	0.63	2.13	0.00	0.00	0.00	-1.34	0.00	F.S. soil weight
0.00	0.00	0.63	-3.63	0.00	0.00	0.00	2.27	0.00	P.S. soil weight
-0.66	0.00	0.00	0.00	0.00	-1.63	0.00	1.07	0.00	F.S. lateral soil force
1.37	0.00	0.00	0.00	0.00	-1.63	0.00	-2.24	0.00	P.S. lateral soil force
0.00	0.00	1.88	2.13	0.00	0.00	0.00	-4.00	0.00	Vertical water force
-2.12	0.00	0.00	0.00	0.00	-2.75	0.00	5.82	0.00	Lateral water force
						0.00	0.00	0.00	Wind load
						0.00	0.00	0.00	FS wave load
						0.00	0.00	0.00	Soil Vertical EQ force
						0.00	0.00	0.00	Soil Lateral EQ force
						0.00	0.00	0.00	Con. Vertical EQ force
						0.00	0.00	0.00	Con. Lateral EQ force
						0.00	0.00	0.00	F.S. Surcharge load
						0.00	0.00	0.00	P.S. Surcharge load
						0.00	0.00	0.00	Unbalanced load
						0.00	0.00	0.00	Impact load
0.00	0.00	-2.57	1.67	0.00	0.00	0.00	4.29	0.00	Hydrostatic uplift
-1.407	**0.000**	**6.245**				**0.000**	**7.652**	**0.000**	**SUM.**

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	LC3	Checked by	JMH	Date	Dec-20
				References	

Shear and Moment on the Wall

Update

V_u	-0.79	(kips/ft)
M_u	2.29	(kips-ft/ft)

Note: enter load factors

Soil Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6	-0.013	0.063
PS	1.6	0.027	-0.130

Factored V & M

V_u =	0.023	(kips/ft)
M_u =	-0.108	(kips-ft/ft)

Water Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6	-0.507	1.496

Factored V & M

V_u =	-0.811	(kips/ft)
M_u =	2.394	(kips-ft/ft)

Wind Force:

Load Factor		Unfact. V	Unfact. M
FS	1		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Wave Force:

Load Factor		Unfact. V	Unfact. M
FS	1		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Earthquake Force:

Load Factor		Unfact. V	Unfact. M
PS	1		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Impact Force:

Load Factor		Unfact. V	Unfact. M
FS	1		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

AECOM

Job	Maurepaus Swamp	Project No.	60589133		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Summary of Foundation Loads	Checked by	JMH	Date	Dec-20
					References

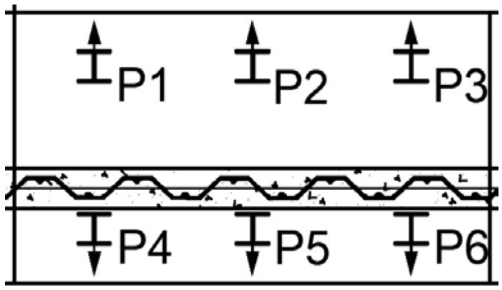
Load Case	Fx (kips)	Fy (kips)	Fz (kips)	Mx (kip-ft)	My (kip-ft)	Mz (kip-ft)
LC1	0.00	0.00	140.51	0.00	21.75	0.00
LC2	-25.32	0.00	98.54	0.00	165.87	0.00
LC3	-25.32	0.00	112.42	0.00	137.73	0.00

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Soil & Pile Information Required for CPGA	Checked by	JMH	Date	Dec-20
					References

Pile Layout: 6 HP Piles

Row 1			Row 2		
pile no.	x	y	pile no.	x	y
1	3.00	-6.00	4	-3.00	-6.00
2	3.00	0.00	5	-3.00	0.00
3	3.00	6.00	6	-3.00	6.00



Tip Elevation: (For CPGA, need Tip Elevation as a function of CPGA Axis at B.O. Slab, +Z points downward)

B.O.S. Elevation =	7.89	NAVD88
Pile Tip EL =	-28	NAVD89
"TIP" in CPGA =	**35.89**	**ft**

Pile Properties & Attributes

E =	29000000.00	psi	
A =	21.40	in^2	HP14X73
I_x =	729.00	in^4	
I_y =	261.00	in^4	
C_{33} =	1.70	(factor for method of axial load transfer from pile to soil; = 1 full tip bearing, = 2 full skin friction)	
S_x =	107.00	in^3	
S_y =	35.80	in^3	
F_y =	50.00	ksi	

Note:All soil properties and pile capacities are taken from 95% submittial for Maurepaus Intake Strcuture

Allowable Compression (AC) =	30.00	kips
Allowable Tension (AT) =	18.00	kips
ACC =	492.66	kips
ATT =	535.00	kips
AM1 =	2972.22	kip-in
AM2 =	994.44	kip-in

AECOM

Job	Maurepaus Swamp	Project No.	60632162
Description	T-WALL SECTION	Computed by AML	Date Dec-20
	KCS-2 (Represents KCS-4)		
	Soil & Pile Information Required for CPGA	Checked by JMH	Date Dec-20
			References

Es Value for CPGA Run:

Monolith width = 18 ft

E_s = 540.40 psi = 0.5404 ksi

GROUP FACTORS	
Pile Spacing in Direction of Loading	From EM1110-2-2906
	D
3B	0.33
4B	0.38
5B	0.45
6B	0.56
7B	0.71
8B	1

Group reduction is based on distance between piles in direction of loading. This includes distance due to battering and is taken over the distance 10 x d_{pile} (point of fixety).

Assume a batter of 6.00

B = d_{pile} = 13.6 in = 1.133 ft

Distance between piles at B.O. Slab = 6.00 ft

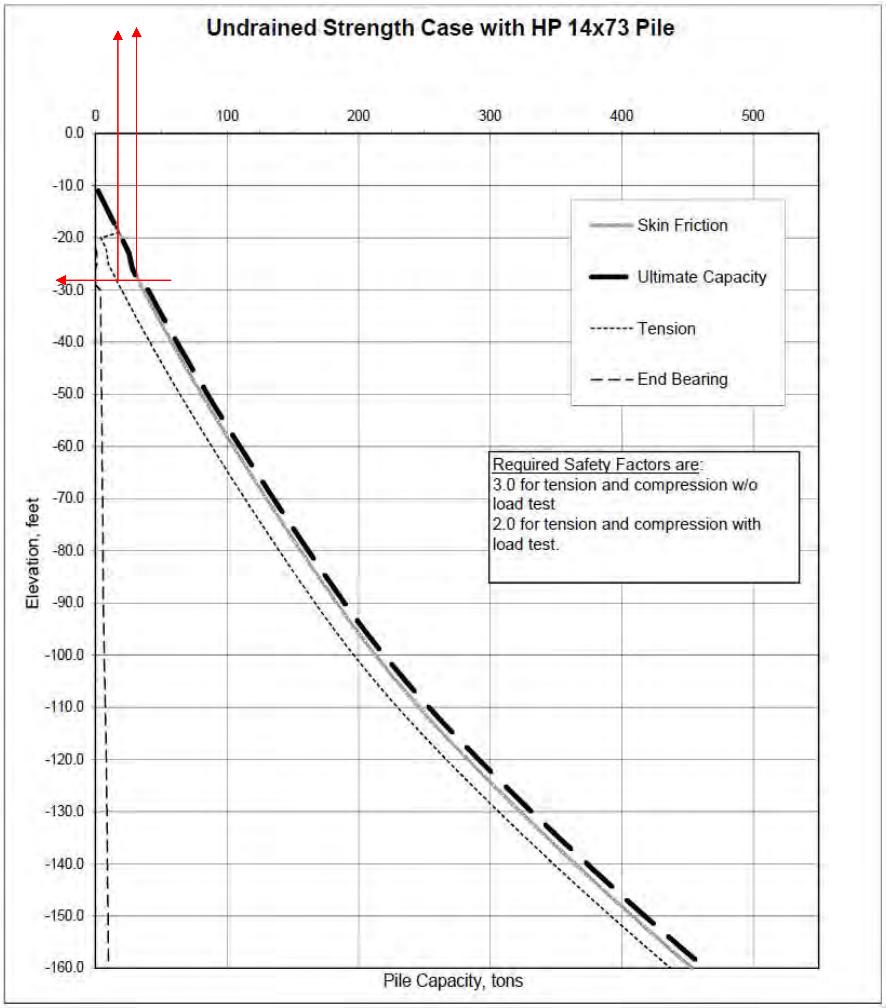
Average distance between piles over 10*dpile = 7.89 ft

Average distance between piles in terms of pile width B = 6.96 B

Group Reduction "D" value for this distance = 0.70

Therefore, Es including group reduction = 0.38 ksi

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Soil & Pile Information Required for CPGA	Checked by	JMH	Date	Dec-20
					References



AECOM

Job	Maurepaus Swamp		Project No.	60632162		
Description	T-WALL SECTION		Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)					
	CPGA Input & Output Files (Pile Analysis)		Checked by	JMH	Date	Dec-20

Input file:

```
100 MONOLITH, TOW EL. 16.13, TOS EL.10.89; HP 14X73  PILES
200 PROP 29000 729 261 21.4 1.7 0 ALL
300 SOIL ES 0.3805 TIP 35.89 0 ALL
400 PIN ALL
500 ALLOW H 30 18 492.7 535 2972.2 994.4 ALL
700 FOVSTR 1.17 1.17 1
800 FOVSTR 1.33 1.33 2 3
900 BATTER 6 All
1200 ANGLE 180 4 TO 6
1400 PILE 1 3 -6 0
1500 PILE 2 3 0 0
1600 PILE 3 3 6 0
1700 PILE 4 -3 -6 0
1800 PILE 5 -3 0 0
1900 PILE 6 -3 6 0
4500 LOAD 1 0 0 140.5 0 21.7 0
4600 LOAD 2 -25.3 0 98.5 0 165.9 0
4700 LOAD 3 -25.3 0 112.4 0 137.7 0
9000 FOUT 1 2 3 4 5 6 7 KCS2P.DOC
9100 PFO ALL
9200 PLB ALL
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

CPGA RESULTS without Load Factors (pinned connection)

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 15-DEC-20     RUN TIME: 10:07:37



    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.10.89; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE   6 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                    X          Y          Z
                                  -----      -----      -----
WITH DIAGONAL COORDINATES = (     -3.00 ,    -6.00 ,     0.00 )
                            (      3.00 ,     6.00 ,     0.00 )


*******************************************************************************

         PILE PROPERTIES AS INPUT


      E            I1           I2            A           C33          B66
     KSI         IN**4        IN**4        IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         SOIL DESCRIPTIONS AS INPUT
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

```
   ES      ESOIL       LENGTH        L            LU
         K/IN**2                    FT            FT
        0.38050E+00     T       0.35890E+02   0.00000E+00

  ESOIL(ORIGINAL)      RGROUP     RCYCLIC
    K/IN**2
   0.38050E+00       0.1000E+01 0.1000E+01

 THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

     ALL


 ******************************************************************************

          PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


  0.17968E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.23229E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.24163E+04  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


 THIS MATRIX APPLIES TO THE FOLLOWING PILES -

       1


 ******************************************************************************

          PILE GEOMETRY AS INPUT AND/OR GENERATED

 NUM         X           Y           Z      BATTER   ANGLE    LENGTH  FIXITY
            FT          FT          FT                          FT

   1       3.00      -6.00        0.00      6.00      0.00     36.39    P
   2       3.00       0.00        0.00      6.00      0.00     36.39    P
   3       3.00       6.00        0.00      6.00      0.00     36.39    P
   4      -3.00      -6.00        0.00      6.00    180.00     36.39    P
   5      -3.00       0.00        0.00      6.00    180.00     36.39    P
   6      -3.00       6.00        0.00      6.00    180.00     36.39    P
                                                              ------
```

```
 218.31


*******************************************************************************

                       APPLIED LOADS

LOAD     PX         PY         PZ          MX          MY           MZ  OVERSTRESS
CASE      K          K          K         FT-K        FT-K         FT-K  COM   TEN

  1       0.0        0.0      140.5         0.0        21.7          0.0 1.17 1.17
  2     -25.3        0.0       98.5         0.0       165.9          0.0 1.33 1.33
  3     -25.3        0.0      112.4         0.0       137.7          0.0 1.33 1.33


*******************************************************************************

         ORIGINAL PILE GROUP STIFFNESS MATRIX

 0.49673E+03 -0.43483E-05  0.34106E-12  0.00000E+00 -0.84008E+05  0.15654E-03
-0.43483E-05  0.13937E+03  0.28394E-04  0.00000E+00  0.10222E-02 -0.34106E-11
 0.56843E-12  0.28394E-04  0.14109E+05  0.00000E+00  0.00000E+00 -0.10222E-02
 0.00000E+00  0.00000E+00  0.00000E+00  0.48761E+08  0.00000E+00 -0.13970E-08
-0.84008E+05  0.10222E-02  0.00000E+00  0.00000E+00  0.18285E+08 -0.36799E-01
 0.15654E-03 -0.34106E-11 -0.10222E-02 -0.13970E-08 -0.36799E-01  0.18973E+07



                     6 PILES    3 LOAD CASES

LOAD CASE    1.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    2.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    3.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.


*******************************************************************************
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

PILE CAP DISPLACEMENTS

LOAD CASE	DX IN	DY IN	DZ IN	RX RAD	RY RAD	RZ RAD
1	0.1080E-01	-0.2160E-08	0.9958E-02	0.1637E-27	0.6385E-04	0.5712E-11
2	-0.1458E+00	-0.1857E-08	0.6981E-02	0.1407E-27	-0.5610E-03	0.4910E-11
3	-0.1598E+00	-0.1887E-08	0.7967E-02	0.1429E-27	-0.6440E-03	0.4989E-11

****

ELASTIC CENTER INFORMATION

ELASTIC CENTER IN PLANE X-Z	X FT	Z FT
	0.00	0.00

****

PILE FORCES IN LOCAL GEOMETRY

M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
* INDICATES PILE FAILURE
# INDICATES CBF BASED ON MOMENTS DUE TO
(F3*EMIN) FOR CONCRETE PILES
B INDICATES BUCKLING CONTROLS

LOAD CASE - 1

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	0.2	0.0	22.5	0.0	-5.1	0.0	0.64	0.04
2	0.2	0.0	22.5	0.0	-5.1	0.0	0.64	0.04
3	0.2	0.0	22.5	0.0	-5.1	0.0	0.64	0.04
4	-0.2	0.0	24.9	0.0	6.9	0.0	0.71	0.05
5	-0.2	0.0	24.9	0.0	6.9	0.0	0.71	0.05
6	-0.2	0.0	24.9	0.0	6.9	0.0	0.71	0.05

AECOM

Job	Maurepaus Swamp		Project No.	60632162		
Description	T-WALL SECTION		Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)					
	CPGA Input & Output Files (Pile Analysis)		Checked by	JMH	Date	Dec-20

LOAD CASE - 2

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	-2.7	0.0	6.9	0.0	81.0	0.0	0.17	0.07
2	-2.7	0.0	6.9	0.0	81.0	0.0	0.17	0.07
3	-2.7	0.0	6.9	0.0	81.0	0.0	0.17	0.07
4	2.6	0.0	26.4	0.0	-79.8	0.0	0.66	0.10
5	2.6	0.0	26.4	0.0	-79.8	0.0	0.66	0.10
6	2.6	0.0	26.4	0.0	-79.8	0.0	0.66	0.10

LOAD CASE - 3

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	-2.9	0.0	10.7	0.0	89.0	0.0	0.27	0.08
2	-2.9	0.0	10.7	0.0	89.0	0.0	0.27	0.08
3	-2.9	0.0	10.7	0.0	89.0	0.0	0.27	0.08
4	2.9	0.0	27.2	0.0	-87.5	0.0	0.68	0.11
5	2.9	0.0	27.2	0.0	-87.5	0.0	0.68	0.11
6	2.9	0.0	27.2	0.0	-87.5	0.0	0.68	0.11

****

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	3.9	0.0	22.2	0.0	0.0	0.0
2	3.9	0.0	22.2	0.0	0.0	0.0
3	3.9	0.0	22.2	0.0	0.0	0.0
4	-3.9	0.0	24.6	0.0	0.0	0.0
5	-3.9	0.0	24.6	0.0	0.0	0.0
6	-3.9	0.0	24.6	0.0	0.0	0.0

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

LOAD CASE - 2

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-1.5	0.0	7.2	0.0	0.0	0.0
2	-1.5	0.0	7.2	0.0	0.0	0.0
3	-1.5	0.0	7.2	0.0	0.0	0.0
4	-6.9	0.0	25.6	0.0	0.0	0.0
5	-6.9	0.0	25.6	0.0	0.0	0.0
6	-6.9	0.0	25.6	0.0	0.0	0.0

LOAD CASE - 3

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-1.1	0.0	11.1	0.0	0.0	0.0
2	-1.1	0.0	11.1	0.0	0.0	0.0
3	-1.1	0.0	11.1	0.0	0.0	0.0
4	-7.3	0.0	26.4	0.0	0.0	0.0
5	-7.3	0.0	26.4	0.0	0.0	0.0
6	-7.3	0.0	26.4	0.0	0.0	0.0

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

CPGA RESULTS without Load Factors (fixed connection)

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 15-DEC-20     RUN TIME: 10:08:14



    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.10.89; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE   6 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                   X          Y          Z
                                 -----      -----      -----
WITH DIAGONAL COORDINATES = (     -3.00 ,    -6.00 ,     0.00 )
                            (      3.00 ,     6.00 ,     0.00 )


******************************************************************************

         PILE PROPERTIES AS INPUT


      E           I1           I2           A           C33          B66
     KSI         IN**4        IN**4        IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

```
******************************************************************************

         SOIL DESCRIPTIONS AS INPUT


   ES      ESOIL       LENGTH        L            LU
         K/IN**2                     FT           FT
        0.38050E+00     T       0.35890E+02   0.00000E+00

 ESOIL(ORIGINAL)      RGROUP      RCYCLIC
   K/IN**2
  0.38050E+00       0.1000E+01 0.1000E+01

THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

    ALL


******************************************************************************

         PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


 0.35937E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.16971E+04  0.00000E+00
 0.00000E+00  0.46458E+02  0.00000E+00 -0.28362E+04  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.24163E+04  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00 -0.28362E+04  0.00000E+00  0.34630E+06  0.00000E+00  0.00000E+00
 0.16971E+04  0.00000E+00  0.00000E+00  0.00000E+00  0.16028E+06  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

```
THIS MATRIX APPLIES TO THE FOLLOWING PILES -

     1


*****************************************************************************

        PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM        X          Y          Z     BATTER   ANGLE   LENGTH  FIXITY
          FT         FT         FT                       FT

  1       3.00      -6.00       0.00     6.00     0.00   36.39    F
  2       3.00       0.00       0.00     6.00     0.00   36.39    F
  3       3.00       6.00       0.00     6.00     0.00   36.39    F
  4      -3.00      -6.00       0.00     6.00   180.00   36.39    F
  5      -3.00       0.00       0.00     6.00   180.00   36.39    F
  6      -3.00       6.00       0.00     6.00   180.00   36.39    F
                                                        ------
 218.31


*****************************************************************************

                        APPLIED LOADS

LOAD     PX         PY         PZ          MX           MY          MZ  OVERSTRESS
CASE      K          K          K         FT-K         FT-K        FT-K  COM    TEN

  1       0.0        0.0      140.5         0.0         21.7         0.0 1.17 1.17
  2     -25.3        0.0       98.5         0.0        165.9         0.0 1.33 1.33
  3     -25.3        0.0      112.4         0.0        137.7         0.0 1.33 1.33


*****************************************************************************
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

```
        ORIGINAL PILE GROUP STIFFNESS MATRIX

 0.60163E+03 -0.39288E-05  0.22737E-12 -0.82036E-04 -0.73334E+05  0.10740E-03
-0.39288E-05  0.27875E+03  0.28182E-04 -0.16786E+05  0.10966E-02 -0.18190E-11
 0.45475E-12  0.28182E-04  0.14112E+05  0.20369E-04 -0.29104E-10 -0.10145E-02
-0.82036E-04 -0.16786E+05  0.20369E-04  0.50793E+08 -0.12164E-01 -0.13970E-08
-0.73334E+05  0.10966E-02 -0.29104E-10 -0.12164E-01  0.19371E+08 -0.43577E-01
 0.10740E-03 -0.13642E-11 -0.10145E-02 -0.13970E-08 -0.43577E-01  0.26981E+07



                    6 PILES   3 LOAD CASES

LOAD CASE    1.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    2.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    3.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.


*******************************************************************************

        PILE CAP DISPLACEMENTS

LOAD
CASE       DX          DY          DZ          RX          RY          RZ
           IN          IN          IN          RAD         RAD         RAD

   1   0.3043E-02 -0.1083E-08  0.9956E-02 -0.3510E-12  0.2496E-04  0.4026E-11
   2  -0.5482E-01 -0.1095E-08  0.6980E-02 -0.4783E-12 -0.1048E-03  0.3115E-11
   3  -0.5878E-01 -0.1124E-08  0.7965E-02 -0.5025E-12 -0.1372E-03  0.3118E-11


*******************************************************************************
             ELASTIC CENTER INFORMATION



ELASTIC CENTER IN PLANE X-Z         X             Z
                                   FT            FT
                                  0.00          0.00


*******************************************************************************
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

```
         PILE FORCES IN LOCAL GEOMETRY

             M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
             * INDICATES PILE FAILURE
             # INDICATES CBF BASED ON MOMENTS DUE TO
                         (F3*EMIN) FOR CONCRETE PILES
             B INDICATES BUCKLING CONTROLS



 LOAD CASE -    1

 PILE    F1      F2      F3        M1        M2        M3   ALF  CBF
          K       K       K      IN-K      IN-K      IN-K

   1     0.1     0.0    22.8       0.0       6.6       0.0 0.65 0.05
   2     0.1     0.0    22.8       0.0       6.6       0.0 0.65 0.05
   3     0.1     0.0    22.8       0.0       6.6       0.0 0.65 0.05
   4    -0.2     0.0    24.7       0.0     -12.1       0.0 0.70 0.05
   5    -0.2     0.0    24.7       0.0     -12.1       0.0 0.70 0.05
   6    -0.2     0.0    24.7       0.0     -12.1       0.0 0.70 0.05


 LOAD CASE -    2

 PILE    F1      F2      F3        M1        M2        M3   ALF  CBF
          K       K       K      IN-K      IN-K      IN-K

   1    -2.2     0.0     3.8       0.0    -111.6       0.0 0.10 0.09
   2    -2.2     0.0     3.8       0.0    -111.6       0.0 0.10 0.09
   3    -2.2     0.0     3.8       0.0    -111.6       0.0 0.10 0.09
   4     2.1     0.0    29.4       0.0     107.7       0.0 0.74 0.13
   5     2.1     0.0    29.4       0.0     107.7       0.0 0.74 0.13
   6     2.1     0.0    29.4       0.0     107.7       0.0 0.74 0.13


 LOAD CASE -    3

 PILE    F1      F2      F3        M1        M2        M3   ALF  CBF
          K       K       K      IN-K      IN-K      IN-K

   1    -2.4     0.0     7.4       0.0    -124.0       0.0 0.19 0.11
   2    -2.4     0.0     7.4       0.0    -124.0       0.0 0.19 0.11
   3    -2.4     0.0     7.4       0.0    -124.0       0.0 0.19 0.11
   4     2.3     0.0    30.6       0.0     119.5       0.0 0.77 0.14
   5     2.3     0.0    30.6       0.0     119.5       0.0 0.77 0.14
   6     2.3     0.0    30.6       0.0     119.5       0.0 0.77 0.14


 ******************************************************************************

         PILE FORCES IN GLOBAL GEOMETRY
```

Job	Maurepaus Swamp		Project No.	60632162		
Description	T-WALL SECTION		Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)					
	CPGA Input & Output Files (Pile Analysis)		Checked by	JMH	Date	Dec-20

LOAD CASE - 1

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	3.8	0.0	22.5	0.0	6.6	0.0
2	3.8	0.0	22.5	0.0	6.6	0.0
3	3.8	0.0	22.5	0.0	6.6	0.0
4	-3.8	0.0	24.4	0.0	12.1	0.0
5	-3.8	0.0	24.4	0.0	12.1	0.0
6	-3.8	0.0	24.4	0.0	12.1	0.0

LOAD CASE - 2

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-1.5	0.0	4.2	0.0	-111.6	0.0
2	-1.5	0.0	4.2	0.0	-111.6	0.0
3	-1.5	0.0	4.2	0.0	-111.6	0.0
4	-6.9	0.0	28.7	0.0	-107.7	0.0
5	-6.9	0.0	28.7	0.0	-107.7	0.0
6	-6.9	0.0	28.7	0.0	-107.7	0.0

LOAD CASE - 3

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-1.1	0.0	7.7	0.0	-124.0	0.0
2	-1.1	0.0	7.7	0.0	-124.0	0.0
3	-1.1	0.0	7.7	0.0	-124.0	0.0
4	-7.3	0.0	29.8	0.0	-119.5	0.0
5	-7.3	0.0	29.8	0.0	-119.5	0.0
6	-7.3	0.0	29.8	0.0	-119.5	0.0

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	CPGA Input & Output Files (Concrete Design)	Checked by	JMH	Date	Dec-20

Input file:

```
100 MONOLITH, TOW EL. 16.13, TOS EL.10.89; HP 14X73  PILES
200 PROP 29000 729 261 21.4 1.7 0 ALL
300 SOIL ES 0.3805 TIP 35.89 0 ALL
400 PIN ALL
500 ALLOW H 30 18 492.7 535 2972.2 994.4 ALL
700 FOVSTR 1 1 1
800 FOVSTR 1 1 2 3
900 BATTER 6 All
1200 ANGLE 180 4 TO 6
1400 PILE 1 3 -6 0
1500 PILE 2 3 0 0
1600 PILE 3 3 6 0
1700 PILE 4 -3 -6 0
1800 PILE 5 -3 0 0
1900 PILE 6 -3 6 0
4500 LOAD 1 0 0 224.8 0 34.8 0
4600 LOAD 2 -40.5 0 157.7 0 265.4 0
4700 LOAD 3 -40.5 0 179.9 0 220.4 0
9000 FOUT 1 2 3 4 5 6 7 KCS2SC.DOC
9100 PFO ALL
9200 PLB ALL
```

Job	Maurepaus Swamp		Project No.	60632162		
Description	T-WALL SECTION		Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)					
	CPGA Input & Output Files (Concrete Design)		Checked by	JMH	Date	Dec-20

CPGA RESULTS with Load Factors

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 15-DEC-20     RUN TIME: 10:08:53



    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.10.89; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE   6 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                   X          Y          Z
                                 -----      -----      -----
WITH DIAGONAL COORDINATES = (     -3.00 ,    -6.00 ,     0.00 )
                            (      3.00 ,     6.00 ,     0.00 )


******************************************************************************

         PILE PROPERTIES AS INPUT


      E           I1           I2            A           C33           B66
     KSI         IN**4        IN**4        IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


******************************************************************************
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	CPGA Input & Output Files (Concrete Design)	Checked by	JMH	Date	Dec-20

```
         SOIL DESCRIPTIONS AS INPUT


   ES     ESOIL      LENGTH       L            LU
         K/IN**2                 FT            FT
        0.38050E+00    T      0.35890E+02   0.00000E+00

 ESOIL(ORIGINAL)      RGROUP     RCYCLIC
   K/IN**2
  0.38050E+00       0.1000E+01 0.1000E+01

THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


 0.17968E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.23229E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.24163E+04  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


THIS MATRIX APPLIES TO THE FOLLOWING PILES -

      1


*******************************************************************************

         PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM        X          Y          Z      BATTER   ANGLE   LENGTH  FIXITY
          FT         FT         FT                        FT

  1       3.00      -6.00       0.00      6.00     0.00   36.39    P
  2       3.00       0.00       0.00      6.00     0.00   36.39    P
  3       3.00       6.00       0.00      6.00     0.00   36.39    P
  4      -3.00      -6.00       0.00      6.00   180.00   36.39    P
  5      -3.00       0.00       0.00      6.00   180.00   36.39    P
  6      -3.00       6.00       0.00      6.00   180.00   36.39    P
                                                         ------
 218.31
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	CPGA Input & Output Files (Concrete Design)	Checked by	JMH	Date	Dec-20

```
******************************************************************************

                        APPLIED LOADS

LOAD     PX         PY         PZ          MX          MY          MZ
CASE      K          K          K         FT-K        FT-K        FT-K

  1       0.0        0.0      224.8         0.0        34.8         0.0
  2     -40.5        0.0      157.7         0.0       265.4         0.0
  3     -40.5        0.0      179.9         0.0       220.4         0.0


******************************************************************************

         ORIGINAL PILE GROUP STIFFNESS MATRIX

 0.49673E+03 -0.43483E-05  0.34106E-12  0.00000E+00 -0.84008E+05  0.15654E-03
-0.43483E-05  0.13937E+03  0.28394E-04  0.00000E+00  0.10222E-02 -0.34106E-11
 0.56843E-12  0.28394E-04  0.14109E+05  0.00000E+00  0.00000E+00 -0.10222E-02
 0.00000E+00  0.00000E+00  0.00000E+00  0.48761E+08  0.00000E+00 -0.13970E-08
-0.84008E+05  0.10222E-02  0.00000E+00  0.00000E+00  0.18285E+08 -0.36799E-01
 0.15654E-03 -0.34106E-11 -0.10222E-02 -0.13970E-08 -0.36799E-01  0.18973E+07


                      6 PILES    3 LOAD CASES

LOAD CASE    1.  NUMBER OF FAILURES =   6.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    2.  NUMBER OF FAILURES =   3.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    3.  NUMBER OF FAILURES =   3.  NUMBER OF PILES IN TENSION =   0.


******************************************************************************
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	CPGA Input & Output Files (Concrete Design)	Checked by	JMH	Date	Dec-20

PILE CAP DISPLACEMENTS

LOAD CASE	DX IN	DY IN	DZ IN	RX RAD	RY RAD	RZ RAD
1	0.1732E-01	-0.3457E-08	0.1593E-01	0.2619E-27	0.1024E-03	0.9141E-11
2	-0.2335E+00	-0.2972E-08	0.1118E-01	0.2251E-27	-0.8986E-03	0.7858E-11
3	-0.2559E+00	-0.3020E-08	0.1275E-01	0.2288E-27	-0.1031E-02	0.7986E-11

****

ELASTIC CENTER INFORMATION

ELASTIC CENTER IN PLANE X-Z	X	Z
	FT	FT
	0.00	0.00

****

PILE FORCES IN LOCAL GEOMETRY

M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
* INDICATES PILE FAILURE
# INDICATES CBF BASED ON MOMENTS DUE TO
(F3*EMIN) FOR CONCRETE PILES
B INDICATES BUCKLING CONTROLS

LOAD CASE - 1

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF	
1	0.3	0.0	36.1	0.0	-8.2	0.0	1.20	0.08	*
2	0.3	0.0	36.1	0.0	-8.2	0.0	1.20	0.08	*
3	0.3	0.0	36.1	0.0	-8.2	0.0	1.20	0.08	*
4	-0.4	0.0	39.9	0.0	11.1	0.0	1.33	0.09	*
5	-0.4	0.0	39.9	0.0	11.1	0.0	1.33	0.09	*
6	-0.4	0.0	39.9	0.0	11.1	0.0	1.33	0.09	*

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	CPGA Input & Output Files (Concrete Design)	Checked by	JMH	Date	Dec-20

LOAD CASE - 2

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF	
	K	K	K	IN-K	IN-K	IN-K			
1	-4.3	0.0	11.0	0.0	129.8	0.0	0.37	0.15	
2	-4.3	0.0	11.0	0.0	129.8	0.0	0.37	0.15	
3	-4.3	0.0	11.0	0.0	129.8	0.0	0.37	0.15	
4	4.2	0.0	42.3	0.0	-127.8	0.0	1.41	0.21	*
5	4.2	0.0	42.3	0.0	-127.8	0.0	1.41	0.21	*
6	4.2	0.0	42.3	0.0	-127.8	0.0	1.41	0.21	*

LOAD CASE - 3

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF	
	K	K	K	IN-K	IN-K	IN-K			
1	-4.7	0.0	17.2	0.0	142.4	0.0	0.57	0.18	
2	-4.7	0.0	17.2	0.0	142.4	0.0	0.57	0.18	
3	-4.7	0.0	17.2	0.0	142.4	0.0	0.57	0.18	
4	4.6	0.0	43.6	0.0	-140.1	0.0	1.45	0.23	*
5	4.6	0.0	43.6	0.0	-140.1	0.0	1.45	0.23	*
6	4.6	0.0	43.6	0.0	-140.1	0.0	1.45	0.23	*

****

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	6.2	0.0	35.5	0.0	0.0	0.0
2	6.2	0.0	35.5	0.0	0.0	0.0
3	6.2	0.0	35.5	0.0	0.0	0.0
4	-6.2	0.0	39.4	0.0	0.0	0.0
5	-6.2	0.0	39.4	0.0	0.0	0.0
6	-6.2	0.0	39.4	0.0	0.0	0.0

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	CPGA Input & Output Files (Concrete Design)	Checked by	JMH	Date	Dec-20

LOAD CASE - 2

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-2.4	0.0	11.5	0.0	0.0	0.0
2	-2.4	0.0	11.5	0.0	0.0	0.0
3	-2.4	0.0	11.5	0.0	0.0	0.0
4	-11.1	0.0	41.0	0.0	0.0	0.0
5	-11.1	0.0	41.0	0.0	0.0	0.0
6	-11.1	0.0	41.0	0.0	0.0	0.0

LOAD CASE - 3

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-1.8	0.0	17.7	0.0	0.0	0.0
2	-1.8	0.0	17.7	0.0	0.0	0.0
3	-1.8	0.0	17.7	0.0	0.0	0.0
4	-11.7	0.0	42.2	0.0	0.0	0.0
5	-11.7	0.0	42.2	0.0	0.0	0.0
6	-11.7	0.0	42.2	0.0	0.0	0.0

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Summary of Shear & Moment	Checked by	JMH	Date	Dec-20
					References

Load Case	$V_{u,max}$ (kip/ft)	$M_{u,max}$ (kip/ft)
LC1	0.00	0.00
LC2	-0.79	2.29
LC3	-0.79	2.29

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Shear & Moment Check for Wall	Checked by	JMH	Date	Dec-20
					References

*** Given Information:**

Wall Thickness:	1.50	ft
Clear Cover:	0.25	ft
Diameter Bar to Start:	0.08	ft
Maximum Shear (V_u):	0.79	kips per foot
Maximum Moment (M_u):	2.29	kip-ft per foot
φ_{shear} =	0.75	(ACI 318)
φ_{moment} =	0.9	(ACI 318)
$f_{y,\ rebar}$ =	60	ksi
f'_c =	4	ksi

*** Shear Calculations:**

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u) (ACI Eq. 11-1)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75	
f'_c =	4	ksi
b =	1	ft strip
d =	1.21	ft

φV_c =	16507.1	lbs	
	16.51	kips	** φVc=16.5 ≥ Vu=0.8, **Shear Capacity OK**

*** Reinforcement Calculations:**

Limit of Maximum Reinforcement: 0.25 x ρ_b (Design Criteria, EM 1110-2-2104, 3-5)

where ρ_b =	0.0285	for f'_c = 4,000psi, fy = 60,000psi
Max Rebar =	0.00713	*b * d

Maximum Reinforcement:	0.0071	* b * d =	1.24	in^2	per 1ft strip

A_{gross} = 1.5 ft * 12 in/ft * 12 in strip = 216.00 in^2

Limits of Minimum Reinforcement:	0.003 x Agross =	0.65	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
	$(3*\sqrt{(f'_c)}*b*d)/f_y$ =	0.55	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)
	$(200*b*d)/f_y$ =	0.58	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)

Min Reinforcement, temp & shrinkage:	0.32	in^2	per 1ft strip, per face
Min Reinforcement, flexural:	0.58	in^2	per 1ft strip, per face

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Shear & Moment Check for Wall	Checked by	JMH	Date	Dec-20
				References	

* Moment Calculations:

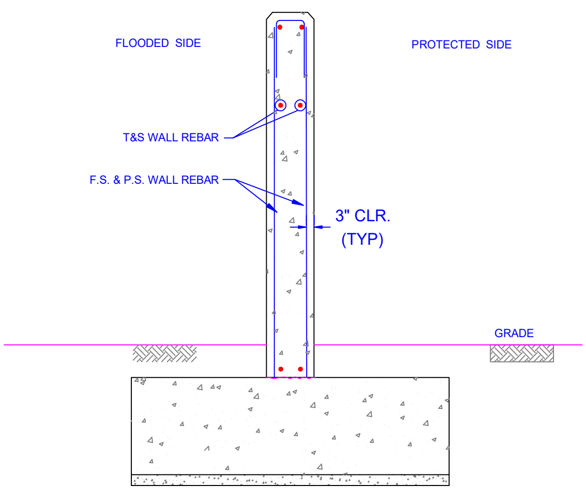
* $T = A_s \times f_y$
* $C = 0.85 \times f'_c \times a \times b$
* Assuming Tension = Compression ⟶ $A_s \times f_y = 0.85 \times f'_c \times a \times b$
* $\varphi Mn = \varphi \times T \times (d - (a / 2))$
  $= \varphi \times A_s \times f_y \times (d - (a / 2))$

* Capacity of Min Flexural Reinforcement:

A_s =	0.580	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	1.20833	
φ_{moment} =	0.9	

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$
= 0.853 in

φM_n =	440.8	kip-in
=	36.73	kip-ft



* Capacity of Maximum Reinforcement:

A_s =	1.240	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	1.21	
φ_{moment} =	0.9	

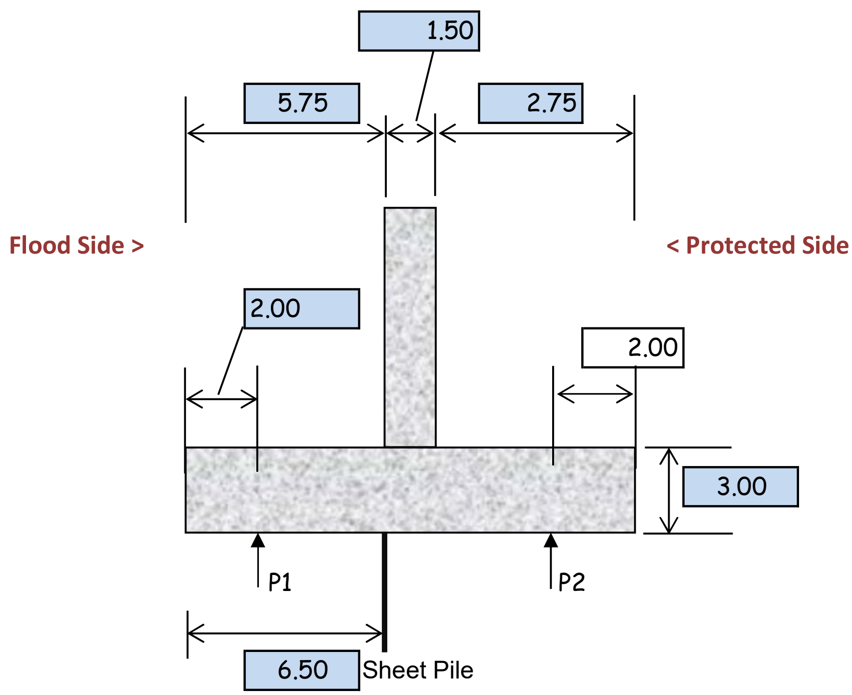
a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$
= 1.823 in

φMn =	909.7	kip-in
=	75.81	kip-ft

**** $\varphi Mn = 75.8 \geq Mu = 2.3$, Section OK**

The minimum proposed reinforcement for T&S Wall Rebar is #6 @ 9" (A = 0.59 in^2) and the minimum proposed reinforcement for F.S. & P.S. Wall Rebar is #6 @ 9"(A=0.59 in^2).

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Slab	Checked by	JMH	Date	Dec-20
					References

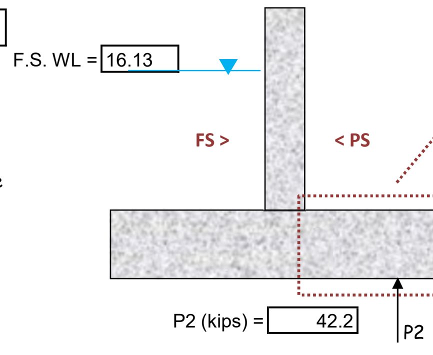


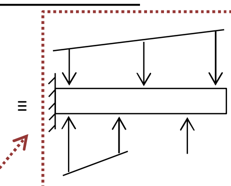
Tributary width (pile spacing): 6 ft Referred to as "width" in calculations

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

Load Case: 3

Analysis of Protected Side of Slab:

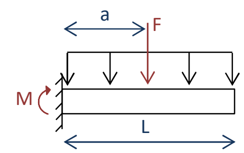




* Here the shear and moment diagrams for the protected side of the slab are presented. The protected side of the slab is considered as a cantilever beam fixed at the face of the wall in protected side.

Allowable Overstress: %

	Formula	Value		Load Fac.			L	F (kips)	F x a = M (k-ft)
Self Weight:	$\gamma_{concrete}$ x H_{slab} x $Width_{Tributary}$ =	2.70	x	1.6	4.32	kips/ft	x 2.75 ft =	11.88	16.34
Soil Load:	γ_{soil} x H_{soil} x Width =	1.37	x	1.6	2.19	kips/ft	x 2.75 ft =	6.02	8.28
Const. Surcharge Load:	Surcharge pressure x Width =		x	1	0.00	kips/ft	x 2.75 ft =	0.00	0.00

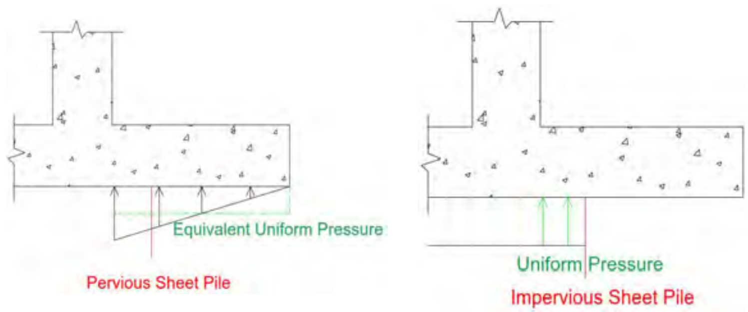


AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

Uplift: ☑ Pervious ☐ Impervio

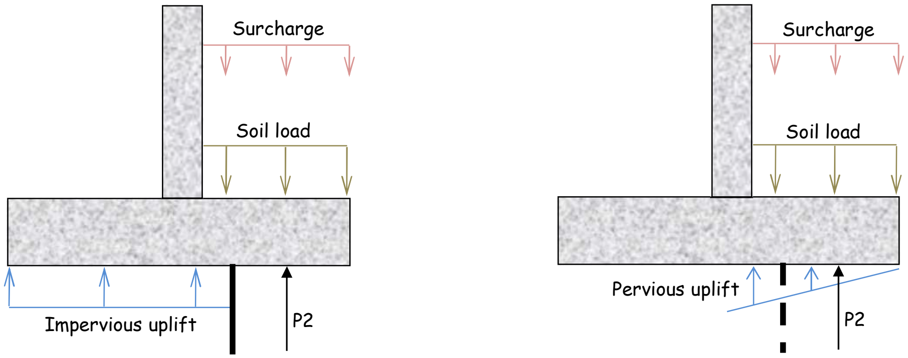
$\gamma_{water} \times H_{water\ w/slab} \times$ Width = 0.42 x 1.6 = 0.68 kips/ft x 2.75 ft = 1.87 | 1.71



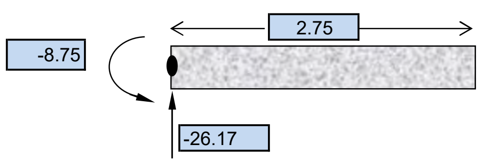
Conc. Earthquake Load:	EQ area pressure x Width =		x	1	0.00	kips/ft x 2.75 ft =	0.00	0.00
Pile P2	P =	42.20	x	1	42.20	kips	42.20	31.65

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	



Reactions Calculations:



Find Reactions at face of wall (assumed to be a fixed support):

R_z = Self Weight + Soil Load - Pile Reaction 2 + (Surch.) - (Uplift)

R_z = -26.17 kips

M_y = -8.75 kips-ft

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

Shear and Moment Calculations:

1) Sign Convention: ↑ → ↺ +

2) Find Equations for each loading to use in shear and moment calculations:
(Moving a distance "X" from the protected side to the wall stem across the slab)

Self Weight:
w_{weight} = -4.32 kips/ft
V_{weight} = -4.32 X
M_{weight} = -4.32 X² / 2

Soil Load:
w_{soil} = -2.19 kips/ft
V_{soil} = -2.19 X
M_{soil} = -2.19 X² / 2

Const. Surcharge:
w_{EQ} = -0 kips/ft
V_{EQ} = -0 X
M_{EQ} = -0 X² / 2

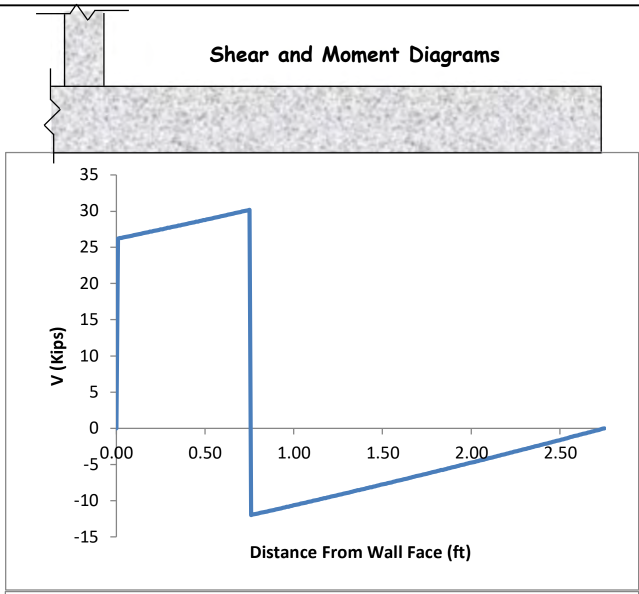
Uplift Load:
w_{uplift} = 0.49 X Kips/ft
V_{uplift} = 0.49 X² / 2
M_{uplift} = 0.49 X^3 / 6

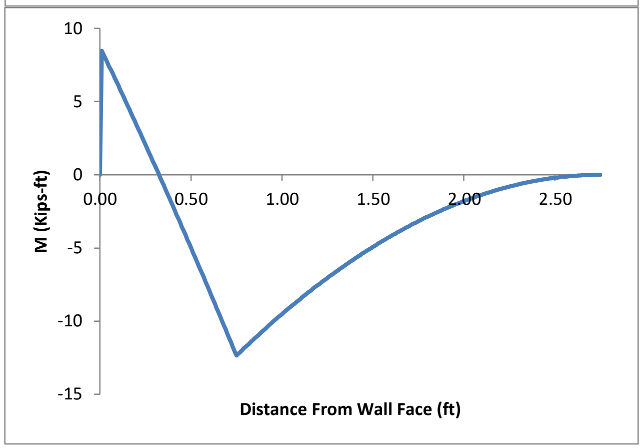
Conc. EQ:
w_{EQ} = -0 kips/ft
V_{EQ} = -0 X
M_{EQ} = -0 X² / 2

Pile P2:
V_{pile} = 42.2 Kips (after x = 2ft)
M_{pile} = 42.2 (X - 2 ft)

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION KCS-2 (Represents KCS-4)	Computed by	AML	Date	Dec-20
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

Shear and Moment Diagrams





Max Shear	
30.17	kips / tributary width / allowable OS =
5.03 Kips	

Max Top Moment	
-12.36	kips / tributary width / allowable OS =
-2.06 Kips	

Max Bottom Moment	
33.7303	kips / tributary width / allowable OS =
5.62 Kips	

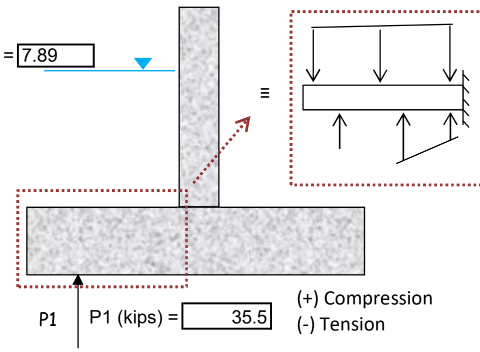
AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

Load Case: 1

Analysis of Flooded Side of Slab:

F.S. WL = 7.89



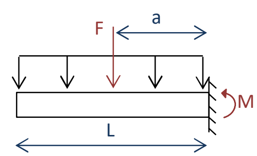
P1 (kips) = 35.5

(+) Compression
(-) Tension

* Here the shear and moment diagrams for the flood side of the slab are presented. The flood side of the slab is considered as a cantilever beam fixed at the face of the wall in flood side.

Allowable Overstress: %

			Load Fac.			L	F (kips)	F x a = M (k-ft)
Self Weight:	$\gamma_{concrete}$ x H_{slab} x Width =	2.70	x 1.6	4.32	kips/ft	x 5.75 ft =	24.84	71.42
Soil Load:	γ_{soil} x H_{soil} x Width =	1.37	x 0	0.00	kips/ft	x 5.75 ft =	0.00	0.00
Const. Surcharge Load:	Surcharge pressure x Width =	1.50	x 1.6	2.40	kips/ft	x 5.75 ft =	13.80	39.68

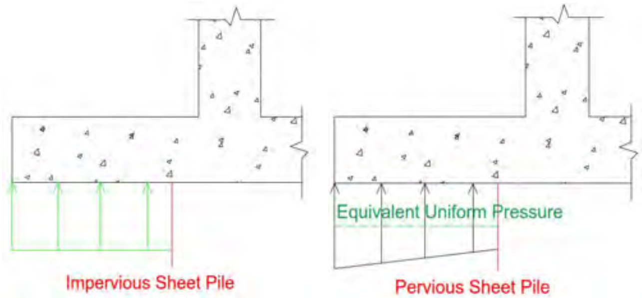


AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

Uplift: ☐ Pervious ☐ Impervious

$\gamma_{water} \times H_{water\ w/slab} \times$ Width = 0.00 x 1.6 0.00 kips/ft x 5.75 ft = 0.00 0.00



Conc. Earthquake Load:	EQ area pressure x Width = 2.01	x		0.00 kips/ft	x 5.75 ft =	0.00	0.00
Pile P1	P = 35.50	x	1	35.50 kips/ft		35.50	133.13

Job	Maurepaus Swamp	Project No.	60632162		
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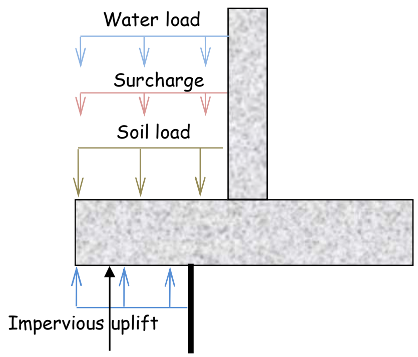
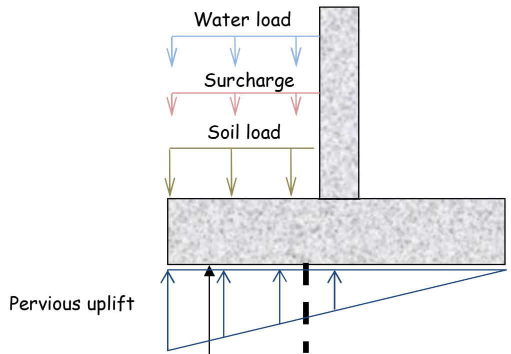
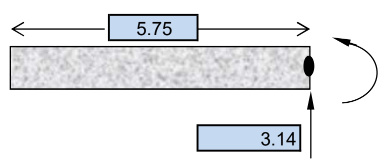
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

Water Weight: $\gamma_{water} \times H_{water} \times$ Width = -1.12 x 0 | 0.00 kips x 5.75 ft = 0.00 | 0.00





Reactions Calculations:



Find Reactions at face of wall (assumed to be a fixed support):

R_z = Self Weight + Soil Load + Surch. - Pile Reaction 1 - Uplift

R_z = 3.14 kips

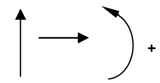
M_y = 22.04 kips-ft

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

Shear and Moment Calculations:

1) Sign Convention:



2) Find Equations for each loading to use in shear and moment calculations:
(Moving a distance "X" from the flood side to the wall stem across the slab)

Self Weight:
w_{weight} = -4.32 kips/ft
V_{weight} = -4.32 X
M_{weight} = -4.32 X^2 / 2

Soil Load:
w_{soil} = -0 kips/ft
V_{soil} = -0 X
M_{soil} = -0 X^2 / 2

Const. Surcharge:
w_{EQ} = -2.4 kips/ft
V_{EQ} = -2.4 X
M_{EQ} = -2.4 X^2 / 2

Uplift Load:
w_{uplift} = 0
V_{uplift} = 0
M_{uplift} = 0

Water Load:
w_{uplift} = -0 kips
V_{uplift} = -0 X
M_{uplift} = -0 X^2 / 2

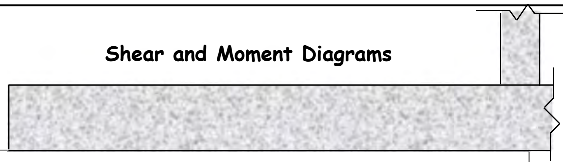
Conc. EQ:
w_{EQ} = -0 kips/ft
V_{EQ} = -0 X
M_{EQ} = -0 X^2 / 2

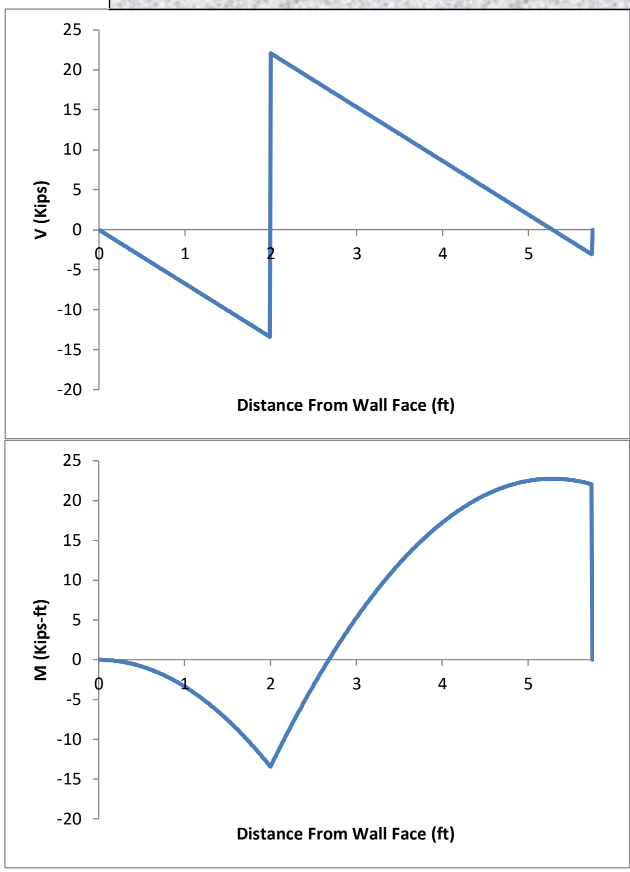
Pile P2:
V_{pile} = 35.5 Kips (after x = 2ft)
M_{pile} = 35.5 (X - 2 ft)

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

Shear and Moment Diagrams





Max Shear	
22.06	kips / tributary width / allowable OS =
3.68 Kips	

Max Top Moment	
-13.44	kips / tributary width / allowable OS =
-2.24 Kips	

Max Bottom Moment	
22.7686	kips / tributary width / allowable OS =
3.79 Kips	

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION KCS-2 (Represents KCS-4)	Computed by	AML	Date	Dec-20
	Slab Conc. Check	Checked by	JMH	Date	Dec-20
				References	

* Given Information:

Slab Thickness:	3.00	ft			
Slab Width:	10.00	ft			
Clear Cover:	0.75	ft			
Diameter Bar to Start:	0.09	ft			
Diameter of Pile:	1.15	ft			
			Load Fact.		
Maximum Pile Reaction:	42.20	kips	1	42.20	kips
Maximum Shear:	5.03	kips			
Maximum Moment (Top):	2.24	kip-ft			
Maximum Moment (Bottom):	5.62	kip-ft			

φ_{shear} =	0.75	(ACI 318)
φ_{moment} =	0.9	(ACI 318)
$f_{y,\ rebar}$ =	60	ksi
f'_c =	4	ksi

* Shear Calculations:

1- Shear Capacity:

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75			
f'_c =	4	ksi		
b =	1	ft strip		
d =	2.20	ft	26.44	in

φV_c =	30095.3	lbs	
	30.10	kips	** φVc=30.1 ≥ Vu=5, **Shear Capacity OK**

AECOM

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					References

2- Punching Shear Capacity (ACI 318-14 Table 22.6.5.2):

Vc = minimum value = Eq. a: $4 \times \sqrt{(f'_c)} \times b_0 \times d$ for $\beta_c < 2.0$

Eq. b: $(2 + (4 / \beta_c)) \times \sqrt{(f'_c)} \times b_0 \times d$ for $\beta_c > 2.0$

Eq. c: $((\alpha_s \times d) / b_0 + 2) \times \sqrt{(f'_c)} \times b_0 \times d$ b_0 / d effect based on α_s

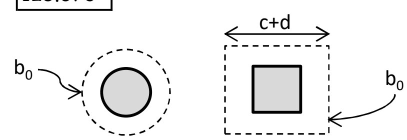
(interior column: α_s = 40, edge column: α_s = 30, corner column: α_s = 20)

d for piles = 26.203 in (Slab thickness - 9" pile embed - cover - $0.5d_{bar}$)

where β_c = Long side / Short side = 1

b_0 = Perimeter of Critical Section = $\pi*(D_{pile} + d)$ = 125.673

α_s = 20 (worst case - corner column)



Vc = minimum value = Eq. a: 833.07 kips

Eq. b: 1249.61 kips

Eq. c: 1285.02 kips

φV_c = 624.81 kips

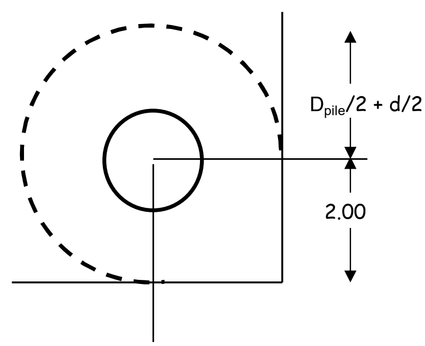
Check corner pile failure to edge of slab:

$D_{pile}/2+d/2$ = 1.67 ft

Diameter of corner failure = 1.667 + 2 ft

= 3.67 ft

Dia. punching shear calc above = 3.33



Diameter of punching shear calculation is smaller than the diameter of this corner failure area. Therefore, no re-check of corner punching failure is required.

φVc used in design = 30.10 kips

** φVc = 30.1k ≥ Vu = 5k, Shear Capacity OK

Maximum Pile Reaction = 42.20

** φVc=625k ≥ Vu=42k, Punching Shear Capacity OK

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Slab Conc. Check	Checked by	JMH	Date	Dec-20
					References

3- Deep Beam One-Way Shear Capacity (φV_{c1}):

For $(w/d) \geq 1.0$, a one-way (normal) shear investigation with loads outside the critical section (located at a distance d from the face of the column, b = footing width) and

$$v_c = 1.9\sqrt{f'_c} + 2500\rho_w\left(\frac{V_u d}{M_u}\right) \geq 2\sqrt{f'_c} \quad \text{(ACI Eq. 11-5)}$$

which reduces for $\rho_w \approx 0.002$ and 3,000 psi $\leq f'_c \leq$ 4,000 psi to $v_c = 1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}\,(V_u d/M_u) \geq 2\sqrt{f'_c}$.

For $(w/d) < 1.0$, $1.0 > M_u/V_u d > 0$; $\infty > V_u d/M_u \geq 1.0$ (no limits on M_u, $V_u d$, other than above)

$$v_c = \left(\frac{d}{w}\right)\left[3.5 - 2.5\left(\frac{M_u}{V_u d}\right)\right]\left[1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}\left(\frac{V_u d}{M_u}\right)\right] \leq 10\sqrt{f'_c} \quad \text{(ACI Eq. 13-2)}$$

w = 1.0 ft — Distance from CL pile to face of Wall + 3" lateral installation tolerance

M_u = 5.62 kip-ft

V_u = 5.03 kips

v_c = 652.2 psi ≤ 10 x √f'c = 632.5 psi limit on shear strength

φV_{c1} = 150.48 kips — ** φVc=150.5 ≥ Vu=5, OK

Therefore, Slab is OK for shear forces found in slab analysis.

<u>* Reinforcement Calculations:</u>

Limit of Maximum Reinforcement: $0.25 \times \rho_b$ (Design Criteria, EM 1110-2-2104, 3-5)

where ρ_b = 0.0285 for f'_c = 4,000psi, fy = 60,000psi

Max Rebar = 0.00713 *b * d

Maximum Reinforcement:	0.0071	* b * d =	2.26	in^2	per 1ft strip

A_{gross} = 3 ft * 12 in/ft * 12 in strip = 432.00 in^2

Limits of Minimum Reinforcement:			
0.003 x Agross =	1.30	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
$(3\sqrt{f'_c} \cdot b \cdot d)/f_y$ =	1.00	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)
$(200 \cdot b \cdot d)/f_y$ =	1.06	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)

Min Reinforcement, temp & shrinkage:	0.65	in^2	per 1ft strip, per face
Min Reinforcement, flexural:	1.06	in^2	per 1ft strip, per face

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-2 (Represents KCS-4)				
	Slab Conc. Check	Checked by	JMH	Date	Dec-20
					References

*** Moment Calculations:**

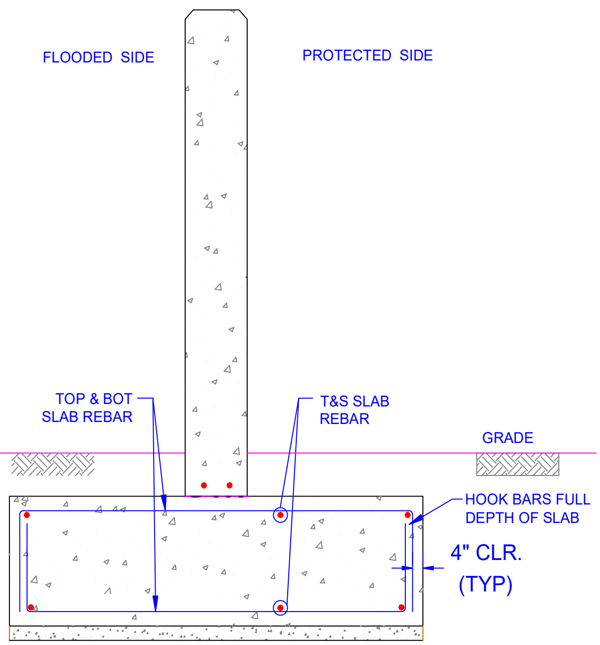
* $T = A_s \times f_y$

* $C = 0.85 \times f'_c \times a \times b$

* Assuming Tension = Compression $\longrightarrow A_s \times f_y = 0.85 \times f'_c \times a \times b$

* $\varphi Mn = \varphi \times T \times (d - (a / 2))$

$= \varphi \times A_s \times f_y \times (d - (a / 2))$



* Capacity of Min Flexural Reinforcement:

A_s =	1.057	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	2.203	
φ_{moment} =	0.9	

$a = (A_s \times f_y) / (0.85 \times f'_c \times b)$

= 1.555 in

φM_n =	1465.1	kip-in
=	122.10	kip-ft

* Capacity of Maximum Reinforcement:

A_s =	2.260	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	2.20	
φ_{moment} =	0.9	

The minimum proposed reinforcement for to T&S Slab Rebar is #6 @ 6"(A = 0.88 in2) and the minimum proposed reinforcment for Top & Bot Slab Rebar is #7 @ 6"(A =1.2in2).

$a = (A_s \times f_y) / (0.85 \times f'_c \times b)$

= 3.324 in

φMn =	3023.8	kip-in
=	251.98	kip-ft

** φMn=252 ≥ Mu=2.2, Section OK	TOP
** φMn=252 ≥ Mu=5.6, Section OK	Bottom

Maurepaus Swamp

Gate Monolith

KCS Gate Monolith

AECOM Project : 60632162

Foundation, Wall & Slab

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New Orleans, LA 70112

(504) 586-8111

Computed by:	JMH	Checked by:	AML
Date:	Dec-20	Date:	Dec-20

AECOM

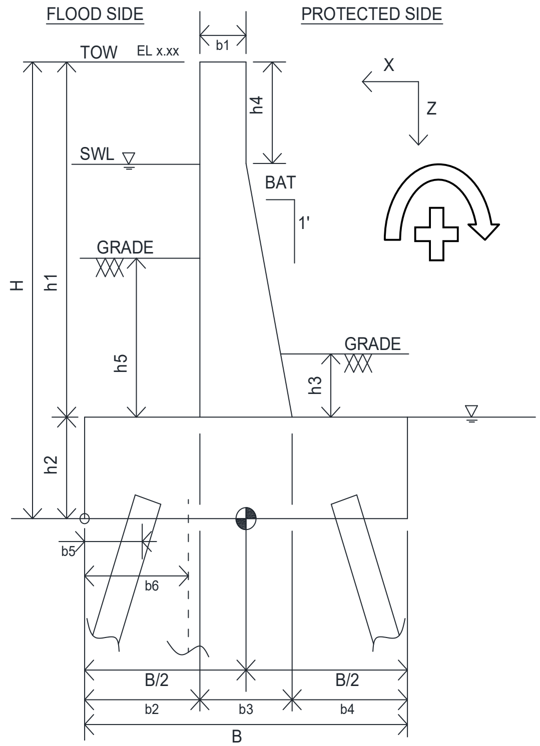
Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Wall Geometry	Checked by	AML	Date	Dec-20

References

WALL GEOMETRY:

Top of Pilaster EL.	16.63	NAVD88
Top of Wall EL.	16.13	NAVD88
100 Yr. Water El.		NAVD88
10 Yr. Water El.		NAVD88
Top of Slab EL.	7.89	NAVD88
H=	12.74	ft.
h1=	8.24	ft.
h2=	4.50	ft. (Base Slab Height)
h3=	0.00	ft. (P.S. Soil Height)
h4=	0.00	ft.
h5=	0.00	ft. (F.S. Soil Height)
B=	10.00	ft. (Base Slab Width)
b1=	1.50	ft. (Wall Stem Width, top)
b2=	5.75	ft. (F.S. Slab Width)
b3=	1.50	ft. (Wall Stem Width, bottom)
b4=	2.75	ft. (P.S. Slab Width)
b5=	2.00	ft. (F.S. Pile Row Edge Space)
b6=	6.50	ft. (Sheet Pile Edge Space)
BAT=	0.00	(Wall Batter, N/A)
PS Grade =	7.89	NAVD88 (Average of PS soil for all)

Monolith Length =	45.5	ft
Bottom Of Slab =	3.39	NAVD88



T-WALL CROSS-SECTION

Notes: 1) positive 'Y' axis is into page

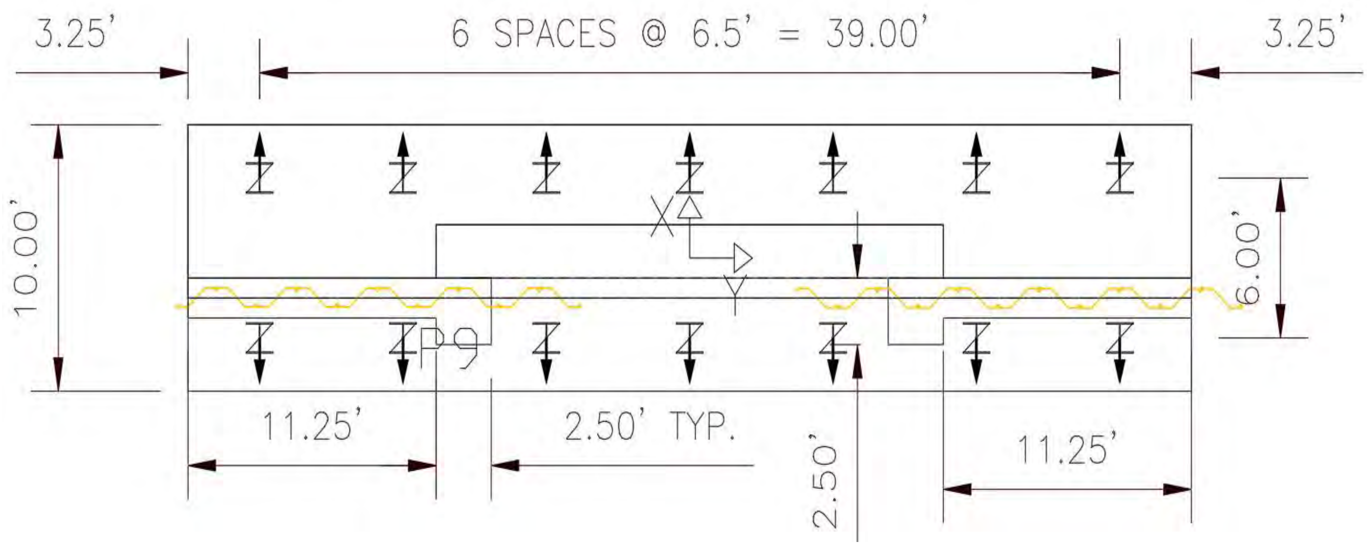
2) pile batters vary from those shown in diagram

Note: In this report, white boxes are for input data and colored boxes are calculated values.

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Applied Loads in SAP Model	Checked by	AML	Date	Dec-20

References

Pile and Pilaster Layout:



AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Assumptions	Checked by	AML	Date	Dec-20

References

Unit Weight of Storm Water =	0.0624	kcf
Wet Unit Weight of Soil =	0.1200	kcf
Sat Unit Weight of Soil =	0.0576	kcf
Unit Weight of Concrete =	0.1500	kcf
Impact Load =	0.0000	k/ft
FS Wind force above SWL=	0.0500	ksf
Construction Surcharge Pressure =	0.2500	ksf
Unbalanced Load for Stability Analysis:		
F_{cap} (k/ft) =	0.00	(10y SWL Case; Force acts at bottom of slab)
F_{cap} (k/ft) =	0.00	(100y SWL Case; Force acts at bottom of slab)
F_{cap} (k/ft) =	0.00	(Water to TOW Case; Force acts at bottom of slab)
K_0, Granular fill =	0.95	(for lateral soil forces)
Assumed Wall Reinforcement Cover =	0.25	ft
Assumed Wall d_{bar} =	0.06	ft
Gate Length =	20.58	ft
Gate Opening =	18.00	ft *Tributary Length = 9'
Gate Weight =	5.66	kip *Taken from similar swing gate from Hoboken project.

***NOTE:** Gate calculations show a gate weight of 8.4 kip:
(8.4 - 5.66) / 14 piles = .2 kip/pile
By inspection, gate weight will not drastically affect the design and the new gate weight passes with the pile capacities along with the shear and moment capacities for the slab. The gate weight will be updated and analyzed for the next submittal.

AECOM

Job	Maurepaus Swamp	Project No.	60632162
Description	Gate Monolith	Computed by JMH	Date Dec-20
	KCS Gate Monolith		
	Load Cases	Checked by AML	Date Dec-20
			References

No. of Load Cases	4

Update

No.	DCD LC No.	Description	FS Water El.	PS Water El.	Pile Design Over Stresses
1	1	Construction + Surcharge	3.39	3.39	1.17
2	2a	Water to TOW (impervious cutoff)	16.13	3.39	1.33
3	2b	Water to TOW (pervious cutoff)	16.13	3.39	1.33
4		Dead + Cooper E80	3.39	3.39	1.00

* Impact load is not applicable for this section, so it is excluded from the load combinations
* Forces induced by 10y water elevation are not applicable for this section, so they are excluded from the load combinations

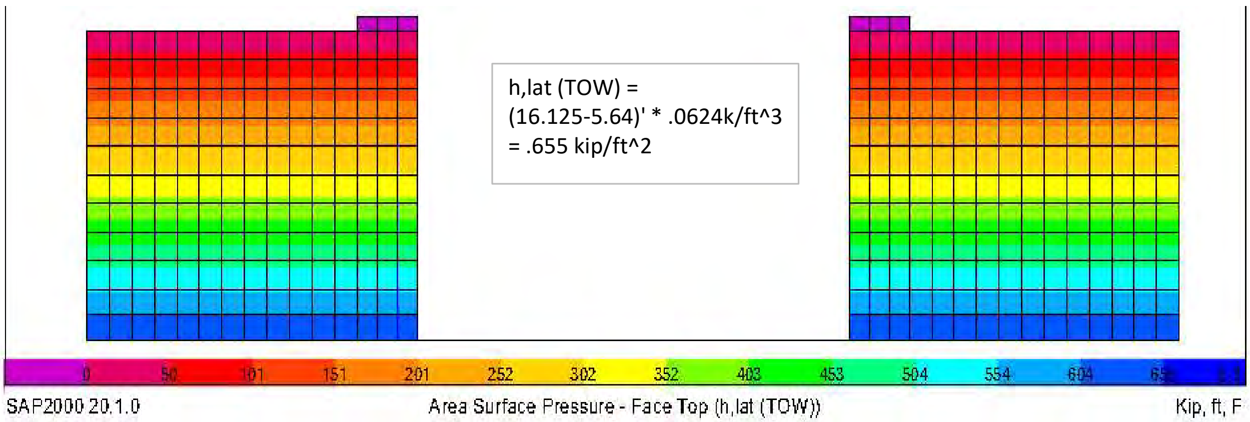
*Earthquake and Wave Loads are to be determined and are excluded from these calculations

AECOM

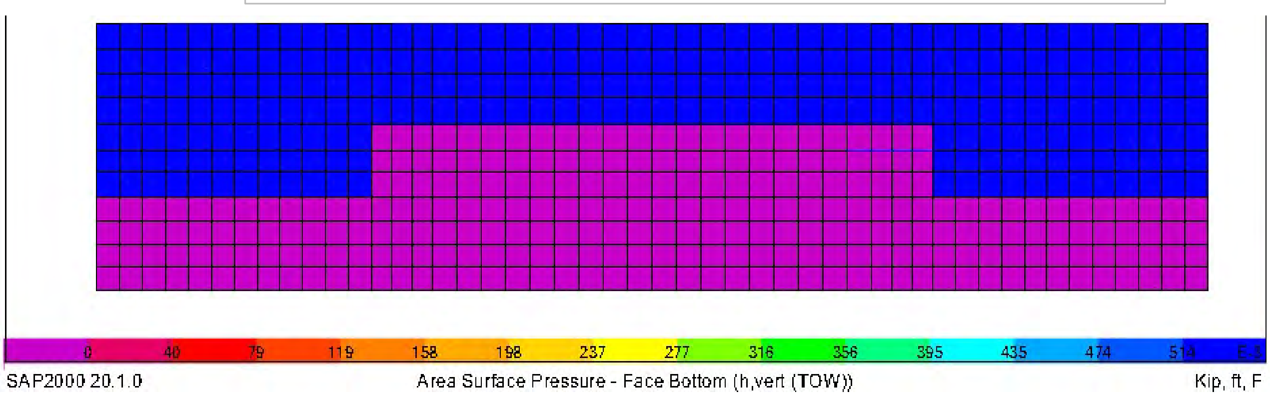
Job	**Maurepaus Swamp**	**Project No.**	**60632162**		
Description	**Gate Monolith**	**Computed by**	**JMH**	**Date**	**Dec-20**
	KCS Gate Monolith				
	Applied Loads in SAP Model	**Checked by**	**AML**	**Date**	**Dec-20**

References

*The following diagrams represent the loads applied in the SAP Model; base reactions were taken from SAP to plug into CPGA to get the pile reactions of the structure.



h,vert (TOW) =
(16.125-7.89)' * .0624k/ft^3 = .514 kip/ft^2
*Note: The gate is flush with the sill so that the sill will not see any vertical water loads



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	KCS Gate Monolith				
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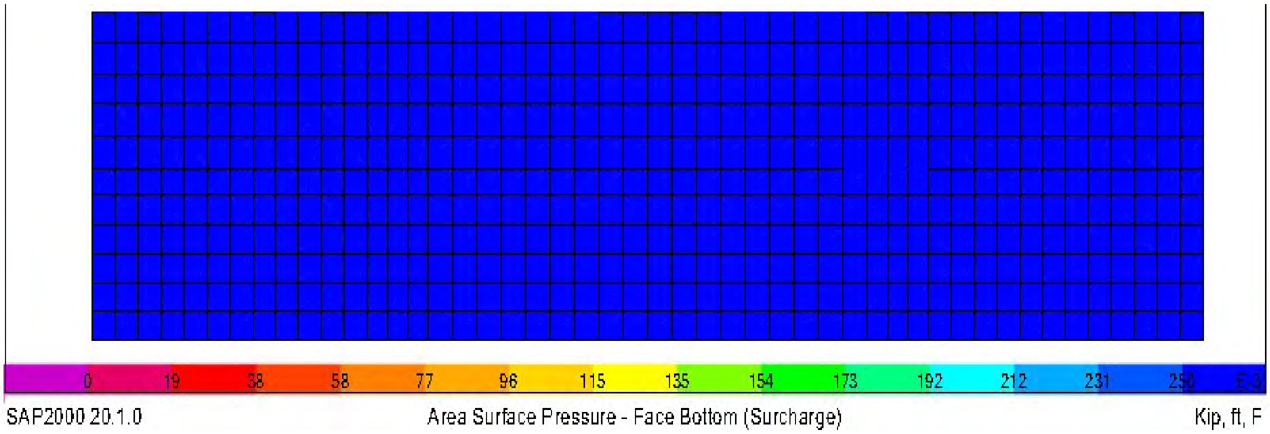
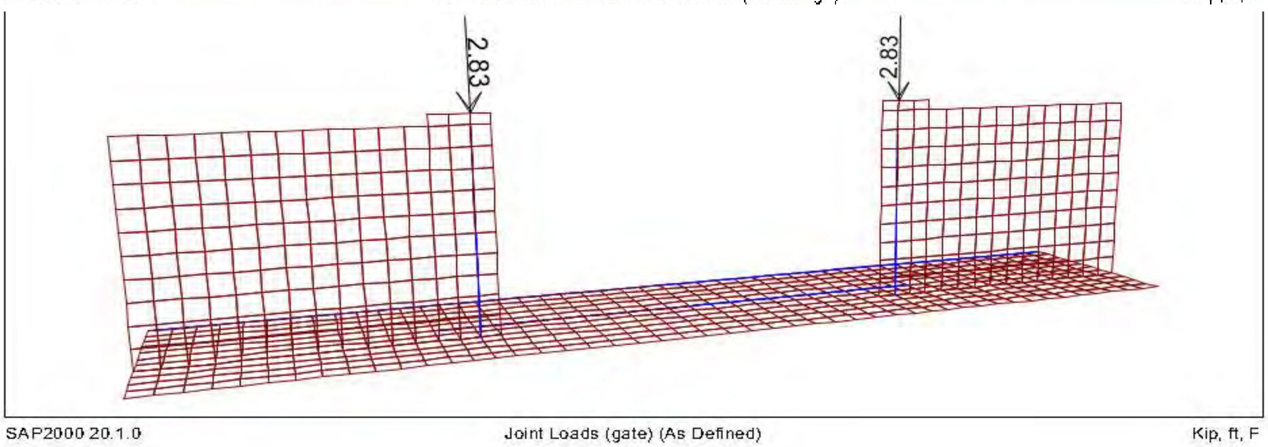
					References

A surcharge of .25 kip/ft^2 is applied to both protected and flood sides of slab. See Assumptions page





Swing Gate weight from Hoboken project = 7.61 kips / (22.5'*7.7') = .044 ksf
Multiplied by the KCS Gate Dimensions = (6.24' x 20.63')(.044ksf) = 5.66 kip / 2 = 2.83 kip

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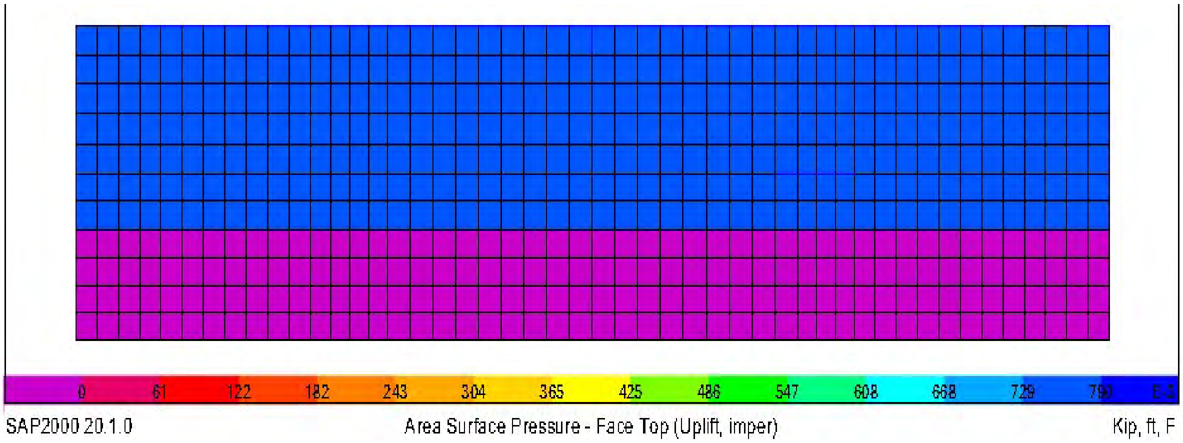
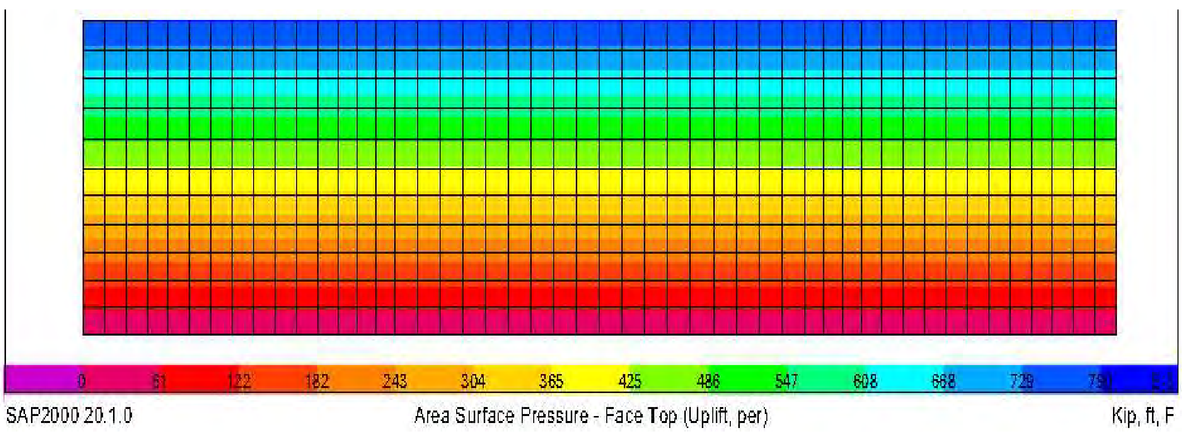
References

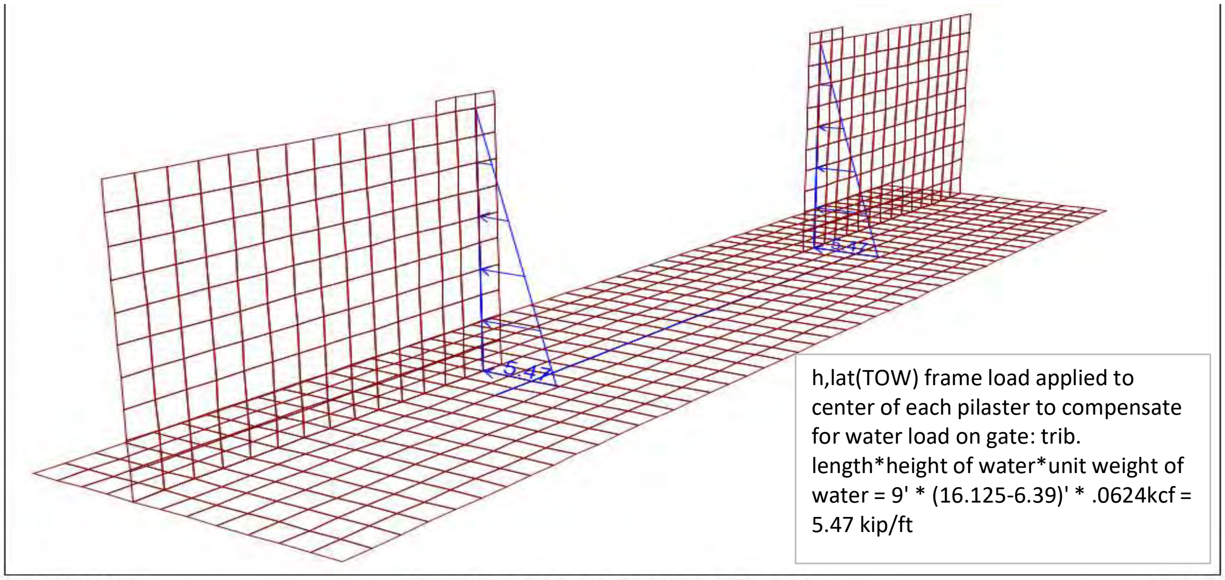


Impervious and Pervious Uplift =
(16.125' - 3.39') * .0624kcf = .79 ksf



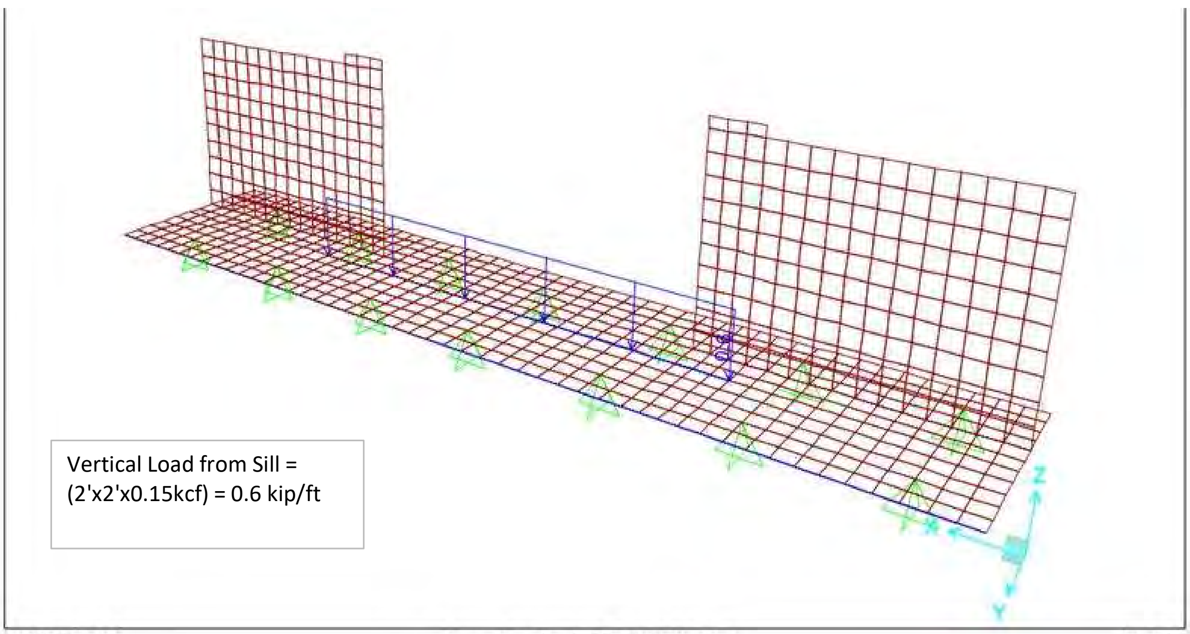
Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Applied Loads in SAP Model	Checked by	AML	Date	Dec-20

References



h,lat(TOW) frame load applied to center of each pilaster to compensate for water load on gate: trib. length*height of water*unit weight of water = 9' * (16.125-6.39)' * .0624kcf = 5.47 kip/ft

SAP2000 20.1.0 Frame Span Loads (h,lat (TOW)) (GLOBAL CSys) Kip, ft, F



Vertical Load from Sill = (2'x2'x0.15kcf) = 0.6 kip/ft

SAP2000 20.1.0 Frame Span Loads (sill) (GLOBAL CSys) Kip, ft, F

AECOM

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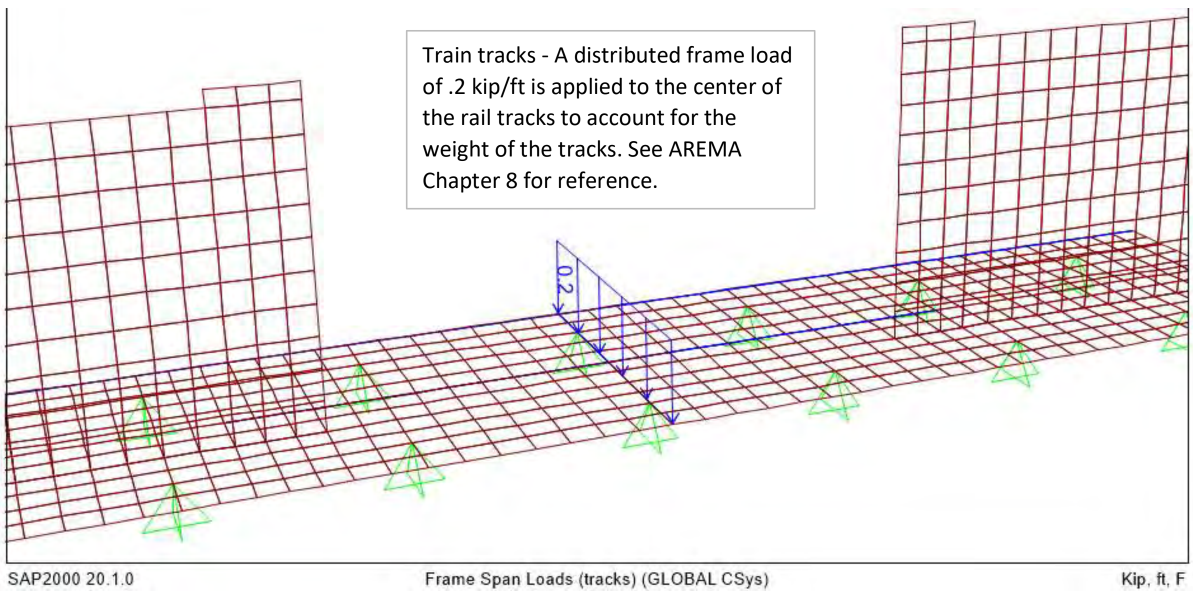
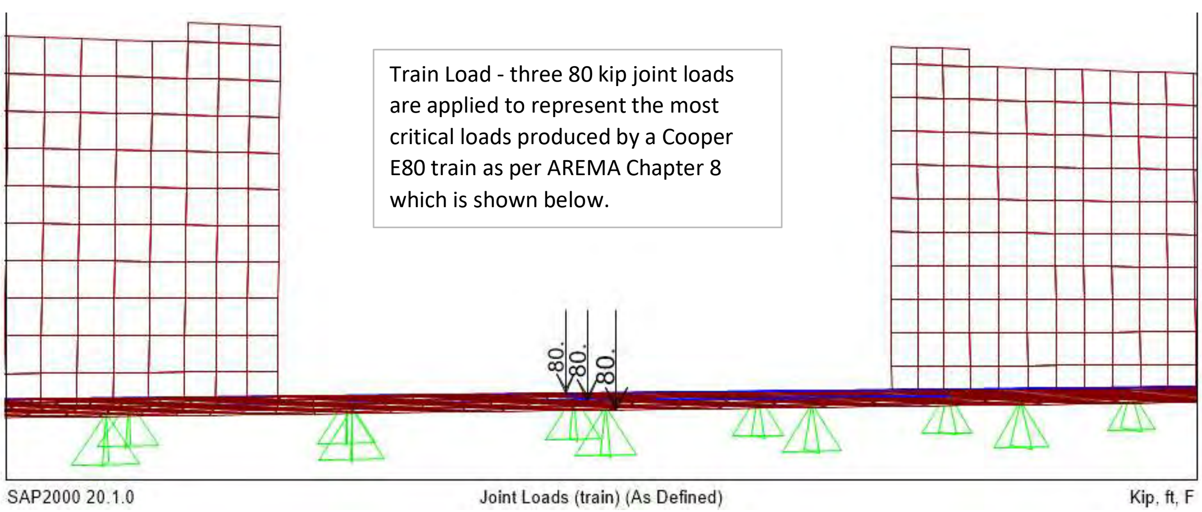
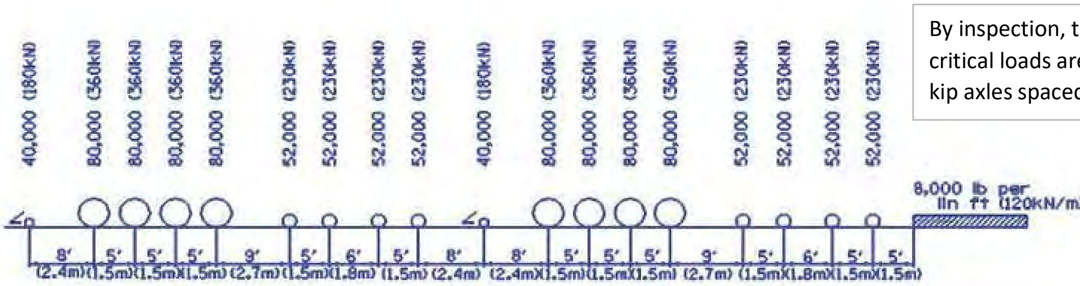
	Applied Loads in SAP Model	Checked by	AML	Date	Dec-20

References







By inspection, the most critical loads are the 80 kip axles spaced at 5'.

AECOM

Job	Maurepaus Swamp	Project No.	60589133		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Summary of Foundation Loads	Checked by	AML	Date	Dec-20
				References	

UNFACTORED LOADS FOR CPGA						
Load Case	Fx (kips)	Fy (kips)	Fz (kips)	Mx (kip-ft)	My (kip-ft)	Mz (kip-ft)
LC1	0.00	0.00	486.68	0.00	74.56	0.00
LC2	-225.51	0.00	264.67	0.00	1174.19	0.00
LC3	-225.51	0.00	318.59	0.00	1064.86	0.00
LC4	0.00	0.00	625.33	0.00	56.01	0.00

This table represents the base reactions taken from SAP. The moments were taken from the centroid of the structure with positive-x facing the flood side and positive-z facing downwards.

*NOTE: Loads exported from SAP 2000 are within 5% on the conservative side of the actual loads on the monolith; OK for this submittal.

FACTORED LOADS FOR CPGA						
Load Case	Fx (kips)	Fy (kips)	Fz (kips)	Mx (kip-ft)	My (kip-ft)	Mz (kip-ft)
LC1	0.00	0.00	778.70	0.00	119.30	0.00
LC2	-360.81	0.00	423.47	0.00	1878.71	0.00
LC3	-360.81	0.00	509.74	0.00	1703.78	0.00
LC4	0.00	0.00	1375.74	0.00	123.23	0.00

AECOM

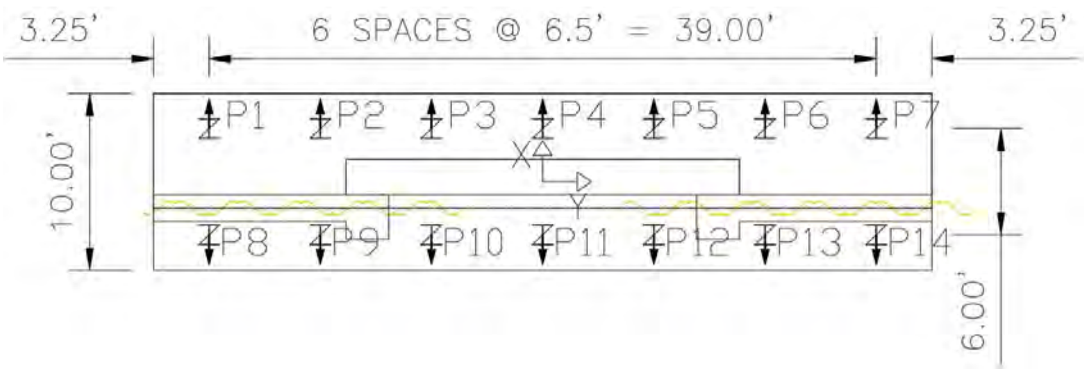
Job	Maurepaus Swamp	Project No.	60632162
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith		
	Soil & Pile Information Required for CPGA	Checked by	AML	Date	Dec-20

References

Pile Layout: 14 HP Piles

Row 1 / Row 2

pile no.	x	y	pile no.	x	y
1	3.00	-19.50	8	-3.00	-19.50
2	3.00	-13.00	9	-3.00	-13.00
3	3.00	-6.50	10	-3.00	-6.50
4	3.00	0.00	11	-3.00	0.00
5	3.00	6.50	12	-3.00	6.50
6	3.00	13.00	13	-3.00	13.00
7	3.00	19.50	14	-3.00	19.50



Tip Elevation: (For CPGA, need Tip Elevation as a function of CPGA Axis at B.O. Slab, +Z points downward)

B.O.S. Elevation =	3.39	NAVD88
Pile Tip El. =	-38	NAVD89
"TIP" in CPGA =	**41.39**	**ft**

Pile Properties & Attributes

E =	29000000.0	psi	
A =	21.40	in^2	HP14X73
I_x =	729.00	in^4	
I_y =	261.00	in^4	
C_{33} =	1.70	(factor for method of axial load transfer from pile to soil; = 1 full tip bearing, = 2 full skin friction)	
S_x =	107.00	in^3	
S_y =	35.80	in^3	
F_y =	50.00	ksi	

*Note: All soil properties and pile capacities are taken from 95% submittal for Maurepas intake structure.

Allowable Compression (AC) =	55.00	kips	
Allowable Tension (AT) =	35.00	kips	
ACC =	492.66	kips	ACC = 5/6x0.67xFyxA
ATT =	535.00	kips	ATT = 5/6x0.67xFyxA
AM1 =	2972.22	kip-in	AM1 = 5/6x0.67xFyxSx
AM2 =	994.44	kip-in	AM2 = 5/6x0.67xFyxSy

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
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					References

Es Value for CPGA Run:

Monolith width = 46 ft

E_s = 540.40 psi = 0.5404 ksi

GROUP FACTORS	
Pile Spacing in Direction of Loading	From EM1110-2-2906
	D
3B	0.33
4B	0.38
5B	0.45
6B	0.56
7B	0.71
8B	1

Group reduction is based on distance between piles in direction of loading. This includes distance due to battering and is taken over the distance 10 x d_{pile} (point of fixety).

Assume a batter of 6.00

B = d_{pile} = 13.6 in = 1.133 ft

Distance between piles at B.O. Slab = 6.00 ft

Average distance between piles over 10*dpile = 7.89 ft

Average distance between piles in terms of pile width B = 6.96 B

Group Reduction "D" value for this distance = 0.70

Therefore, Es including group reduction = 0.38 ksi

AECOM

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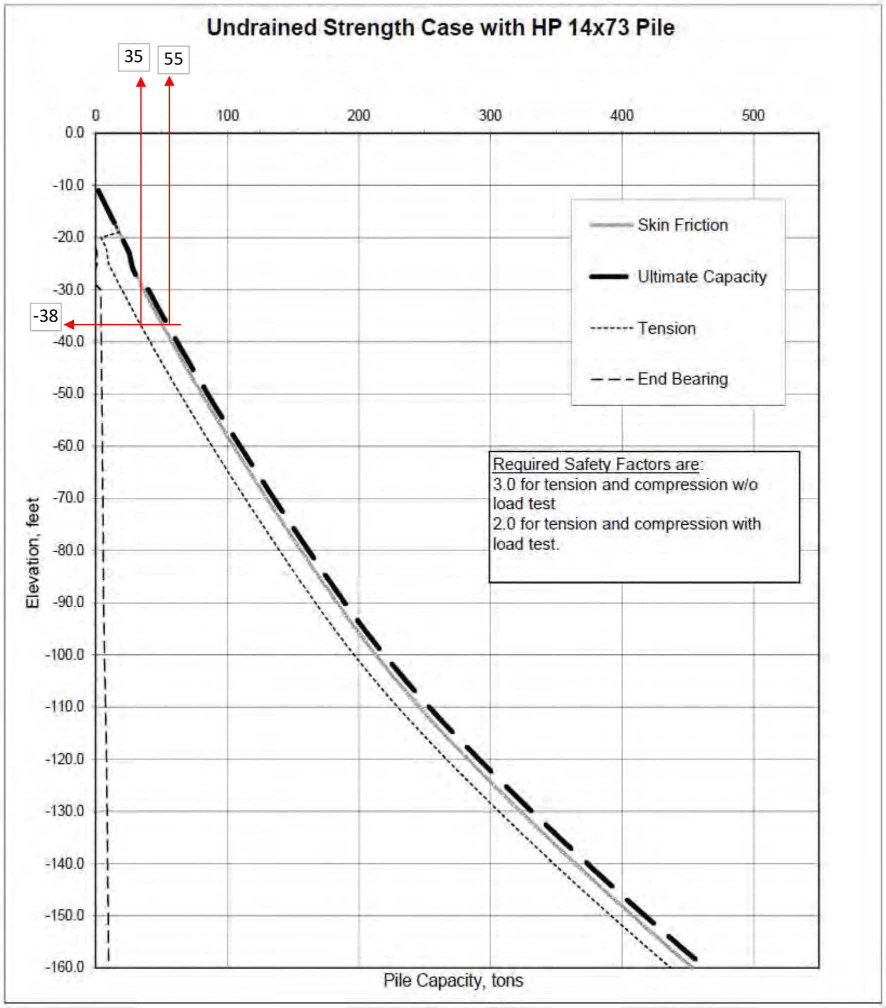
					References



Job	Maurepaus Swamp		Project No.	60632162	
Description	Gate Monolith		Computed by	JMH	Date Dec-20
	KCS Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)		Checked by	AML	Date Dec-20

Input file:

```
100 MONOLITH, TOW EL. 16.13, TOS EL.7.89; HP 14X73  PILES
200 PROP 29000 729 261 21.4 1.7 0 ALL
300 SOIL ES 0.3805 TIP 41.39 0 ALL
400 PIN ALL
500 ALLOW H 55 35 492.7 535 2972.2 994.4 ALL
600 FOVSTR 1.17 1.17 1
700 FOVSTR 1.33 1.33 2 3
800 FOVSTR 1 1 4
900 BATTER 6 All
1200 ANGLE 180 8 TO 14
1300 PILE 1 3 -19.5 0
1400 PILE 2 3 -13 0
1500 PILE 3 3 -6.5 0
1600 PILE 4 3 0 0
1700 PILE 5 3 6.5 0
1800 PILE 6 3 13 0
1900 PILE 7 3 19.5 0
2000 PILE 8 -3 -19.5 0
2100 PILE 9 -3 -13 0
2200 PILE 10 -3 -6.5 0
2300 PILE 11 -3 0 0
2400 PILE 12 -3 6.5 0
2500 PILE 13 -3 13 0
2600 PILE 14 -3 19.5 0
4500 LOAD 1 0 0 486.7 0 74.6 0
4600 LOAD 2 -225.5 0 264.7 0 1174.2 0
4700 LOAD 3 -225.5 0 318.6 0 1064.9 0
4800 LOAD 4 0 0 625.3 0 56 0
9000 FOUT 1 2 3 4 5 6 7 KCS01P.DOC
9100 PFO ALL
9200 PLB ALL
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

CPGA RESULTS without Load Factors (pinned connection)

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 27-DEC-20     RUN TIME: 11:45:14




    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.7.89; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE  14 PILES AND
            4 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                    X          Y          Z
                                  -----      -----      -----
WITH DIAGONAL COORDINATES = (     -3.00 ,   -19.50 ,     0.00 )
                            (      3.00 ,    19.50 ,     0.00 )


******************************************************************************

         PILE PROPERTIES AS INPUT


      E           I1           I2            A           C33          B66
     KSI         IN**4        IN**4        IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


******************************************************************************

         SOIL DESCRIPTIONS AS INPUT
```

```
   ES     ESOIL      LENGTH       L            LU
         K/IN**2                  FT           FT
        0.38050E+00    T      0.41390E+02   0.00000E+00

 ESOIL(ORIGINAL)     RGROUP     RCYCLIC
   K/IN**2
  0.38050E+00       0.1000E+01 0.1000E+01

THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


 0.17968E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.23229E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.20952E+04  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


THIS MATRIX APPLIES TO THE FOLLOWING PILES -

      1


*******************************************************************************
```

AECOM

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Description	Gate Monolith		Computed by	JMH	Date	Dec-20
	KCS Gate Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	AML	Date	Dec-20

PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM	X FT	Y FT	Z FT	BATTER	ANGLE	LENGTH FT	FIXITY
1	3.00	-19.50	0.00	6.00	0.00	41.96	P
2	3.00	-13.00	0.00	6.00	0.00	41.96	P
3	3.00	-6.50	0.00	6.00	0.00	41.96	P
4	3.00	0.00	0.00	6.00	0.00	41.96	P
5	3.00	6.50	0.00	6.00	0.00	41.96	P
6	3.00	13.00	0.00	6.00	0.00	41.96	P
7	3.00	19.50	0.00	6.00	0.00	41.96	P
8	-3.00	-19.50	0.00	6.00	180.00	41.96	P
9	-3.00	-13.00	0.00	6.00	180.00	41.96	P
10	-3.00	-6.50	0.00	6.00	180.00	41.96	P
11	-3.00	0.00	0.00	6.00	180.00	41.96	P
12	-3.00	6.50	0.00	6.00	180.00	41.96	P
13	-3.00	13.00	0.00	6.00	180.00	41.96	P
14	-3.00	19.50	0.00	6.00	180.00	41.96	P

587.45

****

APPLIED LOADS

LOAD CASE	PX K	PY K	PZ K	MX FT-K	MY FT-K	MZ FT-K	OVERSTRESS COM	TEN
1	0.0	0.0	486.7	0.0	74.6	0.0	1.17	1.17
2	-225.5	0.0	264.7	0.0	1174.2	0.0	1.33	1.33
3	-225.5	0.0	318.6	0.0	1064.9	0.0	1.33	1.33
4	0.0	0.0	625.3	0.0	56.0	0.0		

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	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

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         ORIGINAL PILE GROUP STIFFNESS MATRIX

 0.10376E+04 -0.86678E-05  0.56843E-12  0.00000E+00 -0.16978E+06  0.31204E-03
-0.86678E-05  0.32521E+03  0.57384E-04 -0.21684E-18  0.20658E-02 -0.65938E-11
 0.56843E-12  0.57384E-04  0.28547E+05  0.00000E+00  0.29104E-10 -0.20658E-02
 0.00000E+00  0.21684E-18 -0.58208E-10  0.69473E+09  0.00000E+00 -0.18626E-07
-0.16978E+06  0.20658E-02  0.29104E-10  0.00000E+00  0.36997E+08 -0.74369E-01
 0.31204E-03 -0.65938E-11 -0.20658E-02 -0.74506E-08 -0.74369E-01  0.25671E+08



                     14 PILES    4 LOAD CASES

LOAD CASE    1.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    2.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   7.

LOAD CASE    3.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   7.

LOAD CASE    4.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.


*******************************************************************************

         PILE CAP DISPLACEMENTS

LOAD
CASE       DX           DY           DZ           RX           RY           RZ
           IN           IN           IN          RAD          RAD          RAD

   1   0.1589E-01 -0.3202E-08  0.1705E-01  0.1428E-20  0.9712E-04  0.1460E-11
   2  -0.6222E+00 -0.2502E-08  0.9272E-02  0.7769E-21 -0.2475E-02  0.1141E-11
   3  -0.6455E+00 -0.2552E-08  0.1116E-01  0.9351E-21 -0.2617E-02  0.1164E-11
   4   0.1193E-01 -0.4010E-08  0.2190E-01  0.1835E-20  0.7291E-04  0.1829E-11


*******************************************************************************
              ELASTIC CENTER INFORMATION



ELASTIC CENTER IN PLANE X-Z          X             Z
                                    FT            FT
                                   0.00          0.00
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

****

PILE FORCES IN LOCAL GEOMETRY

M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
* INDICATES PILE FAILURE
# INDICATES CBF BASED ON MOMENTS DUE TO
(F3*EMIN) FOR CONCRETE PILES
B INDICATES BUCKLING CONTROLS

LOAD CASE - 1

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	0.2	0.0	33.5	0.0	-7.3	0.0	0.52	0.06
2	0.2	0.0	33.5	0.0	-7.3	0.0	0.52	0.06
3	0.2	0.0	33.5	0.0	-7.3	0.0	0.52	0.06
4	0.2	0.0	33.5	0.0	-7.3	0.0	0.52	0.06
5	0.2	0.0	33.5	0.0	-7.3	0.0	0.52	0.06
6	0.2	0.0	33.5	0.0	-7.3	0.0	0.52	0.06
7	0.2	0.0	33.5	0.0	-7.3	0.0	0.52	0.06
8	-0.3	0.0	37.0	0.0	10.4	0.0	0.57	0.07
9	-0.3	0.0	37.0	0.0	10.4	0.0	0.57	0.07
10	-0.3	0.0	37.0	0.0	10.4	0.0	0.57	0.07
11	-0.3	0.0	37.0	0.0	10.4	0.0	0.57	0.07
12	-0.3	0.0	37.0	0.0	10.4	0.0	0.57	0.07
13	-0.3	0.0	37.0	0.0	10.4	0.0	0.57	0.07
14	-0.3	0.0	37.0	0.0	10.4	0.0	0.57	0.07

LOAD CASE - 2

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	-11.3	0.0	-11.1	0.0	344.2	0.0	0.24	0.28
2	-11.3	0.0	-11.1	0.0	344.2	0.0	0.24	0.28
3	-11.3	0.0	-11.1	0.0	344.2	0.0	0.24	0.28
4	-11.3	0.0	-11.1	0.0	344.2	0.0	0.24	0.28
5	-11.3	0.0	-11.1	0.0	344.2	0.0	0.24	0.28
6	-11.3	0.0	-11.1	0.0	344.2	0.0	0.24	0.28
7	-11.3	0.0	-11.1	0.0	344.2	0.0	0.24	0.28
8	11.3	0.0	49.4	0.0	-342.6	0.0	0.68	0.33
9	11.3	0.0	49.4	0.0	-342.6	0.0	0.68	0.33
10	11.3	0.0	49.4	0.0	-342.6	0.0	0.68	0.33
11	11.3	0.0	49.4	0.0	-342.6	0.0	0.68	0.33
12	11.3	0.0	49.4	0.0	-342.6	0.0	0.68	0.33
13	11.3	0.0	49.4	0.0	-342.6	0.0	0.68	0.33
14	11.3	0.0	49.4	0.0	-342.6	0.0	0.68	0.33

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

LOAD CASE - 3

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	-11.8	0.0	-4.6	0.0	357.4	0.0	0.10	0.28
2	-11.8	0.0	-4.6	0.0	357.4	0.0	0.10	0.28
3	-11.8	0.0	-4.6	0.0	357.4	0.0	0.10	0.28
4	-11.8	0.0	-4.6	0.0	357.4	0.0	0.10	0.28
5	-11.8	0.0	-4.6	0.0	357.4	0.0	0.10	0.28
6	-11.8	0.0	-4.6	0.0	357.4	0.0	0.10	0.28
7	-11.8	0.0	-4.6	0.0	357.4	0.0	0.10	0.28
8	11.7	0.0	50.7	0.0	-355.4	0.0	0.69	0.35
9	11.7	0.0	50.7	0.0	-355.4	0.0	0.69	0.35
10	11.7	0.0	50.7	0.0	-355.4	0.0	0.69	0.35
11	11.7	0.0	50.7	0.0	-355.4	0.0	0.69	0.35
12	11.7	0.0	50.7	0.0	-355.4	0.0	0.69	0.35
13	11.7	0.0	50.7	0.0	-355.4	0.0	0.69	0.35
14	11.7	0.0	50.7	0.0	-355.4	0.0	0.69	0.35

LOAD CASE - 4

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	0.2	0.0	44.0	0.0	-4.7	0.0	0.80	0.09
2	0.2	0.0	44.0	0.0	-4.7	0.0	0.80	0.09
3	0.2	0.0	44.0	0.0	-4.7	0.0	0.80	0.09
4	0.2	0.0	44.0	0.0	-4.7	0.0	0.80	0.09
5	0.2	0.0	44.0	0.0	-4.7	0.0	0.80	0.09
6	0.2	0.0	44.0	0.0	-4.7	0.0	0.80	0.09
7	0.2	0.0	44.0	0.0	-4.7	0.0	0.80	0.09
8	-0.3	0.0	46.6	0.0	8.6	0.0	0.85	0.10
9	-0.3	0.0	46.6	0.0	8.6	0.0	0.85	0.10
10	-0.3	0.0	46.6	0.0	8.6	0.0	0.85	0.10
11	-0.3	0.0	46.6	0.0	8.6	0.0	0.85	0.10
12	-0.3	0.0	46.6	0.0	8.6	0.0	0.85	0.10
13	-0.3	0.0	46.6	0.0	8.6	0.0	0.85	0.10
14	-0.3	0.0	46.6	0.0	8.6	0.0	0.85	0.10

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Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	5.7	0.0	33.0	0.0	0.0	0.0
2	5.7	0.0	33.0	0.0	0.0	0.0
3	5.7	0.0	33.0	0.0	0.0	0.0
4	5.7	0.0	33.0	0.0	0.0	0.0
5	5.7	0.0	33.0	0.0	0.0	0.0
6	5.7	0.0	33.0	0.0	0.0	0.0
7	5.7	0.0	33.0	0.0	0.0	0.0
8	-5.7	0.0	36.5	0.0	0.0	0.0
9	-5.7	0.0	36.5	0.0	0.0	0.0
10	-5.7	0.0	36.5	0.0	0.0	0.0
11	-5.7	0.0	36.5	0.0	0.0	0.0
12	-5.7	0.0	36.5	0.0	0.0	0.0
13	-5.7	0.0	36.5	0.0	0.0	0.0
14	-5.7	0.0	36.5	0.0	0.0	0.0

LOAD CASE - 2

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	-13.0	0.0	-9.0	0.0	0.0	0.0
2	-13.0	0.0	-9.0	0.0	0.0	0.0
3	-13.0	0.0	-9.0	0.0	0.0	0.0
4	-13.0	0.0	-9.0	0.0	0.0	0.0
5	-13.0	0.0	-9.1	0.0	0.0	0.0
6	-13.0	0.0	-9.1	0.0	0.0	0.0
7	-13.0	0.0	-9.1	0.0	0.0	0.0
8	-19.2	0.0	46.9	0.0	0.0	0.0
9	-19.2	0.0	46.9	0.0	0.0	0.0
10	-19.2	0.0	46.9	0.0	0.0	0.0
11	-19.2	0.0	46.9	0.0	0.0	0.0
12	-19.2	0.0	46.9	0.0	0.0	0.0
13	-19.2	0.0	46.9	0.0	0.0	0.0
14	-19.2	0.0	46.9	0.0	0.0	0.0

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

LOAD CASE - 3

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-12.3	0.0	-2.6	0.0	0.0	0.0
2	-12.3	0.0	-2.6	0.0	0.0	0.0
3	-12.3	0.0	-2.6	0.0	0.0	0.0
4	-12.3	0.0	-2.6	0.0	0.0	0.0
5	-12.3	0.0	-2.6	0.0	0.0	0.0
6	-12.3	0.0	-2.6	0.0	0.0	0.0
7	-12.3	0.0	-2.6	0.0	0.0	0.0
8	-19.9	0.0	48.1	0.0	0.0	0.0
9	-19.9	0.0	48.1	0.0	0.0	0.0
10	-19.9	0.0	48.1	0.0	0.0	0.0
11	-19.9	0.0	48.1	0.0	0.0	0.0
12	-19.9	0.0	48.1	0.0	0.0	0.0
13	-19.9	0.0	48.1	0.0	0.0	0.0
14	-19.9	0.0	48.1	0.0	0.0	0.0

LOAD CASE - 4

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	7.4	0.0	43.3	0.0	0.0	0.0
2	7.4	0.0	43.3	0.0	0.0	0.0
3	7.4	0.0	43.3	0.0	0.0	0.0
4	7.4	0.0	43.3	0.0	0.0	0.0
5	7.4	0.0	43.3	0.0	0.0	0.0
6	7.4	0.0	43.3	0.0	0.0	0.0
7	7.4	0.0	43.3	0.0	0.0	0.0
8	-7.4	0.0	46.0	0.0	0.0	0.0
9	-7.4	0.0	46.0	0.0	0.0	0.0
10	-7.4	0.0	46.0	0.0	0.0	0.0
11	-7.4	0.0	46.0	0.0	0.0	0.0
12	-7.4	0.0	46.0	0.0	0.0	0.0
13	-7.4	0.0	46.0	0.0	0.0	0.0
14	-7.4	0.0	46.0	0.0	0.0	0.0

Job	Maurepaus Swamp		Project No.	60632162		
Description	Gate Monolith		Computed by	JMH	Date	Dec-20
	KCS Gate Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	AML	Date	Dec-20

CPGA RESULTS without Load Factors (fixed connection)

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 27-DEC-20     RUN TIME: 11:49:51



    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.7.89; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE  14 PILES AND
            4 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                    X          Y          Z
                                  -----      -----      -----
WITH DIAGONAL COORDINATES = (      -3.00 ,   -19.50 ,     0.00 )
                            (       3.00 ,    19.50 ,     0.00 )


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         PILE PROPERTIES AS INPUT
```

Job	Maurepaus Swamp		Project No.	60632162		
Description	Gate Monolith		Computed by	JMH	Date	Dec-20
	KCS Gate Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	AML	Date	Dec-20

```
      E           I1          I2          A           C33         B66
     KSI         IN**4       IN**4       IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         SOIL DESCRIPTIONS AS INPUT


   ES     ESOIL      LENGTH       L            LU
         K/IN**2                  FT           FT
        0.38050E+00    T      0.41390E+02   0.00000E+00

 ESOIL(ORIGINAL)      RGROUP     RCYCLIC
   K/IN**2
  0.38050E+00       0.1000E+01 0.1000E+01

THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


 0.35937E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.16971E+04  0.00000E+00
 0.00000E+00  0.46458E+02  0.00000E+00 -0.28362E+04  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.20952E+04  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00 -0.28362E+04  0.00000E+00  0.34630E+06  0.00000E+00  0.00000E+00
 0.16971E+04  0.00000E+00  0.00000E+00  0.00000E+00  0.16028E+06  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


THIS MATRIX APPLIES TO THE FOLLOWING PILES -

      1
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

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*******************************************************************************

         PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM        X          Y           Z     BATTER   ANGLE   LENGTH  FIXITY
          FT         FT          FT                        FT

  1      3.00     -19.50       0.00     6.00     0.00    41.96    F
  2      3.00     -13.00       0.00     6.00     0.00    41.96    F
  3      3.00      -6.50       0.00     6.00     0.00    41.96    F
  4      3.00       0.00       0.00     6.00     0.00    41.96    F
  5      3.00       6.50       0.00     6.00     0.00    41.96    F
  6      3.00      13.00       0.00     6.00     0.00    41.96    F
  7      3.00      19.50       0.00     6.00     0.00    41.96    F
  8     -3.00     -19.50       0.00     6.00   180.00    41.96    F
  9     -3.00     -13.00       0.00     6.00   180.00    41.96    F
 10     -3.00      -6.50       0.00     6.00   180.00    41.96    F
 11     -3.00       0.00       0.00     6.00   180.00    41.96    F
 12     -3.00       6.50       0.00     6.00   180.00    41.96    F
 13     -3.00      13.00       0.00     6.00   180.00    41.96    F
 14     -3.00      19.50       0.00     6.00   180.00    41.96    F
                                                         ------
 587.45


*******************************************************************************

                        APPLIED LOADS

LOAD     PX         PY         PZ          MX          MY          MZ  OVERSTRESS
CASE      K          K          K        FT-K        FT-K        FT-K  COM    TEN

  1       0.0        0.0      486.7        0.0        74.6         0.0 1.17 1.17
  2    -225.5        0.0      264.7        0.0      1174.2         0.0 1.33 1.33
  3    -225.5        0.0      318.6        0.0      1064.9         0.0 1.33 1.33
  4       0.0        0.0      625.3        0.0        56.0         0.0


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Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

```
        ORIGINAL PILE GROUP STIFFNESS MATRIX

  0.12823E+04 -0.76889E-05  0.12506E-11 -0.19142E-03 -0.14487E+06  0.19737E-03
 -0.76889E-05  0.65041E+03  0.56887E-04 -0.39167E+05  0.22394E-02 -0.54570E-11
  0.12506E-11  0.56887E-04  0.28554E+05  0.47527E-04  0.00000E+00 -0.20479E-02
 -0.19142E-03 -0.39167E+05  0.47527E-04  0.69961E+09 -0.28383E-01 -0.74506E-08
 -0.14487E+06  0.22394E-02  0.00000E+00 -0.28383E-01  0.39531E+08 -0.90183E-01
  0.19737E-03 -0.54570E-11 -0.20479E-02 -0.74506E-08 -0.90183E-01  0.32650E+08



                    14 PILES    4 LOAD CASES

 LOAD CASE    1.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    2.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   7.

 LOAD CASE    3.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   7.

 LOAD CASE    4.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.


 *******************************************************************************

         PILE CAP DISPLACEMENTS

 LOAD
 CASE       DX          DY          DZ          RX          RY          RZ
            IN          IN          IN          RAD         RAD         RAD

    1   0.4366E-02 -0.1577E-08  0.1704E-01 -0.8671E-13  0.3865E-04  0.1149E-11
    2  -0.2314E+00 -0.1865E-08  0.9270E-02 -0.1883E-12 -0.4915E-03  0.6225E-12
    3  -0.2378E+00 -0.1911E-08  0.1116E-01 -0.1951E-12 -0.5481E-03  0.6232E-12
    4   0.3277E-02 -0.1983E-08  0.2190E-01 -0.1104E-12  0.2901E-04  0.1434E-11


 *******************************************************************************
              ELASTIC CENTER INFORMATION



 ELASTIC CENTER IN PLANE X-Z         X             Z
                                    FT            FT
                                   0.00          0.00
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

```
******************************************************************************

         PILE FORCES IN LOCAL GEOMETRY

             M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
             * INDICATES PILE FAILURE
             # INDICATES CBF BASED ON MOMENTS DUE TO
                         (F3*EMIN) FOR CONCRETE PILES
             B INDICATES BUCKLING CONTROLS
```

LOAD CASE - 1

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	0.1	0.0	33.9	0.0	9.1	0.0	0.53	0.07
2	0.1	0.0	33.9	0.0	9.1	0.0	0.53	0.07
3	0.1	0.0	33.9	0.0	9.1	0.0	0.53	0.07
4	0.1	0.0	33.9	0.0	9.1	0.0	0.53	0.07
5	0.1	0.0	33.9	0.0	9.1	0.0	0.53	0.07
6	0.1	0.0	33.9	0.0	9.1	0.0	0.53	0.07
7	0.1	0.0	33.9	0.0	9.1	0.0	0.53	0.07
8	-0.3	0.0	36.6	0.0	-18.6	0.0	0.57	0.08
9	-0.3	0.0	36.6	0.0	-18.6	0.0	0.57	0.08
10	-0.3	0.0	36.6	0.0	-18.6	0.0	0.57	0.08
11	-0.3	0.0	36.6	0.0	-18.6	0.0	0.57	0.08
12	-0.3	0.0	36.6	0.0	-18.6	0.0	0.57	0.08
13	-0.3	0.0	36.6	0.0	-18.6	0.0	0.57	0.08
14	-0.3	0.0	36.6	0.0	-18.6	0.0	0.57	0.08

LOAD CASE - 2

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	-9.2	0.0	-24.0	0.0	-473.6	0.0	0.51	0.39
2	-9.2	0.0	-24.0	0.0	-473.6	0.0	0.51	0.39
3	-9.2	0.0	-24.0	0.0	-473.6	0.0	0.51	0.39
4	-9.2	0.0	-24.0	0.0	-473.6	0.0	0.51	0.39
5	-9.2	0.0	-24.0	0.0	-473.6	0.0	0.51	0.39
6	-9.2	0.0	-24.0	0.0	-473.6	0.0	0.51	0.39
7	-9.2	0.0	-24.0	0.0	-473.6	0.0	0.51	0.39
8	9.1	0.0	62.3	0.0	468.5	0.0	0.85	0.45
9	9.1	0.0	62.3	0.0	468.5	0.0	0.85	0.45
10	9.1	0.0	62.3	0.0	468.5	0.0	0.85	0.45
11	9.1	0.0	62.3	0.0	468.5	0.0	0.85	0.45
12	9.1	0.0	62.3	0.0	468.5	0.0	0.85	0.45
13	9.1	0.0	62.3	0.0	468.5	0.0	0.85	0.45
14	9.1	0.0	62.3	0.0	468.5	0.0	0.85	0.45

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

LOAD CASE - 3

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	-9.5	0.0	-18.1	0.0	-494.5	0.0	0.39	0.40
2	-9.5	0.0	-18.1	0.0	-494.5	0.0	0.39	0.40
3	-9.5	0.0	-18.1	0.0	-494.5	0.0	0.39	0.40
4	-9.5	0.0	-18.1	0.0	-494.5	0.0	0.39	0.40
5	-9.5	0.0	-18.1	0.0	-494.5	0.0	0.39	0.40
6	-9.5	0.0	-18.1	0.0	-494.5	0.0	0.39	0.40
7	-9.5	0.0	-18.1	0.0	-494.5	0.0	0.39	0.40
8	9.4	0.0	64.2	0.0	488.3	0.0	0.88	0.47
9	9.4	0.0	64.2	0.0	488.3	0.0	0.88	0.47
10	9.4	0.0	64.2	0.0	488.3	0.0	0.88	0.47
11	9.4	0.0	64.2	0.0	488.3	0.0	0.88	0.47
12	9.4	0.0	64.2	0.0	488.3	0.0	0.88	0.47
13	9.4	0.0	64.2	0.0	488.3	0.0	0.88	0.47
14	9.4	0.0	64.2	0.0	488.3	0.0	0.88	0.47

LOAD CASE - 4

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	0.0	0.0	44.2	0.0	4.3	0.0	0.80	0.09
2	0.0	0.0	44.2	0.0	4.3	0.0	0.80	0.09
3	0.0	0.0	44.2	0.0	4.3	0.0	0.80	0.09
4	0.0	0.0	44.2	0.0	4.3	0.0	0.80	0.09
5	0.0	0.0	44.2	0.0	4.3	0.0	0.80	0.09
6	0.0	0.0	44.2	0.0	4.3	0.0	0.80	0.09
7	0.0	0.0	44.2	0.0	4.3	0.0	0.80	0.09
8	-0.3	0.0	46.3	0.0	-16.5	0.0	0.84	0.11
9	-0.3	0.0	46.3	0.0	-16.5	0.0	0.84	0.11
10	-0.3	0.0	46.3	0.0	-16.5	0.0	0.84	0.11
11	-0.3	0.0	46.3	0.0	-16.5	0.0	0.84	0.11
12	-0.3	0.0	46.3	0.0	-16.5	0.0	0.84	0.11
13	-0.3	0.0	46.3	0.0	-16.5	0.0	0.84	0.11
14	-0.3	0.0	46.3	0.0	-16.5	0.0	0.84	0.11

****

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	CPGA Input & Output Files (Pile Analysis)	Checked by	AML	Date	Dec-20

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	5.7	0.0	33.4	0.0	9.1	0.0
2	5.7	0.0	33.4	0.0	9.1	0.0
3	5.7	0.0	33.4	0.0	9.1	0.0
4	5.7	0.0	33.4	0.0	9.1	0.0
5	5.7	0.0	33.4	0.0	9.1	0.0
6	5.7	0.0	33.4	0.0	9.1	0.0
7	5.7	0.0	33.4	0.0	9.1	0.0
8	-5.7	0.0	36.2	0.0	18.6	0.0
9	-5.7	0.0	36.2	0.0	18.6	0.0
10	-5.7	0.0	36.2	0.0	18.6	0.0
11	-5.7	0.0	36.2	0.0	18.6	0.0
12	-5.7	0.0	36.2	0.0	18.6	0.0
13	-5.7	0.0	36.2	0.0	18.6	0.0
14	-5.7	0.0	36.2	0.0	18.6	0.0

LOAD CASE - 2

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	-13.0	0.0	-22.1	0.0	-473.6	0.0
2	-13.0	0.0	-22.1	0.0	-473.6	0.0
3	-13.0	0.0	-22.1	0.0	-473.6	0.0
4	-13.0	0.0	-22.1	0.0	-473.6	0.0
5	-13.0	0.0	-22.1	0.0	-473.6	0.0
6	-13.0	0.0	-22.1	0.0	-473.6	0.0
7	-13.0	0.0	-22.1	0.0	-473.6	0.0
8	-19.2	0.0	59.9	0.0	-468.5	0.0
9	-19.2	0.0	59.9	0.0	-468.5	0.0
10	-19.2	0.0	59.9	0.0	-468.5	0.0
11	-19.2	0.0	59.9	0.0	-468.5	0.0
12	-19.2	0.0	59.9	0.0	-468.5	0.0
13	-19.2	0.0	59.9	0.0	-468.5	0.0
14	-19.2	0.0	59.9	0.0	-468.5	0.0

Job	Maurepaus Swamp		Project No.	60632162		
Description	Gate Monolith		Computed by	JMH	Date	Dec-20
	KCS Gate Monolith					
	CPGA Input & Output Files (Pile Analysis)		Checked by	AML	Date	Dec-20

LOAD CASE - 3

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	-12.4	0.0	-16.2	0.0	-494.5	0.0
2	-12.4	0.0	-16.2	0.0	-494.5	0.0
3	-12.4	0.0	-16.2	0.0	-494.5	0.0
4	-12.4	0.0	-16.2	0.0	-494.5	0.0
5	-12.4	0.0	-16.2	0.0	-494.5	0.0
6	-12.4	0.0	-16.2	0.0	-494.5	0.0
7	-12.4	0.0	-16.2	0.0	-494.5	0.0
8	-19.8	0.0	61.8	0.0	-488.3	0.0
9	-19.8	0.0	61.8	0.0	-488.3	0.0
10	-19.8	0.0	61.8	0.0	-488.3	0.0
11	-19.8	0.0	61.8	0.0	-488.3	0.0
12	-19.8	0.0	61.8	0.0	-488.3	0.0
13	-19.8	0.0	61.8	0.0	-488.3	0.0
14	-19.8	0.0	61.8	0.0	-488.3	0.0

LOAD CASE - 4

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	7.3	0.0	43.6	0.0	4.3	0.0
2	7.3	0.0	43.6	0.0	4.3	0.0
3	7.3	0.0	43.6	0.0	4.3	0.0
4	7.3	0.0	43.6	0.0	4.3	0.0
5	7.3	0.0	43.6	0.0	4.3	0.0
6	7.3	0.0	43.6	0.0	4.3	0.0
7	7.3	0.0	43.6	0.0	4.3	0.0
8	-7.3	0.0	45.7	0.0	16.5	0.0
9	-7.3	0.0	45.7	0.0	16.5	0.0
10	-7.3	0.0	45.7	0.0	16.5	0.0
11	-7.3	0.0	45.7	0.0	16.5	0.0
12	-7.3	0.0	45.7	0.0	16.5	0.0
13	-7.3	0.0	45.7	0.0	16.5	0.0
14	-7.3	0.0	45.7	0.0	16.5	0.0

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	AML	Date	Dec-20

Input file:

```
100 MONOLITH, TOW EL. 16.13, TOS EL.7.89; HP 14X73  PILES
200 PROP 29000 729 261 21.4 1.7 0 ALL
300 SOIL ES 0.3805 TIP 41.39 0 ALL
400 PIN ALL
500 ALLOW H 55 35 492.7 535 2972.2 994.4 ALL
600 FOVSTR 1 1 1
700 FOVSTR 1 1 2 3 4
800 BATTER 6 All
1200 ANGLE 180 8 TO 14
1300 PILE 1 3 -19.5 0
1400 PILE 2 3 -13 0
1500 PILE 3 3 -6.5 0
1600 PILE 4 3 0 0
1700 PILE 5 3 6.5 0
1800 PILE 6 3 13 0
1900 PILE 7 3 19.5 0
2000 PILE 8 -3 -19.5 0
2100 PILE 9 -3 -13 0
2200 PILE 10 -3 -6.5 0
2300 PILE 11 -3 0 0
2400 PILE 12 -3 6.5 0
2500 PILE 13 -3 13 0
2600 PILE 14 -3 19.5 0
4500 LOAD 1 0 0 778.7 0 119.3 0
4600 LOAD 2 -360.8 0 423.5 0 1878.7 0
4700 LOAD 3 -360.8 0 509.7 0 1703.8 0
4800 LOAD 4 0 0 1375.7 0 123.2 0
9000 FOUT 1 2 3 4 5 6 7 KCS01S.DOC
9100 PFO ALL
9200 PLB ALL
```

AECOM

Job	Maurepaus Swamp		Project No.	60632162		
Description	Gate Monolith		Computed by	JMH	Date	Dec-20
	KCS Gate Monolith					
	CPGA Input & Output Files (Concrete Design)		Checked by	AML	Date	Dec-20

CPGA RESULTS with Load Factors

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 27-DEC-20     RUN TIME: 11:50:40




    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.7.89; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE  14 PILES AND
            4 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                    X          Y          Z
                                  -----      -----      -----
WITH DIAGONAL COORDINATES = (     -3.00 ,   -19.50 ,     0.00 )
                            (      3.00 ,    19.50 ,     0.00 )


*******************************************************************************

         PILE PROPERTIES AS INPUT


      E            I1            I2            A            C33           B66
     KSI          IN**4         IN**4         IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


*******************************************************************************
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	AML	Date	Dec-20

```
         SOIL DESCRIPTIONS AS INPUT


    ES      ESOIL       LENGTH        L            LU
           K/IN**2                    FT           FT
          0.38050E+00    T      0.41390E+02   0.00000E+00

  ESOIL(ORIGINAL)      RGROUP     RCYCLIC
    K/IN**2
   0.38050E+00       0.1000E+01 0.1000E+01

 THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

     ALL


 ******************************************************************************

         PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


  0.17968E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.23229E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.20952E+04  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


 THIS MATRIX APPLIES TO THE FOLLOWING PILES -

       1


 ******************************************************************************
```

Job	Maurepaus Swamp		Project No.	60632162	
Description	Gate Monolith		Computed by	JMH	Date Dec-20
	KCS Gate Monolith				
	CPGA Input & Output Files (Concrete Design)		Checked by	AML	Date Dec-20

PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM	X FT	Y FT	Z FT	BATTER	ANGLE	LENGTH FT	FIXITY
1	3.00	-19.50	0.00	6.00	0.00	41.96	P
2	3.00	-13.00	0.00	6.00	0.00	41.96	P
3	3.00	-6.50	0.00	6.00	0.00	41.96	P
4	3.00	0.00	0.00	6.00	0.00	41.96	P
5	3.00	6.50	0.00	6.00	0.00	41.96	P
6	3.00	13.00	0.00	6.00	0.00	41.96	P
7	3.00	19.50	0.00	6.00	0.00	41.96	P
8	-3.00	-19.50	0.00	6.00	180.00	41.96	P
9	-3.00	-13.00	0.00	6.00	180.00	41.96	P
10	-3.00	-6.50	0.00	6.00	180.00	41.96	P
11	-3.00	0.00	0.00	6.00	180.00	41.96	P
12	-3.00	6.50	0.00	6.00	180.00	41.96	P
13	-3.00	13.00	0.00	6.00	180.00	41.96	P
14	-3.00	19.50	0.00	6.00	180.00	41.96	P

587.45

****

APPLIED LOADS

LOAD CASE	PX K	PY K	PZ K	MX FT-K	MY FT-K	MZ FT-K
1	0.0	0.0	778.7	0.0	119.3	0.0
2	-360.8	0.0	423.5	0.0	1878.7	0.0
3	-360.8	0.0	509.7	0.0	1703.8	0.0
4	0.0	0.0	1375.7	0.0	123.2	0.0

****

ORIGINAL PILE GROUP STIFFNESS MATRIX

0.10376E+04	-0.86678E-05	0.56843E-12	0.00000E+00	-0.16978E+06	0.31204E-03
-0.86678E-05	0.32521E+03	0.57384E-04	-0.21684E-18	0.20658E-02	-0.65938E-11
0.56843E-12	0.57384E-04	0.28547E+05	0.00000E+00	0.29104E-10	-0.20658E-02
0.00000E+00	0.21684E-18	-0.58208E-10	0.69473E+09	0.00000E+00	-0.18626E-07
-0.16978E+06	0.20658E-02	0.29104E-10	0.00000E+00	0.36997E+08	-0.74369E-01
0.31204E-03	-0.65938E-11	-0.20658E-02	-0.74506E-08	-0.74369E-01	0.25671E+08

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	AML	Date	Dec-20

```
                    14 PILES    4 LOAD CASES

 LOAD CASE    1.  NUMBER OF FAILURES =   7.  NUMBER OF PILES IN TENSION =   0.

 LOAD CASE    2.  NUMBER OF FAILURES =   7.  NUMBER OF PILES IN TENSION =   7.

 LOAD CASE    3.  NUMBER OF FAILURES =   7.  NUMBER OF PILES IN TENSION =   7.

 LOAD CASE    4.  NUMBER OF FAILURES =  14.  NUMBER OF PILES IN TENSION =   0.


 ******************************************************************************

          PILE CAP DISPLACEMENTS

 LOAD
 CASE       DX          DY          DZ          RX          RY          RZ
            IN          IN          IN          RAD         RAD         RAD

    1   0.2541E-01 -0.5122E-08  0.2728E-01  0.2285E-20  0.1553E-03  0.2336E-11
    2  -0.9956E+00 -0.4003E-08  0.1483E-01  0.1243E-20 -0.3959E-02  0.1826E-11
    3  -0.1033E+01 -0.4082E-08  0.1785E-01  0.1496E-20 -0.4187E-02  0.1862E-11
    4   0.2625E-01 -0.8823E-08  0.4819E-01  0.4038E-20  0.1604E-03  0.4024E-11


 ******************************************************************************
               ELASTIC CENTER INFORMATION



 ELASTIC CENTER IN PLANE X-Z          X             Z
                                     FT            FT
                                    0.00          0.00


 ******************************************************************************
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Job	Maurepaus Swamp		Project No.	60632162	
Description	Gate Monolith		Computed by	JMH	Date Dec-20
	KCS Gate Monolith				
	CPGA Input & Output Files (Concrete Design)		Checked by	AML	Date Dec-20

PILE FORCES IN LOCAL GEOMETRY

M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
* INDICATES PILE FAILURE
# INDICATES CBF BASED ON MOMENTS DUE TO
(F3*EMIN) FOR CONCRETE PILES
B INDICATES BUCKLING CONTROLS

LOAD CASE - 1

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF	
1	0.4	0.0	53.6	0.0	-11.8	0.0	0.97	0.12	
2	0.4	0.0	53.6	0.0	-11.8	0.0	0.97	0.12	
3	0.4	0.0	53.6	0.0	-11.8	0.0	0.97	0.12	
4	0.4	0.0	53.6	0.0	-11.8	0.0	0.97	0.12	
5	0.4	0.0	53.6	0.0	-11.8	0.0	0.97	0.12	
6	0.4	0.0	53.6	0.0	-11.8	0.0	0.97	0.12	
7	0.4	0.0	53.6	0.0	-11.8	0.0	0.97	0.12	
8	-0.5	0.0	59.2	0.0	16.7	0.0	1.08	0.14	*
9	-0.5	0.0	59.2	0.0	16.7	0.0	1.08	0.14	*
10	-0.5	0.0	59.2	0.0	16.7	0.0	1.08	0.14	*
11	-0.5	0.0	59.2	0.0	16.7	0.0	1.08	0.14	*
12	-0.5	0.0	59.2	0.0	16.7	0.0	1.08	0.14	*
13	-0.5	0.0	59.2	0.0	16.7	0.0	1.08	0.14	*
14	-0.5	0.0	59.2	0.0	16.7	0.0	1.08	0.14	*

LOAD CASE - 2

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF	
1	-18.1	0.0	-17.7	0.0	550.8	0.0	0.51	0.59	
2	-18.1	0.0	-17.7	0.0	550.8	0.0	0.51	0.59	
3	-18.1	0.0	-17.7	0.0	550.8	0.0	0.51	0.59	
4	-18.1	0.0	-17.7	0.0	550.8	0.0	0.51	0.59	
5	-18.1	0.0	-17.7	0.0	550.8	0.0	0.51	0.59	
6	-18.1	0.0	-17.7	0.0	550.8	0.0	0.51	0.59	
7	-18.1	0.0	-17.7	0.0	550.8	0.0	0.51	0.59	
8	18.0	0.0	79.0	0.0	-548.1	0.0	1.44	0.71	*
9	18.0	0.0	79.0	0.0	-548.1	0.0	1.44	0.71	*
10	18.0	0.0	79.0	0.0	-548.1	0.0	1.44	0.71	*
11	18.0	0.0	79.0	0.0	-548.1	0.0	1.44	0.71	*
12	18.0	0.0	79.0	0.0	-548.1	0.0	1.44	0.71	*
13	18.0	0.0	79.0	0.0	-548.1	0.0	1.44	0.71	*
14	18.0	0.0	79.0	0.0	-548.1	0.0	1.44	0.71	*

Job	Maurepaus Swamp		Project No.	60632162		
Description	Gate Monolith		Computed by	JMH	Date	Dec-20
	KCS Gate Monolith					
	CPGA Input & Output Files (Concrete Design)		Checked by	AML	Date	Dec-20

LOAD CASE - 3

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF	
	K	K	K	IN-K	IN-K	IN-K			
1	-18.8	0.0	-7.4	0.0	571.9	0.0	0.21	0.59	
2	-18.8	0.0	-7.4	0.0	571.9	0.0	0.21	0.59	
3	-18.8	0.0	-7.4	0.0	571.9	0.0	0.21	0.59	
4	-18.8	0.0	-7.4	0.0	571.9	0.0	0.21	0.59	
5	-18.8	0.0	-7.4	0.0	571.9	0.0	0.21	0.59	
6	-18.8	0.0	-7.4	0.0	571.9	0.0	0.21	0.59	
7	-18.8	0.0	-7.4	0.0	571.9	0.0	0.21	0.59	
8	18.7	0.0	81.2	0.0	-568.7	0.0	1.48	0.74	*
9	18.7	0.0	81.2	0.0	-568.7	0.0	1.48	0.74	*
10	18.7	0.0	81.2	0.0	-568.7	0.0	1.48	0.74	*
11	18.7	0.0	81.2	0.0	-568.7	0.0	1.48	0.74	*
12	18.7	0.0	81.2	0.0	-568.7	0.0	1.48	0.74	*
13	18.7	0.0	81.2	0.0	-568.7	0.0	1.48	0.74	*
14	18.7	0.0	81.2	0.0	-568.7	0.0	1.48	0.74	*

LOAD CASE - 4

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF	
	K	K	K	IN-K	IN-K	IN-K			
1	0.3	0.0	96.7	0.0	-10.3	0.0	1.76	0.21	*
2	0.3	0.0	96.7	0.0	-10.3	0.0	1.76	0.21	*
3	0.3	0.0	96.7	0.0	-10.3	0.0	1.76	0.21	*
4	0.3	0.0	96.7	0.0	-10.3	0.0	1.76	0.21	*
5	0.3	0.0	96.7	0.0	-10.3	0.0	1.76	0.21	*
6	0.3	0.0	96.7	0.0	-10.3	0.0	1.76	0.21	*
7	0.3	0.0	96.7	0.0	-10.3	0.0	1.76	0.21	*
8	-0.6	0.0	102.5	0.0	19.0	0.0	1.86	0.23	*
9	-0.6	0.0	102.5	0.0	19.0	0.0	1.86	0.23	*
10	-0.6	0.0	102.5	0.0	19.0	0.0	1.86	0.23	*
11	-0.6	0.0	102.5	0.0	19.0	0.0	1.86	0.23	*
12	-0.6	0.0	102.5	0.0	19.0	0.0	1.86	0.23	*
13	-0.6	0.0	102.5	0.0	19.0	0.0	1.86	0.23	*
14	-0.6	0.0	102.5	0.0	19.0	0.0	1.86	0.23	*

****

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	CPGA Input & Output Files (Concrete Design)	Checked by	AML	Date	Dec-20

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	9.2	0.0	52.8	0.0	0.0	0.0
2	9.2	0.0	52.8	0.0	0.0	0.0
3	9.2	0.0	52.8	0.0	0.0	0.0
4	9.2	0.0	52.8	0.0	0.0	0.0
5	9.2	0.0	52.8	0.0	0.0	0.0
6	9.2	0.0	52.8	0.0	0.0	0.0
7	9.2	0.0	52.8	0.0	0.0	0.0
8	-9.2	0.0	58.5	0.0	0.0	0.0
9	-9.2	0.0	58.5	0.0	0.0	0.0
10	-9.2	0.0	58.5	0.0	0.0	0.0
11	-9.2	0.0	58.5	0.0	0.0	0.0
12	-9.2	0.0	58.5	0.0	0.0	0.0
13	-9.2	0.0	58.5	0.0	0.0	0.0
14	-9.2	0.0	58.5	0.0	0.0	0.0

LOAD CASE - 2

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	-20.8	0.0	-14.5	0.0	0.0	0.0
2	-20.8	0.0	-14.5	0.0	0.0	0.0
3	-20.8	0.0	-14.5	0.0	0.0	0.0
4	-20.8	0.0	-14.5	0.0	0.0	0.0
5	-20.8	0.0	-14.5	0.0	0.0	0.0
6	-20.8	0.0	-14.5	0.0	0.0	0.0
7	-20.8	0.0	-14.5	0.0	0.0	0.0
8	-30.8	0.0	75.0	0.0	0.0	0.0
9	-30.8	0.0	75.0	0.0	0.0	0.0
10	-30.8	0.0	75.0	0.0	0.0	0.0
11	-30.8	0.0	75.0	0.0	0.0	0.0
12	-30.8	0.0	75.0	0.0	0.0	0.0
13	-30.8	0.0	75.0	0.0	0.0	0.0
14	-30.8	0.0	75.0	0.0	0.0	0.0

Job	Maurepaus Swamp		Project No.	60632162		
Description	Gate Monolith		Computed by	JMH	Date	Dec-20
	KCS Gate Monolith					
	CPGA Input & Output Files (Concrete Design)		Checked by	AML	Date	Dec-20

LOAD CASE - 3

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	-19.8	0.0	-4.2	0.0	0.0	0.0
2	-19.8	0.0	-4.2	0.0	0.0	0.0
3	-19.8	0.0	-4.2	0.0	0.0	0.0
4	-19.8	0.0	-4.2	0.0	0.0	0.0
5	-19.8	0.0	-4.2	0.0	0.0	0.0
6	-19.8	0.0	-4.2	0.0	0.0	0.0
7	-19.8	0.0	-4.2	0.0	0.0	0.0
8	-31.8	0.0	77.0	0.0	0.0	0.0
9	-31.8	0.0	77.0	0.0	0.0	0.0
10	-31.8	0.0	77.0	0.0	0.0	0.0
11	-31.8	0.0	77.0	0.0	0.0	0.0
12	-31.8	0.0	77.0	0.0	0.0	0.0
13	-31.8	0.0	77.0	0.0	0.0	0.0
14	-31.8	0.0	77.0	0.0	0.0	0.0

LOAD CASE - 4

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	16.2	0.0	95.3	0.0	0.0	0.0
2	16.2	0.0	95.3	0.0	0.0	0.0
3	16.2	0.0	95.3	0.0	0.0	0.0
4	16.2	0.0	95.3	0.0	0.0	0.0
5	16.2	0.0	95.3	0.0	0.0	0.0
6	16.2	0.0	95.3	0.0	0.0	0.0
7	16.2	0.0	95.3	0.0	0.0	0.0
8	-16.2	0.0	101.2	0.0	0.0	0.0
9	-16.2	0.0	101.2	0.0	0.0	0.0
10	-16.2	0.0	101.2	0.0	0.0	0.0
11	-16.2	0.0	101.2	0.0	0.0	0.0
12	-16.2	0.0	101.2	0.0	0.0	0.0
13	-16.2	0.0	101.2	0.0	0.0	0.0
14	-16.2	0.0	101.2	0.0	0.0	0.0

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Summary of Shear & Moment	Checked by	AML	Date	Dec-20
					References

Load Case	$V_{u,max}$ (kip/ft)	$M_{u,max}$ (kip/ft)
LC1	0.00	0.00
LC2	3.39	9.29
LC3	3.39	9.29
LC4	0.00	0.00

*Note: LC 1 and 4 only have vertical forces, so there is no shear or moment on the wall.

The following calculations are the max shear (Vu) and moment (Mu) on the wall form LC 2 and LC 3:

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JOB TITLE Maurepas WSLP Structures – KCS Gate
PROJECT/JOB NO. CALCULATION NO.
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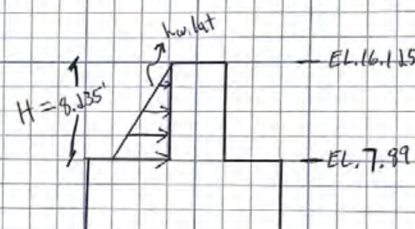
SCALE SHEET NO. 1 OF

Wall Calculations:

Assumptions:

$t = 1.5' = 18"$
$cover = 3"$
$d = 18" - 3" - .75"$ ⇝ Assume #6 bars
$b = 12"$
$\phi_{shear} = .75$
$\phi_{moment} = .9$
$F_y = 60$ ksi
$f'_c = 4$ ksi

* These calculations only show the loading condition for water to TOW (LC 2 & 3) shown below:



① Shear Calculations:

$h_{w,lat} \rightarrow V_u = \frac{1}{2}(\gamma_{water})(H)^2 = \frac{1}{2}(.0624\ k/ft^3)(8.135')^2$

$V_u = 2.116$ kip/ft

$1.6\ V_u = \boxed{3.39\ \text{kip/ft} = V_u \text{ on 1' of wall}}$

② Moment Calculations:

$h_{w,lat} \rightarrow M_u = V_u\left(\frac{H}{3}\right) = (3.39)\left(\frac{8.135'}{3}\right) = 9.29\ \frac{k\text{-}ft}{ft}$

$\boxed{M_u = 9.29\ \frac{k\text{-}ft}{ft} \text{ on 1' of wall}}$

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Shear & Moment Check for Wall	Checked by	AML	Date	Dec-20
					References

*** Given Information:**

Wall Thickness:	1.50	ft
Clear Cover:	0.25	ft
Diameter Bar to Start:	0.06	ft
Maximum Shear (V_u):	3.39	kips per foot
Maximum Moment (M_u):	9.29	kip-ft per foot
φ_{shear} =	0.75	(ACI 318)
φ_{moment} =	0.9	(ACI 318)
$f_{y, rebar}$ =	60	ksi
f'_c =	4	ksi

*** Shear Calculations:**

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u) (ACI Eq. 11-1)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75	
f'_c =	4	ksi
b =	1	ft strip
d =	1.22	ft

φV_c =	16649.4	lbs	
	16.65	kips	** φVc=16.6 ≥ Vu=3.4, **Shear Capacity OK**

*** Reinforcement Calculations:**

Limit of Maximum Reinforcement: 0.25 x ρ_b (Design Criteria, EM 1110-2-2104, 3-5)

where ρ_b =	0.0285	for f'_c = 4,000psi, fy = 60,000psi
Max Rebar =	0.00713	*b * d

Maximum Reinforcement:	0.0071	* b * d =	1.25	in^2	per 1ft strip

A_{gross} = 1.5 ft * 12 in/ft * 12 in strip = 216.00 in^2

Limits of Minimum Reinforcement:	0.005 x Agross =	1.08	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
	$(3*\sqrt{(f'_c)}*b*d)/f_y$ =	0.55	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)
	$(200*b*d)/f_y$ =	0.59	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)

Min Reinforcement, temp & shrinkage:	0.54	in^2	per 1ft strip, per face
Min Reinforcement, flexural:	0.59	in^2	per 1ft strip, per face

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Shear & Moment Check for Wall	Checked by	AML	Date	Dec-20
					References

* Moment Calculations:

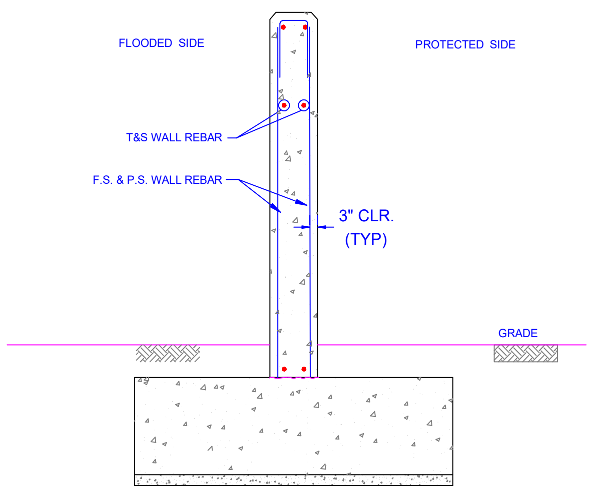
* $T = A_s \times f_y$
* $C = 0.85 \times f'_c \times a \times b$
* Assuming Tension = Compression ⟶ $A_s \times f_y = 0.85 \times f'_c \times a \times b$
* $\varphi Mn = \varphi \times T \times (d - (a / 2))$
  $= \varphi \times A_s \times f_y \times (d - (a / 2))$

* Capacity of Min Flexural Reinforcement:

A_s =	0.585	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	1.21875	
φ_{moment} =	0.9	

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$
= 0.860 in

φM_n =	448.4	kip-in
=	37.37	kip-ft



* Capacity of Maximum Reinforcement:

A_s =	1.250	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	1.22	
φ_{moment} =	0.9	

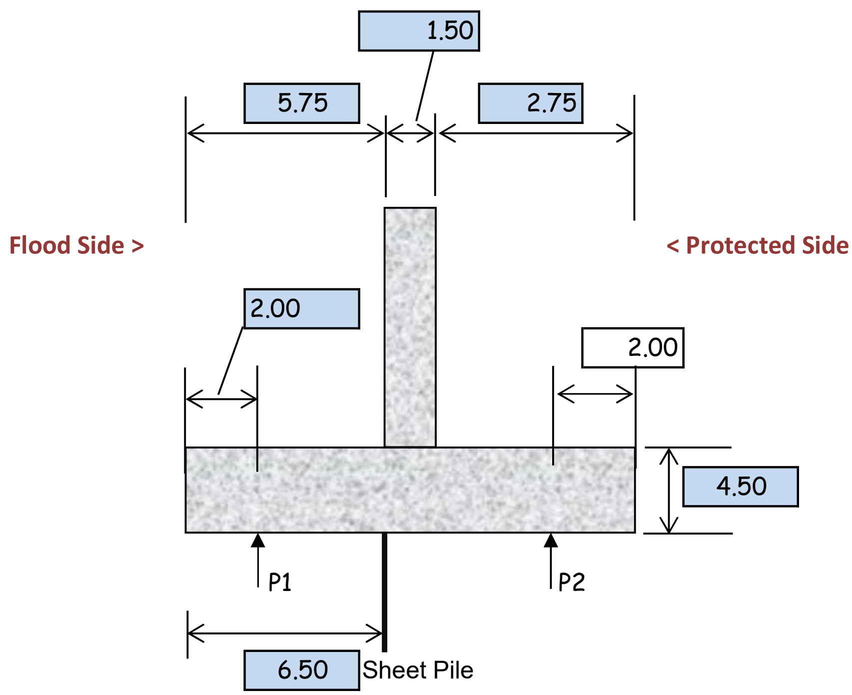
a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$
= 1.839 in

φMn =	925.4	kip-in
=	77.12	kip-ft

**** $\varphi Mn=77.1 \geq Mu=9.3$, Section OK**

The minimum proposed reinforcement for T&S Wall Rebar is #6 @ 9" (A = 0.59 in^2) and the minimum proposed reinforcement for F.S. & P.S. Wall Rebar is #6 @ 9"(A=0.59 in^2).

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Slab	Checked by	AML	Date	Dec-20
					References



Tributary width (pile spacing): 6.5 ft Referred to as "width" in calculations

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
					References

*Note: The following calculations represent the total shear (Vu) and moment (Mu) on both sides of the slab for all Load Combos. The calcs shown below only consider the t-wall section in this monolith. In theory, adding the gate sill will increase the rigidity of the structure; therefore, if the t-wall section of the monolith passes, then the gate (or middle) section of the monolith will also pass. Capacity calculations for the slab can be found in the "Slab Conc Check" tab. All reactions are taken from the pinned or fixed results from CPGA.

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JOB TITLE Maurepas WSLP Structures – KCS Gate
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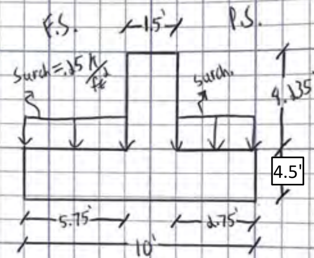
SCALE SHEET NO. 2 OF

Slab Calculations:

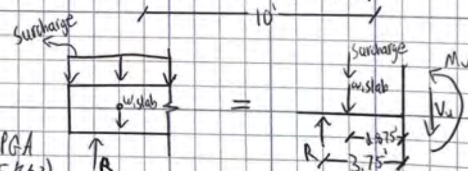
1) Construction Surcharge

→ Concrete wt.
→ Surcharge = .25 K/ft²
→ Assume 6.5' of trib. length between piles
→ $\gamma_{conc.}$ = .15 k/ft³



Flood Side:

V_u →



R = 33.4 Kip from CPGA

w,slab = (5.75')(6.5')(4.5')(.15 k/ft³)

w,slab = 25.23 Kip

Surcharge = (.25 K/ft²)(5.75')(6.5')

Surcharge = 9.34 Kip

V_u = 9.34 + 25.23 + (- 33.4)

V_u = 1.17 Kip

$1.6V_u = \frac{1.87 \text{ Kip}}{6.5'}$ = .29 Kip/ft

6.5' → trib. length

4x4 = 1 in

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
					References

JOB TITLE
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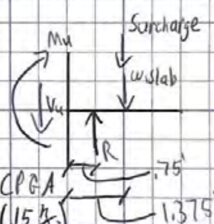
$M_u \rightarrow R = 33.4$ Kip @ 3.75' ⊖
$w_i slab = 25.23$ Kip @ 2.875' ⊕
Surch. = 9.34 kip @ 2.875' ⊕

$M_u = (9.34)(2.875) + (25.23)(2.875') - (33.4)(3.75)$
$M_u = -25.86$ kip-ft
$1.6\ M_u = \frac{-41.38 \text{ kip-ft}}{6.5'} = -6.36 \frac{\text{kip-ft}}{\text{ft}}$
6.5' → trib. length

Protected Side:

$V_u \rightarrow$



$R = 36.5$ kip from CPGA
$w_i slab = (2.75')(6.5')(4.5')(.15 \frac{k}{ft^3})$
$w_i slab = 12.07$ kip
$Surcharge = (2.75')(6.5')(.25 ksf)$
$Surcharge = 4.47$ kip

$V_u = 4.47 + 12.07 - 36.5$
$V_u = -19.96$ Kip
$1.6\ V_u = \frac{-31.94 \text{ Kip}}{6.5'} = V_u = -4.91 \frac{\text{kip}}{\text{ft}}$

$M_u \rightarrow R = 36.5$ Kip @ .75' ⊖
$W_i slab = 12.07$ Kip @ 1.375' ⊕
Surcharge = 4.47 Kip @ 1.375' ⊕

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
				References	

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SCALE SHEET NO. 4 OF

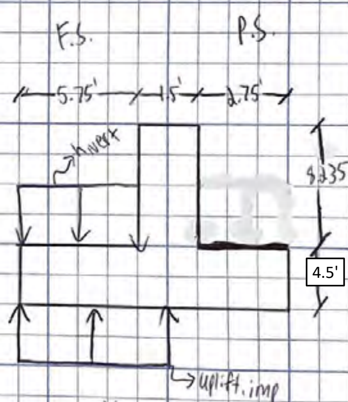
$M_u = (4.47)(1.375) + (12.07)(1.375) - (36.5)(.75)$

$M_u =$ -4.63 kip-ft

$1.6\,M_u = \dfrac{-7.41 \text{ kip-ft}}{6.5'} = -1.14 \dfrac{\text{kip-ft}}{\text{ft}} = M_u$

2. Water to TOW (impervious)

→ concrete weight
→ h_{lat} can be ignored
→ h_{vert}
→ Uplift, impervious (assume sheetpile is at middle of wall)
→ Assume 6.5' of trib length between piles



Flood Side:

V_u →

R = -22.1 kip from CPGA

$w_{slab} = (5.75')(6.5')(4.5')(.15 \text{ kcf})$

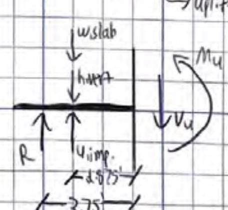
$w_{slab} =$ 25.23 Kip

$h_{vert} = (5.75')(6.5')(8.335')(.0624 \text{ kcf})$

$h_{vert} = 19.21$ Kip

Uplift $= (5.75')(6.5')(12.74')(.0624 \text{ kcf})$

Uplift = 29.71 Kip



4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
					References

AECOM Imagine it. Delivered.

JOB TITLE
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SCALE SHEET NO. 5 OF

$V_u = 22.1 + 25.23 + 19.21 - 29.71$

$V_u = 36.83$ kip

$1.6 V_u = \frac{58.93 \text{ kip}}{6.5'} = 9.07 \frac{\text{kip}}{\text{ft}} = V_u$

$M_u \longrightarrow$ $R = -22.1$ kip @ $3.75'$ (+)

$w_{slab} = 25.23$ kip @ $2.875'$ (+)

$h_{vert} = 19.21$ kip @ $2.875'$ (+)

Uplift $= 29.71$ kip @ $2.875'$ (−)

$M_u = 22.1(3.75) + (25.23)(2.875) + (19.21)(2.875) - (29.71)(2.875)$

$M_u = 125.22$ kip-ft

$1.6 M_u = \frac{200.36 \text{ kip-ft}}{6.5'} = 30.82 \frac{\text{kip-ft}}{\text{ft}} = M_u$

6.5' → trib length

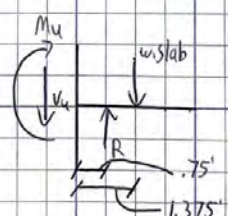
Protected Side:

$V_u \rightarrow$

$R = 59.9$ kip from CGA

$w_{slab} = (2.75')(6.5')(4.5')(.15\ kcf)$

$w_{slab} = 12.07$ kip



$V_u = 12.07 - 59.9$

$V_u = -47.83$ kip

$1.6 V_u = \frac{-76.53 \text{ kip}}{6.5'} = -11.77 \frac{\text{kip}}{\text{ft}} = V_u$

6.5' → trib length

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
					References

AECOM Imagine it. Delivered.

JOB TITLE
PROJECT/JOB NO. CALCULATION NO.
COMPUTED BY JH DATE
VERIFIED BY DATE
SCALE SHEET NO. 6 OF

$M_u \rightarrow R = \boxed{59.9}$ Kip @ .75' ⊖

$w,slab = \boxed{12.07}$ kip @ 1.375' ⊕

$M_u = (\boxed{12.07})(1.375) - (\boxed{59.9})(.75)$

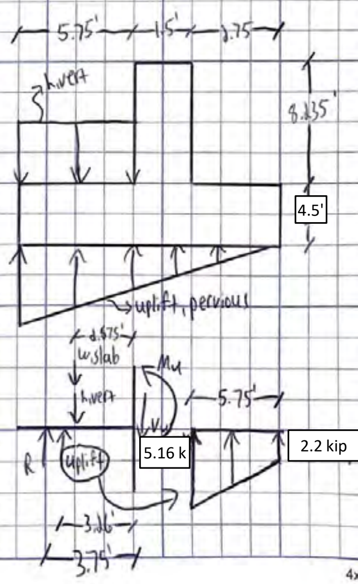
$M_u = \boxed{-28.33}$ kip-ft

$1.6 M_u = \dfrac{\boxed{-45.33} \text{ kip-ft}}{6.5'} = \boxed{-6.97} \dfrac{\text{kip-ft}}{\text{ft}} = M_u$

trib length

3. Water to TOW (pervious)

→ concrete wt.
→ h,lat can be ignored
→ h,vert
→ uplift, pervious
→ Assume 6.5' of trib length between piles



Flood Side:

$V_u \rightarrow R = \boxed{-16.2}$ kip from CPGA

$w,slab = \boxed{25.23}$ kip (see prev. calcs)

$h,vert = 19.21$ kip (see prev. calcs)

$Uplift = \left(\dfrac{\boxed{5.16 + 2.2}}{2}\right)(5.75)$

$Uplift = \boxed{21.16}$ Kip

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
					References

AECOM Imagine it. Delivered.

JOB TITLE
PROJECT/JOB NO. CALCULATION NO.
COMPUTED BY JH DATE
VERIFIED BY DATE
SCALE SHEET NO. 7 OF

$V_u = 16.2 + 25.23 + 19.21 - 21.16$

$V_u = 39.48$ Kip

$1.6V_u = \frac{63.17 \text{ kip}}{6.5'} = 9.72 \text{ Kip/ft} = V_u$

6.5' → trib. length

$M_u \rightarrow$ R = −16.2 Kip @ 3.75' (+)

w_{slab} = 25.23 Kip @ 2.875' (+)

h_{vert} = 19.21 Kip @ 2.875' (+)

Uplift = 21.16 Kip @ 3.26' (−)

$M_u = (16.2)(3.75) + (25.23)(2.875) + (19.21)(2.875) - (21.16)(3.26)$

$M_u = 119.53$ Kip-ft

$1.6M_u = \frac{191.25 \text{ kip-ft}}{6.5'} = 29.42 \frac{\text{Kip-ft}}{\text{ft}} = M_u$

Protected Side:

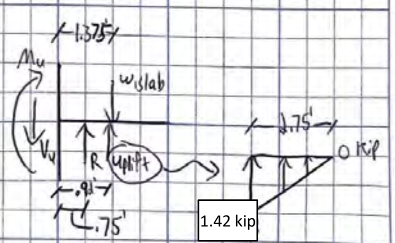
$V_u \rightarrow$

R = 61.8 Kip from CPGA

w_{slab} = 12.07 Kip (see prev. calcs)

Uplift = $\frac{1}{2}bh = \frac{1}{2}(1.42)(2.75)$

Uplift = 1.95 Kip



4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
					References

AECOM Imagine it. Delivered.

JOB TITLE

PROJECT/JOB NO. CALCULATION NO.

COMPUTED BY JH DATE

VERIFIED BY DATE

SCALE SHEET NO. 8 OF

$V_u = 12.07 - 61.8 - 1.95$

$V_u = -51.68$ kip

$1.6V_u = \frac{-82.69 \text{ kip}}{6.5'} = -12.72 \frac{\text{kip}}{\text{ft}} = V_u$

$M_u \longrightarrow$ R = 61.8 kip @ .75' ⊖

wslab = 12.07 kip @ 1.375' ⊕

Uplift = 1.95 kip @ .92' ⊖

$M_u = (12.07)(1.375) - (61.8)(.75) - (1.95)(.92)$

$M_u = -31.55$ kip-ft

$1.6M_u = \frac{-50.48 \text{ kip-ft}}{6.5'} = -7.77 \frac{\text{kip-ft}}{\text{ft}} = M_u$

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
					References

AECOM

Job ____ Project No. ____ Page ___ of ___

Description ____ Computed by JH Sheet ___ of ___

Checked by ____ Date ____

Reference

*NOTE: The shear and moment capacities shown in this report are for b=1' of slab; the calcs on this page show the loading for b=4.71' of slab, so the capacities are multiplied by 4.71'.

*NOTE: Sill weight will add rigidity to the slab; it is excluded from the calcs on this page. Detailed checks and analysis will be performed for the next submittal.

(4) Dead + Cooper E80

→ assume 6' span between piles with a simple beam analysis

→ assume b = 4.71' = width of rail

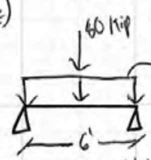
→ assume t = 4.5'

→ wt. of concrete

→ wt of one axle of Cooper E80 (80 kip)

→ Load Factor = 2.2 for Usual Case

→ wt. of rails (.2 k/ft)



→ Dead wt
- concrete = (4.5')(4.71')(.15 kcf) = 3.18 k/ft
- rails = .2 k/ft

Total Uniform Load = 3.38 k/ft

V_u → Dead wt → Concrete = (4.5')(4.71')(6')(.15 kcf)
= 19.08 kip

→ Rails = (.2 k/ft)(6')
= 1.2 kip

→ Cooper E80 Axle = 80 kip

V_u = 80 + 19.08 + 1.2 = 100.3 kip

2.2 V_u = 220.62 kip = V_u **< ϕVc = 4.71*50.6 =238.33 kip -- OK**

M,train = P*L/4 = (80*6)/4 = 120 k-ft

M,uniform = wL^2/8 = (3.38*6^2)/8 = 15.21 k-ft

M,total = 2.2*135.21 k-ft = 297.46 k -ft **< ϕMn = 4.71*344.97 =1624.81 kip-ft -- OK**

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Slab Conc. Check	Checked by	AML	Date	Dec-20
					References

*** Given Information:**

Slab Thickness:	4.50	ft				
Slab Width:	10.00	ft				
Clear Cover:	0.75	ft				
Diameter Bar to Start:	0.09	ft				
Diameter of Pile:	1.13	ft	Load Fact.			
Maximum Pile Reaction:	101.20	kips	1	101.20	kips	*From Factored CPGA Results
Maximum Shear:	12.72	kips				
Maximum Moment (Top):	30.82	kip-ft				
Maximum Moment (Bottom):	7.77	kip-ft				

φ_{shear} =	0.75	(ACI 318)
φ_{moment} =	0.9	(ACI 318)
$f_{y, rebar}$ =	60	ksi
f'_c =	4	ksi

*** Shear Calculations:**

1- Shear Capacity:

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75			
f'_c =	4	ksi		
b =	1	ft strip		
d =	3.70	ft	44.44	in

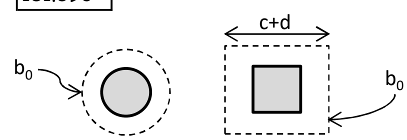
φV_c =	50586.8	lbs	
	50.59	kips	** φVc=50.6 ≥ Vu=12.7, **Shear Capacity OK**

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Slab Conc. Check	Checked by	AML	Date	Dec-20
				References	

2- Punching Shear Capacity (ACI 318-14 Table 22.6.5.2):

Vc = minimum value = Eq. a: $4 \times \sqrt{(f'_c)} \times b_0 \times d$ for $\beta_c < 2.0$
Eq. b: $(2 + (4 / \beta_c)) \times \sqrt{(f'_c)} \times b_0 \times d$ for $\beta_c > 2.0$
Eq. c: $((\alpha_s \times d) / b_0 + 2) \times \sqrt{(f'_c)} \times b_0 \times d$ b_0 / d effect based on α_s
(interior column: α_s = 40, edge column: α_s = 30, corner column: α_s = 20)

d for piles = 44.203 in (Slab thickness - 9" pile embed - cover - $0.5d_{bar}$)
where β_c = Long side / Short side = 1
b_0 = Perimeter of Critical Section = $\pi*(D_{pile} + d)$ = 181.593
α_s = 20 (worst case - corner column)



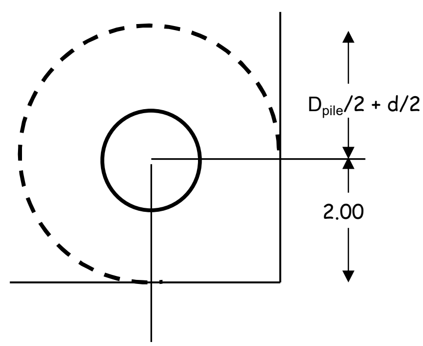
Vc = minimum value = Eq. a: 2030.68 kips
Eq. b: 3046.02 kips
Eq. c: 3486.86 kips

φV_c = 1523.01 kips

Check corner pile failure to edge of slab:
$D_{pile}/2+d/2$ = 2.41 ft

Diameter of corner failure = 2.408 + 2 ft
= 4.41 ft

Dia. punching shear calc above = 4.82



Diameter of punching shear calculation is smaller than the diameter of this corner failure area. Therefore, no re-check of corner punching failure is required.

φVc used in design = 50.59 kips

** φVc = 50.6k ≥ Vu = 12.7k, Shear Capacity OK

Maximum Pile Reaction = 101.20

** φVc=1523k ≥ Vu=101k, Punching Shear Capacity OK

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
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3- Deep Beam One-Way Shear Capacity (φV_{c1}):

For $(w/d) \geq 1.0$, a one-way (normal) shear investigation with loads outside the critical section (located at a distance d from the face of the column, b = footing width) and

$$v_c = 1.9\sqrt{f'_c} + 2500\rho_w\left(\frac{V_u d}{M_u}\right) \geq 2\sqrt{f'_c} \quad \text{(ACI Eq. 11-5)}$$

which reduces for $\rho_w \approx 0.002$ and 3,000 psi $\leq f'_c \leq$ 4,000 psi to $v_c = 1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}(V_u d/M_u) \geq 2\sqrt{f'_c}$.

For $(w/d) < 1.0$, $1.0 > M_u/V_u d > 0$; $\infty > V_u d/M_u \geq 1.0$ (no limits on M_u, $V_u d$, other than above)

$$v_c = \left(\frac{d}{w}\right)\left[3.5 - 2.5\left(\frac{M_u}{V_u d}\right)\right]\left[1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}\left(\frac{V_u d}{M_u}\right)\right] \leq 10\sqrt{f'_c} \quad \text{(ACI Eq. 13-2)}$$

w = 1.0 ft — Distance from CL pile to face of Wall + 3" lateral installation tolerance

M_u = 30.82 kip-ft

V_u = 12.72 kips

v_c = 896.2 psi $\leq$ 10 x √f'c = 632.5 psi limit on shear strength

φV_{c1} = 252.93 kips — ** φVc=252.9 ≥ Vu=12.7, OK

Therefore, Slab is OK for shear forces found in slab analysis.

<u>* Reinforcement Calculations:</u>

Limit of Maximum Reinforcement: 0.25 x ρ_b (Design Criteria, EM 1110-2-2104, 3-5)

where ρ_b = 0.0285 for f'_c = 4,000psi, fy = 60,000psi

Max Rebar = 0.00713 *b * d

Maximum Reinforcement:	0.0071	* b * d =	3.80	in^2	per 1ft strip

A_{gross} = 4.5 ft * 12 in/ft * 12 in strip = 648.00 in^2

Limits of Minimum Reinforcement:	0.005 x Agross =	3.24	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
	$(3*\sqrt{(f'_c)}*b*d)/f_y$ =	1.69	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)
	$(200*b*d)/f_y$ =	1.78	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)

Min Reinforcement, temp & shrinkage:	1.62	in^2	per 1ft strip, per face
Min Reinforcement, flexural:	1.78	in^2	per 1ft strip, per face

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Slab Conc. Check	Checked by	AML	Date	Dec-20
				References	

*** Moment Calculations:**

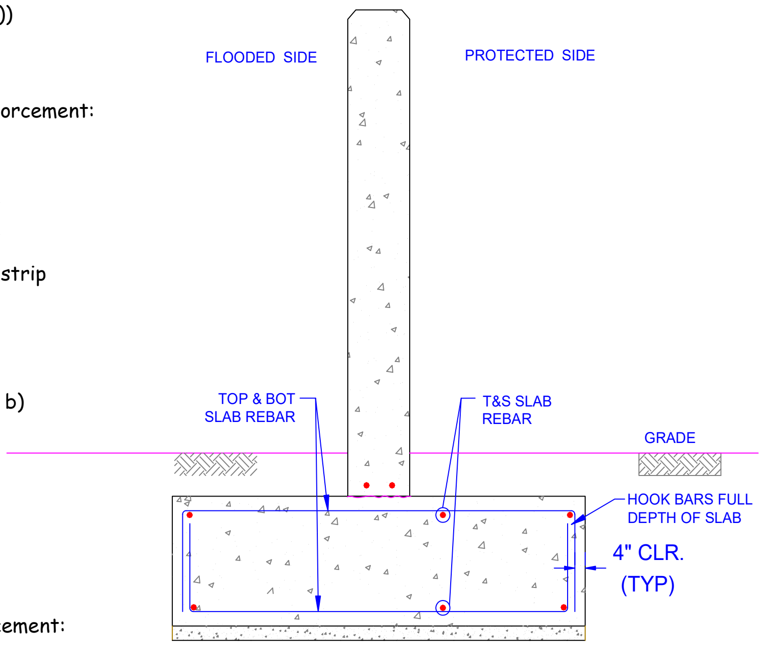
* $T = A_s \times f_y$

* $C = 0.85 \times f'_c \times a \times b$

* Assuming Tension = Compression $\longrightarrow$ $A_s \times f_y = 0.85 \times f'_c \times a \times b$

* $\varphi Mn = \varphi \times T \times (d - (a / 2))$

$= \varphi \times A_s \times f_y \times (d - (a / 2))$



* Capacity of Min Flexural Reinforcement:

A_s =	1.777	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	3.703	
φ_{moment} =	0.9	

$a = (A_s \times f_y) / (0.85 \times f'_c \times b)$

= 2.614 in

φM_n =	4139.6	kip-in
=	344.97	kip-ft

* Capacity of Maximum Reinforcement:

A_s =	3.799	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	3.70	
φ_{moment} =	0.9	

The minimum proposed reinforcement for to T&S Slab Rebar is #9 @ 6"(A = 2.0 in2) and the minimum proposed reinforcment for Top & Bot Slab Rebar is #9 @ 6"(A =2.0 in2).

$a = (A_s \times f_y) / (0.85 \times f'_c \times b)$

= 5.587 in

φMn =	8543.4	kip-in
=	711.95	kip-ft

** φMn=711.9 ≥ Mu=30.8, Section OK	TOP
** φMn=711.9 ≥ Mu=7.8, Section OK	Bottom

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	Gate Monolith	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
	Slab Calculations	Checked by	AML	Date	Dec-20
					References

*Note: The following calculations represent the total shear (Vu) and moment (Mu) on both sides of the slab for all load cases. Capacity calculations for the slab can be found in the "Slab Conc Check" tab.

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JOB TITLE
PROJECT/JOB NO. CALCULATION NO.
COMPUTED BY JH DATE
VERIFIED BY DATE
SCALE SHEET NO. 9 OF

• Shear + Moment on Pilaster

→ Assume gate opening is 18' wide (trib. length = 9')

→ Pilasters are 2.5' × 2.5'

→ wall stem height = 8.235' = H

① $V_u \rightarrow \frac{1}{2}(\gamma_{water})(H^2)(\text{trib. length})$

$= \frac{1}{2}(.0624 \text{ kcf})(8.235')^2(9')$

$= (19.04 \text{ Kip})\,1.6 = 30.47 \text{ Kip}$

② $M_u \rightarrow V_u\left(\frac{H}{3}\right) = (30.47 \text{ Kip})\left(\frac{8.235'}{3}\right)$

$M_u =$ 83.64 k-ft

4x4 = 1 in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	GATE SUPPORT STRUCTURES	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
S, M & T Check for Pilaster River Road Gate		Checked by	AML	Date	Dec-20
				References	

*** Given Information:**

Pilaster Width:	2.50	ft			
Pilaster Thickness:	2.50	ft			
Clear Cover:	0.33	ft	=	4.00	in
Diameter Bar to Start:	0.08	ft	=	1.00	in
Stirup Bar Dia:	0.05	ft	=	0.625	in
Maximum Shear (V_u):	30.5	kips per foot			
Maximum Moment (M_u):	133.82	kip-ft per foot			
Gate Wt. Induced Moment ($M_{u,gate}$):	N/A	kip-ft per foot			
Maximum Torsion (T_u):	N/A	kip-ft			
φ_{shear} =	0.75	(ACI 318)			
φ_{moment} =	0.9	(ACI 318)			
$\varphi_{torsion}$ =	0.75	(ACI 318)			
$f_{y,\ rebar}$ =	60	ksi			
f'_c =	4	ksi			

*NOTE: Even though shear and moment capacities far exceed the exerted shear and moment on the pilaster, it has been sized at 2.5' x 2.5' to account for possible higher stresses due to the swing gate eccentricity which will be analyzed in the next phase.

*** Shear Calculations:**

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u) (ACI Eq. 11-1)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75			
f'_c =	4	ksi		
b =	2	ft strip		
d =	2.13	ft	25.50	in

φV_c =	58059.4	lbs	
	58.06	kips	** φVc=58.1 ≥ Vu=30.5, **Shear Capacity OK**

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	GATE SUPPORT STRUCTURES KCS Gate Monolith	Computed by	JMH	Date	Dec-20
S, M & T Check for Pilaster River Road Gate		Checked by	AML	Date	Dec-20
				References	

*** Reinforcement Calculations:**

Limit of Maximum Reinforcement: $0.25 \times \rho_b$ (Design Criteria, EM 1110-2-2104, 3-5)

where ρ_b = 0.0285 for f'_c = 4,000psi, fy = 60,000psi

Max Rebar = 0.00713 *b * d

Maximum Reinforcement: 0.0071 * b * d = 4.36 in^2 per 2ft strip

A_{gross} = 2.5 ft * 12 in/ft * 24 in strip = 720.00 in^2

Limits of Minimum Reinforcement:			
$0.003 \times A_{gross}$ =	2.16	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
$(3*\sqrt{f'_c}*b*d)/f_y$ =	1.94	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)
$(200*b*d)/f_y$ =	2.04	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)

Min Reinforcement, temp & shrinkage:	1.08	in^2	per 2ft strip, per face
Min Reinforcement, flexural:	2.04	in^2	per 2ft strip, per face

*** Moment Calculations:**

* $T = A_s \times f_y$
* $C = 0.85 \times f'_c \times a \times b$
* Assuming Tension = Compression $\longrightarrow$ $A_s \times f_y = 0.85 \times f'_c \times a \times b$
* $\varphi Mn = \varphi \times T \times (d - (a / 2))$
  $= \varphi \times A_s \times f_y \times (d - (a / 2))$

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	GATE SUPPORT STRUCTURES	Computed by	JMH	Date	Dec-20
	KCS Gate Monolith				
S, M & T Check for Pilaster River Road Gate		Checked by	AML	Date	Dec-20
				References	

* Capacity of Min Flexural Reinforcement:

A_s =	2.040	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	2	ft strip
d =	2.13	
φ_{moment} =	0.9	

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$

= 1.500 in

φM_n =	2726.5	kip-in
=	227.21	kip-ft

Min reinforcement is sufficient.

* Capacity of Maximum Reinforcement:

A_s =	4.361	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	2	ft strip
d =	2.125	
φ_{moment} =	0.9	

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$

= 3.206 in

φMn =	5626.9	kip-in
=	468.91	kip-ft

**** φMn=468.9 ≥ Mu=133.8, Section OK**

Maurepaus Swamp

T-WALL SECTION

KCS-5

AECOM Project : 60632162

Foundation, Wall & Slab

AECOM

1555 Poydras Street

Suite 1200

New Orleans, LA 70112

(504) 586-8111

Computed by:	AML	Checked by:	JMH
Date:	Dec-20	Date:	Dec-20

AECOM

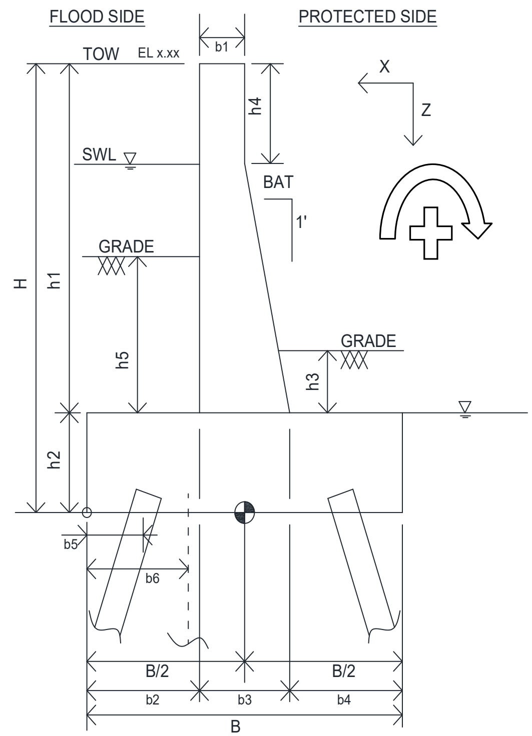
Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Wall Geometry	Checked by	JMH	Date	Dec-20

References

WALL GEOMETRY:

Top of Wall EL.	16.13	NAVD88	
100 Yr. Water El.		NAVD88	
10 Yr. Water El.		NAVD88	
Top of Slab EL.	12.89	NAVD88	
H=	6.24	ft.	
h1=	3.24	ft.	
h2=	3.00	ft.	(Base Slab Height)
h3=	3.24	ft.	(P.S. Soil Height)
h4=	0.00	ft.	
h5=	3.24	ft.	(F.S. Soil Height)
B=	10.00	ft.	(Base Slab Width)
b1=	1.50	ft.	(Wall Stem Width, top)
b2=	5.75	ft.	(F.S. Slab Width)
b3=	1.50	ft.	(Wall Stem Width, bottom)
b4=	2.75	ft.	(P.S. Slab Width)
b5=	2.00	ft.	(F.S. Pile Row Edge Space)
b6=	6.50	ft.	(Sheet Pile Edge Space)
BAT=	0.00	(Wall Batter, N/A)	
PS Grade =	16.13	NAVD88 (Average of PS soil for all)	

Monolith Length =	18.0	ft
Bottom Of Slab =	9.89	NAVD88



T-WALL CROSS-SECTION

Notes: 1) positive 'Y' axis is into page

2) pile batters vary from those shown in diagram

Note: In this report, white boxes are for input data and colored boxes are calculated values.

Note: *Soil will be at TOW for the majority of the monolith. Therfore, we will just assume the entire wall will be covered for the calculations as this will make the results conservative

Job	**Maurepaus Swamp**	**Project No.**	**60632162**		
Description	**T-WALL SECTION**	**Computed by**	**AML**	**Date**	**Dec-20**
	KCS-5				
	Assumptions	**Checked by**	**JMH**	**Date**	**Dec-20**

References

Unit Weight of Storm Water =	0.0624	kcf
Wet Unit Weight of Soil =	0.1200	kcf
Sat Unit Weight of Soil =	0.0576	kcf
Unit Weight of Concrete =	0.1500	kcf
Impact Load =	0.0000	k/ft
FS Wind force above SWL=	0.0500	ksf
Construction Surcharge Pressure =	0.2500	ksf
Unbalanced Load for Stability Analysis:		
F_{cap} (k/ft) =	0.00	(10y SWL Case; Force acts at bottom of slab)
F_{cap} (k/ft) =	0.00	(100y SWL Case; Force acts at bottom of slab)
F_{cap} (k/ft) =	0.00	(Water to TOW Case; Force acts at bottom of slab)
K_0, Granular fill =	0.95	(for lateral soil forces)
Assumed Reinforcement Cover =	0.25	ft
Assumed Wall d_{bar} =	0.08	ft

AECOM

Job	**Maurepaus Swamp**	**Project No.**	**60632162**
Description	**T-WALL SECTION**	**Computed by**	**AML**
	KCS-5	**Date**	**Dec-20**
	Load Cases	**Checked by**	**JMH**
		Date	**Dec-20**
			References

No. of Load Cases	3

Update

No.	DCD LC No.	Description	FS Water El.	PS Water El.	Pile Design Over Stresses
1	1	Construction Surcharge	9.89	9.89	1.17
2	2a	Water to TOW (impervious cutoff)	16.13	9.89	1.33
3	2b	Water to TOW (pervious cutoff)	16.13	9.89	1.33

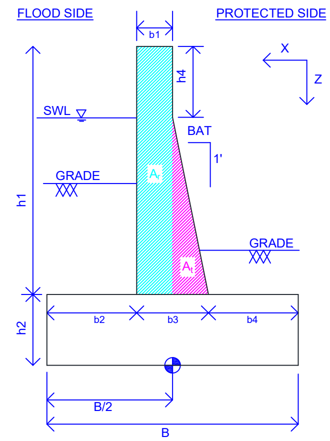
* Impact load is not applicable for this section, so it is excluded from the load combinations
* Forces induced by 10y water elevation are not applicable for this section, so they are excluded from the load combinations

*Earthquake and Wave Loads are to be determined and are excluded from these calculations

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Foundation Load Calculation	Checked by	JMH	Date	Dec-20
				References	

Weight:



Wall stem weight = $[(b_1 \times h_1) + 0.5(h_1 - h_4)(b_3 - b_1)]\ \gamma_{conc.}$

Wall stem weight = 0.73 (kip/ft)

$X_{cen} = [(A_r \times X_{cen-Ar}) + (A_t \times X_{cen-At})]/(A_r + A_t)$

X_{cen} = -1.5

Base slab weight = $h_2 \times B \times \gamma_{conc.}$ =

Base slab weight = 4.5 (kip/ft)

X_{cen} = 0

Soil Force (Dry & Sat.):

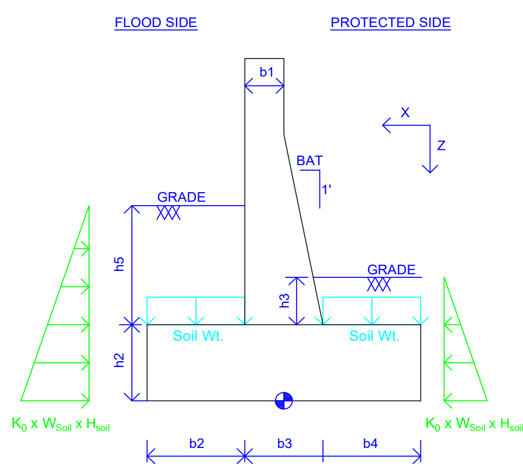
	Water EL.	FS Soil EL.	PS Soil EL.
Dry	9.89	16.13	16.13
Top of Wall EL.	16.13	16.13	16.13

F.S. soil weight = $(b_2 \times h_5)\ \gamma_{soil.}$

F.S. soil weight =	2.24	(kip/ft)	**Dry**
	1.07	(kip/ft)	**TOW**

$X_{cen} = B/2 - b_2/2$

X_{cen} =	2.13	**Dry**
	2.13	**TOW**



P.S. soil weight = $[(b_4 \times h_3) + (BAT \times h_3^2)/2]\ \gamma_{soil.}$

P.S. soil weight =	1.07	(kip/ft)	**Dry**
	1.07	(kip/ft)	**TOW**

$X_{cen} = [(A_r \times X_{cen-Ar}) + (A_t \times X_{cen-At})]/(A_r + A_t)$

X_{cen} =	-3.63	**Dry**
	-3.63	**TOW**

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Foundation Load Calculation	Checked by	JMH	Date	Dec-20
				References	

F.S. soil lat. force = $0.5\ K_0\ \gamma_{soil}\ (h_2 + h_5)^2$

F.S. soil lat. force =	-2.22	(kip/ft)	Dry
	-1.07	(kip/ft)	TOW

$Z_{cen} = (h_2+h_5)/3$

Z_{cen} =	-2.08	Dry
	-2.08	TOW

P.S. soil lat. force = $0.5\ K_0\ \gamma_{soil}\ (h_2 + h_3)^2$

P.S. soil lat. force =	2.22	(kip/ft)	Dry
	2.22	(kip/ft)	TOW

$Z_{cen} = (h_2+h_5)/3$

Z_{cen} =	-2.08	Dry
	-2.08	TOW

Soil Force (SWL):

	Water EL.	FS Soil EL.	PS Soil EL.
100 Yr. Water El.	0	16.13	16.13
10 Yr. Water El.	0	16.13	16.13

F.S. soil weight = $(b_2 \times h_5)\ \gamma_{soil.}$

F.S. soil weight =	2.24	(kip/ft)	100y
		(kip/ft)	10y

$X_{cen} = B/2 - b_2/2$

X_{cen} =	2.13	100y
		10y

P.S. soil weight = $[(b_4 \times h_3) + (BAT \times h_3^2)/2]\ \gamma_{soil.}$

P.S. soil weight =	1.07	(kip/ft)	100y
		(kip/ft)	10y

$X_{cen} = [(A_r \times X_{cen-Ar}) + (A_t \times X_{cen-At})]/(A_r + A_t)$

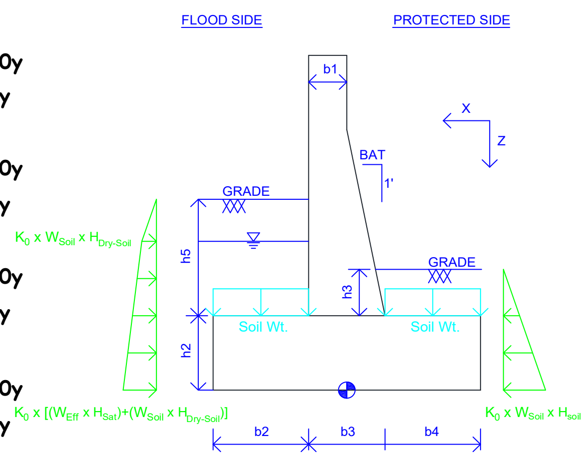
X_{cen} =	-3.63	100y
		10y

F.S. soil lat. force = $0.5\ K_0\ \gamma_{soil}\ (h_2 + h_5)^2$

F.S. soil lat. force =	-2.22	(kip/ft)	100y
			10y

$Z_{cen} = (h_2+h_5)/3$

Z_{cen} =	-2.08	100y
		10y



AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Foundation Load Calculation	Checked by	JMH	Date	Dec-20
				References	

P.S. soil lat. force = 0.5 K_0 γ_{soil} $(h_2 + h_3)^2$

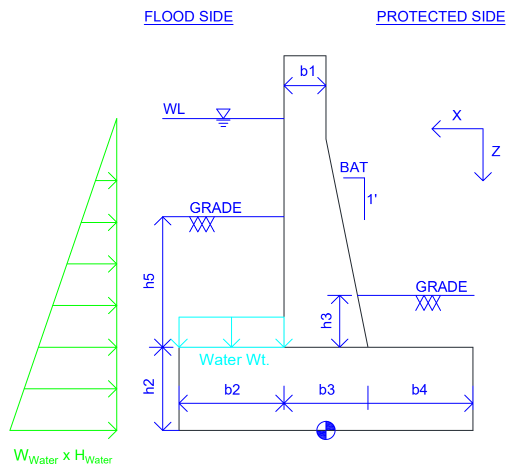
P.S. soil lat. force =	2.22	(kip/ft)	100y
		(kip/ft)	10y

$Z_{cen} = (h_2+h_5)/3$

Z_{cen} =	-2.08	100y
		10y

Water Force (SWL & TOW):

	Water EL.
10 Yr. Water El.	0
100 Yr. Water El.	0
Top of Wall EL.	16.13



F.S. water weight = $(b_2 \times H_w)$ γ_{water}

F.S. water weight =		(kip/ft)	10y
	0.00	(kip/ft)	100y
	1.16	(kip/ft)	TOW

$X_{cen} = B/2 - b_2/2$

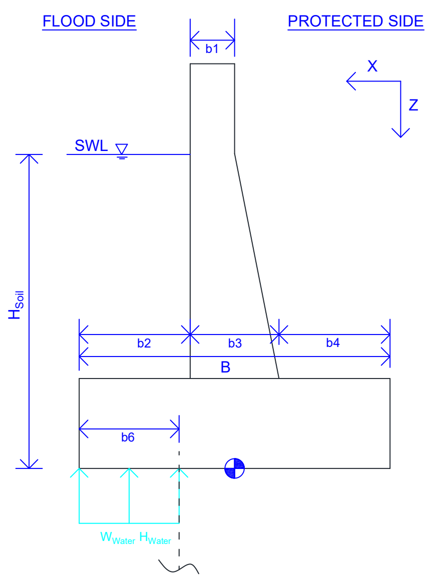
X_{cen} =		10y
	0.00	100y
	2.13	TOW

F.S. water lat. force = 0.5 γ_{water} Hw^2

F.S. water lat. force =		(kip/ft)	10y
	0.00	(kip/ft)	100y
	-1.21	(kip/ft)	TOW

$Z_{cen} = H_w/3$

Z_{cen} =		10y
	3.30	100y
	-2.08	TOW



Impervious uplift Force = $(b_6 \times H_w)$ γ_{water}

Impervious uplift Force =		(kip/ft)	10y
	4.01	(kip/ft)	100y
	-2.53	(kip/ft)	TOW

$X_{cen} = B/2 - b_6/2$

X_{cen} =		10y
	1.75	100y
	1.75	TOW

AECOM

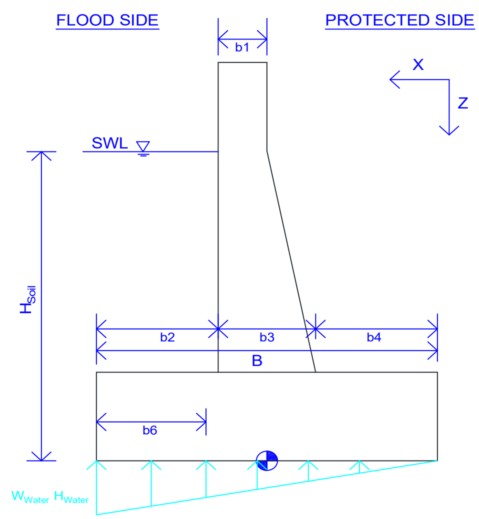
Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Foundation Load Calculation	Checked by	JMH	Date	Dec-20
					References

Pervious uplift Force = $(b_6 \times H_w)\ \gamma_{water}$

Pervious uplift Force =			10y
	3.09	(kip/ft)	100y
	-1.95	(kip/ft)	TOW

$X_{cen} = B/2 - B/3$

X_{cen} =	1.67	10y
	1.67	100y
	1.67	TOW



AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Foundation Loads	Checked by	JMH	Date	Dec-20

References

Foundation Loads

Dead Loads:

			X-Cent.
Wall stem weight =	0.73	(kip/ft)	-1.50
Base slab weight =	4.5	(kip/ft)	0.00

Soil Forces:

	Water EL.	FS Soil EL.	PS Soil EL.	Wt. of FS Soil (k/ft)	X-Cent.	Wt. of PS Soil (k/ft)	X-Cent.	FS Soil Lateral Force (k/ft)	Z-Cent.	PS Soil Lateral Force (k/ft)	Z-Cent.
Dry	9.89	16.13	16.13	2.236	2.13	1.069	-3.63	-2.219	-2.08	2.219	-2.08
100 Yr. Water El.	0.0	16.13	16.13	2.236	2.13	1.069	-3.63	-2.219	-2.08	2.219	-2.08
Top of Wall EL.	16.1	16.13	16.13	1.073	2.13	1.069	-3.63	-1.065	-2.08	2.219	-2.08
10 Yr. Water El.	0.0	16.13	16.13	2.236	2.13	1.069	-3.63	-2.219	-2.08	2.219	-2.08

Water Forces:

	Water EL.	Wt. of FS Water (k/ft)	X-Cent.	FS Water Lateral Force (k/ft)	Z-Cent.
100 Yr. Water El.	0.0	0.000	0.00	0.000	3.30
Top of Wall EL.	16.1	1.163	2.13	-1.215	-2.08
10 Yr. Water El.	0.0	0.000	0.00	0.000	3.30

Wind Force:

				Z-Cent.	
0.05 ksf x monolith height =	0.312	k/ft	Construction	-3.12	(Apply to PS)
	0	k/ft	No Water	-6.24	
	-0.807	k/ft	100y SWL	1.83	
	-0.807	k/ft	10y SWL	1.83	

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Foundation Loads	Checked by	JMH	Date	Dec-20

References

Surcharge Forces:

0.25 ksf * F.S. width =	1.438	k/ft	X_{Cen} =	2.13
0.25 ksf * P.S. width =	0.688	k/ft	X_{Cen} =	-3.63

Unbalanced Load:

100y SWL	0.00	k/ft in (+) X Direction, acting at bottom of slab (Z-coordinate = 0)	Z_{Cen} =	
TOW	0.00	k/ft in (+) X Direction, acting at bottom of slab (Z-coordinate = 0)	Z_{Cen} =	
10y SWL	0.00	k/ft in (+) X Direction, acting at bottom of slab (Z-coordinate = 0)	Z_{Cen} =	

Impact Load:

0.00	k/ft in (-) X Direction, acting at top of wall (Z-coordinate = TOW)	Z_{Cen} =	-6.24

Uplift Loads:

Impervious:

T.O.W. :	-2.53	k/ft	X_{Cen} =	1.75
100 Yr. Water El. :	4.01	k/ft		
10 Yr. Water El. :	4.01	k/ft		

Job	Maurepaus Swamp	Project No.	60632162
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5		
	Foundation Loads	Checked by	JMH	Date	Dec-20

References

Pervious:

T.O.W.	-1.95	k/ft	X_{Cen} =	1.67
100 Yr. Water El.	3.09	k/ft		
10 Yr. Water El. :	3.09	k/ft		

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Shear & Moment Calculation on Wall	Checked by	JMH	Date	Dec-20
				References	

Note: Shear is calculated at distance d from the bottom of the wall

d = wall thickness - cover - (1/2)d_{bar} = 1.21 ft

Elevation of distance d = 14.10 NAVD 88

Soil Force (Dry & Sat.):

	Water EL.	FS Soil EL.	PS Soil EL.
Dry	9.89	16.13	16.13
Top of Wall EL.	16.13	16.13	16.13

F.S. soil lat. force = 0.5 K_0 γ_{soil} $(H_{Soil})^2$

F.S. soil lat. force at d = -0.24 (kip/ft) Dry

-0.11 (kip/ft) TOW

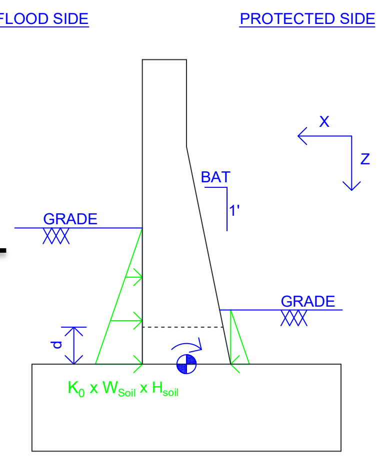
F.S. soil lat. force at bottom of the wall = -0.60 (kip/ft) Dry

-0.29 (kip/ft) TOW

M = F_{Soil} x H_{Soil}/3

M = 0.65 (k-ft/ft) Dry

0.31 (k-ft/ft) TOW



P.S. soil lat. force = 0.5 K_0 γ_{soil} $(H_{Soil})^2$

P.S. soil lat. force at d = 0.24 (kip/ft) Dry

0.24 (kip/ft) TOW

P.S. soil lat. force at bottom of the wall = 0.60 (kip/ft) Dry

0.60 (kip/ft) TOW

M = F_{Soil} x H_{Soil}/3

M = -0.65 (k-ft/ft) Dry

-0.65 (k-ft/ft) TOW

AECOM

Job	Maurepaus Swamp	Project No.	60632162
Description	T-WALL SECTION KCS-5	Computed by	AML	Date	Dec-20
	Shear & Moment Calculation on Wall	Checked by	JMH	Date	Dec-20

References

Water Force (SWL & TOW):

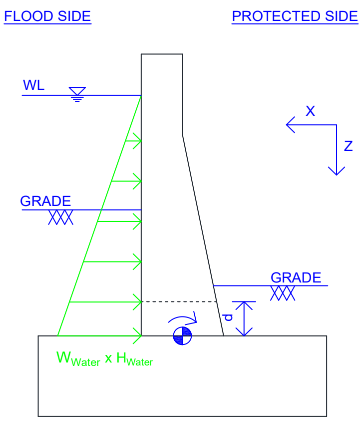
	Water EL.
10 Yr. Water El.	0
100 Yr. Water El.	0
Top of Wall EL.	16.13

F.S. water lat. force = 0.5 γ_{water} Hw^2

	Value	Units	Case
F.S. water lat. force at d =		(kip/ft)	10y
	0.00	(kip/ft)	100y
	-0.13	(kip/ft)	TOW
F.S. water force at bottom of the wall =	0.00	(kip/ft)	10y
	0.00	(kip/ft)	100y
	-0.33	(kip/ft)	TOW

$M = F_{Water} \times H_{Water}/3$

	Value	Units	Case
M =		(k-ft/ft)	10y
	0.00	(k-ft/ft)	100y
	0.35	(k-ft/ft)	TOW



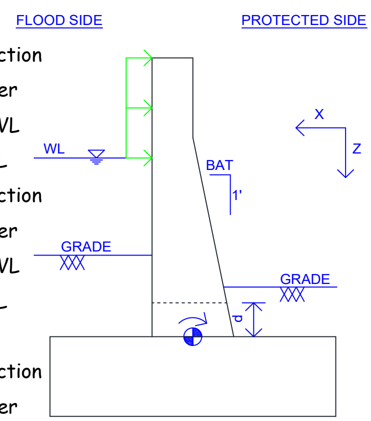
Wind Force:

F.S. wind force = P_{Wind} x Area

	Value	Units	Case
F.S. wind force at d =	0.10	(kip/ft)	Construction
	0.00	(kip/ft)	No Water
	-0.10	(kip/ft)	100y SWL
	-0.10	(kip/ft)	10y SWL
F.S. wind force at bottom of the wall =	0.16	(kip/ft)	Construction
	0.00	(kip/ft)	No Water
	-0.16	(kip/ft)	100y SWL
	-0.16	(kip/ft)	10y SWL

$M = F_{Wind} \times Z_{cent.}$

	Value	Units	Case
M =	-0.26	(k-ft/ft)	Construction
	0.00	(k-ft/ft)	No Water
	0.26	(k-ft/ft)	100y SWL
	0.26	(k-ft/ft)	10y SWL



AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	LC1	Checked by	JMH	Date	Dec-20
					References

LC1: Construction Surcharge

Loads

Deselect All

Dead Loads:

☑ Wall Stem Wt. ☑ Base Slab Wt.

Soil Forces:

Dry	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
10 Yr. Water El.	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
100 Yr. Water El.	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
Top of Wall EL.	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force

Water Forces:

10 Yr. Water El.	☐ F.S. Water	☐ F.S. Lat. Water
100 Yr. Water El.	☐ F.S. Water	☐ F.S. Lat. Water
Top of Wall EL.	☐ F.S. Water	☐ F.S. Lat. Water

Wind Force:

Construction	☐ P.S. Lat. Wind
No Water	☐ F.S. Lat. Wind
10 Yr. Water El.	☐ F.S. Lat. Wind
100 Yr. Water El.	☐ F.S. Lat. Wind

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	LC1	Checked by	JMH	Date	Dec-20

References

Wave Force:

- 10 Yr. Water El. ☐ F.S. Lat. Wave
- 100 Yr. Water El. ☐ F.S. Lat. Wave
- Top of Wall EL. ☐ F.S. Lat. Wave

Earthquake Force:

- MDE ☐ Soil Ver. MDE ☐ Soil Lat. MDE ☐ Conc. Ver. MDE ☐ Conc. Lat. MDE
- OBE ☐ Soil Ver. OBE ☐ Soil Lat. OBE ☐ Conc. Ver. OBE ☐ Conc. Lat. OBE

Surcharge Forces:

☑ F.S. Surcharge Force ☑ P.S. Surcharge Force

Unbalanced Load:

- 10 Yr. Water El. ☐ Lat. Unbalance
- 100 Yr. Water El. ☐ Lat. Unbalance
- Top of Wall EL. ☐ Lat. Unbalance

Impact Load:

☐ Lat. Impact force

Uplift Loads:

Impervious
- ☐ 10y SWL Uplift Pressure
- ☐ 100y SWL Uplift
- ☐ TOW Uplift Pressure

Pervious
- ☐ 10y SWL Uplift Pressure
- ☐ 100y SWL Uplift
- ☐ TOW Uplift Pressure

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	LC1	Checked by	JMH	Date	Dec-20
				References	

Fx	Fy	Fz	'X' Centroid	'Y' Centroid	'Z' Centroid	Mx	My	Mz	NOTES:
(kip/ft)	(kip/ft)	(kip/ft)	(ft)	(ft)	(ft)	(kip-ft/ft)	(kip-ft/ft)	(kip-ft/ft)	
0.00	0.00	0.73	-1.50	0.00	0.00	0.00	1.10	0.00	Wall stem weight
0.00	0.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00	Base slab weight
						0.00	0.00	0.00	F.S. soil weight
						0.00	0.00	0.00	P.S. soil weight
						0.00	0.00	0.00	F.S. lateral soil force
						0.00	0.00	0.00	P.S. lateral soil force
						0.00	0.00	0.00	Vertical water force
						0.00	0.00	0.00	Lateral water force
						0.00	0.00	0.00	Wind load
						0.00	0.00	0.00	FS wave load
						0.00	0.00	0.00	Soil Vertical EQ force
						0.00	0.00	0.00	Soil Lateral EQ force
						0.00	0.00	0.00	Con. Vertical EQ force
						0.00	0.00	0.00	Con. Lateral EQ force
0.00	0.00	1.44	2.13	0.00	0.00	0.00	-3.06	0.00	F.S. Surcharge load
0.00	0.00	0.69	-3.63	0.00	0.00	0.00	2.49	0.00	P.S. Surcharge load
						0.00	0.00	0.00	Unbalanced load
						0.00	0.00	0.00	Impact load
						0.00	0.00	0.00	Hydrostatic uplift
0.000	**0.000**	**7.356**				**0.000**	**0.533**	**0.000**	**SUM.**

AECOM

Job	Maurepaus Swamp		Project No.	60632162		
Description	T-WALL SECTION		Computed by	AML	Date	Dec-20
	KCS-5					
	LC1		Checked by	JMH	Date	Dec-20

References

Shear and Moment on the Wall

Note: enter load factors

Update

V_u	0.00	(kips/ft)
M_u	0.00	(kips-ft/ft)

Soil Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6		
PS	1.6		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Water Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Wind Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Wave Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Earthquake Force:

Load Factor		Unfact. V	Unfact. M
PS	1.6		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Impact Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	LC2	Checked by	JMH	Date	Dec-20
					References

LC2: Water to TOW (impervious cutoff)

Loads

Deselect All

Dead Loads:

- [x] Wall Stem Wt.
- [x] Base Slab Wt.

Soil Forces:

Dry	[ ] F.S. Soil Wt.	[ ] P.S. Soil Wt.	[ ] F.S. Lat. Soil Force	[ ] P.S. Lat. Soil Force
10 Yr. Water El.	[ ] F.S. Soil Wt.	[ ] P.S. Soil Wt.	[ ] F.S. Lat. Soil Force	[ ] P.S. Lat. Soil Force
100 Yr. Water El.	[ ] F.S. Soil Wt.	[ ] P.S. Soil Wt.	[ ] F.S. Lat. Soil Force	[ ] P.S. Lat. Soil Force
Top of Wall EL.	[x] F.S. Soil Wt.	[x] P.S. Soil Wt.	[x] F.S. Lat. Soil Force	[x] P.S. Lat. Soil Force

Water Forces:

10 Yr. Water El.	[ ] F.S. Water	[ ] F.S. Lat. Water
100 Yr. Water El.	[ ] F.S. Water	[ ] F.S. Lat. Water
Top of Wall EL.	[x] F.S. Water	[x] F.S. Lat. Water

Wind Force:

Construction	[ ] P.S. Lat. Wind Force
No Water	[ ] F.S. Lat. Wind
10 Yr. Water El.	[ ] F.S. Lat. Wind
100 Yr. Water El.	[ ] F.S. Lat. Wind

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	LC2	Checked by	JMH	Date	Dec-20

References

Wave Force:

10 Yr. Water El. — ☐ F.S. Lat. Wave

100 Yr. Water El. — ☐ F.S. Lat. Wave

Top of Wall EL. — ☐ F.S. Lat. Wave

Earthquake Force:

MDE — ☐ Soil Ver. MDE ☐ Soil Lat. MDE ☐ Conc. Ver. MDE ☐ Conc. Lat. MDE

OBE — ☐ Soil Ver. OBE ☐ Soil Lat. OBE ☐ Conc. Ver. OBE ☐ Conc. Lat. OBE

Surcharge Forces:

☐ F.S. Surcharge Force ☐ P.S. Surcharge Force

Unbalanced Load:

10 Yr. Water El. — ☐ Lat. Unbalance

100 Yr. Water El. — ☐ Lat. Unbalance

Top of Wall EL. — ☐ Lat. Unbalance

Impact Load:

☐ Lat. Impact force

Uplift Loads:

Impervious
- ☐ 10y SWL Uplift Pressure
- ☐ 100y SWL Uplift
- ☑ TOW Uplift Pressure

Pervious
- ☐ 10y SWL Uplift Pressure
- ☐ 100y SWL Uplift
- ☐ TOW Uplift Pressure

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	LC2	Checked by	JMH	Date	Dec-20
				References	

Fx	Fy	Fz	'X' Centroid	'Y' Centroid	'Z' Centroid	Mx	My	Mz	NOTES:
(kip/ft)	(kip/ft)	(kip/ft)	(ft)	(ft)	(ft)	(kip-ft/ft)	(kip-ft/ft)	(kip-ft/ft)	
0.00	0.00	0.73	-1.50	0.00	0.00	0.00	1.10	0.00	Wall stem weight
0.00	0.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00	Base slab weight
0.00	0.00	1.07	2.13	0.00	0.00	0.00	-2.28	0.00	F.S. soil weight
0.00	0.00	1.07	-3.63	0.00	0.00	0.00	3.88	0.00	P.S. soil weight
-1.07	0.00	0.00	0.00	0.00	-2.08	0.00	2.22	0.00	F.S. lateral soil force
2.22	0.00	0.00	0.00	0.00	-2.08	0.00	-4.62	0.00	P.S. lateral soil force
0.00	0.00	1.16	2.13	0.00	0.00	0.00	-2.47	0.00	Vertical water force
-1.21	0.00	0.00	0.00	0.00	-2.08	0.00	2.53	0.00	Lateral water force
						0.00	0.00	0.00	Wind load
						0.00	0.00	0.00	FS wave load
						0.00	0.00	0.00	Soil Vertical EQ force
						0.00	0.00	0.00	Soil Lateral EQ force
						0.00	0.00	0.00	Con. Vertical EQ force
						0.00	0.00	0.00	Con. Lateral EQ force
						0.00	0.00	0.00	F.S. Surcharge load
						0.00	0.00	0.00	P.S. Surcharge load
						0.00	0.00	0.00	Unbalanced load
						0.00	0.00	0.00	Impact load
0.00	0.00	-2.53	1.75	0.00	0.00	0.00	4.43	0.00	Hydrostatic uplift
-0.061	**0.000**	**6.004**				**0.000**	**4.776**	**0.000**	**SUM.**

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	LC2	Checked by	JMH	Date	Dec-20
				References	

Shear and Moment on the Wall

Update

V_u	-0.01	(kips/ft)
M_u	0.03	(kips-ft/ft)

Note: enter load factors

Soil Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6	-0.113	0.310
PS	1.6	0.235	-0.646

Factored V & M

V_u =	0.196	(kips/ft)
M_u =	-0.538	(kips-ft/ft)

Water Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6	-0.129	0.354

Factored V & M

V_u =	-0.206	(kips/ft)
M_u =	0.566	(kips-ft/ft)

Wind Force:

Load Factor		Unfact. V	Unfact. M
FS	1		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Wave Force:

Load Factor		Unfact. V	Unfact. M
FS	1		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Earthquake Force:

Load Factor		Unfact. V	Unfact. M
PS	1		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Impact Force:

Load Factor		Unfact. V	Unfact. M
FS	1		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	LC3	Checked by	JMH	Date	Dec-20
					References

LC3: Water to TOW (pervious cutoff)

Loads

Deselect All

Dead Loads:

☑ Wall Stem Wt. ☑ Base Slab Wt.

Soil Forces:

Dry	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
10 Yr. Water El.	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
100 Yr. Water El.	☐ F.S. Soil Wt.	☐ P.S. Soil Wt.	☐ F.S. Lat. Soil Force	☐ P.S. Lat. Soil Force
Top of Wall EL.	☑ F.S. Soil Wt.	☑ P.S. Soil Wt.	☑ F.S. Lat. Soil Force	☑ P.S. Lat. Soil Force

Water Forces:

10 Yr. Water El.	☐ F.S. Water	☐ F.S. Lat. Water
100 Yr. Water El.	☐ F.S. Water	☐ F.S. Lat. Water
Top of Wall EL.	☑ F.S. Water	☑ F.S. Lat. Water

Wind Force:

Construction	☐ P.S. Lat. Wind Force
No Water	☐ F.S. Lat. Wind
10 Yr. Water El.	☐ F.S. Lat. Wind
100 Yr. Water El.	☐ F.S. Lat. Wind

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	LC3	Checked by	JMH	Date	Dec-20
				References	

Wave Force:

- 10 Yr. Water El. — ☐ F.S. Lat. Wave
- 100 Yr. Water El. — ☐ F.S. Lat. Wave
- Top of Wall EL. — ☐ F.S. Lat. Wave

Earthquake Force:

- MDE — ☐ Soil Ver. MDE ☐ Soil Lat. MDE ☐ Conc. Ver. MDE ☐ Conc. Lat. MDE
- OBE — ☐ Soil Ver. OBE ☐ Soil Lat. OBE ☐ Conc. Ver. OBE ☐ Conc. Lat. OBE

Surcharge Forces:

- ☐ F.S. Surcharge Force ☐ P.S. Surcharge Force

Unbalanced Load:

- 10 Yr. Water El. — ☐ Lat. Unbalance
- 100 Yr. Water El. — ☐ Lat. Unbalance
- Top of Wall EL. — ☐ Lat. Unbalance

Impact Load:

- ☐ Lat. Impact force

Uplift Loads:

Impervious
- ☐ 10y SWL Uplift Pressure
- ☐ 100y SWL Uplift
- ☐ TOW Uplift Pressure

Pervious
- ☐ 10y SWL Uplift Pressure
- ☐ 100y SWL Uplift
- ☑ TOW Uplift Pressure

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	LC3	Checked by	JMH	Date	Dec-20
					References

Fx	Fy	Fz	'X' Centroid	'Y' Centroid	'Z' Centroid	Mx	My	Mz	NOTES:
(kip/ft)	(kip/ft)	(kip/ft)	(ft)	(ft)	(ft)	(kip-ft/ft)	(kip-ft/ft)	(kip-ft/ft)	
0.00	0.00	0.73	-1.50	0.00	0.00	0.00	1.10	0.00	Wall stem weight
0.00	0.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00	Base slab weight
0.00	0.00	1.07	2.13	0.00	0.00	0.00	-2.28	0.00	F.S. soil weight
0.00	0.00	1.07	-3.63	0.00	0.00	0.00	3.88	0.00	P.S. soil weight
-1.07	0.00	0.00	0.00	0.00	-2.08	0.00	2.22	0.00	F.S. lateral soil force
2.22	0.00	0.00	0.00	0.00	-2.08	0.00	-4.62	0.00	P.S. lateral soil force
0.00	0.00	1.16	2.13	0.00	0.00	0.00	-2.47	0.00	Vertical water force
-1.21	0.00	0.00	0.00	0.00	-2.08	0.00	2.53	0.00	Lateral water force
						0.00	0.00	0.00	Wind load
						0.00	0.00	0.00	FS wave load
						0.00	0.00	0.00	Soil Vertical EQ force
						0.00	0.00	0.00	Soil Lateral EQ force
						0.00	0.00	0.00	Con. Vertical EQ force
						0.00	0.00	0.00	Con. Lateral EQ force
						0.00	0.00	0.00	F.S. Surcharge load
						0.00	0.00	0.00	P.S. Surcharge load
						0.00	0.00	0.00	Unbalanced load
						0.00	0.00	0.00	Impact load
0.00	0.00	-1.95	1.67	0.00	0.00	0.00	3.25	0.00	Hydrostatic uplift
-0.061	**0.000**	**6.588**				**0.000**	**3.592**	**0.000**	**SUM.**

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	LC3	Checked by	JMH	Date	Dec-20
				References	

Shear and Moment on the Wall

Note: enter load factors

Update

V_u	-0.01	(kips/ft)
M_u	0.03	(kips-ft/ft)

Soil Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6	-0.113	0.310
PS	1.6	0.235	-0.646

Factored V & M

V_u =	0.196	(kips/ft)
M_u =	-0.538	(kips-ft/ft)

Water Force:

Load Factor		Unfact. V	Unfact. M
FS	1.6	-0.129	0.354

Factored V & M

V_u =	-0.206	(kips/ft)
M_u =	0.566	(kips-ft/ft)

Wind Force:

Load Factor		Unfact. V	Unfact. M
FS	1		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Wave Force:

Load Factor		Unfact. V	Unfact. M
FS	1		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Earthquake Force:

Load Factor		Unfact. V	Unfact. M
PS	1		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

Impact Force:

Load Factor		Unfact. V	Unfact. M
FS	1		

Factored V & M

V_u =	0.000	(kips/ft)
M_u =	0.000	(kips-ft/ft)

AECOM

Job	Maurepaus Swamp	Project No.	60589133
Description	T-WALL SECTION KCS-5	Computed by	AML	Date	Dec-20
	Summary of Foundation Loads	Checked by	JMH	Date	Dec-20
			References

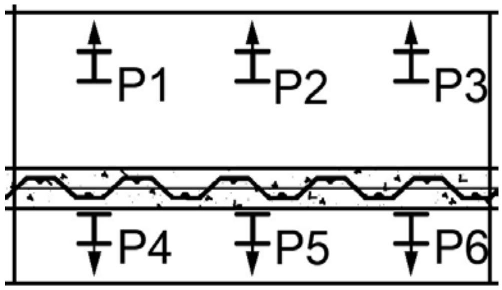
Load Case	Fx (kips)	Fy (kips)	Fz (kips)	Mx (kip-ft)	My (kip-ft)	Mz (kip-ft)
LC1	0.00	0.00	132.41	0.00	9.60	0.00
LC2	-1.09	0.00	108.07	0.00	85.96	0.00
LC3	-1.09	0.00	118.58	0.00	64.65	0.00

AECOM

Job	Maurepaus Swamp	Project No.	60632162
Description	T-WALL SECTION	Computed by AML	Date Dec-20
	KCS-5		
	Soil & Pile Information Required for CPGA	Checked by JMH	Date Dec-20
			References

Pile Layout: 6 HP Piles

Row 1			Row 2		
pile no.	x	y	pile no.	x	y
1	3.00	-6.00	4	-3.00	-6.00
2	3.00	0.00	5	-3.00	0.00
3	3.00	6.00	6	-3.00	6.00



Tip Elevation: (For CPGA, need Tip Elevation as a function of CPGA Axis at B.O. Slab, +Z points downward)

B.O.S. Elevation = 9.89 NAVD88
Pile Tip EL = -28 NAVD89
"TIP" in CPGA = 37.89 ft

Pile Properties & Attributes

E =	29000000.00	psi	
A =	21.40	in^2	HP14X73
I_x =	729.00	in^4	
I_y =	261.00	in^4	
C_{33} =	1.70	(factor for method of axial load transfer from pile to soil; = 1 full tip bearing, = 2 full skin friction)	
S_x =	107.00	in^3	
S_y =	35.80	in^3	
F_y =	50.00	ksi	

Note:All soil properties and pile capacities are taken from 95% submittial for Maurapaus Intake Strcuture

Allowable Compression (AC) =	30.00	kips
Allowable Tension (AT) =	18.00	kips
ACC =	492.66	kips
ATT =	535.00	kips
AM1 =	2972.22	kip-in
AM2 =	994.44	kip-in

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Soil & Pile Information Required for CPGA	Checked by	JMH	Date	Dec-20
					References

Es Value for CPGA Run:

Monolith width = 18 ft

E_s = 540.40 psi = 0.5404 ksi

GROUP FACTORS	
Pile Spacing in Direction of Loading	From EM1110-2-2906
	D
3B	0.33
4B	0.38
5B	0.45
6B	0.56
7B	0.71
8B	1

Group reduction is based on distance between piles in direction of loading. This includes distance due to battering and is taken over the distance 10 x d_{pile} (point of fixety).

Assume a batter of 6.00

B = d_{pile} = 13.6 in = 1.133 ft

Distance between piles at B.O. Slab = 6.00 ft

Average distance between piles over 10*dpile = 7.89 ft

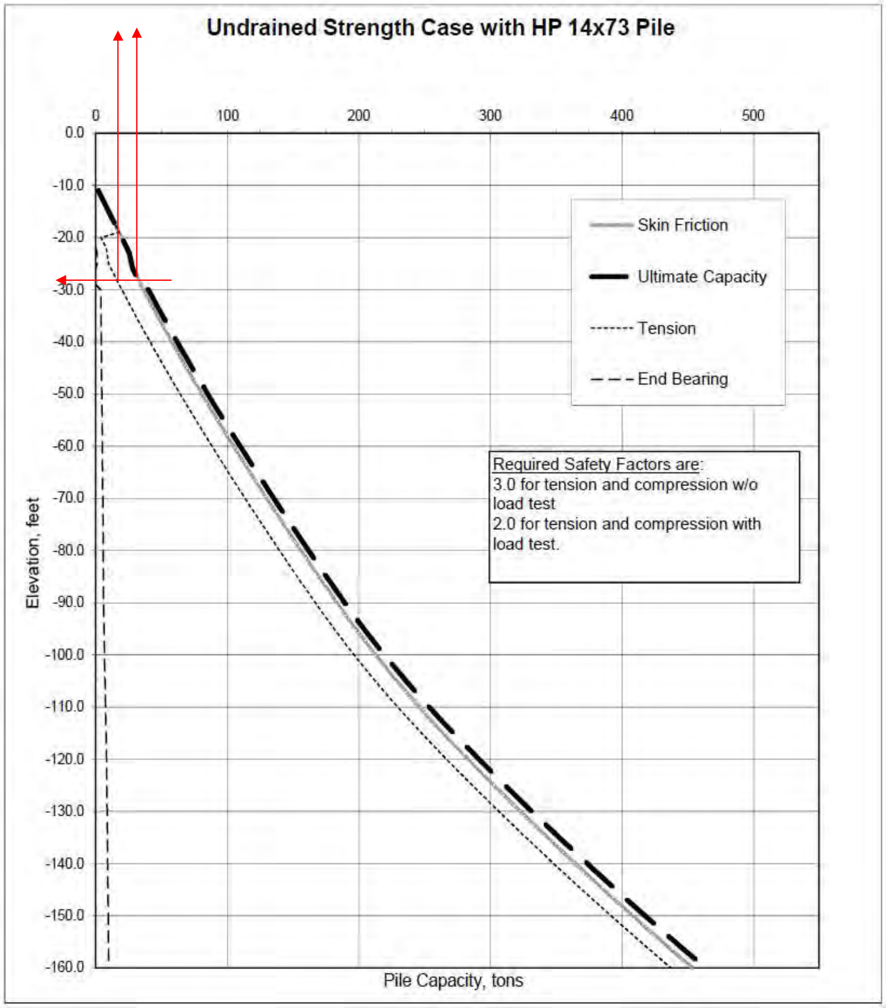
Average distance between piles in terms of pile width B = 6.96 B

Group Reduction "D" value for this distance = 0.70

Therefore, Es including group reduction = 0.38 ksi

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Soil & Pile Information Required for CPGA	Checked by	JMH	Date	Dec-20
					References



Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

Input file:

```
100 MONOLITH, TOW EL. 16.13, TOS EL.12.89; HP 14X73  PILES
200 PROP 29000 729 261 21.4 1.7 0 ALL
300 SOIL ES 0.3805 TIP 37.89 0 ALL
400 PIN ALL
500 ALLOW H 30 18 492.7 535 2972.2 994.4 ALL
700 FOVSTR 1.17 1.17 1
800 FOVSTR 1.33 1.33 2 3
900 BATTER 6 All
1200 ANGLE 180 4 TO 6
1400 PILE 1 3 -6 0
1500 PILE 2 3 0 0
1600 PILE 3 3 6 0
1700 PILE 4 -3 -6 0
1800 PILE 5 -3 0 0
1900 PILE 6 -3 6 0
4500 LOAD 1 0 0 132.4 0 9.6 0
4600 LOAD 2 -1.1 0 108.1 0 86 0
4700 LOAD 3 -1.1 0 118.6 0 64.6 0
9000 FOUT 1 2 3 4 5 6 7 KCS5P.DOC
9100 PFO ALL
9200 PLB ALL
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

CPGA RESULTS without Load Factors (pinned connection)

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 15-DEC-20     RUN TIME: 12:13:58



    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.12.89; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE   6 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                   X          Y          Z
                                 -----      -----      -----
WITH DIAGONAL COORDINATES = (     -3.00 ,    -6.00 ,     0.00 )
                            (      3.00 ,     6.00 ,     0.00 )


*******************************************************************************

         PILE PROPERTIES AS INPUT


      E           I1            I2            A           C33           B66
     KSI         IN**4         IN**4        IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


*******************************************************************************
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

```
         SOIL DESCRIPTIONS AS INPUT


   ES      ESOIL       LENGTH        L            LU
          K/IN**2                    FT           FT
         0.38050E+00    T      0.37890E+02   0.00000E+00

 ESOIL(ORIGINAL)      RGROUP     RCYCLIC
   K/IN**2
  0.38050E+00       0.1000E+01 0.1000E+01

THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


 0.17968E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.23229E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.22888E+04  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


THIS MATRIX APPLIES TO THE FOLLOWING PILES -

      1


*******************************************************************************

         PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM        X          Y          Z     BATTER   ANGLE   LENGTH  FIXITY
          FT         FT         FT                        FT

  1       3.00      -6.00       0.00     6.00     0.00    38.41    P
  2       3.00       0.00       0.00     6.00     0.00    38.41    P
  3       3.00       6.00       0.00     6.00     0.00    38.41    P
  4      -3.00      -6.00       0.00     6.00   180.00    38.41    P
  5      -3.00       0.00       0.00     6.00   180.00    38.41    P
  6      -3.00       6.00       0.00     6.00   180.00    38.41    P
                                                         ------
 230.48
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

```
******************************************************************************

                        APPLIED LOADS

LOAD     PX         PY         PZ          MX          MY           MZ  OVERSTRESS
CASE      K          K          K         FT-K        FT-K         FT-K  COM   TEN

  1       0.0        0.0      132.4         0.0         9.6          0.0 1.17 1.17
  2      -1.1        0.0      108.1         0.0        86.0          0.0 1.33 1.33
  3      -1.1        0.0      118.6         0.0        64.6          0.0 1.33 1.33


******************************************************************************

         ORIGINAL PILE GROUP STIFFNESS MATRIX

 0.47605E+03 -0.40967E-05  0.34106E-12  0.00000E+00 -0.79540E+05  0.14748E-03
-0.40967E-05  0.13937E+03  0.26884E-04  0.00000E+00  0.96784E-03 -0.32969E-11
 0.22737E-12  0.26884E-04  0.13364E+05  0.00000E+00  0.29104E-10 -0.96784E-03
 0.00000E+00  0.00000E+00  0.00000E+00  0.46188E+08  0.00000E+00 -0.11642E-08
-0.79540E+05  0.96784E-03  0.29104E-10  0.00000E+00  0.17320E+08 -0.34842E-01
 0.14748E-03 -0.32969E-11 -0.96784E-03 -0.11642E-08 -0.34842E-01  0.18259E+07



                      6 PILES    3 LOAD CASES

LOAD CASE    1.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    2.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    3.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.


******************************************************************************

         PILE CAP DISPLACEMENTS
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

LOAD CASE	DX	DY	DZ	RX	RY	RZ
	IN	IN	IN	RAD	RAD	RAD
1	0.4775E-02	-0.1969E-08	0.9907E-02	0.1364E-27	0.2858E-04	0.5411E-11
2	0.3285E-01	-0.2056E-08	0.8089E-02	0.1424E-27	0.2104E-03	0.5650E-11
3	0.2221E-01	-0.2078E-08	0.8874E-02	0.1439E-27	0.1467E-03	0.5710E-11

****

ELASTIC CENTER INFORMATION

ELASTIC CENTER IN PLANE X-Z	X	Z
	FT	FT
	0.00	0.00

****

PILE FORCES IN LOCAL GEOMETRY

M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
* INDICATES PILE FAILURE
# INDICATES CBF BASED ON MOMENTS DUE TO
(F3*EMIN) FOR CONCRETE PILES
B INDICATES BUCKLING CONTROLS

LOAD CASE - 1

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	0.1	0.0	21.8	0.0	-1.8	0.0	0.62	0.04
2	0.1	0.0	21.8	0.0	-1.8	0.0	0.62	0.04
3	0.1	0.0	21.8	0.0	-1.8	0.0	0.62	0.04
4	-0.1	0.0	22.9	0.0	3.6	0.0	0.65	0.04
5	-0.1	0.0	22.9	0.0	3.6	0.0	0.65	0.04
6	-0.1	0.0	22.9	0.0	3.6	0.0	0.65	0.04

Job	Maurepaus Swamp		Project No.	60632162		
Description	T-WALL SECTION		Computed by	AML	Date	Dec-20
	KCS-5					
	CPGA Input & Output Files (Pile Analysis)		Checked by	JMH	Date	Dec-20

LOAD CASE - 2

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	0.6	0.0	13.5	0.0	-17.7	0.0	0.34	0.03
2	0.6	0.0	13.5	0.0	-17.7	0.0	0.34	0.03
3	0.6	0.0	13.5	0.0	-17.7	0.0	0.34	0.03
4	-0.6	0.0	23.0	0.0	19.1	0.0	0.58	0.05
5	-0.6	0.0	23.0	0.0	19.1	0.0	0.58	0.05
6	-0.6	0.0	23.0	0.0	19.1	0.0	0.58	0.05

LOAD CASE - 3

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF
	K	K	K	IN-K	IN-K	IN-K		
1	0.4	0.0	16.5	0.0	-11.6	0.0	0.41	0.03
2	0.4	0.0	16.5	0.0	-11.6	0.0	0.41	0.03
3	0.4	0.0	16.5	0.0	-11.6	0.0	0.41	0.03
4	-0.4	0.0	23.6	0.0	13.2	0.0	0.59	0.05
5	-0.4	0.0	23.6	0.0	13.2	0.0	0.59	0.05
6	-0.4	0.0	23.6	0.0	13.2	0.0	0.59	0.05

****

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	3.6	0.0	21.5	0.0	0.0	0.0
2	3.6	0.0	21.5	0.0	0.0	0.0
3	3.6	0.0	21.5	0.0	0.0	0.0
4	-3.6	0.0	22.6	0.0	0.0	0.0
5	-3.6	0.0	22.6	0.0	0.0	0.0
6	-3.6	0.0	22.6	0.0	0.0	0.0

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

LOAD CASE - 2

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	2.8	0.0	13.2	0.0	0.0	0.0
2	2.8	0.0	13.2	0.0	0.0	0.0
3	2.8	0.0	13.2	0.0	0.0	0.0
4	-3.2	0.0	22.8	0.0	0.0	0.0
5	-3.2	0.0	22.8	0.0	0.0	0.0
6	-3.2	0.0	22.8	0.0	0.0	0.0

LOAD CASE - 3

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	3.1	0.0	16.2	0.0	0.0	0.0
2	3.1	0.0	16.2	0.0	0.0	0.0
3	3.1	0.0	16.2	0.0	0.0	0.0
4	-3.5	0.0	23.4	0.0	0.0	0.0
5	-3.5	0.0	23.4	0.0	0.0	0.0
6	-3.5	0.0	23.4	0.0	0.0	0.0

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

CPGA RESULTS without Load Factors (fixed connection)

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 15-DEC-20     RUN TIME: 12:15:14



    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.12.89; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE   6 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                   X          Y          Z
                                 -----      -----      -----
WITH DIAGONAL COORDINATES = (     -3.00 ,    -6.00 ,     0.00 )
                            (      3.00 ,     6.00 ,     0.00 )


*******************************************************************************

         PILE PROPERTIES AS INPUT


      E           I1           I2           A           C33          B66
     KSI         IN**4        IN**4        IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

```
******************************************************************************

         SOIL DESCRIPTIONS AS INPUT


   ES      ESOIL       LENGTH        L            LU
         K/IN**2                     FT           FT
        0.38050E+00     T       0.37890E+02   0.00000E+00

 ESOIL(ORIGINAL)      RGROUP     RCYCLIC
   K/IN**2
  0.38050E+00       0.1000E+01 0.1000E+01

THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

    ALL


******************************************************************************

         PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


 0.35937E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.16971E+04  0.00000E+00
 0.00000E+00  0.46458E+02  0.00000E+00 -0.28362E+04  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.22888E+04  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00 -0.28362E+04  0.00000E+00  0.34630E+06  0.00000E+00  0.00000E+00
 0.16971E+04  0.00000E+00  0.00000E+00  0.00000E+00  0.16028E+06  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

THIS MATRIX APPLIES TO THE FOLLOWING PILES -

1

****

PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM	X FT	Y FT	Z FT	BATTER	ANGLE	LENGTH FT	FIXITY
1	3.00	-6.00	0.00	6.00	0.00	38.41	F
2	3.00	0.00	0.00	6.00	0.00	38.41	F
3	3.00	6.00	0.00	6.00	0.00	38.41	F
4	-3.00	-6.00	0.00	6.00	180.00	38.41	F
5	-3.00	0.00	0.00	6.00	180.00	38.41	F
6	-3.00	6.00	0.00	6.00	180.00	38.41	F

230.48

****

APPLIED LOADS

LOAD CASE	PX K	PY K	PZ K	MX FT-K	MY FT-K	MZ FT-K	OVERSTRESS COM	TEN
1	0.0	0.0	132.4	0.0	9.6	0.0	1.17	1.17
2	-1.1	0.0	108.1	0.0	86.0	0.0	1.33	1.33
3	-1.1	0.0	118.6	0.0	64.6	0.0	1.33	1.33

****

AECOM

Job	Maurepaus Swamp		Project No.	60632162		
Description	T-WALL SECTION		Computed by	AML	Date	Dec-20
	KCS-5					
	CPGA Input & Output Files (Pile Analysis)		Checked by	JMH	Date	Dec-20

```
        ORIGINAL PILE GROUP STIFFNESS MATRIX

 0.58095E+03 -0.36771E-05  0.34106E-12 -0.82036E-04 -0.68867E+05  0.98336E-04
-0.36771E-05  0.27875E+03  0.26672E-04 -0.16786E+05  0.10422E-02 -0.18190E-11
 0.34106E-12  0.26672E-04  0.13367E+05  0.20369E-04  0.00000E+00 -0.96018E-03
-0.82036E-04 -0.16786E+05  0.20369E-04  0.48219E+08 -0.12164E-01 -0.69849E-09
-0.68867E+05  0.10422E-02  0.00000E+00 -0.12164E-01  0.18406E+08 -0.41620E-01
 0.98336E-04 -0.13642E-11 -0.96018E-03 -0.69849E-09 -0.41620E-01  0.26266E+07



                     6 PILES   3 LOAD CASES

LOAD CASE    1.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    2.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    3.  NUMBER OF FAILURES =   0.  NUMBER OF PILES IN TENSION =   0.


*******************************************************************************

        PILE CAP DISPLACEMENTS

LOAD
CASE       DX          DY          DZ          RX          RY          RZ
           IN          IN          IN          RAD         RAD         RAD

   1   0.1333E-02 -0.9929E-09  0.9905E-02 -0.3447E-12  0.1125E-04  0.3749E-11
   2   0.8541E-02 -0.1009E-08  0.8087E-02 -0.3181E-12  0.8802E-04  0.4031E-11
   3   0.5569E-02 -0.1031E-08  0.8872E-02 -0.3374E-12  0.6295E-04  0.4032E-11


*******************************************************************************
             ELASTIC CENTER INFORMATION



ELASTIC CENTER IN PLANE X-Z         X             Z
                                   FT            FT
                                  0.00          0.00


*******************************************************************************
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

PILE FORCES IN LOCAL GEOMETRY

M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
* INDICATES PILE FAILURE
# INDICATES CBF BASED ON MOMENTS DUE TO (F3*EMIN) FOR CONCRETE PILES
B INDICATES BUCKLING CONTROLS

LOAD CASE - 1

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	0.0	0.0	21.9	0.0	1.4	0.0	0.63	0.04
2	0.0	0.0	21.9	0.0	1.4	0.0	0.63	0.04
3	0.0	0.0	21.9	0.0	1.4	0.0	0.63	0.04
4	-0.1	0.0	22.8	0.0	-6.9	0.0	0.65	0.05
5	-0.1	0.0	22.8	0.0	-6.9	0.0	0.65	0.05
6	-0.1	0.0	22.8	0.0	-6.9	0.0	0.65	0.05

LOAD CASE - 2

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	0.4	0.0	14.3	0.0	27.0	0.0	0.36	0.04
2	0.4	0.0	14.3	0.0	27.0	0.0	0.36	0.04
3	0.4	0.0	14.3	0.0	27.0	0.0	0.36	0.04
4	-0.5	0.0	22.2	0.0	-31.5	0.0	0.56	0.06
5	-0.5	0.0	22.2	0.0	-31.5	0.0	0.56	0.06
6	-0.5	0.0	22.2	0.0	-31.5	0.0	0.56	0.06

LOAD CASE - 3

PILE	F1 K	F2 K	F3 K	M1 IN-K	M2 IN-K	M3 IN-K	ALF	CBF
1	0.3	0.0	17.0	0.0	17.6	0.0	0.43	0.04
2	0.3	0.0	17.0	0.0	17.6	0.0	0.43	0.04
3	0.3	0.0	17.0	0.0	17.6	0.0	0.43	0.04
4	-0.4	0.0	23.1	0.0	-22.5	0.0	0.58	0.05
5	-0.4	0.0	23.1	0.0	-22.5	0.0	0.58	0.05
6	-0.4	0.0	23.1	0.0	-22.5	0.0	0.58	0.05

****

PILE FORCES IN GLOBAL GEOMETRY

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	CPGA Input & Output Files (Pile Analysis)	Checked by	JMH	Date	Dec-20

LOAD CASE - 1

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	3.6	0.0	21.6	0.0	1.4	0.0
2	3.6	0.0	21.6	0.0	1.4	0.0
3	3.6	0.0	21.6	0.0	1.4	0.0
4	-3.6	0.0	22.5	0.0	6.9	0.0
5	-3.6	0.0	22.5	0.0	6.9	0.0
6	-3.6	0.0	22.5	0.0	6.9	0.0

LOAD CASE - 2

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	2.8	0.0	14.1	0.0	27.0	0.0
2	2.8	0.0	14.1	0.0	27.0	0.0
3	2.8	0.0	14.1	0.0	27.0	0.0
4	-3.1	0.0	22.0	0.0	31.5	0.0
5	-3.1	0.0	22.0	0.0	31.5	0.0
6	-3.1	0.0	22.0	0.0	31.5	0.0

LOAD CASE - 3

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	3.1	0.0	16.7	0.0	17.6	0.0
2	3.1	0.0	16.7	0.0	17.6	0.0
3	3.1	0.0	16.7	0.0	17.6	0.0
4	-3.4	0.0	22.8	0.0	22.5	0.0
5	-3.4	0.0	22.8	0.0	22.5	0.0
6	-3.4	0.0	22.8	0.0	22.5	0.0

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	CPGA Input & Output Files (Concrete Design)	Checked by	JMH	Date	Dec-20

Input file:

```
100 MONOLITH, TOW EL. 16.13, TOS EL.12.89; HP 14X73  PILES
200 PROP 29000 729 261 21.4 1.7 0 ALL
300 SOIL ES 0.3805 TIP 37.89 0 ALL
400 PIN ALL
500 ALLOW H 30 18 492.7 535 2972.2 994.4 ALL
700 FOVSTR 1 1 1
800 FOVSTR 1 1 2 3
900 BATTER 6 All
1200 ANGLE 180 4 TO 6
1400 PILE 1 3 -6 0
1500 PILE 2 3 0 0
1600 PILE 3 3 6 0
1700 PILE 4 -3 -6 0
1800 PILE 5 -3 0 0
1900 PILE 6 -3 6 0
4500 LOAD 1 0 0 211.9 0 15.4 0
4600 LOAD 2 -1.7 0 172.9 0 137.5 0
4700 LOAD 3 -1.7 0 189.7 0 103.4 0
9000 FOUT 1 2 3 4 5 6 7 KCS5SC.DOC
9100 PFO ALL
9200 PLB ALL
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	CPGA Input & Output Files (Concrete Design)	Checked by	JMH	Date	Dec-20

CPGA RESULTS with Load Factors

```
CPGA - CASE PILE GROUP ANALYSIS PROGRAM
RUN DATE: 15-DEC-20     RUN TIME: 12:16:01




    FOR PILES WITH UNSUPPORTED HEIGHT:
         A. CPGA CANNOT CALCULATE PMAXMOM FOR NH TYPE SOIL
         B. THE ALLOWABLE STRESS CHECKS, ASC AND AST, ARE
            NOT FULLY DEVELOPED FOR UNSUPPORTED PILES.
            WORK IS IN PROGRESS TO COMPLETE THIS ASPECT OF CPGA.

    ELASTIC CENTER LOCATION IS NOT COMPUTED FOR 3-DIMENSIONAL PROBLEMS.


MONOLITH, TOW EL. 16.13, TOS EL.12.89; HP 14X73  PILES
DATA UNKNOWN - REJECTED.



THERE ARE   6 PILES AND
            3 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                   X          Y          Z
                                 -----      -----      -----
WITH DIAGONAL COORDINATES = (     -3.00 ,    -6.00 ,     0.00 )
                            (      3.00 ,     6.00 ,     0.00 )


*******************************************************************************

         PILE PROPERTIES AS INPUT


      E           I1           I2            A           C33          B66
     KSI         IN**4        IN**4        IN**2
 0.29000E+05  0.72900E+03  0.26100E+03  0.21400E+02  0.17000E+01  0.00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


*******************************************************************************
```

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	CPGA Input & Output Files (Concrete Design)	Checked by	JMH	Date	Dec-20

```
         SOIL DESCRIPTIONS AS INPUT


   ES     ESOIL      LENGTH       L            LU
         K/IN**2                  FT           FT
        0.38050E+00    T      0.37890E+02   0.00000E+00

 ESOIL(ORIGINAL)      RGROUP     RCYCLIC
   K/IN**2
  0.38050E+00       0.1000E+01 0.1000E+01

THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         PILE STIFFNESSES AS CALCULATED FROM PROPERTIES


 0.17968E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.23229E+02  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.22888E+04  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
 0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00


THIS MATRIX APPLIES TO THE FOLLOWING PILES -

      1


*******************************************************************************

         PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM        X          Y          Z      BATTER   ANGLE   LENGTH  FIXITY
          FT         FT         FT                        FT

  1       3.00      -6.00       0.00      6.00     0.00   38.41    P
  2       3.00       0.00       0.00      6.00     0.00   38.41    P
  3       3.00       6.00       0.00      6.00     0.00   38.41    P
  4      -3.00      -6.00       0.00      6.00   180.00   38.41    P
  5      -3.00       0.00       0.00      6.00   180.00   38.41    P
  6      -3.00       6.00       0.00      6.00   180.00   38.41    P
                                                          ------
 230.48
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	CPGA Input & Output Files (Concrete Design)	Checked by	JMH	Date	Dec-20

```
*******************************************************************************

                         APPLIED LOADS

LOAD      PX         PY         PZ           MX           MY           MZ
CASE       K          K          K          FT-K         FT-K         FT-K

  1       0.0        0.0      211.9          0.0         15.4          0.0
  2      -1.7        0.0      172.9          0.0        137.5          0.0
  3      -1.7        0.0      189.7          0.0        103.4          0.0


*******************************************************************************

         ORIGINAL PILE GROUP STIFFNESS MATRIX

 0.47605E+03 -0.40967E-05  0.34106E-12  0.00000E+00 -0.79540E+05  0.14748E-03
-0.40967E-05  0.13937E+03  0.26884E-04  0.00000E+00  0.96784E-03 -0.32969E-11
 0.22737E-12  0.26884E-04  0.13364E+05  0.00000E+00  0.29104E-10 -0.96784E-03
 0.00000E+00  0.00000E+00  0.00000E+00  0.46188E+08  0.00000E+00 -0.11642E-08
-0.79540E+05  0.96784E-03  0.29104E-10  0.00000E+00  0.17320E+08 -0.34842E-01
 0.14748E-03 -0.32969E-11 -0.96784E-03 -0.11642E-08 -0.34842E-01  0.18259E+07



                       6 PILES    3 LOAD CASES

LOAD CASE    1.  NUMBER OF FAILURES =   6.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    2.  NUMBER OF FAILURES =   3.  NUMBER OF PILES IN TENSION =   0.

LOAD CASE    3.  NUMBER OF FAILURES =   3.  NUMBER OF PILES IN TENSION =   0.


*******************************************************************************
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	CPGA Input & Output Files (Concrete Design)	Checked by	JMH	Date	Dec-20

```
         PILE CAP DISPLACEMENTS


 LOAD
 CASE        DX          DY          DZ          RX          RY          RZ
             IN          IN          IN          RAD         RAD         RAD

    1   0.7661E-02 -0.3152E-08  0.1586E-01  0.2183E-27  0.4585E-04  0.8661E-11
    2   0.5305E-01 -0.3289E-08  0.1294E-01  0.2278E-27  0.3389E-03  0.9040E-11
    3   0.3609E-01 -0.3326E-08  0.1419E-01  0.2303E-27  0.2374E-03  0.9139E-11


 ******************************************************************************
              ELASTIC CENTER INFORMATION



 ELASTIC CENTER IN PLANE X-Z          X             Z
                                     FT            FT
                                    0.00          0.00


 ******************************************************************************

         PILE FORCES IN LOCAL GEOMETRY

             M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
             * INDICATES PILE FAILURE
             # INDICATES CBF BASED ON MOMENTS DUE TO
                       (F3*EMIN) FOR CONCRETE PILES
             B INDICATES BUCKLING CONTROLS



 LOAD CASE -     1

 PILE    F1       F2       F3        M1        M2        M3   ALF  CBF
         K        K        K        IN-K      IN-K      IN-K

   1     0.1      0.0     35.0       0.0      -2.9       0.0 1.17 0.07          *
   2     0.1      0.0     35.0       0.0      -2.9       0.0 1.17 0.07          *
   3     0.1      0.0     35.0       0.0      -2.9       0.0 1.17 0.07          *
   4    -0.2      0.0     36.6       0.0       5.7       0.0 1.22 0.08          *
   5    -0.2      0.0     36.6       0.0       5.7       0.0 1.22 0.08          *
   6    -0.2      0.0     36.6       0.0       5.7       0.0 1.22 0.08          *
```

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	CPGA Input & Output Files (Concrete Design)	Checked by	JMH	Date	Dec-20

LOAD CASE - 2

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF	
	K	K	K	IN-K	IN-K	IN-K			
1	0.9	0.0	21.6	0.0	-28.5	0.0	0.72	0.07	
2	0.9	0.0	21.6	0.0	-28.5	0.0	0.72	0.07	
3	0.9	0.0	21.6	0.0	-28.5	0.0	0.72	0.07	
4	-1.0	0.0	36.8	0.0	30.9	0.0	1.23	0.11	*
5	-1.0	0.0	36.8	0.0	30.9	0.0	1.23	0.11	*
6	-1.0	0.0	36.8	0.0	30.9	0.0	1.23	0.11	*

LOAD CASE - 3

PILE	F1	F2	F3	M1	M2	M3	ALF	CBF	
	K	K	K	IN-K	IN-K	IN-K			
1	0.6	0.0	26.3	0.0	-18.9	0.0	0.88	0.07	
2	0.6	0.0	26.3	0.0	-18.9	0.0	0.88	0.07	
3	0.6	0.0	26.3	0.0	-18.9	0.0	0.88	0.07	
4	-0.7	0.0	37.8	0.0	21.5	0.0	1.26	0.10	*
5	-0.7	0.0	37.8	0.0	21.5	0.0	1.26	0.10	*
6	-0.7	0.0	37.8	0.0	21.5	0.0	1.26	0.10	*

****

PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	5.8	0.0	34.5	0.0	0.0	0.0
2	5.8	0.0	34.5	0.0	0.0	0.0
3	5.8	0.0	34.5	0.0	0.0	0.0
4	-5.8	0.0	36.2	0.0	0.0	0.0
5	-5.8	0.0	36.2	0.0	0.0	0.0
6	-5.8	0.0	36.2	0.0	0.0	0.0

Job	Maurepaus Swamp		Project No.	60632162		
Description	T-WALL SECTION		Computed by	AML	Date	Dec-20
	KCS-5					
	CPGA Input & Output Files (Concrete Design)		Checked by	JMH	Date	Dec-20

LOAD CASE - 2

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	4.5	0.0	21.2	0.0	0.0	0.0
2	4.5	0.0	21.2	0.0	0.0	0.0
3	4.5	0.0	21.2	0.0	0.0	0.0
4	-5.0	0.0	36.5	0.0	0.0	0.0
5	-5.0	0.0	36.5	0.0	0.0	0.0
6	-5.0	0.0	36.5	0.0	0.0	0.0

LOAD CASE - 3

PILE	PX	PY	PZ	MX	MY	MZ
	K	K	K	IN-K	IN-K	IN-K
1	4.9	0.0	25.9	0.0	0.0	0.0
2	4.9	0.0	25.9	0.0	0.0	0.0
3	4.9	0.0	25.9	0.0	0.0	0.0
4	-5.5	0.0	37.4	0.0	0.0	0.0
5	-5.5	0.0	37.4	0.0	0.0	0.0
6	-5.5	0.0	37.4	0.0	0.0	0.0

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Summary of Shear & Moment	Checked by	JMH	Date	Dec-20
					References

Load Case	$V_{u,max}$ (kip/ft)	$M_{u,max}$ (kip/ft)
LC1	0.00	0.00
LC2	-0.01	0.03
LC3	-0.01	0.03

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION KCS-5	Computed by	AML	Date	Dec-20
	Shear & Moment Check for Wall	Checked by	JMH	Date	Dec-20
					References

*** Given Information:**

Wall Thickness:	1.50	ft
Clear Cover:	0.25	ft
Diameter Bar to Start:	0.08	ft
Maximum Shear (V_u):	0.01	kips per foot
Maximum Moment (M_u):	0.03	kip-ft per foot
φ_{shear} =	0.75	(ACI 318)
φ_{moment} =	0.9	(ACI 318)
$f_{y,\ rebar}$ =	60	ksi
f'_c =	4	ksi

*** Shear Calculations:**

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u) (ACI Eq. 11-1)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75	
f'_c =	4	ksi
b =	1	ft strip
d =	1.21	ft

φV_c =	16507.1	lbs	
	16.51	kips	** φVc=16.5 ≥ Vu=0, *Shear Capacity OK*

*** Reinforcement Calculations:**

Limit of Maximum Reinforcement: 0.25 x ρ_b (Design Criteria, EM 1110-2-2104, 3-5)

where ρ_b =	0.0285	for f'_c = 4,000psi, fy = 60,000psi
Max Rebar =	0.00713	*b * d

Maximum Reinforcement:	0.0071	* b * d =	1.24	in^2	per 1ft strip

A_{gross} = 1.5 ft * 12 in/ft * 12 in strip = 216.00 in^2

Limits of Minimum Reinforcement:	0.003 x Agross =	0.65	in^2	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
	$(3*\sqrt{(f'_c)}*b*d)/f_y$ =	0.55	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)
	$(200*b*d)/f_y$ =	0.58	in^2	(ACI 318-14, 9.6.1.2, min for flexural members)

Min Reinforcement, temp & shrinkage:	0.32	in^2	per 1ft strip, per face
Min Reinforcement, flexural:	0.58	in^2	per 1ft strip, per face

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION KCS-5	Computed by	AML	Date	Dec-20
	Shear & Moment Check for Wall	Checked by	JMH	Date	Dec-20
				References	

*** Moment Calculations:**

* $T = A_s \times f_y$

* $C = 0.85 \times f'_c \times a \times b$

* Assuming Tension = Compression ⟶ $A_s \times f_y = 0.85 \times f'_c \times a \times b$

* $\varphi Mn = \varphi \times T \times (d - (a / 2))$

$= \varphi \times A_s \times f_y \times (d - (a / 2))$

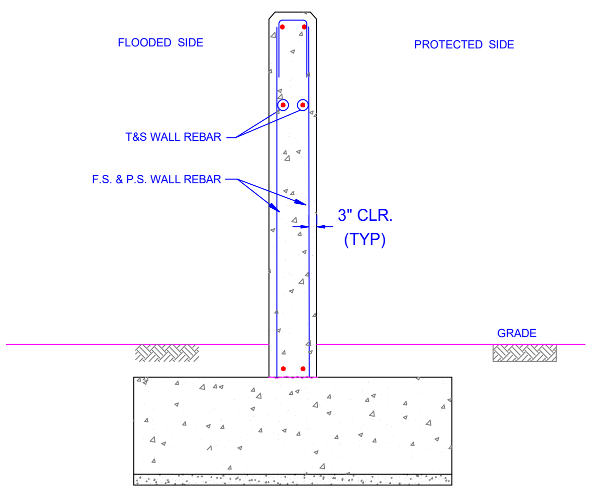
* Capacity of Min Flexural Reinforcement:

A_s =	0.580	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	1.20833	
φ_{moment} =	0.9	

$a = (A_s \times f_y) / (0.85 \times f'_c \times b)$

= 0.853 in

φM_n =	440.8	kip-in
=	36.73	kip-ft



* Capacity of Maximum Reinforcement:

A_s =	1.240	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	1.21	
φ_{moment} =	0.9	

$a = (A_s \times f_y) / (0.85 \times f'_c \times b)$

= 1.823 in

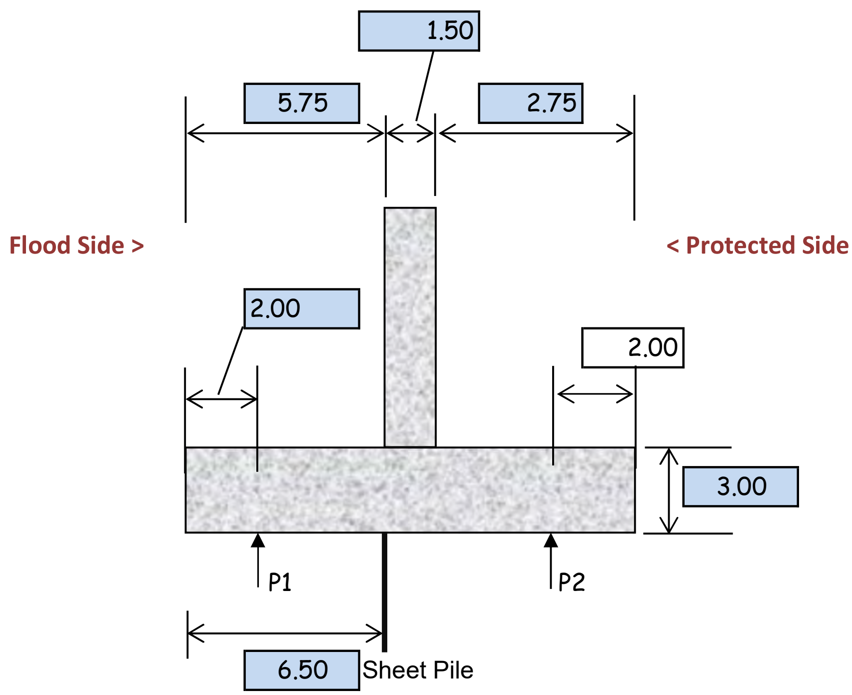
φMn =	909.7	kip-in
=	75.81	kip-ft

**** φMn=75.8 ≥ Mu=0, Section OK**

The minimum proposed reinforcement for T&S Wall Rebar is #6 @ 9" (A = 0.59 in^2) and the minimum proposed reinforcement for F.S. & P.S. Wall Rebar is #6 @ 9"(A=0.59 in^2).

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
Slab		Checked by	JMH	Date	Dec-20
					References



Tributary width (pile spacing): 6 ft Referred to as "width" in calculations

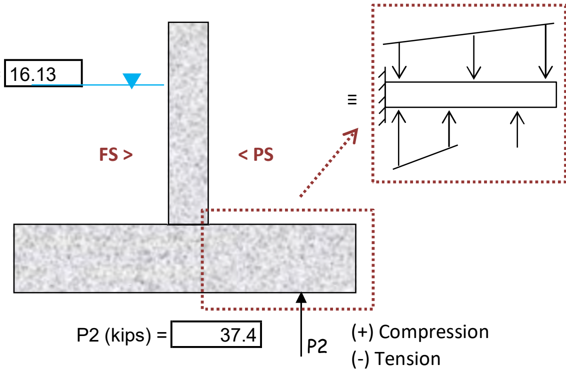
AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

Load Case: 3

Analysis of Protected Side of Slab:

F.S. WL = 16.13



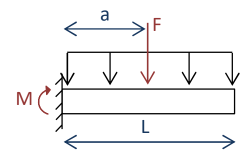
P2 (kips) = 37.4

(+) Compression
(-) Tension

* Here the shear and moment diagrams for the protected side of the slab are presented. The protected side of the slab is considered as a cantilever beam fixed at the face of the wall in protected side.

Allowable Overstress: %

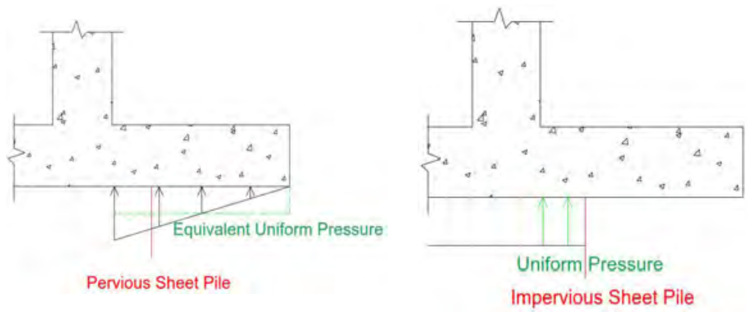
				Load Fac.			L	F (kips)	F x a = M (k-ft)
Self Weight:	$\gamma_{concrete} \times H_{slab} \times Width_{Tributary}$ =	2.70	x	1.6	4.32	kips/ft	x 2.75 ft =	11.88	16.34
Soil Load:	$\gamma_{soil} \times H_{soil} \times Width$ =	2.33	x	1.6	3.73	kips/ft	x 2.75 ft =	10.26	14.11
Const. Surcharge Load:	Surcharge pressure x Width =		x	1.6	0.00	kips/ft	x 2.75 ft =	0.00	0.00



AECOM

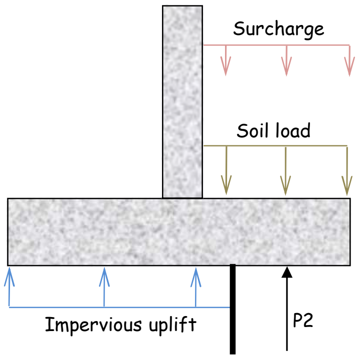
Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

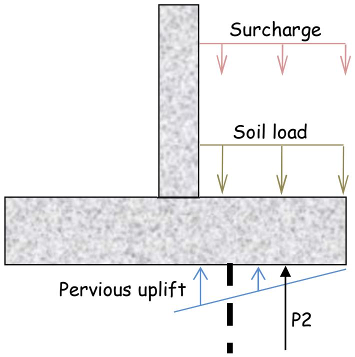
Uplift:	☑ Pervious ☐ Impervio	$\gamma_{water} \times H_{water\ w/slab} \times$ Width =	0.32	x	1.6	0.51	kips/ft	x 2.75 ft =	1.41	1.29



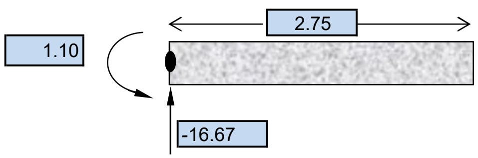
Conc. Earthquake Load:	EQ area pressure x Width =		x	1	0.00	kips/ft	x 2.75 ft =	0.00	0.00
Pile P2	P =	37.40	x	1	37.40	kips		37.40	28.05

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	





Reactions Calculations:



Find Reactions at face of wall (assumed to be a fixed support):

R_z = Self Weight + Soil Load - Pile Reaction 2 + (Surch.) - (Uplift)

R_z = -16.67 kips

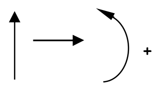
M_y = 1.10 kips-ft

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

Shear and Moment Calculations:

1) Sign Convention:



2) Find Equations for each loading to use in shear and moment calculations:
(Moving a distance "X" from the protected side to the wall stem across the slab)

Self Weight:
w_{weight} = -4.32 kips/ft
V_{weight} = -4.32 X
M_{weight} = -4.32 X² / 2

Soil Load:
w_{soil} = -3.73 kips/ft
V_{soil} = -3.73 X
M_{soil} = -3.73 X² / 2

Const. Surcharge:
w_{EQ} = -0 kips/ft
V_{EQ} = -0 X
M_{EQ} = -0 X² / 2

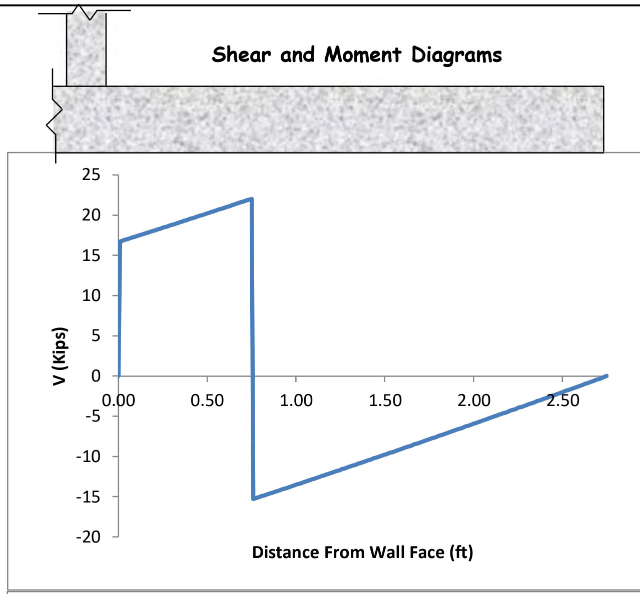
Uplift Load:
w_{uplift} = 0.37 X Kips/ft
V_{uplift} = 0.37 X² / 2
M_{uplift} = 0.37 X^3 / 6

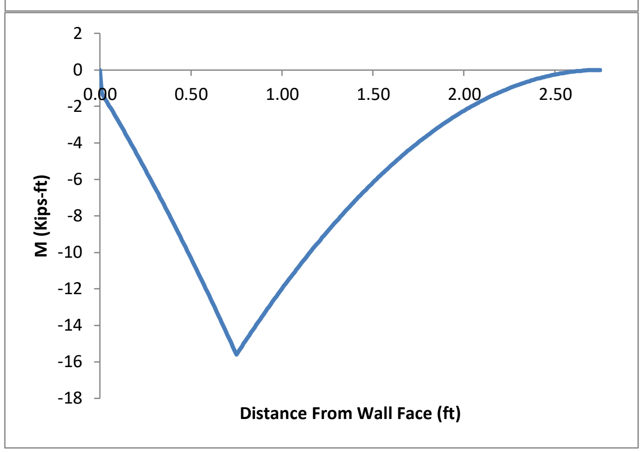
Conc. EQ:
w_{EQ} = -0 kips/ft
V_{EQ} = -0 X
M_{EQ} = -0 X² / 2

Pile P2:
V_{pile} = 37.4 Kips (after x = 2ft)
M_{pile} = 37.4 (X - 2 ft)

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Slab Calculation	Checked by	JMH	Date	Dec-20
					References

Shear and Moment Diagrams





Max Shear	
22.04	kips / tributary width / allowable OS =
3.67 Kips	

Max Top Moment	
-15.607	kips / tributary width / allowable OS =
-2.60 Kips	

Max Bottom Moment	
17.3095	kips / tributary width / allowable OS =
2.88 Kips	

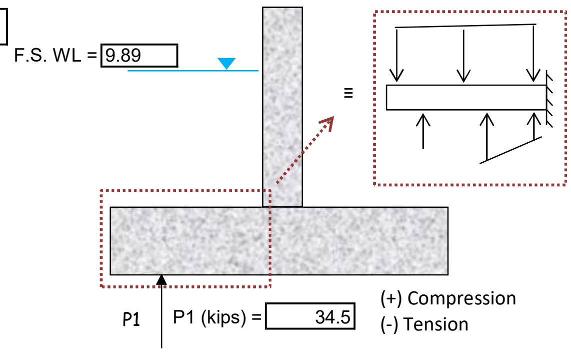
AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

Load Case: 1

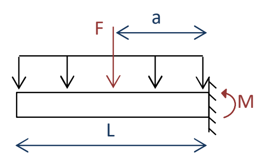
Analysis of Flooded Side of Slab:

* Here the shear and moment diagrams for the flood side of the slab are presented. The flood side of the slab is considered as a cantilever beam fixed at the face of the wall in flood side.



Allowable Overstress: %

	Formula			Load Fac.			L	F (kips)	F x a = M (k-ft)
Self Weight:	$\gamma_{concrete} \times H_{slab} \times$ Width =	2.70	x	1.6	4.32	kips/ft	x 5.75 ft =	24.84	71.42

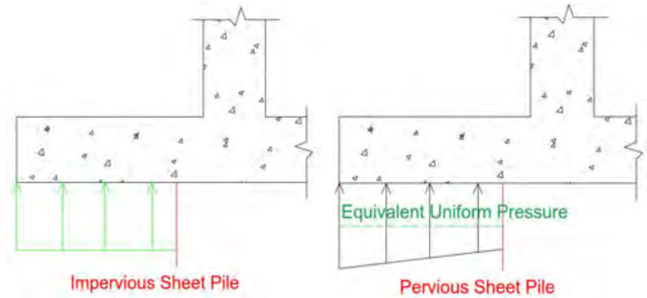


	Formula								
Soil Load:	$\gamma_{soil} \times H_{soil} \times$ Width =	2.33	x	0	0.00	kips/ft	x 5.75 ft =	0.00	0.00
Const. Surcharge Load:	Surcharge pressure x Width =	1.50	x	1.6	2.40	kips/ft	x 5.75 ft =	13.80	39.68

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

Uplift: ☐ Pervious ☐ Impervious	$\gamma_{water} \times H_{water\ w/slab} \times$ Width =	0.00	x 1.6	0.00	kips/ft	x 5.75 ft =	0.00	0.00

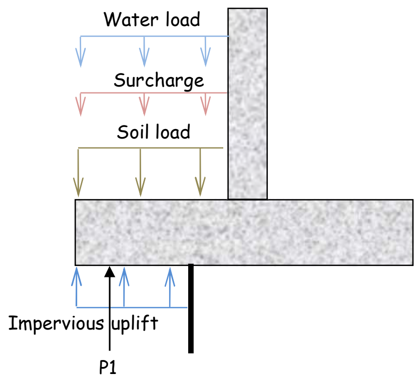


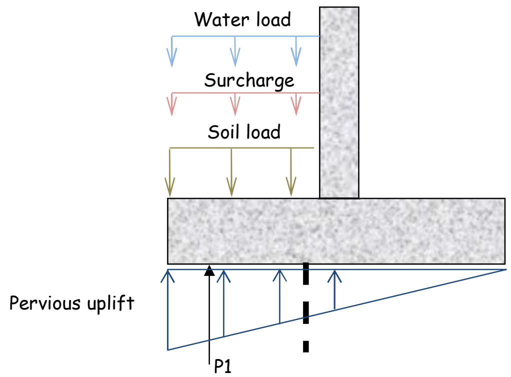
Conc. Earthquake Load:	EQ area pressure x Width =	1.85	x	0.00	kips/ft	x 5.75 ft =	0.00	0.00
Pile P1	P =	34.50	x 1	34.50	kips/ft		34.50	129.38

AECOM

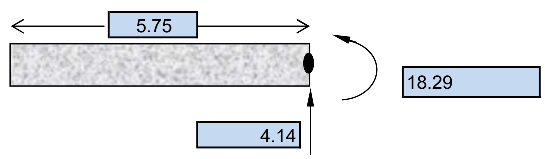
Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Slab Calculation	Checked by	JMH	Date	Dec-20
				References	

Water Weight: $\gamma_{water} \times H_{water} \times Width =$ -1.12 x 0 0.00 kips x 5.75 ft = 0.00 0.00





Reactions Calculations:



Find Reactions at face of wall (assumed to be a fixed support):

$R_z =$ Self Weight + Soil Load + Surch. - Pile Reaction 1 - Uplift

$R_z =$ 4.14 kips

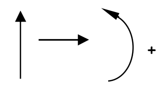
$M_y =$ 18.29 kips-ft

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Slab Calculation	Checked by	JMH	Date	Dec-20
					References

Shear and Moment Calculations:

1) Sign Convention:



2) Find Equations for each loading to use in shear and moment calculations:
(Moving a distance "X" from the flood side to the wall stem across the slab)

Self Weight:
w_{weight} = -4.32 kips/ft
V_{weight} = -4.32 X
M_{weight} = -4.32 X² / 2

Soil Load:
w_{soil} = -0 kips/ft
V_{soil} = -0 X
M_{soil} = -0 X² / 2

Const. Surcharge:
w_{EQ} = -2.4 kips/ft
V_{EQ} = -2.4 X
M_{EQ} = -2.4 X² / 2

Uplift Load:
w_{uplift} = 0
V_{uplift} = 0
M_{uplift} = 0

Water Load:
w_{uplift} = -0 kips
V_{uplift} = -0 X
M_{uplift} = -0 X² / 2

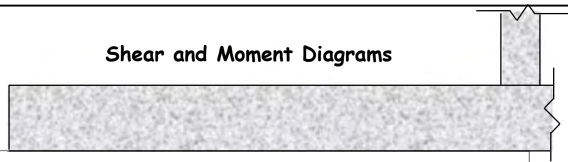
Conc. EQ:
w_{EQ} = -0 kips/ft
V_{EQ} = -0 X
M_{EQ} = -0 X² / 2

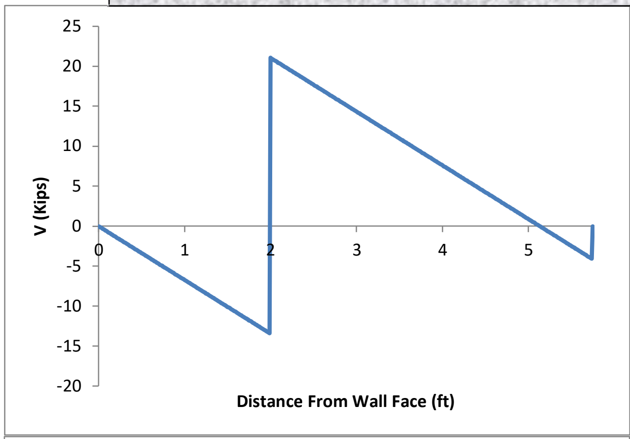
Pile P2:
V_{pile} = 34.5 Kips (after x = 2ft)
M_{pile} = 34.5 (X - 2 ft)

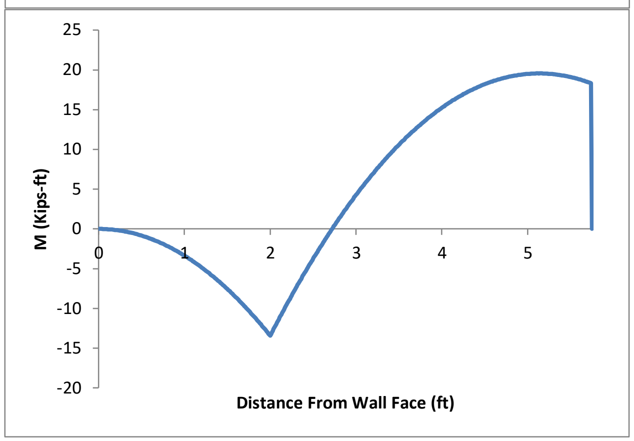
AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Slab Calculation	Checked by	JMH	Date	Dec-20
					References

Shear and Moment Diagrams







Max Shear	
21.06	kips / tributary width / allowable OS =
3.51 Kips	

Max Top Moment	
-13.44	kips / tributary width / allowable OS =
-2.24 Kips	

Max Bottom Moment	
19.5602	kips / tributary width / allowable OS =
3.26 Kips	

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION	Computed by	AML	Date	Dec-20
	KCS-5				
	Slab Conc. Check	Checked by	JMH	Date	Dec-20
					References

Given Information:

Slab Thickness:	3.00	ft			
Slab Width:	10.00	ft			
Clear Cover:	0.75	ft			
Diameter Bar to Start:	0.09	ft			
Diameter of Pile:	1.15	ft			
			Load Fact.		
Maximum Pile Reaction:	37.40	kips	1	37.40	kips
Maximum Shear:	3.67	kips			
Maximum Moment (Top):	2.60	kip-ft			
Maximum Moment (Bottom):	3.26	kip-ft			

φ_{shear} =	0.75	(ACI 318)
φ_{moment} =	0.9	(ACI 318)
$f_{y,\ rebar}$ =	60	ksi
f'_c =	4	ksi

Shear Calculations:

1- Shear Capacity:

Design Shear Strength (φV_n) ≥ Required Shear Strength (V_u)

Shear Capacity (φV_c): $\varphi_{shear} * 2 * \sqrt{f'_c} * b * d$ (ACI Eq. 11-3)

φ_{shear} =	0.75			
f'_c =	4	ksi		
b =	1	ft strip		
d =	2.20	ft	26.44	in

φV_c =	30095.3	lbs	
	30.10	kips	** $\varphi Vc=30.1 \geq Vu=3.7$, **Shear Capacity OK**

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION KCS-5	Computed by	AML	Date	Dec-20
	Slab Conc. Check	Checked by	JMH	Date	Dec-20
					References

2- Punching Shear Capacity (ACI 318-14 Table 22.6.5.2):

Vc = minimum value = Eq. a: $4 \times \sqrt{f'_c} \times b_0 \times d$ for $\beta_c < 2.0$

Eq. b: $(2 + (4 / \beta_c)) \times \sqrt{f'_c} \times b_0 \times d$ for $\beta_c > 2.0$

Eq. c: $((\alpha_s \times d) / b_0 + 2) \times \sqrt{f'_c} \times b_0 \times d$ b_0 / d effect based on α_s

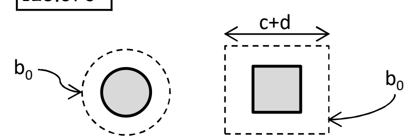
(interior column: α_s = 40, edge column: α_s = 30, corner column: α_s = 20)

d for piles = 26.203 in (Slab thickness - 9" pile embed - cover - $0.5d_{bar}$)

where β_c = Long side / Short side = 1

b_0 = Perimeter of Critical Section = $\pi*(D_{pile} + d)$ = 125.673

α_s = 20 (worst case - corner column)



Vc = minimum value = Eq. a: 833.07 kips

Eq. b: 1249.61 kips

Eq. c: 1285.02 kips

φV_c = 624.81 kips

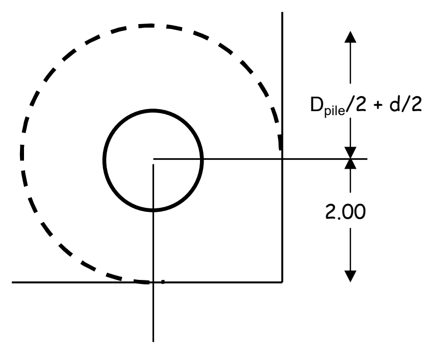
Check corner pile failure to edge of slab:

$D_{pile}/2+d/2$ = 1.67 ft

Diameter of corner failure = 1.667 + 2 ft

= 3.67 ft

Dia. punching shear calc above = 3.33



Diameter of punching shear calculation is smaller than the diameter of this corner failure area. Therefore, no re-check of corner punching failure is required.

φVc used in design = 30.10 kips

** φVc = 30.1k ≥ Vu = 3.7k, Shear Capacity OK

Maximum Pile Reaction = 37.40

** φVc=625k ≥ Vu=37k, Punching Shear Capacity OK

AECOM

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION KCS-5	Computed by	AML	Date	Dec-20
	Slab Conc. Check	Checked by	JMH	Date	Dec-20
				References	

3- Deep Beam One-Way Shear Capacity (φV_{c1}):

For $(w/d) \geq 1.0$, a one-way (normal) shear investigation with loads outside the critical section (located at a distance d from the face of the column, b = footing width) and

$$v_c = 1.9\sqrt{f'_c} + 2500\rho_w\left(\frac{V_u d}{M_u}\right) \geq 2\sqrt{f'_c} \quad \text{(ACI Eq. 11-5)}$$

which reduces for $\rho_w \approx 0.002$ and $3{,}000 \text{ psi} \leq f'_c \leq 4{,}000$ psi to $v_c = 1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}\,(V_u d/M_u) \geq 2\sqrt{f'_c}$.

For $(w/d) < 1.0$, $1.0 > M_u/V_u d > 0$; $\infty > V_u d/M_u \geq 1.0$ (no limits on M_u, $V_u d$, other than above)

$$v_c = \left(\frac{d}{w}\right)\left[3.5 - 2.5\left(\frac{M_u}{V_u d}\right)\right]\left[1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}\left(\frac{V_u d}{M_u}\right)\right] \leq 10\sqrt{f'_c} \quad \text{(ACI Eq. 13-2)}$$

w = 1.0 ft — Distance from CL pile to face of Wall + 3" lateral installation tolerance

M_u = 3.26 kip-ft

V_u = 3.67 kips

v_c = 745.8 psi ≤ 10 x √f'c = 632.5 psi limit on shear strength

φV_{c1} = 150.48 kips — ** φVc=150.5 ≥ Vu=3.7, OK

Therefore, Slab is OK for shear forces found in slab analysis.

<u>* Reinforcement Calculations:</u>

Limit of Maximum Reinforcement: $0.25 \times \rho_b$ (Design Criteria, EM 1110-2-2104, 3-5)

where ρ_b = 0.0285 for f'_c = 4,000psi, fy = 60,000psi

Max Rebar = 0.00713 *b * d

Maximum Reinforcement:	0.0071	* b * d =	2.26	in²	per 1ft strip

A_{gross} = 3 ft * 12 in/ft * 12 in strip = 432.00 in²

Limits of Minimum Reinforcement:	0.003 x Agross =	1.30	in²	(EM 1110-2-2104, 2.9.3, temp. & shrinkage)
	$(3\sqrt{f'_c}\,b d)/f_y$ =	1.00	in²	(ACI 318-14, 9.6.1.2, min for flexural members)
	$(200 b d)/f_y$ =	1.06	in²	(ACI 318-14, 9.6.1.2, min for flexural members)

Min Reinforcement, temp & shrinkage:	0.65	in²	per 1ft strip, per face
Min Reinforcement, flexural:	1.06	in²	per 1ft strip, per face

Job	Maurepaus Swamp	Project No.	60632162		
Description	T-WALL SECTION KCS-5	Computed by	AML	Date	Dec-20
	Slab Conc. Check	Checked by	JMH	Date	Dec-20
				References	

*** Moment Calculations:**

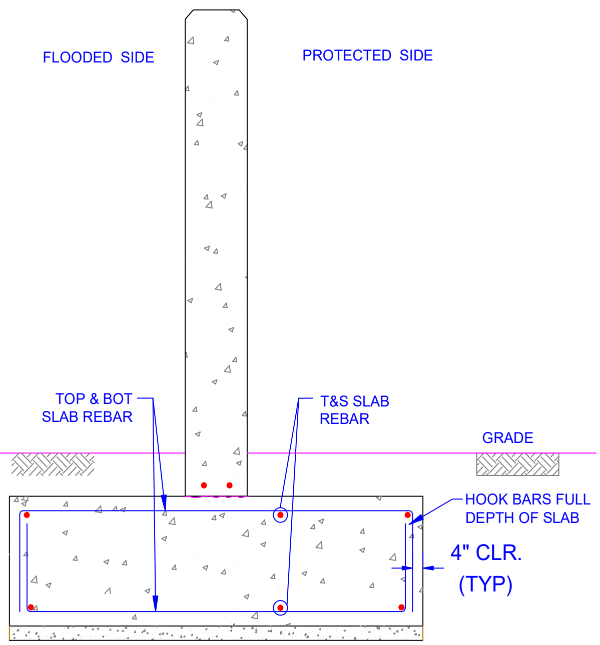
* $T = A_s \times f_y$

* $C = 0.85 \times f'_c \times a \times b$

* Assuming Tension = Compression $\longrightarrow A_s \times f_y = 0.85 \times f'_c \times a \times b$

* $\varphi Mn = \varphi \times T \times (d - (a / 2))$

$= \varphi \times A_s \times f_y \times (d - (a / 2))$



* Capacity of Min Flexural Reinforcement:

A_s =	1.057	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	2.203	
φ_{moment} =	0.9	

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$

= 1.555 in

φM_n =	1465.1	kip-in
=	122.10	kip-ft

* Capacity of Maximum Reinforcement:

A_s =	2.260	in^2
f_y =	60	ksi
f'_c =	4	ksi
b =	1	ft strip
d =	2.20	
φ_{moment} =	0.9	

The minimum proposed reinforcement for to T&S Slab Rebar is #6 @ 6"(A = 0.88 in2) and the minimum proposed reinforcment for Top & Bot Slab Rebar is #7 @ 6"(A =1.2in2).

a = $(A_s \times f_y) / (0.85 \times f'_c \times b)$

= 3.324 in

φMn =	3023.8	kip-in
=	251.98	kip-ft

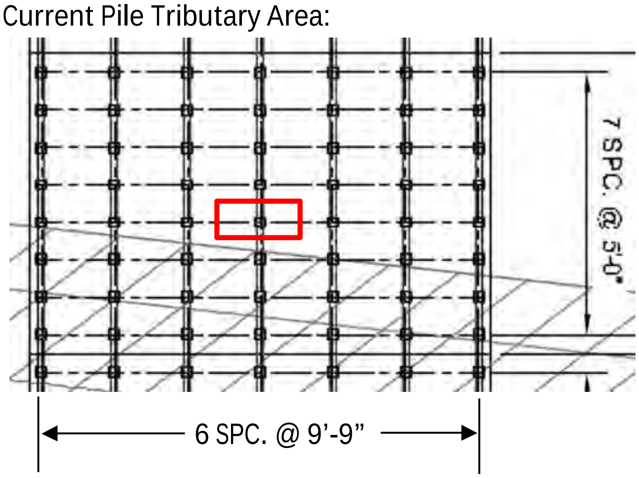
** φMn=252 ≥ Mu=2.6, Section OK	TOP
** φMn=252 ≥ Mu=3.3, Section OK	Bottom

The addition of WSLP flood protection at Airline Hwy will change the loads experienced by the Conveyance Channel Box Culverts. The prevailing alternative at this location is an embankment solution where the road is elevated to the Design Flood EL +16.13, as opposed to construction of a flat gated closure or bridge over flood control features. What follows is a preliminary update of the pile foundation to account for additional weight of soil (traffic loads were previously included). This should provide a reasonable estimate of additional number of piles and/or length of pile required for the purpose of the Rough Order of Magnitude Cost Estimate. The Maurepas Airline Culverts will be fully designed for the new soil conditions when the Project moves from Preliminary into Full Maurepas-WSLP design.

1) 95% Design soil pressure from calculations:
    - Soil Info:
        - Assumed soil cover was 5'-9"
        - γ_{soil} = 110 pcf
        - Pressure on roof slab was calculated as 632.5 psf (low water table condition)
    - Pile Info:
        - 18" x 18" PPC Piles are assumed
        - Max. reaction from 95% Airline Hwy SAP2000 model = 19.136k per foot of culvert mono
        - 19.14k/ft * 5' pile tributary width = 95.7 kips
        - Ultimate Pile Capacity Required = 95.7 kips * FOS 2.0 = 192 kips
        - Current Tip EL -76.0; Pile Butt EL -11.0; Total Pile Length = 65'

2) Anticipated soil pressure from elevated road:
    - Soil to TOW EL +16.13
    - Current TO Box EL +0.30
    - New pressure = (16.13' – 0.3') * 110 pcf = 1,741.3 psf
    - Added pressure = 1741.3 psf – 632.5 psf = 1,108.8 psf

3) Current Pile Tributary Area:



- A center pile will have the largest tributary area. This area = 9.75' * 5' = 48.75 ft^2

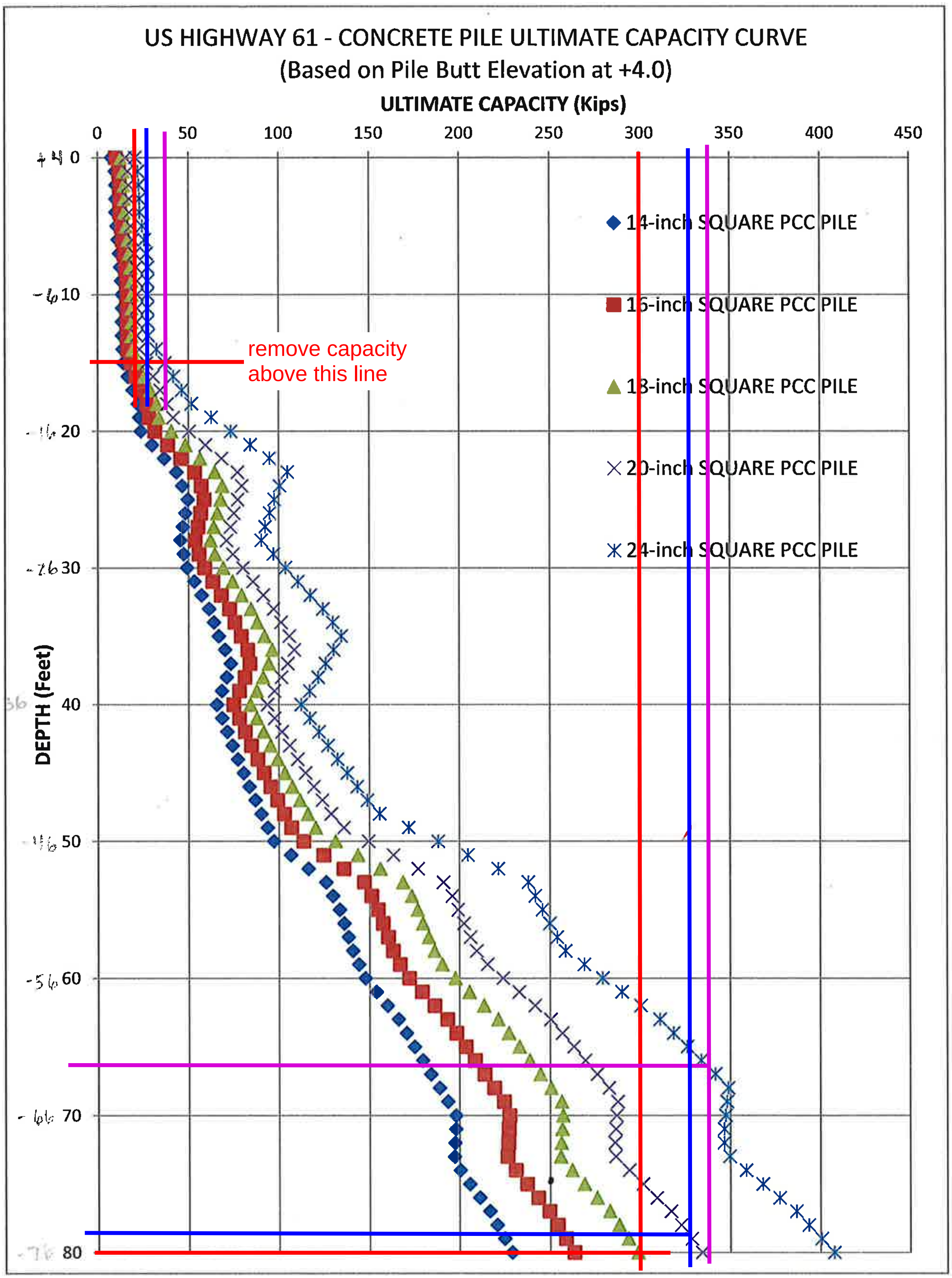
4) Added Load on Pile:
   - 48.75 ft^2 * 1,108.8 psf = 54,054 lb = 54 kips per pile
   - Ultimate Pile Capacity Required = (95.7 kips + 54 kips) * FOS 2.0 = 299.4 kips
   - Must adjust pile capacity curves in 95% calculations for lower Butt elevation than what is assumed in the curve. Assumed Butt EL +4, so must remove capacity of top 15' of pile

5) If size and number of piles is unchanged, new required tip EL:
   - Tip EL -80 Capacity = 299 kips - ~20 kips = 279 kips. Not enough, need more length but pile capacity curves stop here and required PPC pile is becoming quite long (will need splice).

6) Pile grid is very tight in culvert's long direction (5' spacing). In the short direction the piles are located directly beneath walls, creating load paths directly from wall into slab and foundation. To avoid re-arrangement of piles that may drastically affect stress patterns in the concrete, try a larger pile instead of adding more piles. This is also advisable over adding piles because group effects of a tight pile grid will start to become significant; this reduces the overall pile capacity because piles are within each other's influence zones.

7) If piles increased from 18" square to 20" or 24" square PPC:
   - 20" Option:
     - Capacity at EL -11 = ~25 kips. Therefore, required capacity = 300 kip + 25 kip = 325 kip
     - ~EL -78 meets this requirement. Therefore, could use 20" PPC Piles with Tip EL -80
   - 24" Option:
     - Capacity at EL -11 = ~40 kips. Therefore, required capacity = 300 kip + 40 kip = 340 kip
     - ~EL -67 meets this requirement. Therefore, could use 24" PPC Piles with Tip EL -70

8) Additional note on load changes: The added depth of fill will somewhat reduce the affects of traffic loads on the culvert, as these loads dissipate within the soil column. This load reduction is ignored in this check to provide a little conservatism in the tip elevations.


US HIGHWAY 61 - CONCRETE PILE ULTIMATE CAPACITY CURVE
(Based on Pile Butt Elevation at +4.0)
ULTIMATE CAPACITY (Kips)
0
50
100
150
200
250
300
350
400
450
DEPTH (Feet)
+4 0
-6 10
-16 20
-26 30
-36 40
-46 50
-56 60
-66 70
-76 80
14-inch SQUARE PCC PILE
16-inch SQUARE PCC PILE
18-inch SQUARE PCC PILE
20-inch SQUARE PCC PILE
24-inch SQUARE PCC PILE
remove capacity
above this line

References:

EXCERPTS FROM 95% CALCULATIONS & PLANS

URS

Job: Mississippi River to Maurepas Swamp		**Project #:**	10001801				
Description:	Airline Hwy Crossing	**Computed By:**	BCB	**Date:**	Aug-12	**Page:**	of
	Load Calculations under Road	**Checked By:**	PBJ	**Date:**	9/13	**Sheet:**	of

* External Dry Soil Pressure: For image, see S_Lat_Const and S_Dry_Unbal.

$\gamma_{soil,\ dry}$ = 110 pcf

$q_{surcharge}$ = 250 psf (LL_Surcharge)

K_0 = 0.8 Geotechnical Report

Lateral Soil Pressure = $K_0 * (q_{surcharge} + \gamma_{soil,\ dry} * h)$ EM 1110-2-2502, Eq 3-43

Elevation	Soil depth (ft)	Lateral Pressure (psf)
	0	200
	3.88	541.00
	4.25	574.00
	5.00	640.00
0.30	5.75	706.00
-0.10	6.15	740.83
-0.29	6.34	758.25
-9.50	15.55	1568.40
-9.88	15.93	1601.40
-10.25	16.30	1634.40
-11.00	17.05	1700.40

Full Soil Column (S_Vert):

Vertical Soil Pressure, roof = $\gamma_{soil,\ dry} * h$

= 632.5 psf

Vertical Soil Pressure, base slab = $\gamma_{soil,\ dry} * h$

= 1710.5 psf

5' Soil Column (S_Dry_Unbal):

Vertical Soil Pressure, base slab = $\gamma_{soil,\ dry} * h$

= 385.0 psf

* Soil Forces when water at Maximum Water Table: For image, see S_Lat_MaxWT.

$\gamma_{soil,\ dry}$ = 110 pcf

$\gamma_{soil,\ effective}$ = 47.6 pcf

K_0 = 0.8

Lateral Soil Pressure = $K_0 * [\gamma_{soil,\ dry} * (h-h_{w}) + \gamma_{soil,\ effective} * (h_w)]$

Elevation	Soil depth (ft)	Pressure (psf)
6.05	0.00	0.0
0.30	5.75	256.4
-0.10	6.15	271.5
-0.29	6.34	279.0
-9.50	15.55	629.6
-9.88	15.93	643.9
-10.25	16.30	658.1
-11.00	17.05	686.7

Vertical Soil Pressure, roof = $\gamma_{soil,\ effective} * h$

= 273.7 psf

Vertical Soil Pressure, slab lip = $\gamma_{soil,\ effective} * h$

= 740.2 psf

* Soil Forces when water at Minimum Water Table: For image, see S_Lat_MinWT.

$\gamma_{soil,\ dry}$ = 110 pcf

$\gamma_{soil,\ effective}$ = 47.6 pcf

K_0 = 0.8

Lateral Soil Pressure = $K_0 * [\gamma_{soil,\ dry} * h_w + \gamma_{soil,\ effective} * (h-h_w)]$ EM 1110-2-2502, Eq 3-40

Elevation	Soil depth (ft)	Pressure (psf)
6.05	0.00	0.0
0.30	5.75	506.0
-0.10	6.15	540.8
-0.29	6.34	558.3
-9.50	15.55	1368.4
-9.88	15.93	1401.4
-10.25	16.30	1434.4
-11.00	17.05	1500.4

Vertical Soil Pressure, roof = $\gamma_{soil,\ dry} * h$

= 632.5 psf

Vertical Soil Pressure, slab lip = $\gamma_{soil,\ effective} * h$

= 1710.5 psf

TABLE: Joint Reactions				
Joint	OutputCase	CaseType	F1	F3
Text	Text	Text	Kip	Kip
Pile 1	2b_truck4	LinStatic	-0.005343	11.434
Pile 1	3b_truck4	LinStatic	-0.032	8.872
Pile 1	Ser-3-Truck 4	LinStatic	-0.032	8.872
Pile 2	2b_truck4	LinStatic	-0.034	16.998
Pile 2	3b_truck4	LinStatic	-0.048	11.721
Pile 2	Ser-3-Truck 4	LinStatic	-0.048	11.721
Pile 3	2b_truck4	LinStatic	-0.015	16.36
Pile 3	3b_truck4	LinStatic	-0.021	11.03
Pile 3	Ser-3-Truck 4	LinStatic	-0.021	11.03
Pile 4	2b_truck4	LinStatic	0.001289	16.908
Pile 4	3b_truck4	LinStatic	0.001289	11.656
Pile 4	Ser-3-Truck 4	LinStatic	0.001289	11.656
Pile 5	2b_truck4	LinStatic	0.014	17.844
Pile 5	3b_truck4	LinStatic	0.02	12.514
Pile 5	Ser-3-Truck 4	LinStatic	0.02	12.514
Pile 6	2b_truck4	LinStatic	0.035	19.136 → MAX
Pile 6	3b_truck4	LinStatic	0.049	13.859
Pile 6	Ser-3-Truck 4	LinStatic	0.049	13.859
Pile 7	2b_truck4	LinStatic	0.003822	14.45
Pile 7	3b_truck4	LinStatic	0.03	11.888
Pile 7	Ser-3-Truck 4	LinStatic	0.03	11.888

* All reactions are calculated on per foot basis with respect to the longitudinal pile spacing. Therefore we must multiply the vertical reaction by the longitudinal pile spacing. The smallest pile spacing under Airline Hwy is 5'-0". The anticipated maximum pile reaction is then going to be 19.136 x 5 = 95.68 kips

Using a Factor of Safety = 2.0, Ultimate Pile Capacity Required = 192 kips

TABLE 1

Canadian National Rail Road Crossing

Concrete Piles with butt elevation +4.0 ft. actual butt elevation = - 9.75

RECOMMENDED ULTIMATE SINGLE COMPRESSIVE CAPACITIES OF SQUARE PRECAST CONCRETE PILES (kips)					
Tip Depth (ft)	Pile Size (Inches)				
	14	16	18	20	24
50	105	120	135	150	181
60	147	170	195	218	265
70	173	199	230	258	316
80	211	243	279	312	380

$\alpha = 0.65$

- 22.6 27.4 31.0 38.1

220.4 251.6 281 341.9

=> use 18" pile

TABLE 2

US HWY. 61

Concrete Piles with butt elevation +4.0 ft. actual butt elevation = -11.0

RECOMMENDED ULTIMATE SINGLE COMPRESSIVE CAPACITIES OF SQUARE PRECAST CONCRETE PILES (kips)					
Tip Depth (ft)	Pile Size (Inches)				
	14	16	18	20	24
50	96	113	131	149	188
60	146	171	198	224	279
70	197	226	257	287	347
80	227	261	299	334	407

- 14.3 16.7 19.0 23.8

246.7 282.3 315 383.2

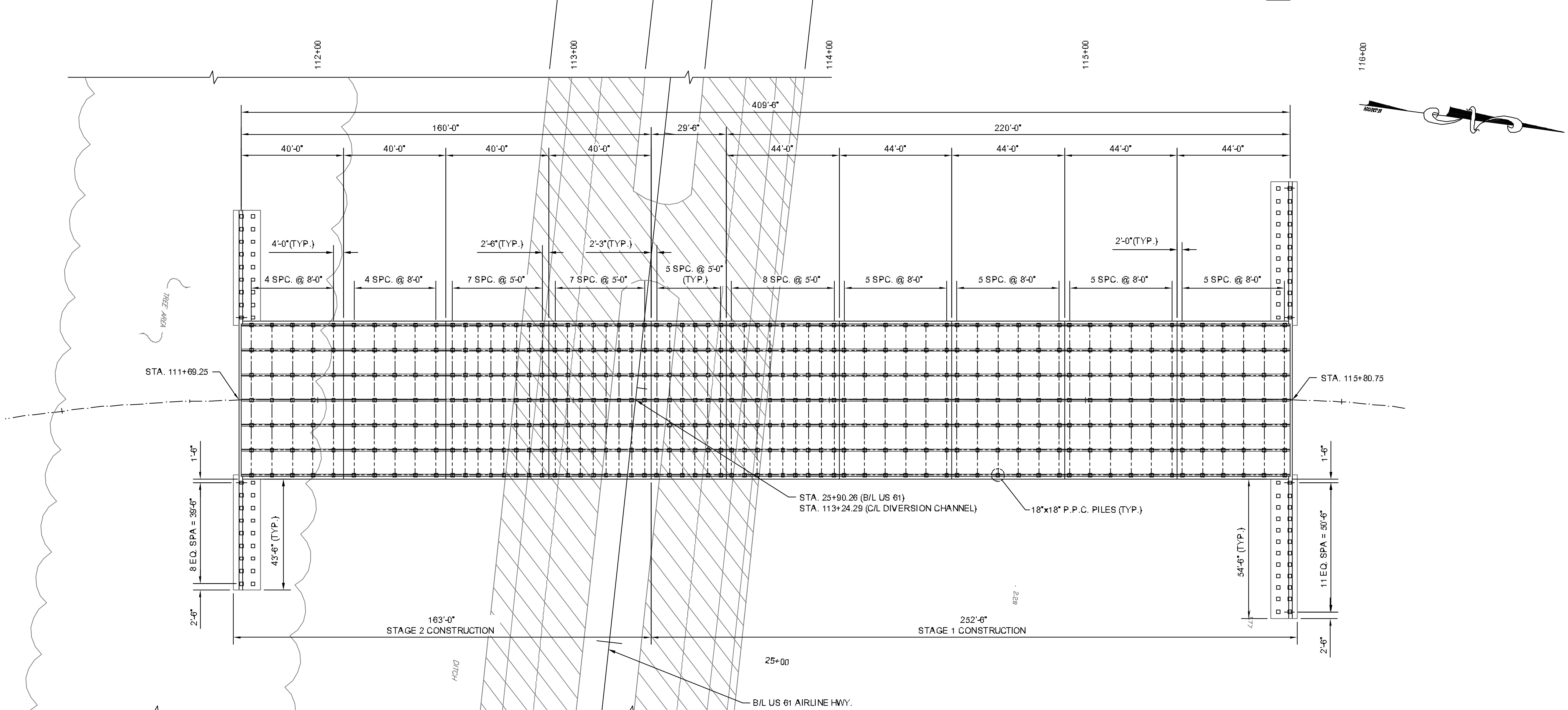
=> use 18" pile

95% DESIGN DRAWINGS

AIRLINE HIGHWAY PILE CHART

PILE TYPE	TOP OF PILE ELEVATION	TIP ELEVATION	PAYMENT LENGTH (FT)	DESIGN SERVICE LOAD (TONS)
18" X 18 P.P.C.	-11.00	-76.00	65	63.25

NOTE: TOTAL NUMBER OF P.P.C. PILES = 533



PILE LAYOUT PLAN

SCALE: 1" =20'-0"

LEGEND

☐ 18" X 18" P.P.C. PILE (533 TOTAL)

20' 10' 0 20'

SCALE:1"=20'-0"

NOTES:
1. SEE SHEET AG-4.01 and AG-4.02 FOR GENERAL NOTES.
2. SEE SHEET AS-2.00 FOR STRUCTURAL NOTES.
3. SEE SHEET UC-1.01, UC-1.02 AND UC-2.01 FOR CULVERT PLAN, PROFILE AND SECTION.
4. ALL CULVERT SECTIONS ARE REFERENCED FROM B/L US 61 AIRLINE HWY.
5. SEE SHEETS UC-3.01 TO UC-3.03 FOR STAGE OF CONSTRUCTION SEQUENCE.
6. SEE SHEET PS-11.02 FOR PRECAST PRE STRESSED CONCRETE PILE INFORMATION.

REV.	DATE	DESCRIPTION	BY

URS
3500 N. Causeway Blvd., Suite 900
Metairie, Louisiana 70002
(504) 837-6326

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
COASTAL ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70802

MISSISSIPPI RIVER REINTRODUCTION INTO MAUREPAS SWAMP
ST. JOHN THE BAPTIST PARISH, LOUISIANA

P.O.-29 URS PROJECT NUMBER: 10001801

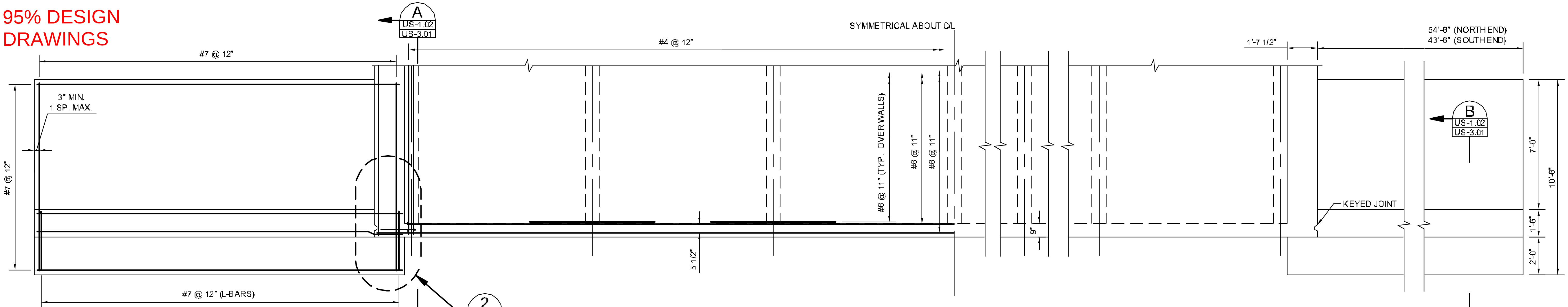
95% SUBMITTAL

AIRLINE HIGHWAY (U.S. 61)
PILE LAYOUT PLAN

DRAWN BY: SDC III
DESIGNED BY: BCB
APPROVED BY:
DATE: SEPTEMBER, 2013
SHEET US-1.01

P:\OCPR\10001801 Final Design II\CAD\Current Drawings\Maurepas_US-1.01.dwg, Sep 18, 2013 - 9:10:16AM, silas_cunningham

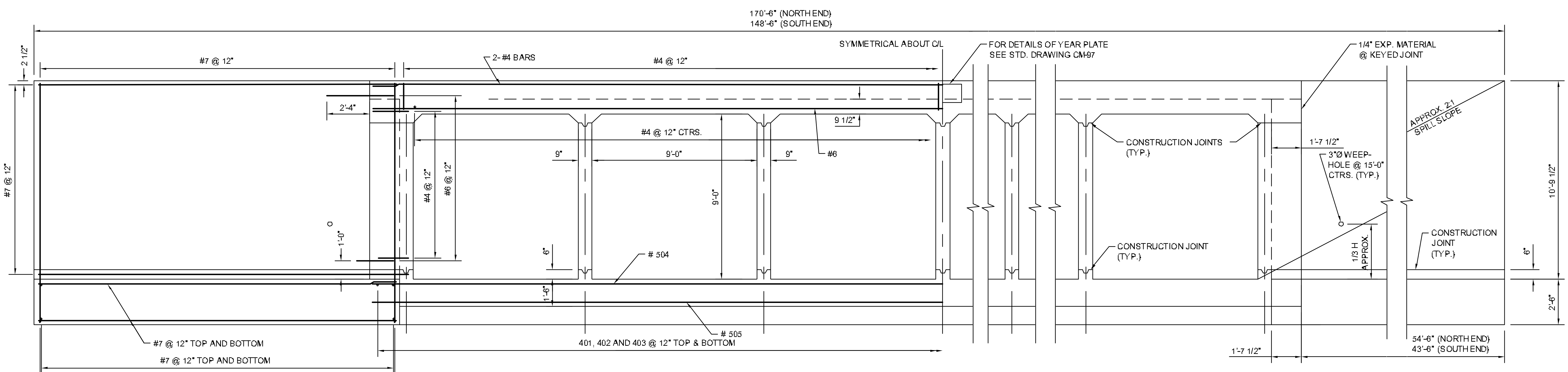
95% DESIGN DRAWINGS



PLAN AT END OF CULVERT

SCALE: 3/8" =1'-0"

NOTE: PILES NOT SHOWN FOR CLARITY.



ELEVATION AT END OF CULVERT

SCALE: 3/8" =1'-0"

NOTE: PILES NOT SHOWN FOR CLARITY.

4' 2' 0 4'

SCALE: 3/8"=1'-0"

REV.	DATE	DESCRIPTION	BY

URS

3500 N. Causeway Blvd., Suite 900
Metairie, Louisiana 70002
(504) 837-8328

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
COASTAL ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70802

MISSISSIPPI RIVER REINTRODUCTION INTO MAUREPAS SWAMP
ST. JOHN THE BAPTIST PARISH, LOUISIANA

P.O.-29 URS PROJECT NUMBER: 10001801

95% SUBMITTAL

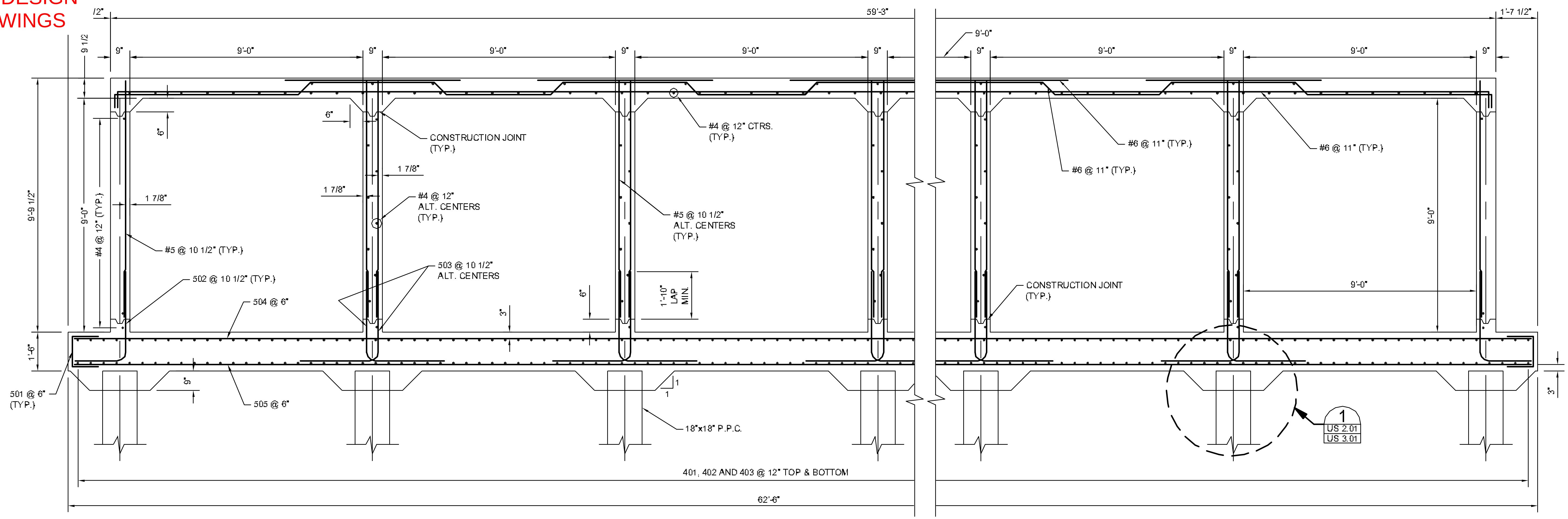
AIRLINE HIGHWAY (U.S. 61)
REINF. CONCRETE BOX CULVERT
PLAN AND END ELEVATION

DATE: SEPTEMBER, 2013

DRAWN BY: SDC III | DESIGNED BY: BCB | APPROVED BY: RCK | SHEET US-1.02

C:\Users\silas_cunningham\appdata\local\temp\AcPublish_4560\Maurepas_US-1.02.dwg, Sep 18, 2013 - 9:10:17AM, silas_cunningham

95% DESIGN DRAWINGS



SECTION THRU CULVERT BARREL

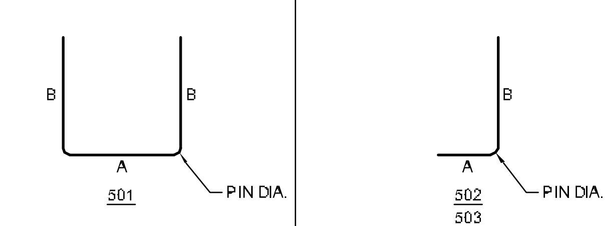
SCALE: 1/2" =1'-0"

BOTTOM SLAB REINFORCING BAR SCHEDULE

MARK	NO. REQ'D.	LENGTH	A	B	C	PIN DIA.
401	432	39'-6"	-	-	-	-
402	108	29'-0"	-	-	-	-
403	540	43'-6"	-	-	-	-
501	838	6'-3"	1'-1"	2'-7"	-	3 3/4"
502	838	5'-5 1/2"	1'-11 1/2"	3'-6"	-	3 3/4"
503	3352	6'-1"	2'-7"	3'-6"	-	3 3/4"
504	419	52'-3"	-	-	-	-
505	419	52'-3"	-	-	-	-
506	3216	2'-0"	-	-	-	-

STANDARD REINFORCING BAR BENDS

BAR BENDING DIAGRAM



SCALE: 1/2"= 1'-0"

REV.	DATE	DESCRIPTION	BY

URS
3500 N. Causeway Blvd., Suite 900
Metairie, Louisiana 70002
(504) 837-6326

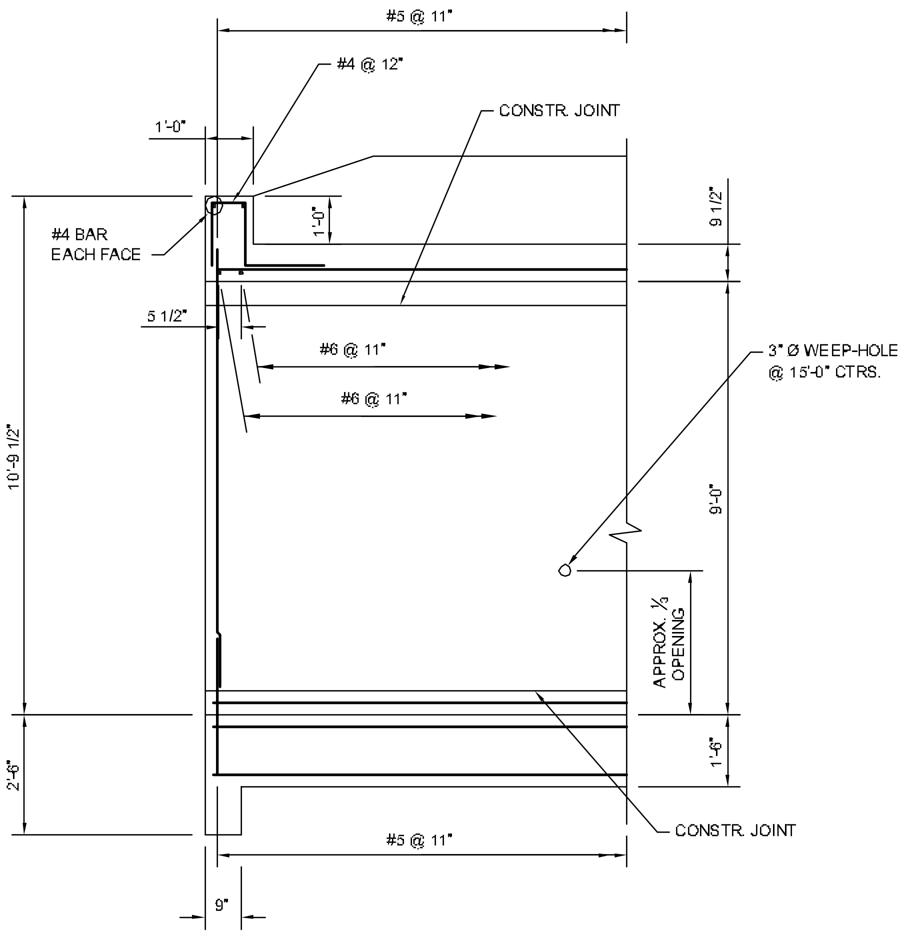
LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
COASTAL ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70802

DRAWN BY: SDC III
DESIGNED BY: BCB

MISSISSIPPI RIVER REINTRODUCTION INTO MAUREPAS SWAMP
ST. JOHN THE BAPTIST PARISH, LOUISIANA
P.O.-29 URS PROJECT NUMBER: 10001301
95% SUBMITTAL
APPROVED BY: RCK

AIRLINE HIGHWAY (U.S. 61)
REINF. CONCRETE BOX CULVERT
REINFORCEMENT SECTION
DATE: SEPTEMBER, 2013
SHEET US-2.01

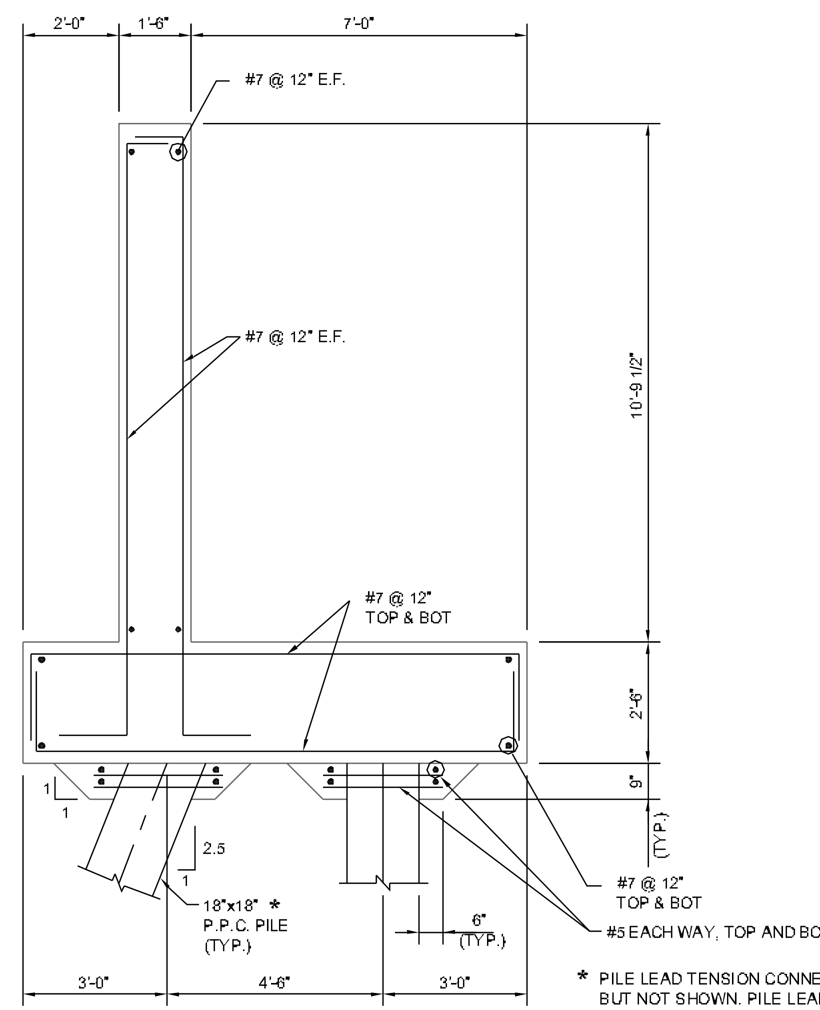
95% DESIGN
DRAWINGS



SECTION A

US-1.02
US-3.01

SCALE: 1/2"=1'-0"

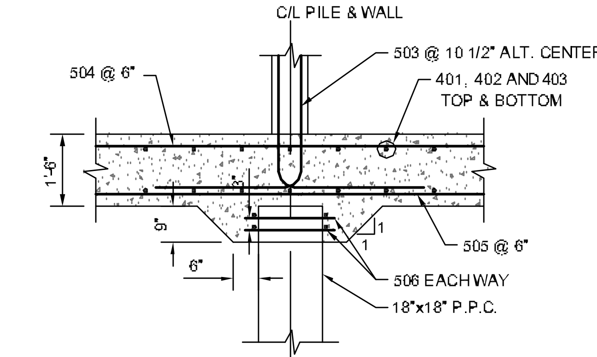


* PILE LEAD TENSION CONNECTER REQUIRED BUT NOT SHOWN. PILE LEAD TENSION CONNECTER SHALL BE DESIGNED BY PILE MANUFACTURER'S LICENSED ENGINEER FOR 25 kips OF TENSION AT SERVICE LEVEL. THE CONTRACTOR SHALL SUBMIT SEALED DESIGN COMPUTATIONS WITH PILE SUBMITTAL FOR REVIEW AND APPROVAL

SECTION B

US-1.02
US-3.01

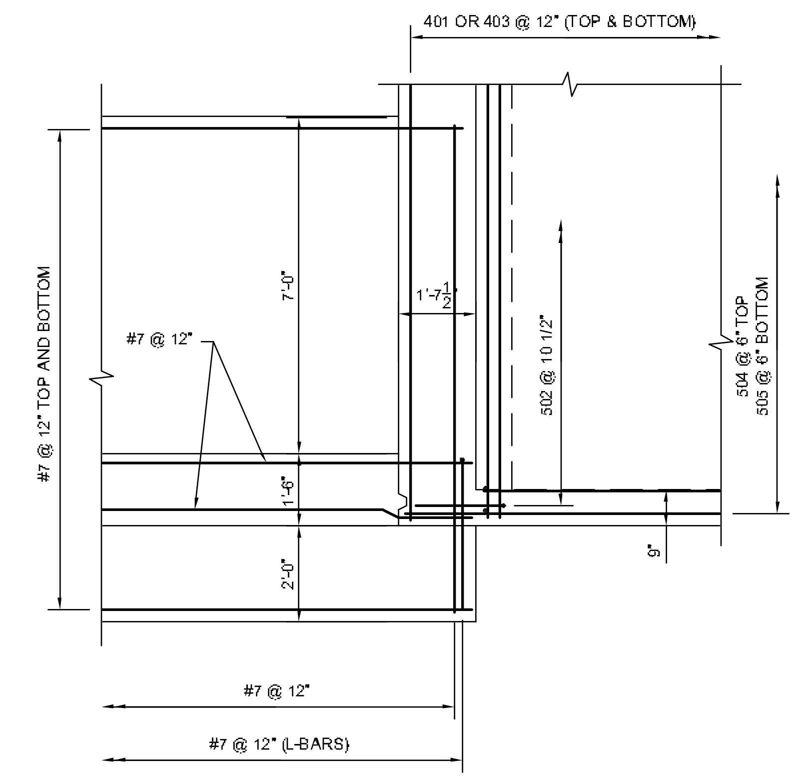
SCALE: 1/2"=1'-0"



DETAIL 1

US-2.01
US-3.01

SCALE: 1/2"=1'-0"



BOTTOM SLAB CORNER REBAR

DETAIL 2

US-1.02
US-3.01

SCALE: 1/2"=1'-0"

NOTES:
1. SEE STANDARD DRAWING CCSM 7-10 S 90° 1 FOR REBAR DETAILS IN WALLS, TOP SLAB AND WINGWALL SECTIONS.
2. SEE SHEET PS-11.02 FOR PRECAST PRESTRESSED CONCRETE PILE INFORMATION.

2' 1' 0 2'

SCALE: 1/2"= 1'-0"

REV.	DATE	DESCRIPTION	BY

URS
3500 N. Causeway Blvd., Suite 900
Metairie, Louisiana 70002
(504) 837-8326

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
COASTAL ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70802

MISSISSIPPI RIVER REINTRODUCTION INTO MAUREPAS SWAMP
ST. JOHN THE BAPTIST PARISH, LOUISIANA

P.O.-29 URS PROJECT NUMBER: 10001801

95% SUBMITTAL

AIRLINE HIGHWAY (U.S. 61)
REINF. CONCRETE BOX
CULVERT DETAILS

DATE: SEPTEMBER, 2013

DRAWN BY: SDC III
DESIGNED BY: BCB
APPROVED BY:
SHEET US-3.01

References:

95% Maurepas Inlet Structure Geotech

Information and Pile Capacity Curves

Es: USING P-y CURVE DATA

↳ CALIBRATED SPRING IN SAP MODEL IS $22^{k}/0.69" = 31.884^{k}/_{IN}$

↳ FROM CPGA MANUAL, WE KNOW:

PILE STIFFNESS COEFF., $K = \dfrac{C_o E I}{R^3}$

C_o = FIXETY CONSTANT = 0.707 FOR CONSTANT E_s, PINNED
E = 29,000,000 PSI
I = $904\ IN^4$ (STRONG AXIS)
$R = \sqrt[4]{\dfrac{EI}{E_s}}$ (INCH)

$$\Rightarrow K = 31.884\ ^{k}/_{IN} = 31{,}884.06\ ^{\#}/_{IN} = \frac{(0.707)(29{,}000{,}000\ PSI)(904\ IN^4)}{\left[\sqrt[4]{\dfrac{(29{,}000{,}000)(904)}{E_s}}\right]^3}$$

*NOTE: The Ix used here is for HP14x89; the difference in Es is negligible compared to the HP14x73; it is OK to use for this submittal and will be updated in the next phase.

SOLVING FOR E_s, W/EXCEL ⇒ $E_s = 540.36\ PSI = \underline{0.5404\ KSI}$

LATERAL GROUP REDUCTION: HSDRS GUIDELINES SECTION 4.3

- PARALLEL TO LOADING, TRAILING PILES (NO "FLOOD SIDE" CONDITION HERE)

$R_g = 0.48\,(S_b/b)^{0.38}$, $S_b = 9'\text{-}3" = 111"$, $b = 14"$

$= 1.054$ ⇒ NO REDUCTION NECESSARY

CRITICAL BUCKLING LOAD: CPGA MANUAL PG 40 - FOR CONSTANT E_s, UNSUPPORTED LENGTH (CONSERVATIVE)

$P_{CR} = n\sqrt{E_s E I}$ WHERE $n = 1$ - PINNED

$= 1\sqrt{(0.5404\ KSI)(29{,}000\ KSI)(904\ IN^4)} = \underline{3763.8\ KIPS}$

URS

Job	MAUREPAS DIVERSION	Project No.	10001876	Page ___ of ___	Sheet ___ of ___
Description	PILE PROPERTIES FOR STRUCTURAL CHECK	Computed by	LBR	Date	7/2013
		Checked by		Date	

Reference

*ALLOWABLE STRESSES: CPGA MANUAL PG 42-43; AISC 9TH ED PG 5-42;

ACC: IF $\sqrt{\frac{2\pi^2 E}{F_y}} > \sqrt{\frac{\pi^2 EA}{PCR}}$

$E = 29{,}000 KSI$
$F_y = 50 KSI$
$A = 26.1 IN^2$
$S.F. = 5/3 \times 6/5 = 2$

THEN $ACC = \left[\frac{F_y \cdot A}{S.F.}\right]\left[1 - \frac{F_y \cdot A}{4 \cdot PCR}\right]$

OTHERWISE

$ACC = PCR / S.F.$

↳ $\sqrt{\frac{2\pi^2 \times 29{,}000 KSI}{50 KSI}} = 106.999$ ↳ $\sqrt{\frac{\pi^2 \times 29{,}000 KSI \times 26.1 IN^2}{3763.8^k}} = 44.55$

*NOTE: ACC, ATT, AM1, and AM2 for this submittal are updated with their respective proper pile properties. However, this information will be updated for the next submittal as we collect more specific geotechnical data for these areas.

$\therefore ACC = \left[\frac{50 KSI \times 26.1 IN^2}{2}\right]\left[1 - \frac{50 KSI \times 26.1 IN^2}{4 \times 3763.8^k}\right] = \underline{\underline{595.94^k}}$

ATT: $ATT = \frac{A \cdot F_y}{S.F.} = \frac{26.1 IN^2 \times 50 KSI}{2} = \underline{\underline{652.5^k}}$

*COMBINED BENDING FACTOR: CPGA MANUAL P.32

$COMP = \left[\frac{F3}{ACC} + \cancel{MF1} \times \left(\frac{M1}{AM1}\right) + \cancel{MF2} \times \left(\frac{M2}{AM2}\right)\right]\left(\frac{1}{OSF}\right) \leq 1.0$

- NO TENSION FORCES - , MF1 & MF2 ACCOUNT FOR $P\Delta$ - NONE PRESENT

*AXIAL LOAD FACTOR: CPGA MANUAL P.31

$ALF = \frac{F3}{AC} \times \frac{1}{OSF} \leq 1$, AC = ALLOWABLE COMPRESSION = $\underline{294^k}$

USACE SAFETY
AISC SAFETY

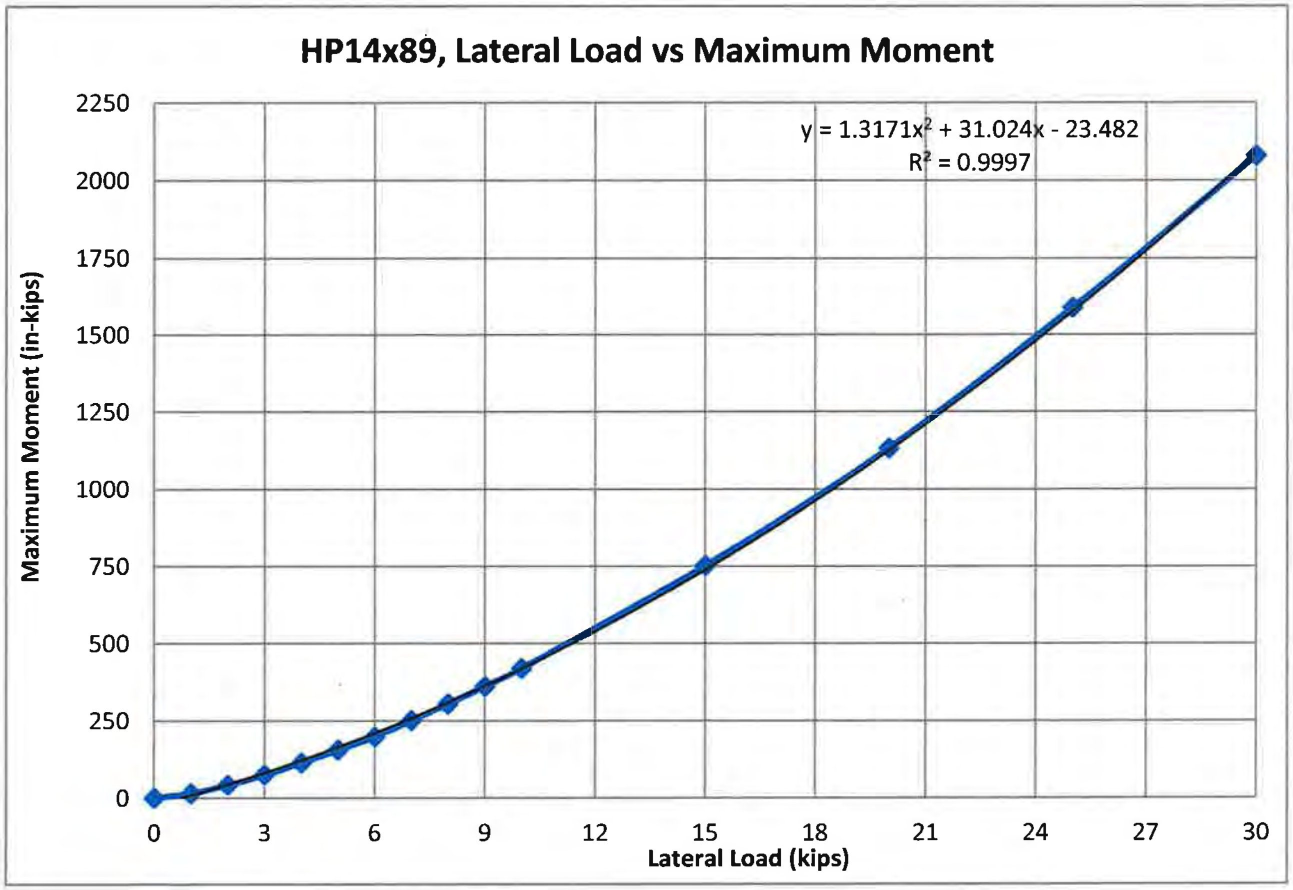
↳ $AM1 = S_x \cdot F_y \cdot = (131 IN^3)(50 KSI)(5/6)(2/3) = \underline{3638.9^{k \cdot IN}}$

↳ AM2 NOT NECESSARY FOR 2D.

AM2 = Sy x Fy = 44.3 in3 * 50ksi * 5/6 * 2/3 = 1230.5 k-in

Job:	Maurepas Freshwater Diversion	Project #:	10001876				
Desc.:	HP14x89 - Lateral Load vs. Maximum Moment	Computed By:	LBR	Date:	Jul-13	Page:	of
	For Pile Structural Check	Checked By:		Date:		Sheet:	of

Applied Lateral Load (kips)	Maximum Moment (in-kips)
0	0
1	14.702
2	41.727
3	74.687
4	113.767
5	155.378
6	198.52
7	251.398
8	304.99
9	361.114
10	419.316
15	751.755
20	1131.07
25	1587.535
30	2079.189



INLET STRUCTURE COMPRESSIVE PILE CAPACITIES

URS Quality - It's Good Business	QMS Form 3-4 (MM) Rev. 2013 QMS Date: 28 Feb 2013
IE QMS - Americas	**Detail Check**

Project Name	Lake Maurepas Diversion	**Client**	CPRA
Project Location	St. John the Baptist Parish, LA	**PM**	Naveen Chillara
Project Number	10001876	**PIC**	Mike Patorno

Identifying Information

(This section is to be completed by the Project Manager or the PM's Designee.)

Assigned Checker: Graham Forsythe — Comments Required by: June 18, 2013

Work Product Originator: Ignacio Harrouch

Work Product to be Checked: Pile capacities

☒ This Detail Check is a check for correctness, completeness and technical accuracy.

☐ This Detail Check is only a technical edit for format, spelling, grammar, pagination and readability.

Specific Instructions: Enter specific instructions for the work product.

Submitted by: [signature] — 9/30/13

Project Manager Signature — **Date**

Comments

(This Section is to be completed by the Checker.)

Select:

A. ☒ Checker has no comments.

or

B. ☐ Comments have been provided on:

- ☐ Marked directly on work product
- ☐ Comment and Disposition Form 3-5
- ☐ Other; Specify: Discussed with originator

[signature] — 6/18/2013

Checker Signature — **Date**

Verification

(This section is to be completed by the Checker after verification of comment incorporation, if box B is checked off above.)

Select:

C. ☐ Verification of comment incorporation has been performed by Checker. There are no outstanding issues.

or

D. ☐ Verification of comment incorporation has been performed by Checker. Unresolved issues have been submitted to the Project Manager or Designee for final resolution.

and

E. ☐ Checker asserts that the work product review is complete.

Checker Signature — **Date**

APPROVAL and DISTRIBUTION

☒ Detail Check is complete.

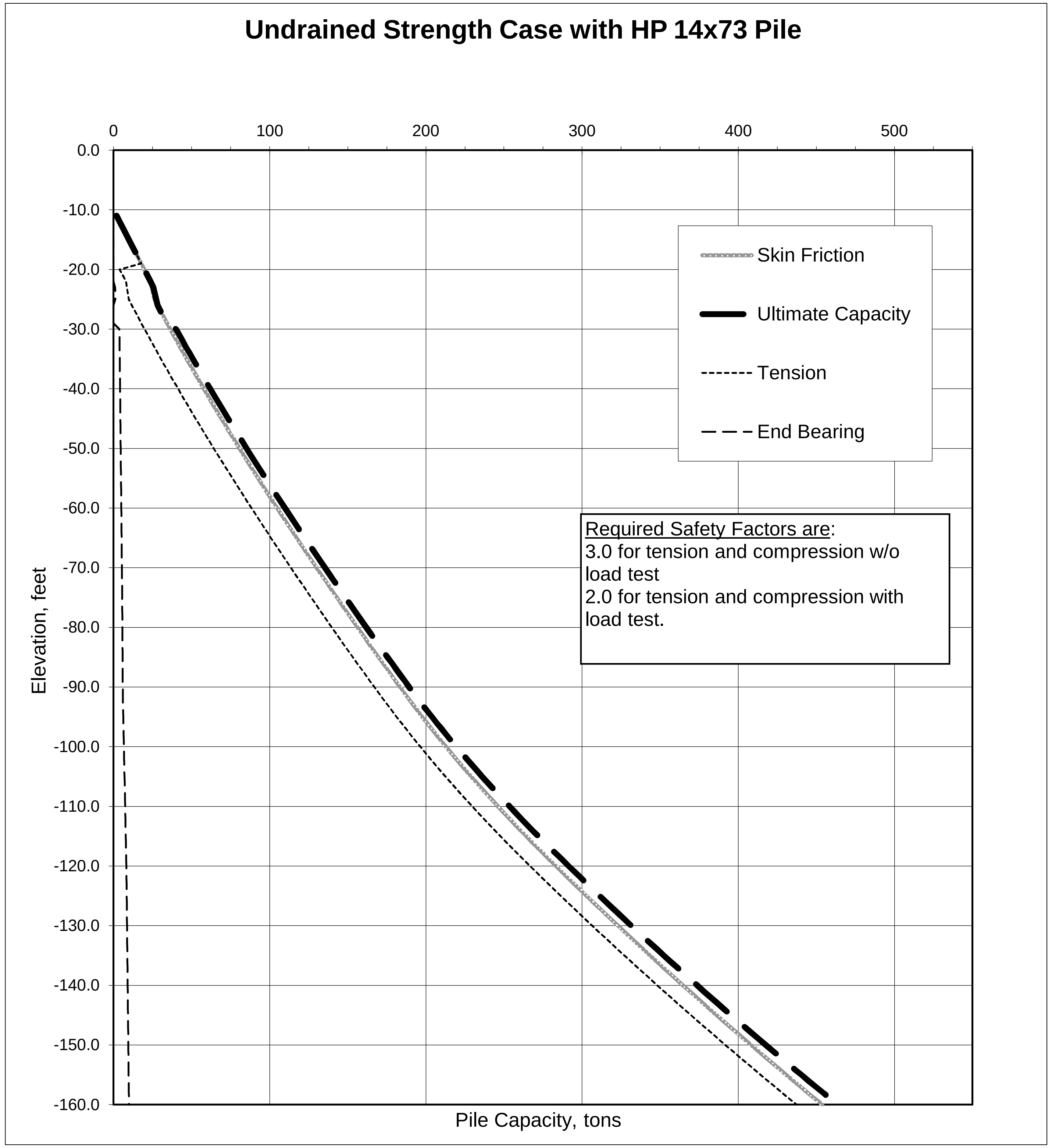
[signature] — 9/30/13 Click here to enter a date.

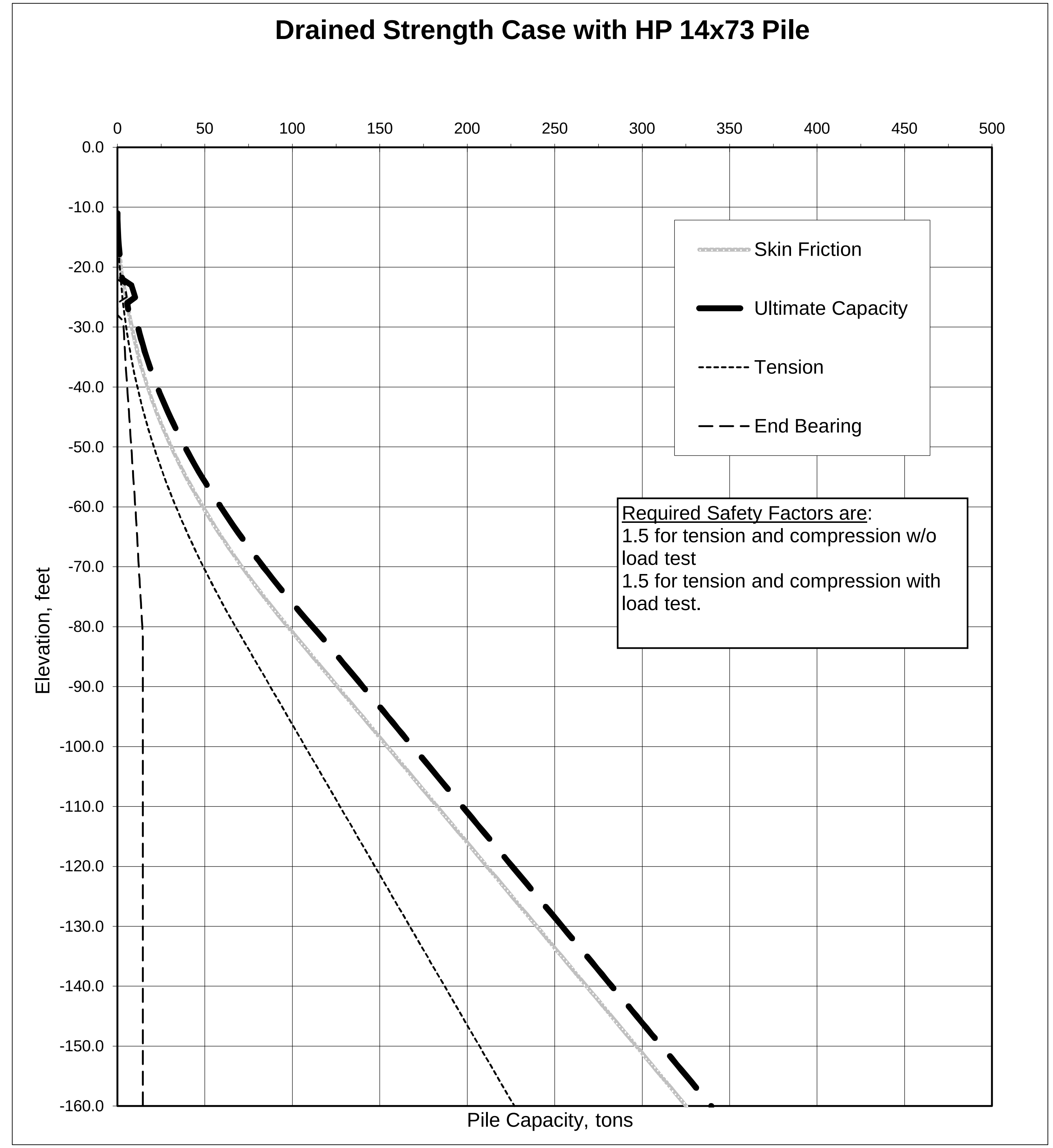
Project Manager or Designee Signature — **Date**

Distribution:

Project Central File – Quality File Folder

Other – Specify: Enter names here.

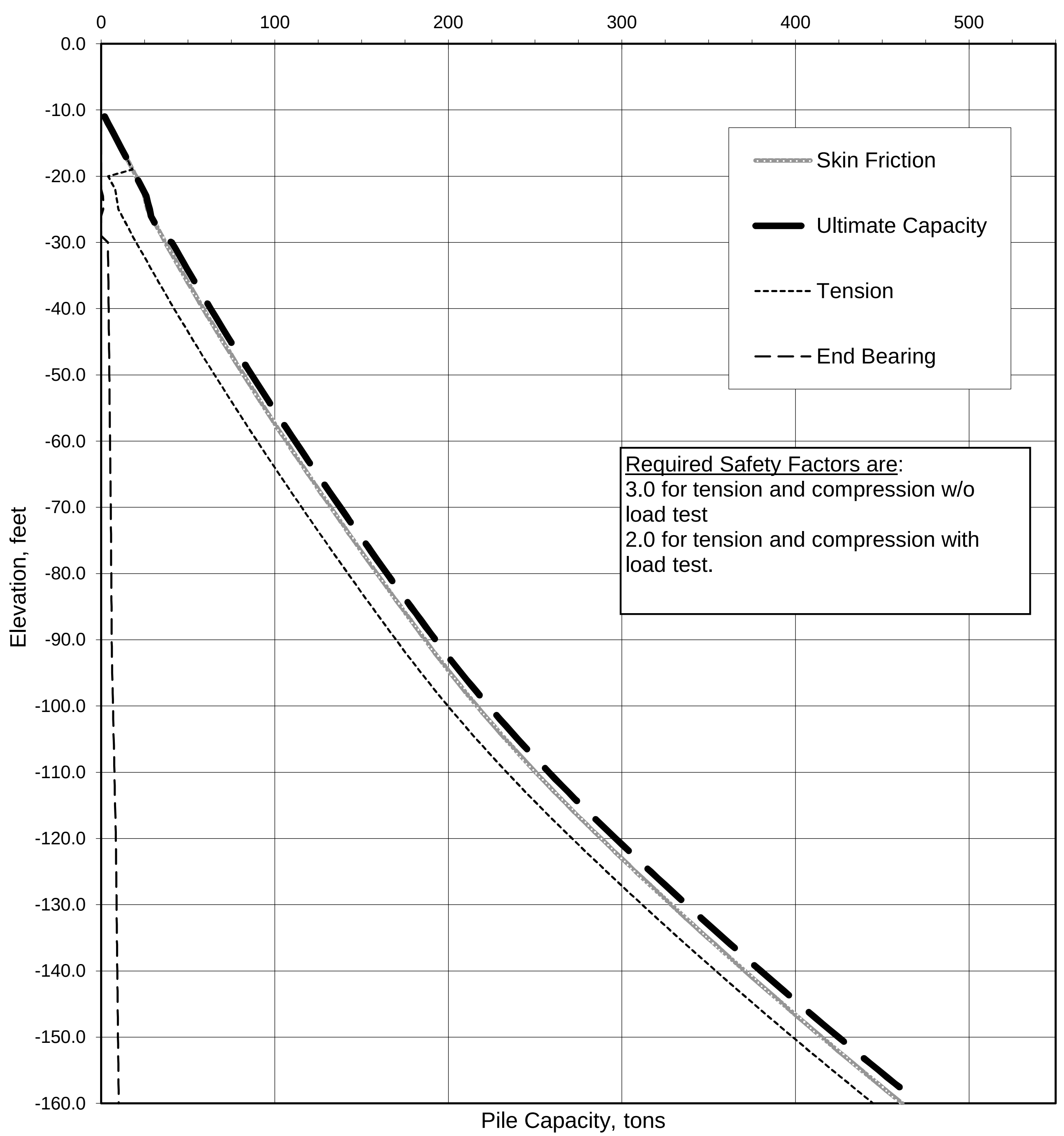




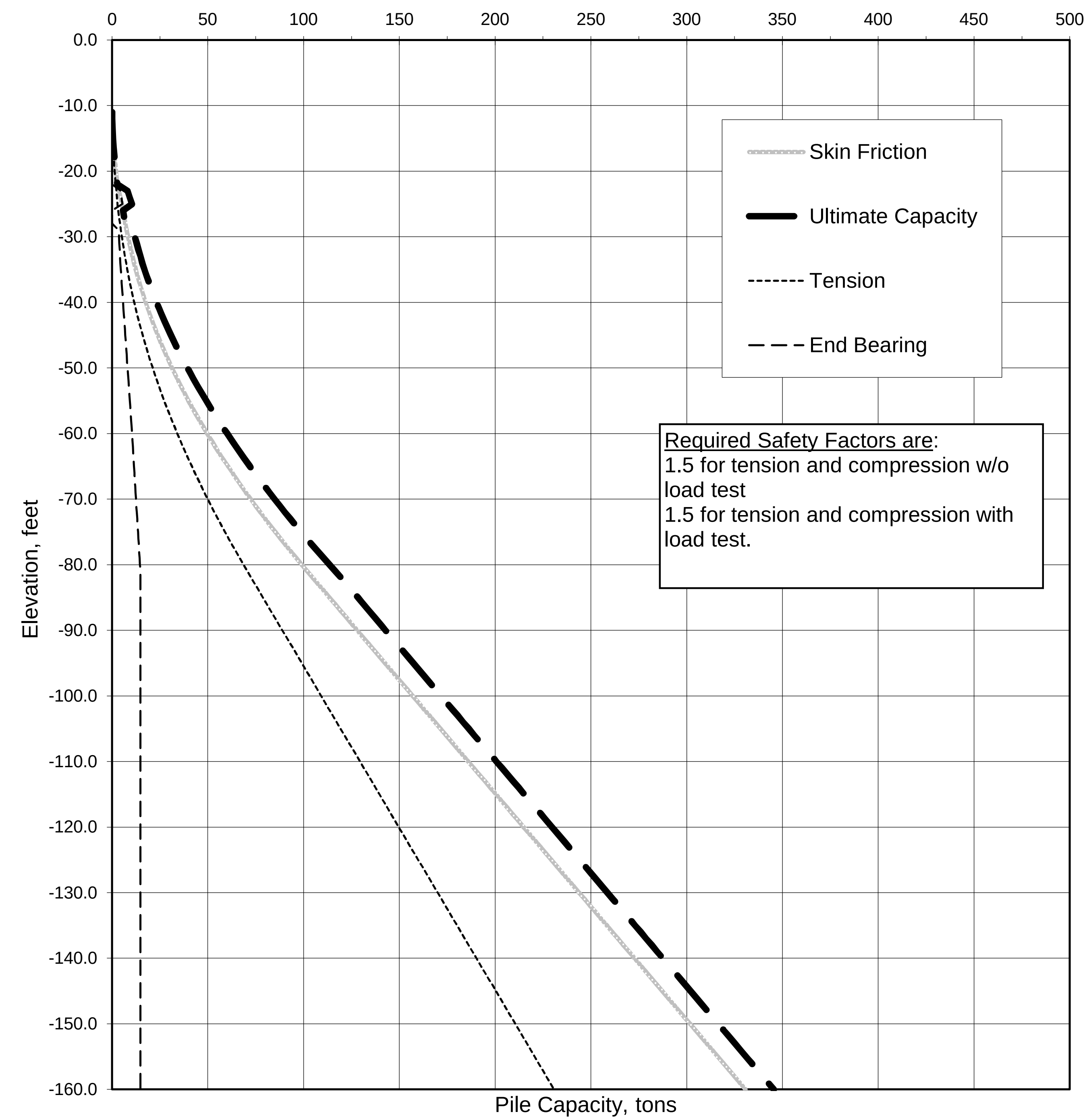
Notes:
1. Pile capacity curves represent axial resistance for a single pile and do not consider group effects.
2. Curves indicate Ultimate Capacity; the appropriate safety factors should be applied to arrive at the Allowable Capacity

Coastal Protection and Restoration Authority Lake Maurepas Diversion Canal	Project No. 10001863	**Pile Capacities: Intake Structure HP - 14X73**	URS	Appendix E

Undrained Strength Case with HP 14x89 Pile



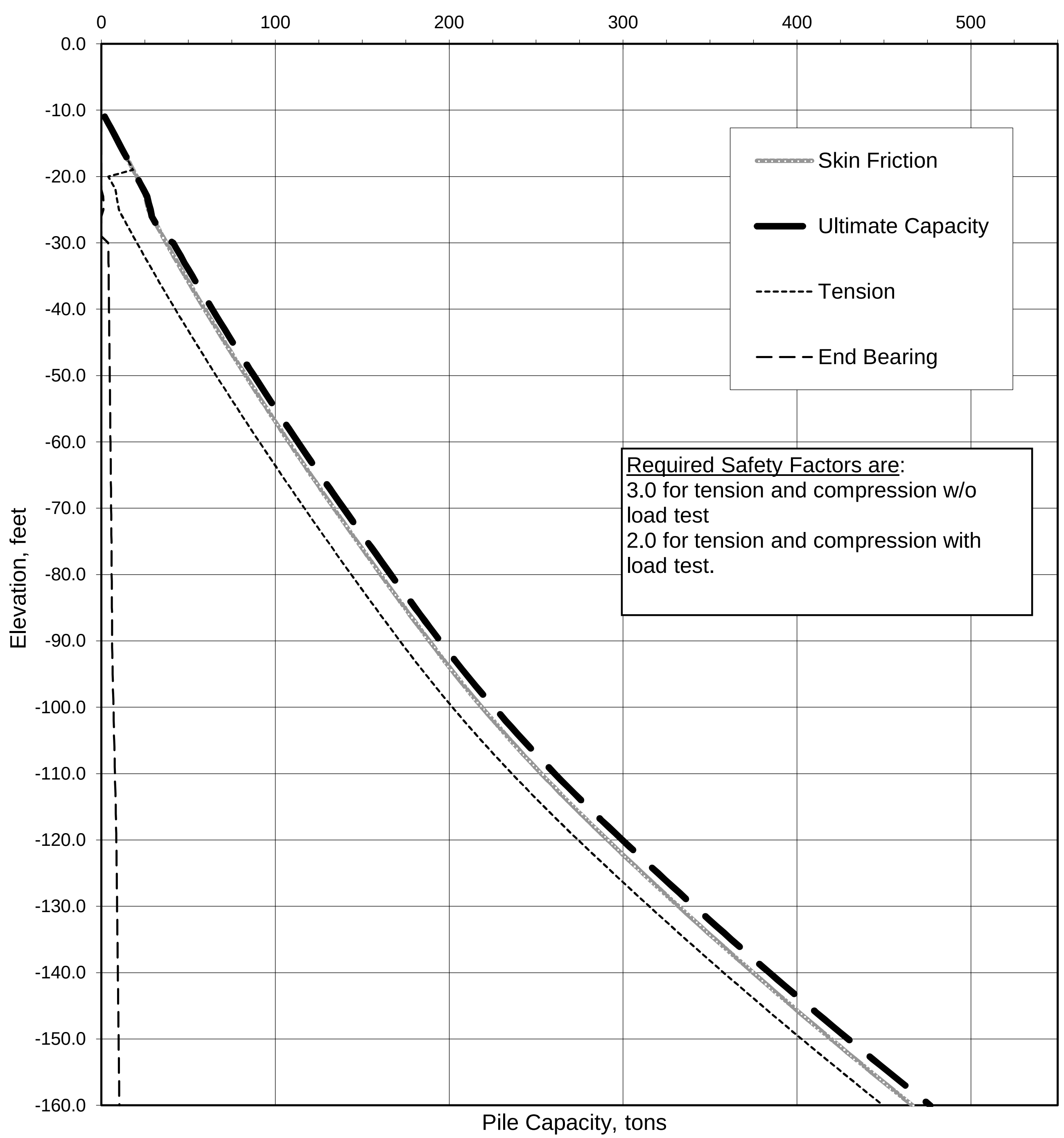
Drained Strength Case with HP 14x89 Pile



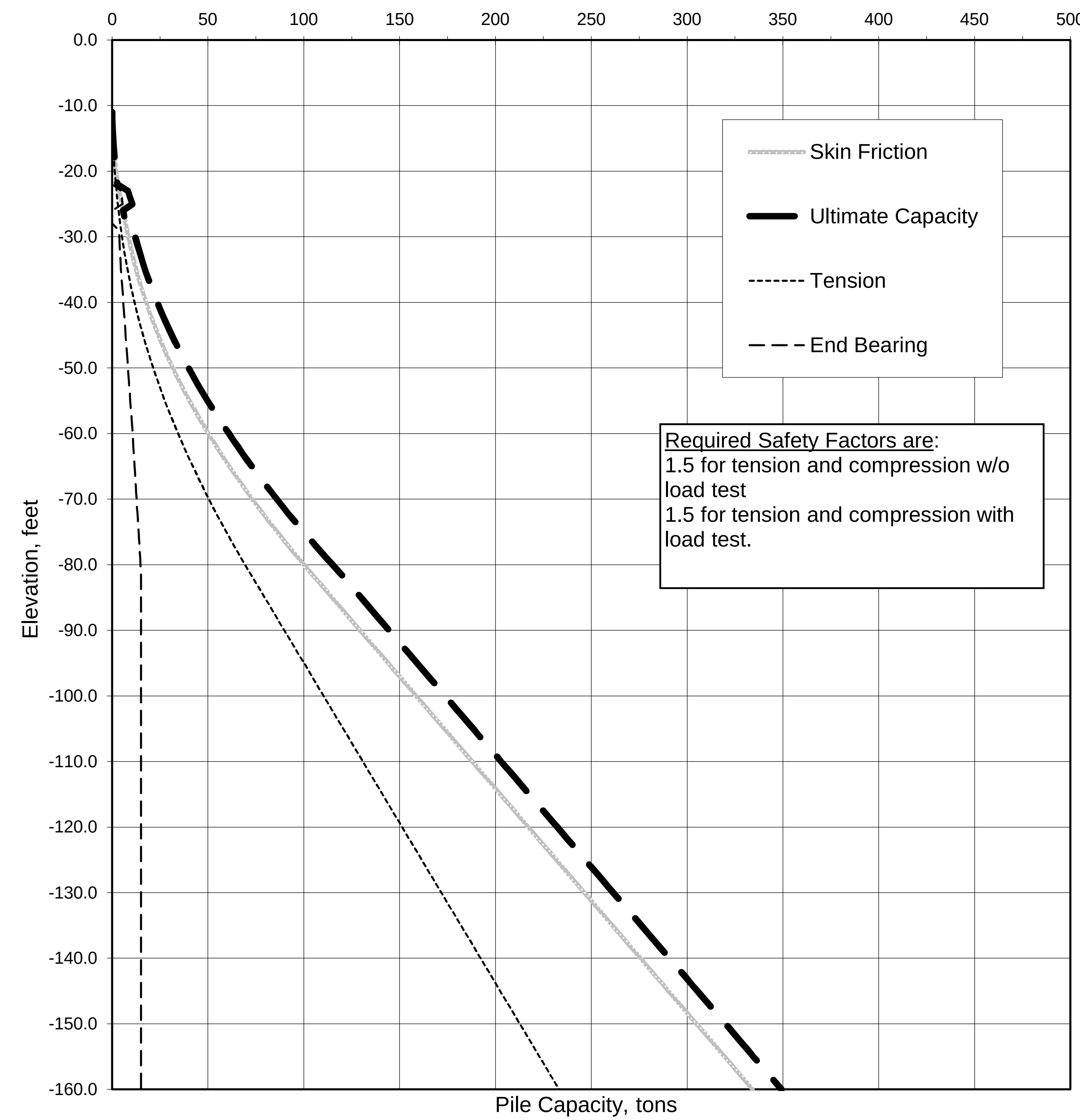
Notes:
1. Pile capacity curves represent axial resistance for a single pile and do not consider group effects.
2. Curves indicate Ultimate Capacity; the appropriate safety factors should be applied to arrive at the Allowable Capacity

Coastal Protection and Restoration Authority Lake Maurepas Diversion Canal	Project No. 10001863	**Pile Capacities: Intake Structure HP - 14X89**	URS	Appendix E

Undrained Strength Case with HP 14x102 Pile

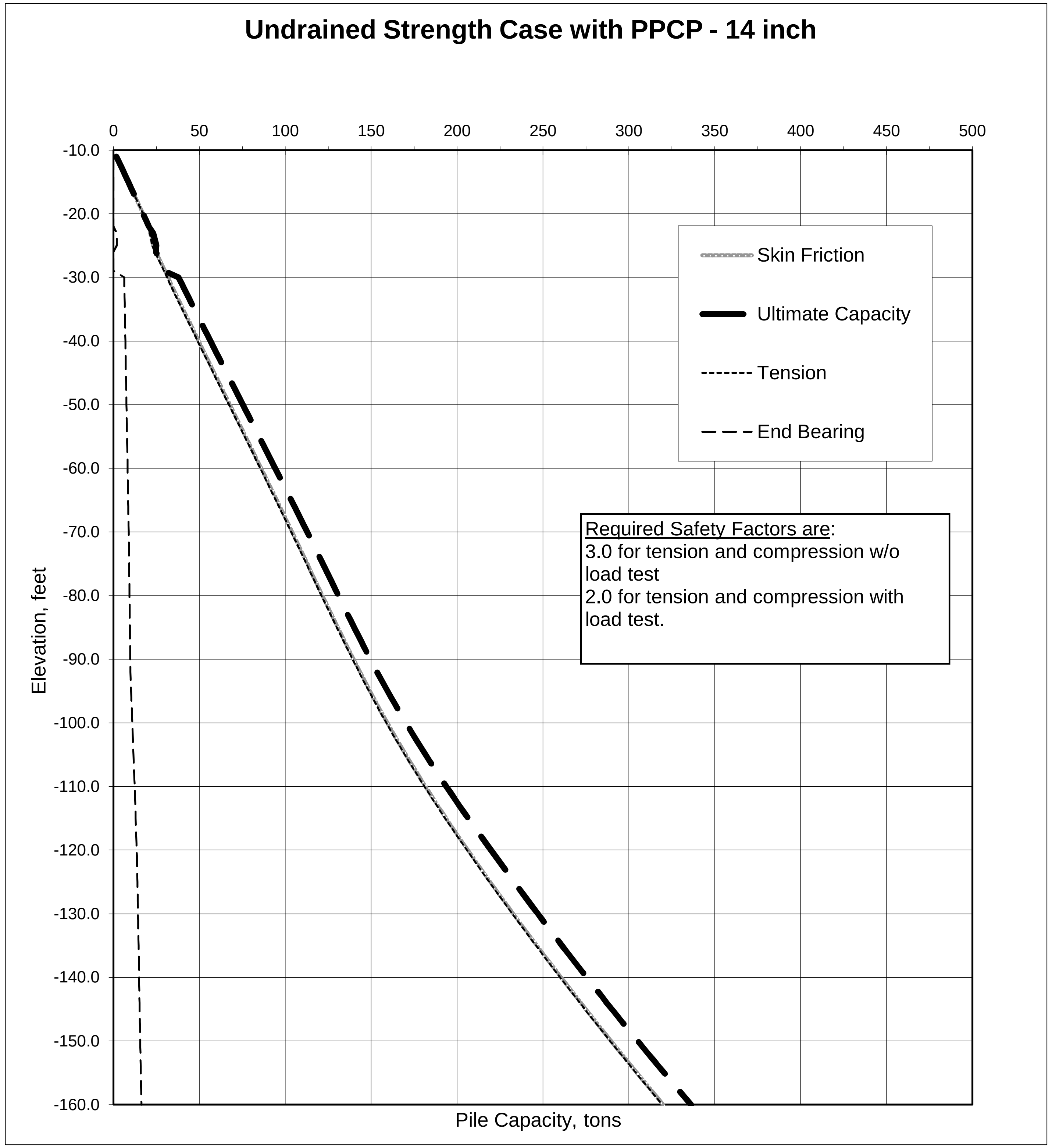


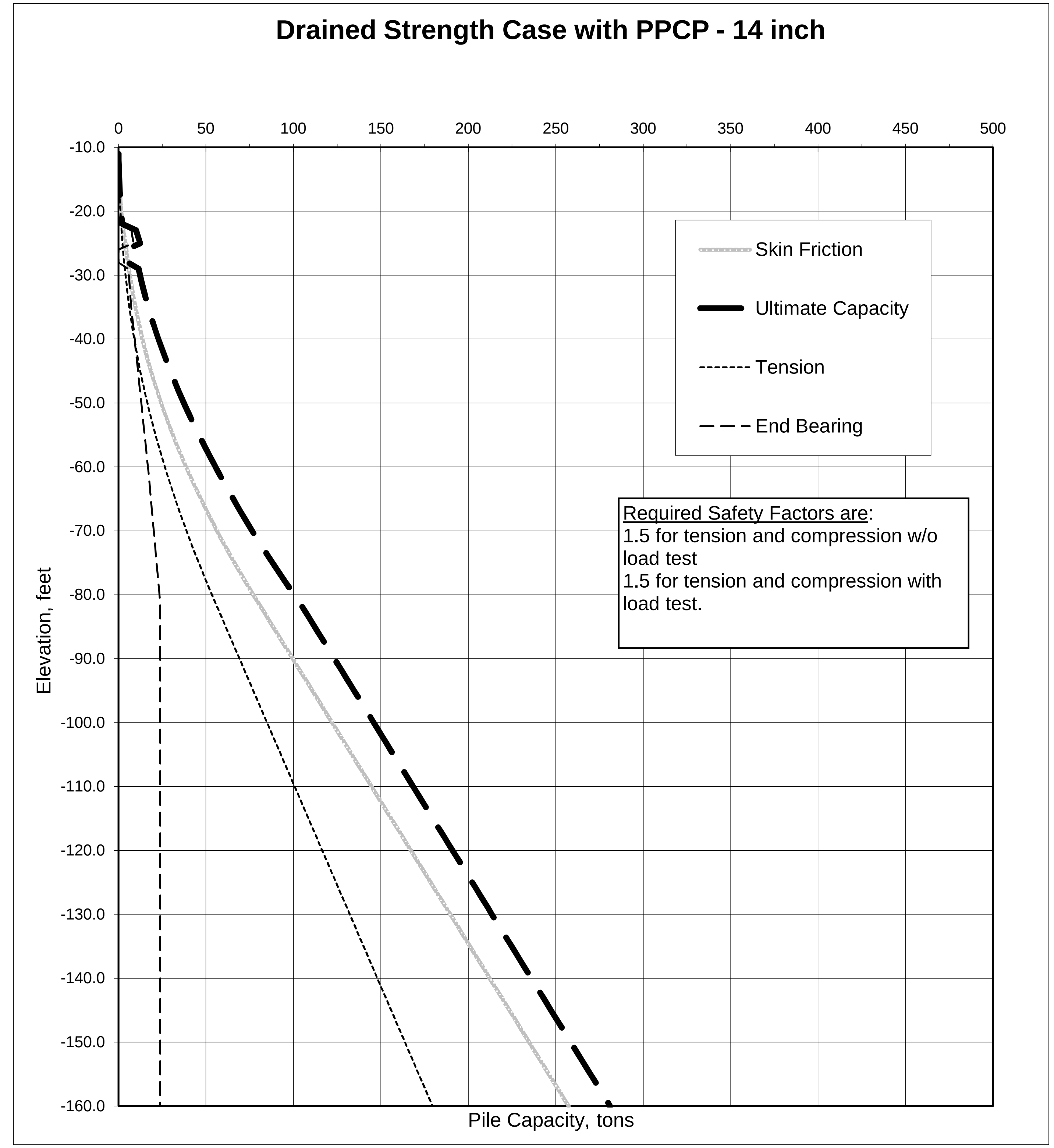
Drained Strength Case with HP 14x102 Pile



Notes:
1. Pile capacity curves represent axial resistance for a single pile and do not consider group effects.
2. Curves indicate Ultimate Capacity; the appropriate safety factors should be applied to arrive at the Allowable Capacity

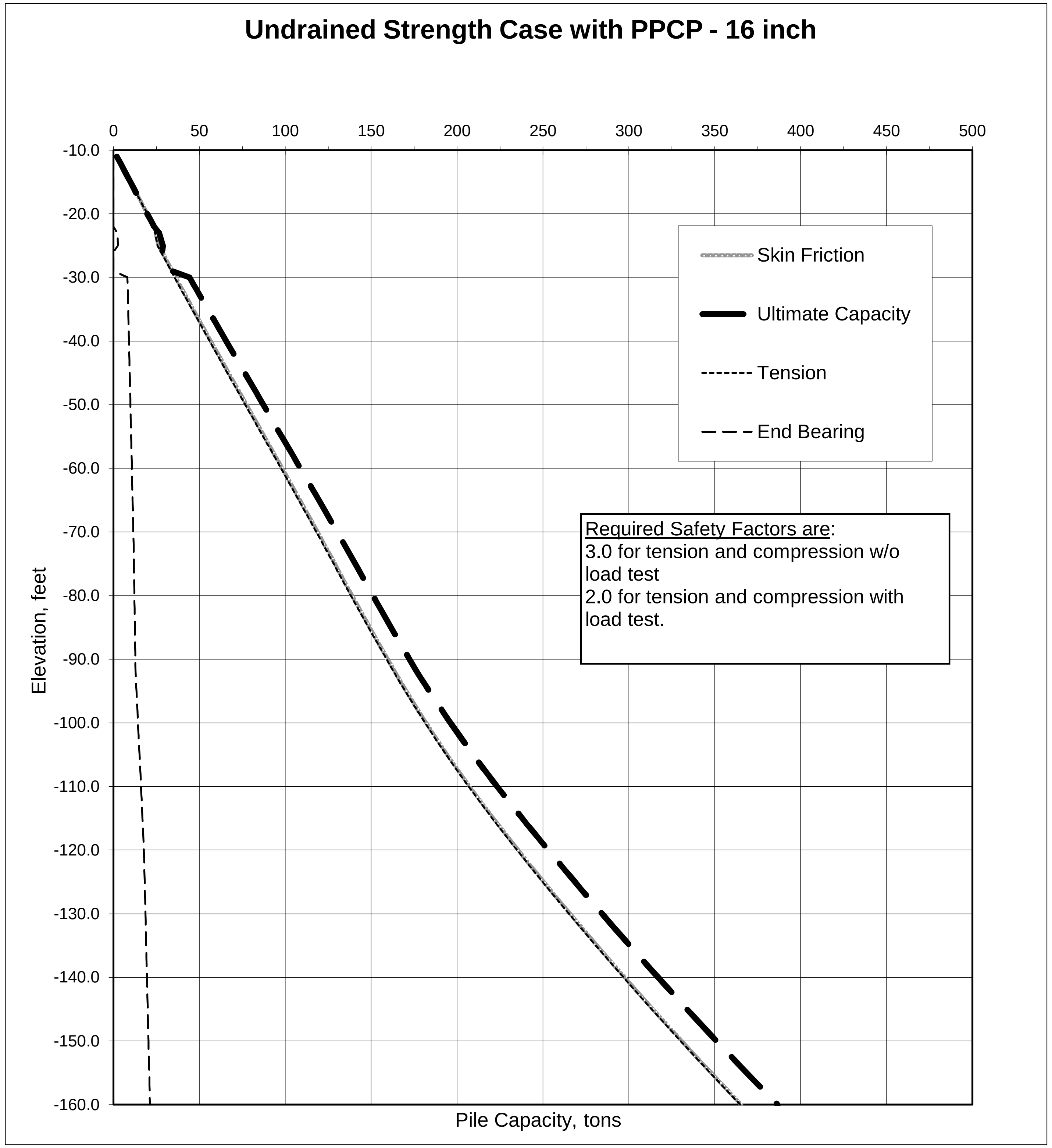
Coastal Protection and Restoration Authority Lake Maurepas Diversion Canal	Project No. 10001863	Pile Capacities: Intake Structure HP - 14X102	URS	Appendix E

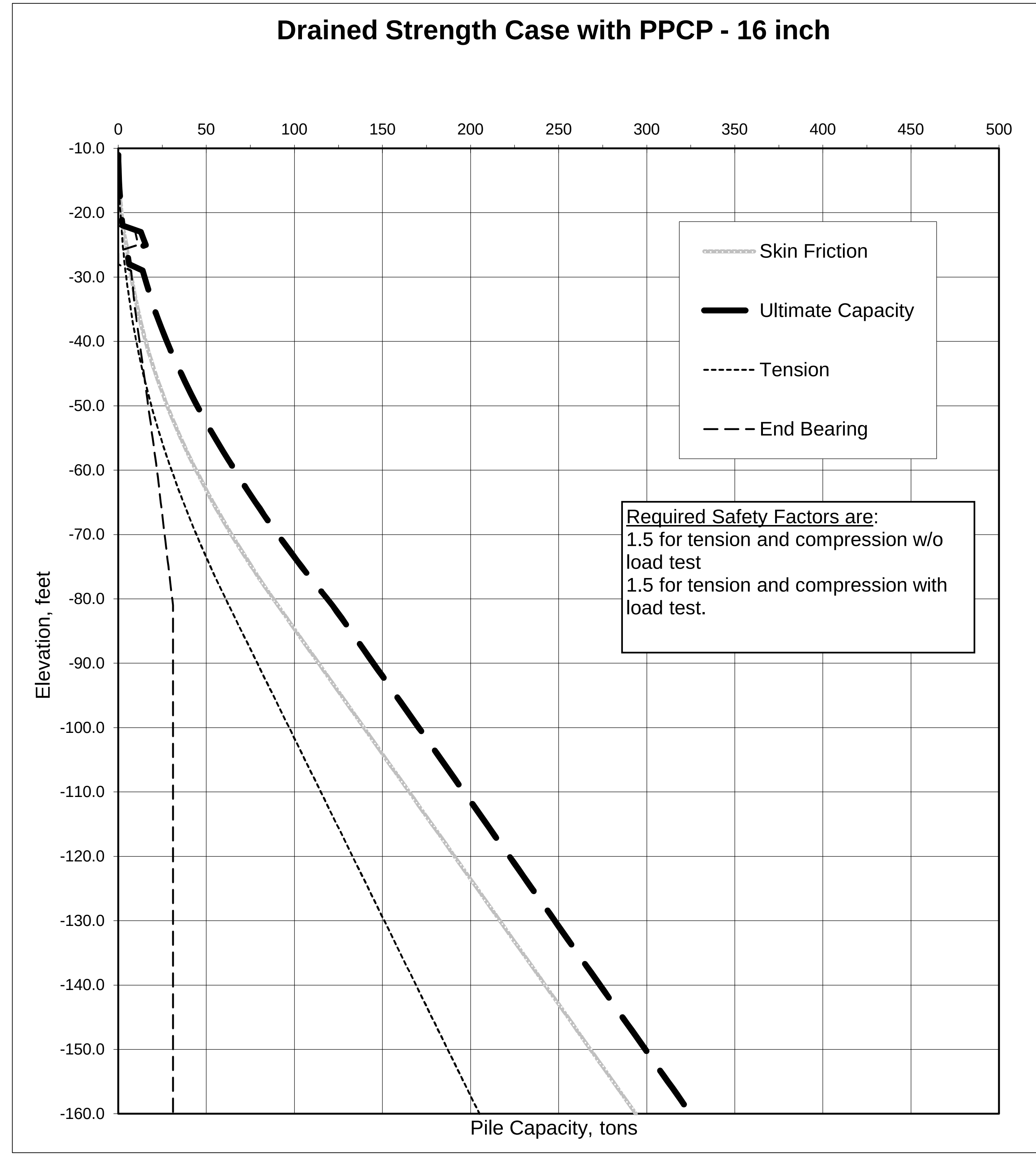




Notes:
1. Pile capacity curves represent axial resistance for a single pile and do not consider group effects.
2. Curves indicate Ultimate Capacity; the appropriate safety factors should be applied to arrive at the Allowable Capacity

Coastal Protection and Restoration Authority Lake Maurepas Diversion Canal	Project No. 10001863	**Pile Capacities: Lake Maurepas PPCP - 14 inch**	URS	Appendix E

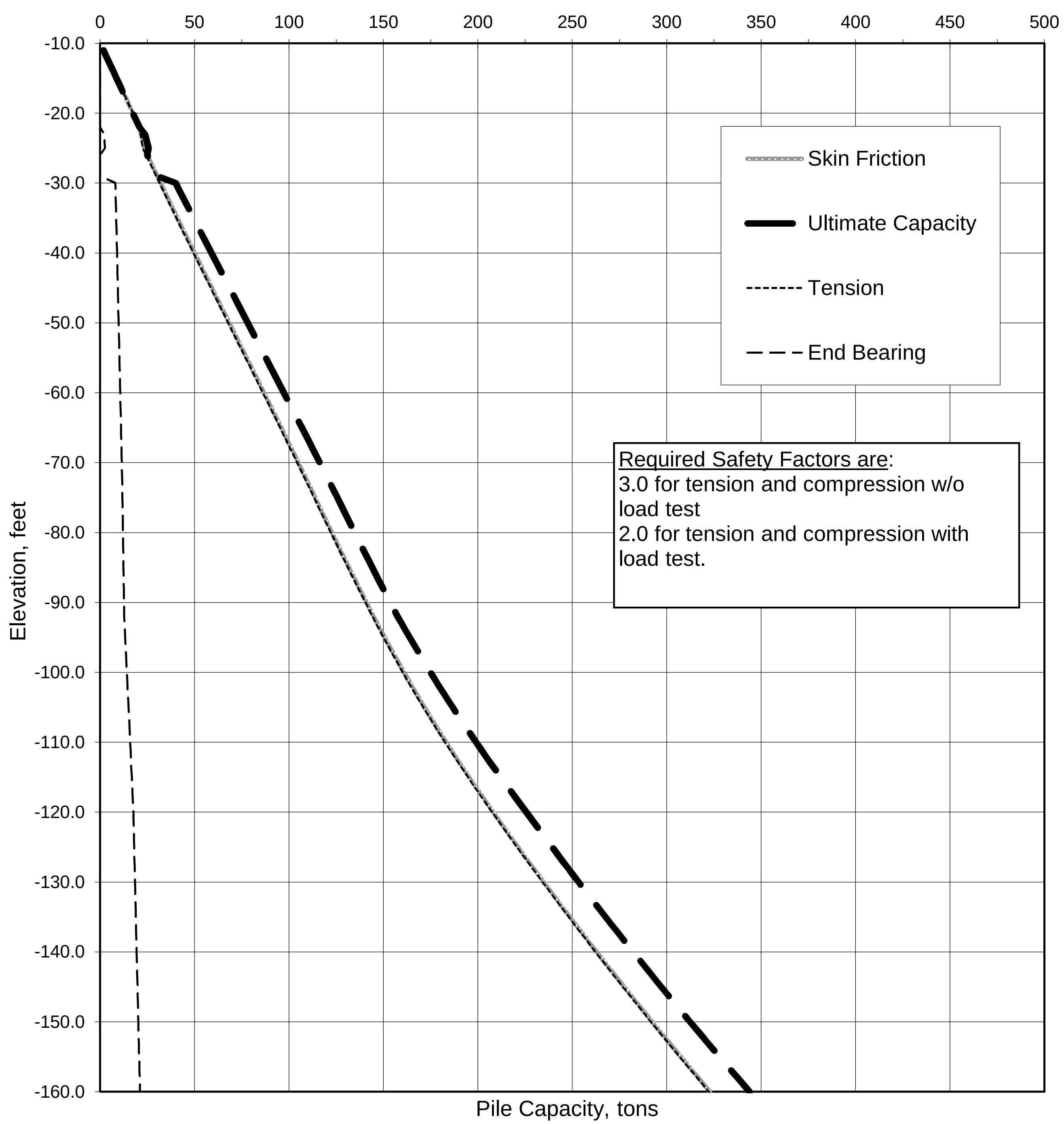




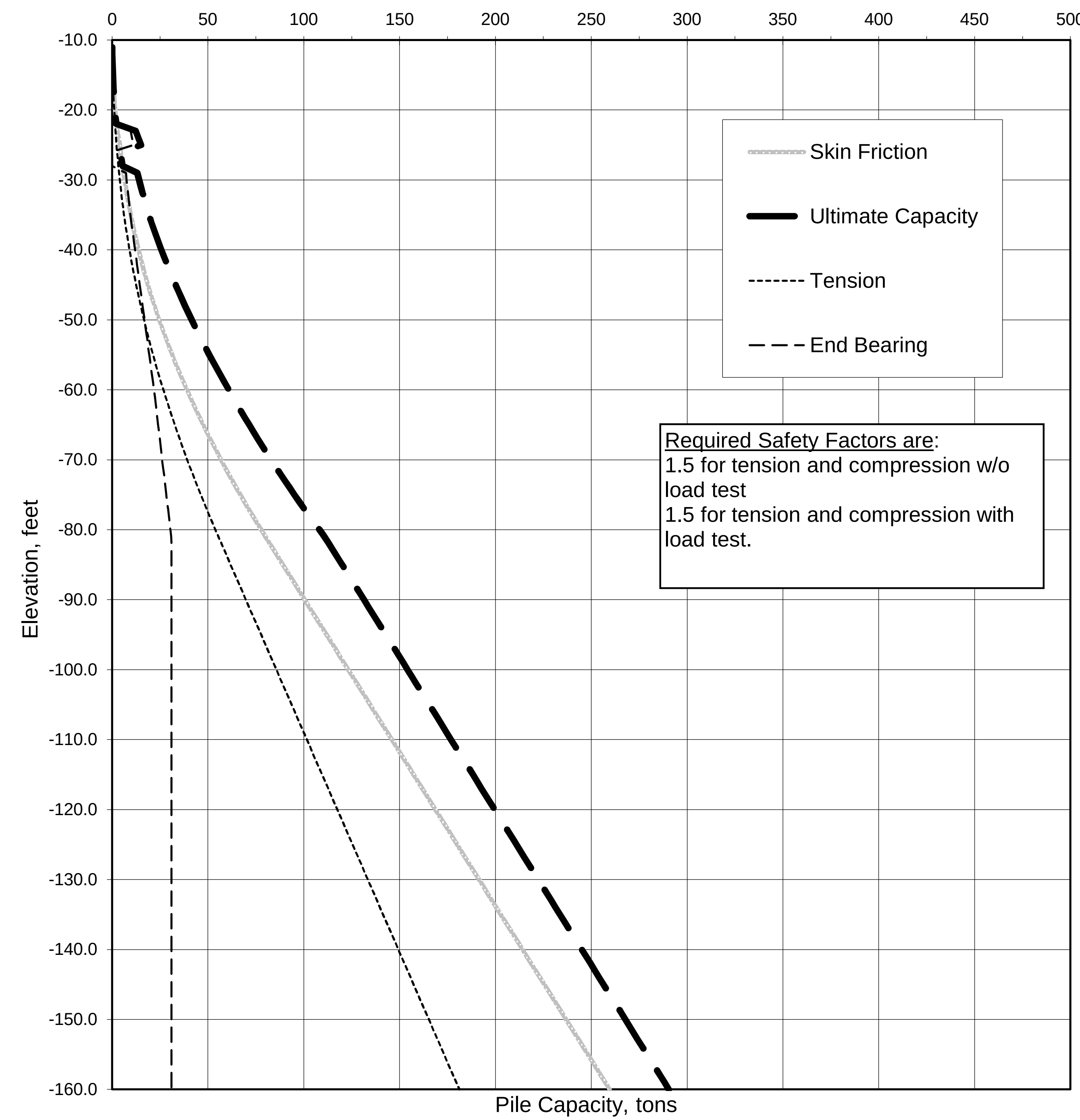
Notes:
1. Pile capacity curves represent axial resistance for a single pile and do not consider group effects.
2. Curves indicate Ultimate Capacity; the appropriate safety factors should be applied to arrive at the Allowable Capacity

Coastal Protection and Restoration Authority Lake Maurepas Diversion Canal	Project No. 10001863	Pile Capacities: Lake Maurepas PPCP - 16 inch	URS	Appendix E

Undrained Strength Case with PIPE PILE - 18 inch



Drained Strength Case with PIPE PILE - 18 inch



Notes:
1. Pile capacity curves represent axial resistance for a single pile and do not consider group effects.
2. Curves indicate Ultimate Capacity; the appropriate safety factors should be applied to arrive at the Allowable Capacity

Coastal Protection and Restoration Authority Lake Maurepas Diversion Canal	Project No. 10001863	Pile Capacities: Lake Maurepas PIPE PILE - 18 inch	URS	Appendix E

Maurepas Swamp

WSLP

Steel Gates

AECOM Project: 60632162

SECTION 2

Date: Dec-20

Job	Maurepas Swamp	Project No.	60589133		
	WSLP				
Description	Steel Gates	Computed by		Date	Dec-20
	AECOM Project: 60632162				
	Table of Contents	Checked by		Date	Dec-20
					References

TABLE OF CONTENTS

Maurepaus Swamp

River Road Crossing

Steel Roller Gate Design

AECOM Project : 60632162

1555 Poydras Street
Suite 1200
New Orleans, LA 70112
(504) 586-8111

Computed by:	SJW	Checked by:	JMH
Date:	20-Dec	Date:	20-Dec

General Info/Assumptions:

1) Steel roller gate is being designed using USACE ETL 1110-2-584, “Design of Hydraulic Steel Structures” (30 June 2014), including Appendix F, “Closure Gates”.

2) Top of Gate is EL +16.13. Top of slab is at EL +10.49.

4) As per EM 1110-2-584, skin plate is designed as a fixed end beam spanning between intercostals. In order to ensure that the flat plate theory is applicable, deflection will be limited to 0.4 times thickness.

5) Also per same EM, intercostals are designed as simple beams spanning between girders.

6) Also per same EM, girders are designed as simple beams, spanning between hinges on one side of the opening and bearings on the other.

7) A992, Grade 50 steel used for all steel members

8) For the 15% Design, two (2) load cases are examined. The specific cases have been chosen because engineering judgement dictates they will likely be the worst case conditions for the gate

Case 1) Water to TOW EL 16.13:
Flood water to Top of Wall EL 16.13

Case 2) Construction with Wind:
50 psf wind load on Protected Side of gate

- Impact, IM3, Extreme Load. May be neglected unless the Engineer has reason to believe this load may exist.

- Earthquake, not considered for the design of closure gates, but should be considered for gate support columns and walls.

- Environmental, W, Wind, See ASCE for recurrence interval, in lieu of site-specific data, use 15 psf during operation and up to 50 psf when not in operation (fully closed or fully open).

F.4.2. Design Load Cases. The following load cases shall be evaluated using the load factors listed in Table F-1.

- Case 1: Strength I, Gate not operating:

$$\Sigma\gamma i Q_{m} = \gamma_{D2} D + \gamma_{Hs2} H_{s2} \quad \text{(F-1)}$$

- Case 2: Strength I, Gate not operating, Gate subjected to the upper level Wind pressure of up to 50 psf:

$$\Sigma\gamma_i Q_{m} = \gamma_{D2} D + \gamma_{EV2} W_2 \quad \text{(F-2)}$$

- Case 3: Strength II, Gate operating, Hinged gate subjected to Dead and Wind (lower level of 15 psf), operating load is treated as a reaction:

$$\Sigma\gamma_i Q_{m} = \gamma_{D2} D + \gamma_{EV2} W_1 \quad \text{(F-3)}$$

- Case 4: Strength II, Gate operating, Wheeled gate subjected to Dead and Operating load:

$$\Sigma\gamma_i Q_{m} = \gamma_{D2} D + \gamma_{EV2} Q_2 \quad \text{(F-4)}$$

Table F-1. Load Factors for Closure Gates.

	Load Cases		Loads/Load Factors							
	Limit State	Description	γD	γG	γHs	γHd	γQ	γEV	γIM	γEQ
TOW CASE	Strength I	Gate Closed	0	0	1.4	0	0	0	0	0
CONST. + WIND	Strength I	Gate Closed	1.2	0	0	0	0	1.3	0	0
	Strength II	Gate Open	1.2	0	0	0	0	1.3	0	0
	Strength II	Gate Open	0	0	0	0	1.3	0	0	0

F.4.3. Design for Individual Members. The following paragraphs include a brief description of design assumptions and design considerations.

F.4.3.1. Skin plate. Skin plates shall be sized such that the maximum calculated stress is less than the yield limit state of $\alpha\phi F_y$. Skin plates shall be designed for hydrostatic loading only. Stresses shall be determined based on small deflection thin plate theory and by using Equation F-1. Deflection shall be limited to 0.4 of the plate thickness to prevent the development of significant membrane stresses. More than one thickness of plate may be desirable for taller gates. The minimum plate thickness shall be ¼ in. Appendix C provides additional guidance on skin plate design.

AECOM Imagine it. Delivered.

JOB TITLE

PROJECT/JOB NO. CALCULATION NO.

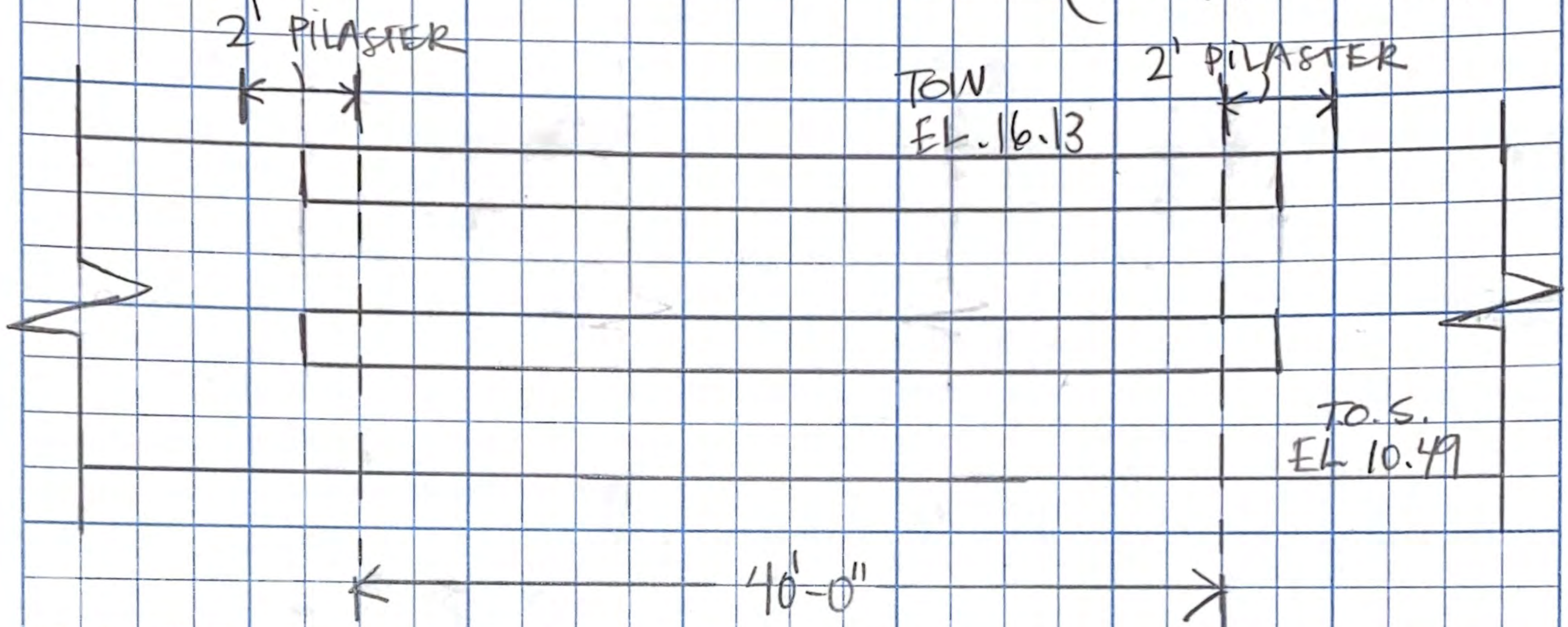
COMPUTED BY SJW DATE DEC-2020

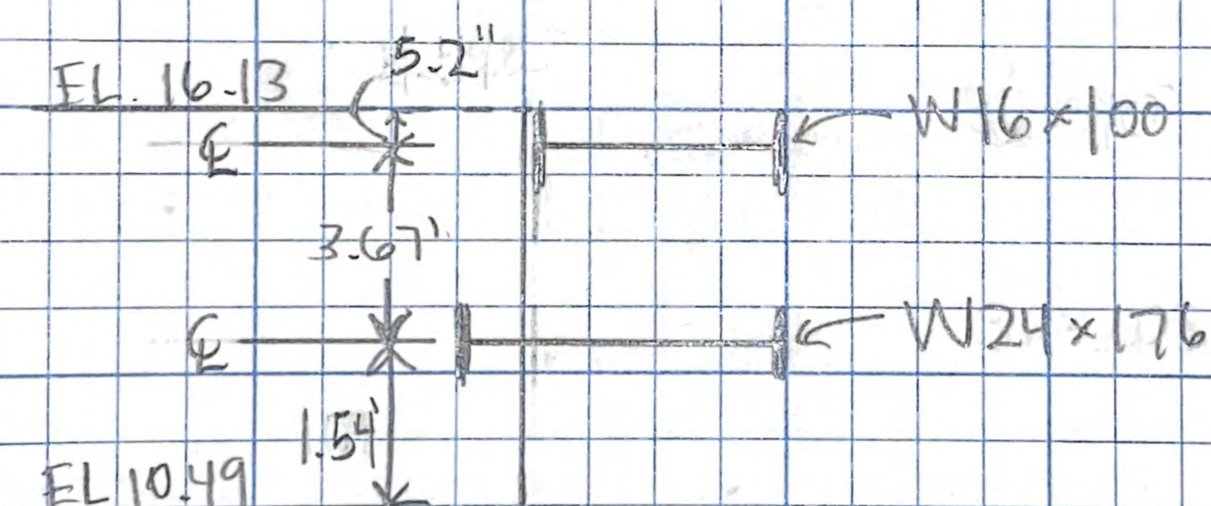
VERIFIED BY JMH DATE DEC-2020

SCALE SHEET NO. 1 OF

A) TOP & BOTTOM GIRDER DESIGNS:

TRY W16×100 TOP
W24×176 BOTTOM } TAKEN FROM PREVIOUS USACE FLOODGATE DESIGN (SIMILAR SIZE)





LOAD CASES FOR 15% SUBMITTAL:

LC1: WATER TO T.O. WALL EL. 16.13

LC2: CONSTRUCTION + WIND

4x4 = 1 in

AECOM Imagine it. Delivered.

JOB TITLE

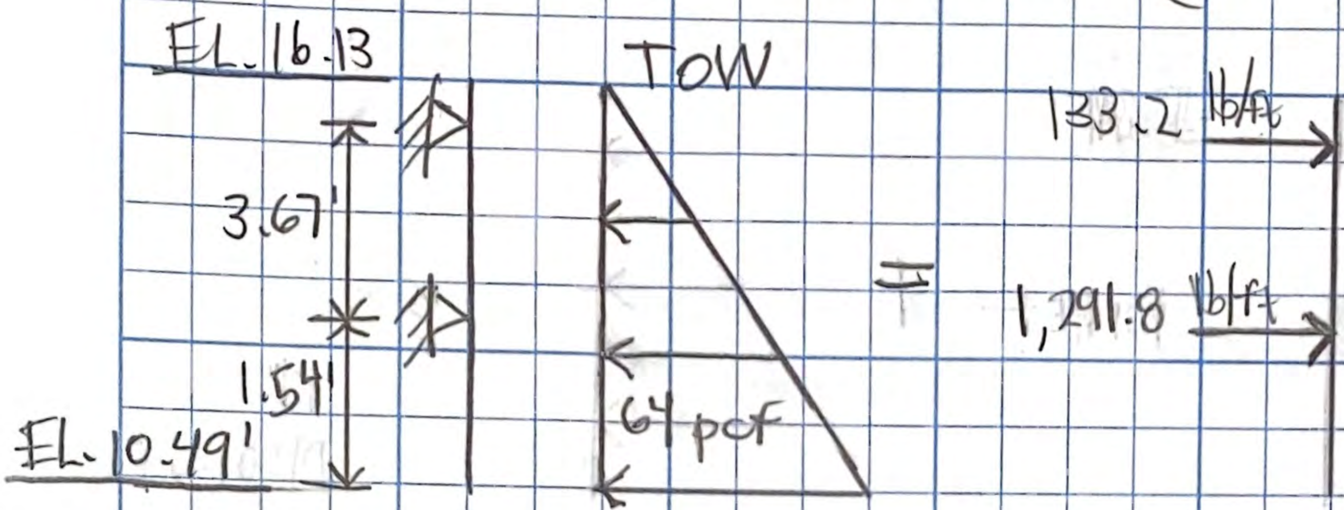
PROJECT/JOB NO. CALCULATION NO.

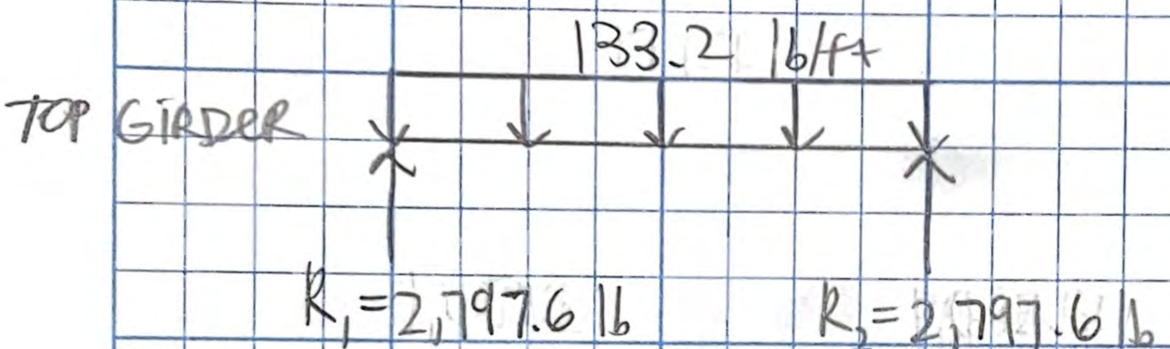
COMPUTED BY SJW DATE DEC-2020

VERIFIED BY JMH DATE DEC-2020

SCALE SHEET NO. 2 OF

LC1, WATER TO T.O.W.: (0D+1.4H_s)

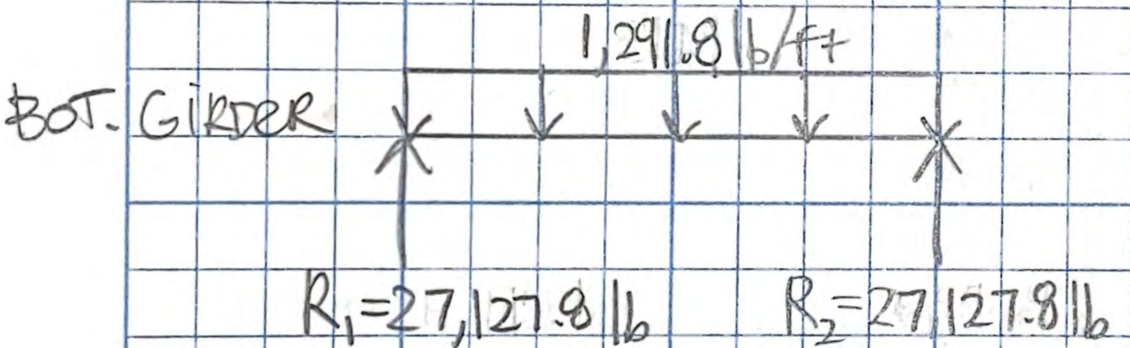




$$R_1=R_2=\frac{WL}{2}=\frac{(133.2\ lb/ft)(42')}{2}$$

$$M_{MAX,TOP}=\frac{WL^2}{8}=\frac{(133.2\ lb/ft)(42')^2}{8}$$

$$=\underline{29,375\ lb\text{-}ft}$$



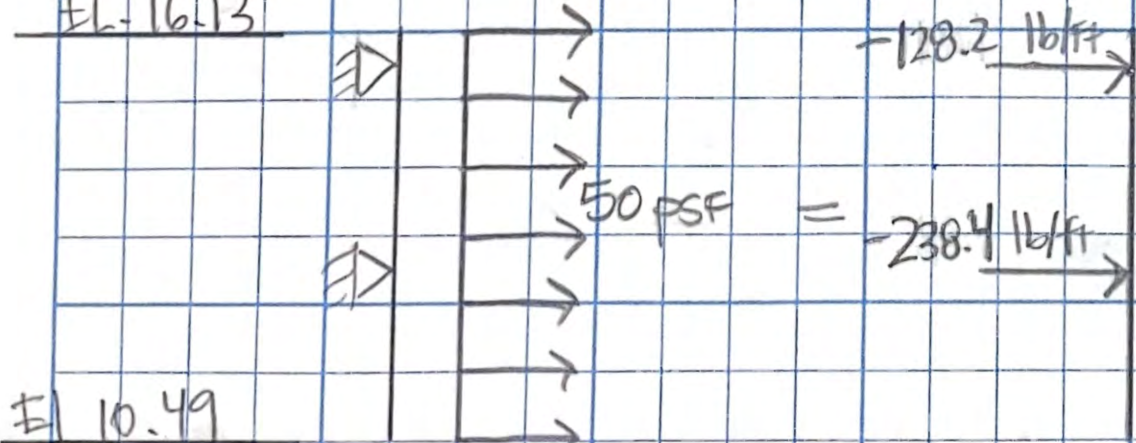
$$R_1=R_2=\frac{WL}{2}=\frac{(1,291.8\ lb/ft)(42')}{2}$$

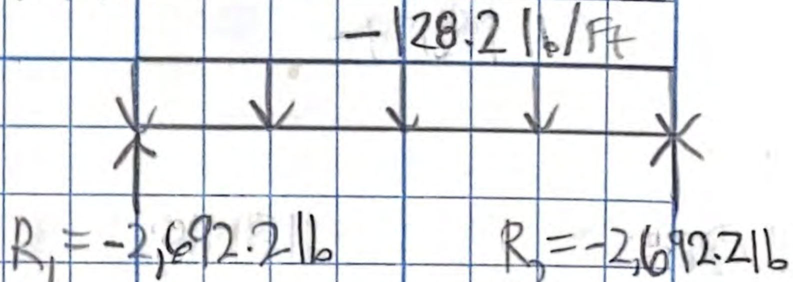
$$M_{MAX,BOT}=\frac{WL^2}{8}=\frac{(1,291.8\ lb/ft)(42')^2}{8}$$

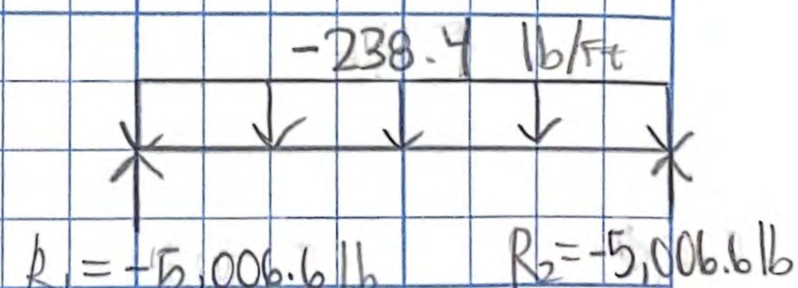
$$=\underline{284,842\ lb\text{-}ft}$$

LC2, CONST. + WIND: (1.2D+1.3W)

-50 PSF WIND (EXTREME) ON PROTECTED SIDE PER ETL







4x4 = 1 in

AECOM Imagine it. Delivered.

JOB TITLE

PROJECT/JOB NO. CALCULATION NO.

COMPUTED BY SJW DATE DEC-2020

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SCALE SHEET NO. 3 OF

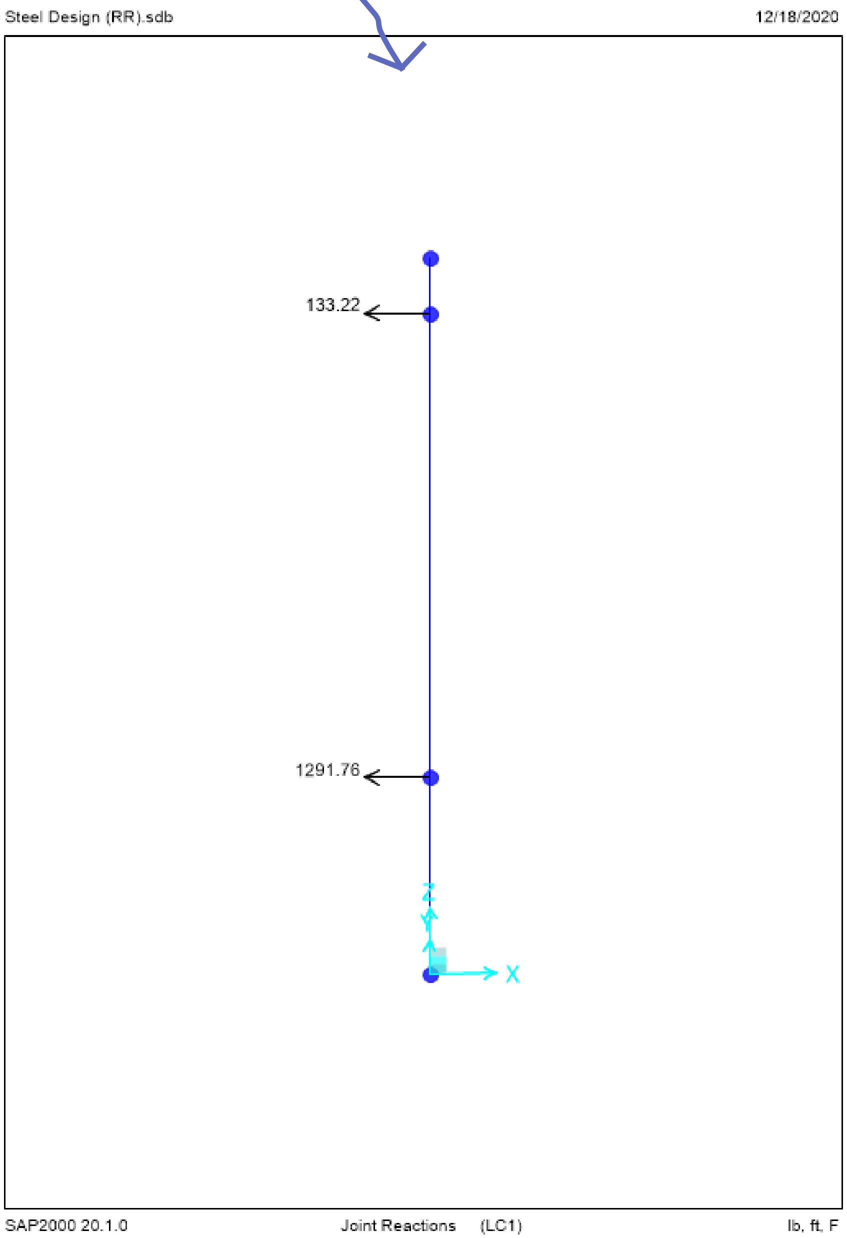
$$M_{MAX,TOP} = \frac{(128.2)(42)^2}{8} = \underline{28,268.1 \text{ lb-Ft}}$$

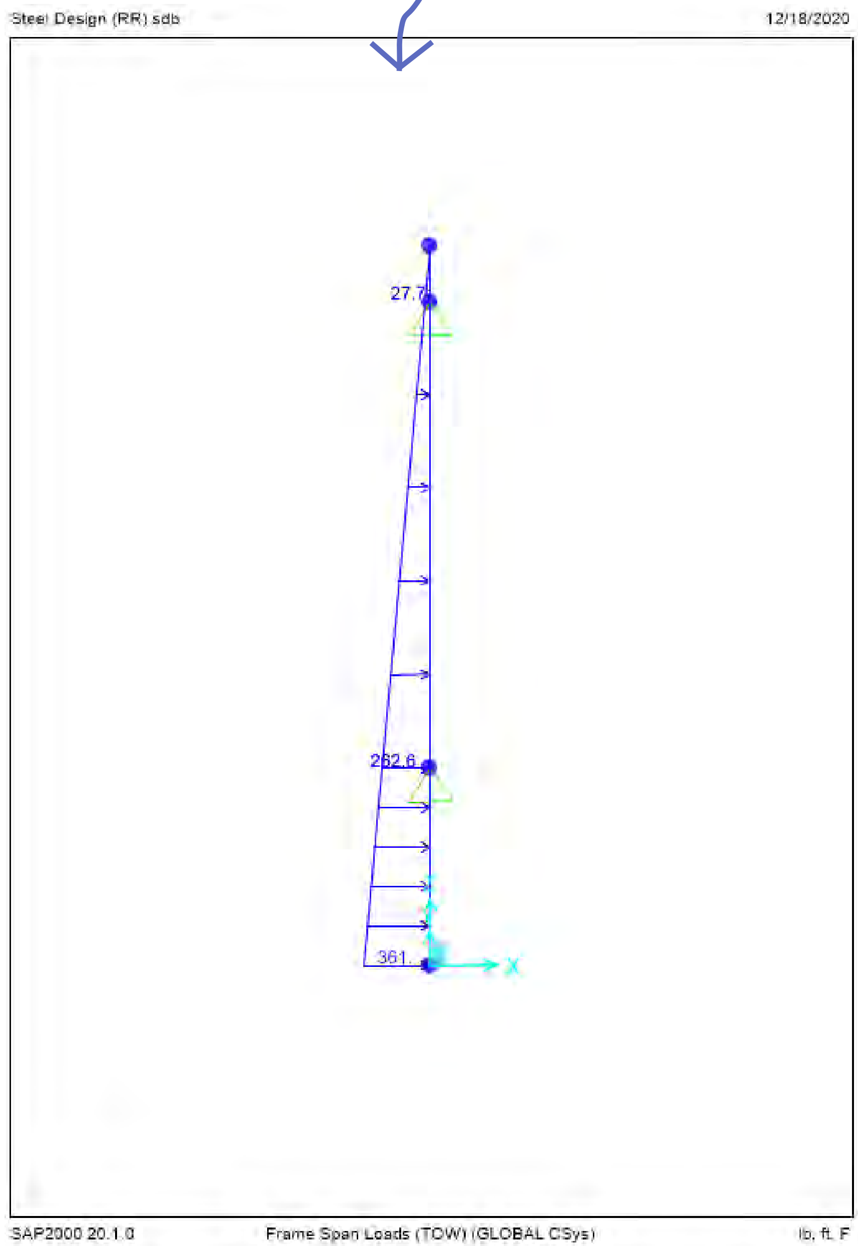
$$M_{MAX,Bot} = \frac{(238.4)(42)^2}{8} = \underline{52,569.4 \text{ lb-Ft}}$$

4x4 = 1 in

Factored loads
LC1 = 0D +1.4Hs

Unfactored load

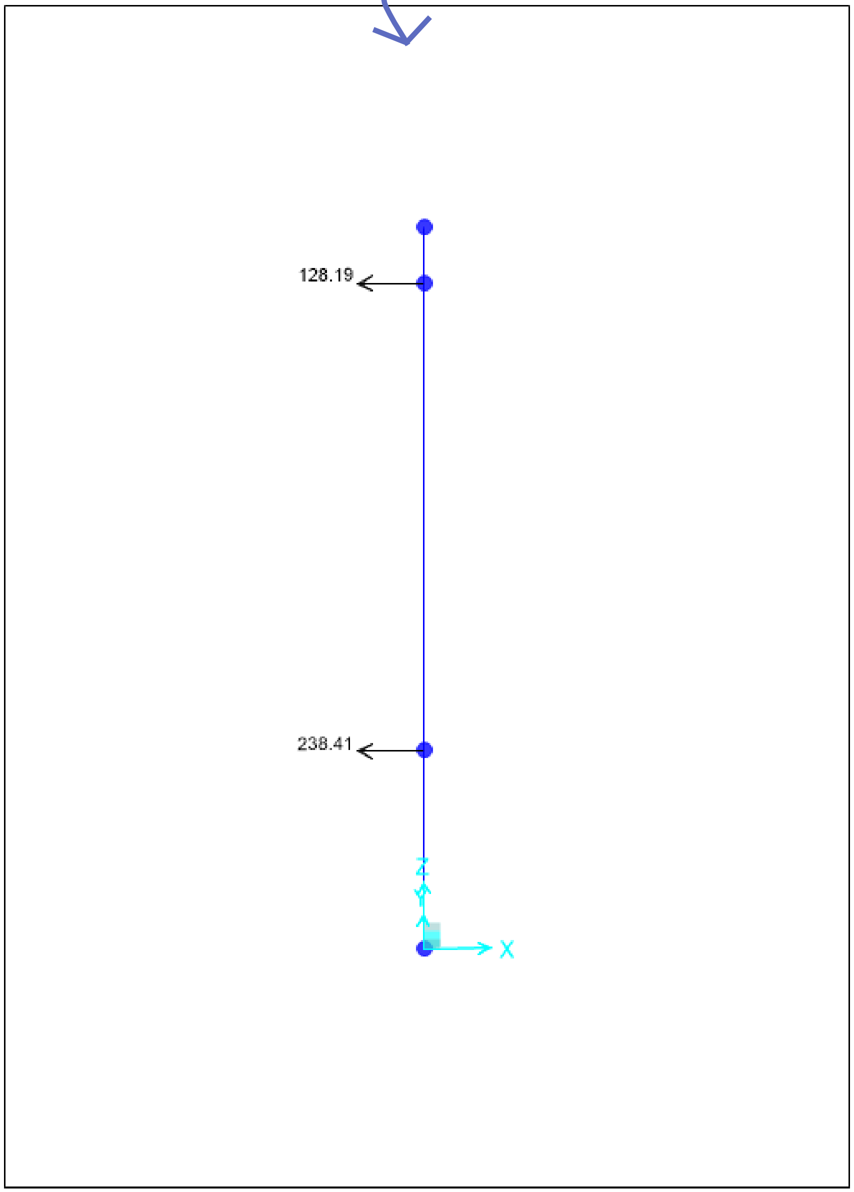




Factored loads
LC2 = 1.2D + 1.3W

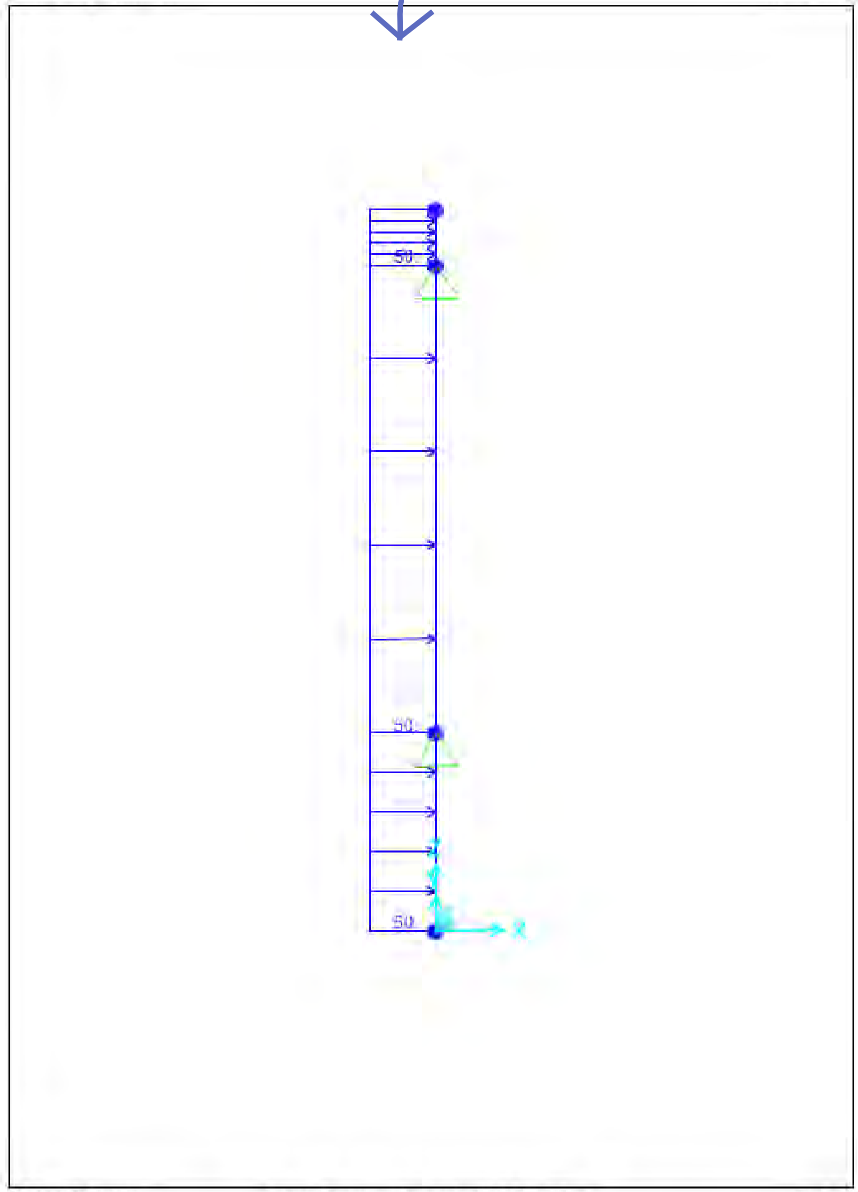
Unfactored load

Steel Design (RR).sdb 12/18/2020



SAP2000 20.1.0 Joint Reactions (LC2) lb, ft, F

Steel Design (RR).sdb 12/18/2020



SAP2000 20.1.0 Frame Span Loads (wind) (GLOBAL CSys) lb, ft, F

PROJECT | **Project #** 60632162 | **Sheet** ____ of ____
Maurepas Swamp | **Computed By** SJW | **Date** December-20
River Road Roller Gate Design | **Checked By** JMH | **Date** December-20

Top&Bottom Girder Design
Load Case: *Water to T.O. Wall*

Reference:
AISC Steel Const Manual 15th Ed.

MATERIAL PROPERTIES

Material: A992 F_y = 50 *ksi* ϕ = 0.9 for bending
E = 29000 *ksi* α = 0.85 from USACE ETL 1110-2-584

Top Girder Design

Top Girder	Designation	Area	Depth	Web Thickness	Flange Width	Flange Thickness	Nominal Wt. Per ft.	Elastic Properties Axis X-X I	S	r	Z	Axis Y-Y I	S	r	h_0	J	C_w
		A	d	t_w	b_f	t_f		I	S	r	Z	I	S	r	h_0	J	C_w
		in^2	in	in	in	in	lb	in^4	in^3	in	in^3	in^4	in^3	in	in	in^4	in^6
	W16x100	29.4	16.97	0.585	10.425	0.985	100	1490	175	7.1	198	186	35.7	2.51	16	7.73	11900

$b_f/2t_f$ = 5.3 < 9.2 $= 0.38\sqrt{(E / F_y)}$ *(AISC Table B4.1a)*

h/t_w = 29.0 < 90.6 $= 3.76\sqrt{(E / F_y)}$

Compact Section

Following AISC Section F2 - Doubly Symmetric Compact I-shaped Members…

1) Yield: $M_n = M_p = F_yZ_x$ = 9,900.0 k-in = **825.0 k-ft** *(F2-1)*

2) Lateral-Torsional Buckling:

L_b = 11.000 ft = 132 in

$L_p = 1.76r_y\sqrt{(E / F_y)}$ = 106.39 in *(F2-5)*

$L_r = 1.95r_{ts} * E/(0.7F_y) * \sqrt{\{(J*c / S_xh_0) + \sqrt{[(J*c / S_xh_0)^2 + 6.76(0.7*Fy / E)^2]}\}}$

$r_{ts}^2 = \sqrt{(I_y * C_w)} / S_x$ = 8.50

r_{ts} = 2.92

L_r = 392.46 in

(b) Lp < Lb < Lr

$M_n = C_b * \{M_p - (M_p - 0.7*F_y*S_x) * [(L_b - L_p) / (L_r - L_p)] \leq M_p$ *(F2-2)*

Conservatively setting C_b = 1

M_n = 9,562.0 k-in = **796.8 k-ft**

3) Moment Factoring & Check:

M_{max} =	29.38	k-ft		
$\phi\alpha M_n$ =	609.58	k-ft	⟶	***OK***

4) Deflection Check: Simple Beam $\Delta_{max} = (5*w*l^4) / (384*E*I_x)$

Max allowable deflection Δ_{allow} = L/240 = 2.1 in

Distributed load =	133.22	lb/ft =	11.10	lb/in
Span length =	42	ft =	504	in

Δ_{max} =	0.216	in	⟶	***OK***

Bottom Girder Design

Bottom Girder	Designation	Area	Depth	Web Thickness	Flange Width	Flange Thickness	Nominal Wt. Per ft.	Elastic Properties Axis X-X				Axis Y-Y					
		A	d	tw	bf	tf		I	S	r	Z	I	S	r	h_0	J	C_w
		in2	in	in	in	in	lb	in4	in3	in	in^3	in4	in3	in	in	in^4	in^6
	W24x176	51.7	25.24	0.75	12.89	1.34	176	5680	450	10.5	511	479	74.3	3.04	24	23.9	68400

$b_f/2t_f$ = 4.8 < 9.2 $= 0.38\sqrt{(E / F_y)}$ *(AISC Table B4.1a)*

h/t_w = 33.7 < 90.6 $= 3.76\sqrt{(E / F_y)}$

Compact Section

Following AISC Section F2 - Doubly Symmetric Compact I-shaped Members…

1) Yield: $M_n = M_p = F_yZ_x =$ 25,550.0 k-in = **2,129.2 k-ft** *(F2-1)*

2) Lateral-Torsional Buckling:

$L_b =$ 11.000 ft = 132 in

$L_p = 1.76r_y\sqrt{(E / F_y)} =$ 128.85 in *(F2-5)*

$L_r = 1.95r_{ts} * E/(0.7F_y) * \sqrt{\{(J*c / S_xh_0) + \sqrt{[(J*c / S_xh_0)^2 + 6.76(0.7*Fy / E)^2]}\}}$

$r_{ts}^2 =$ $\sqrt{(I_y * C_w)} / S_x =$ 12.72

$r_{ts} =$ 3.57

$L_r =$ 448.85 in

(b) Lp < Lb < Lr

$M_n = C_b * \{M_p - (M_p - 0.7*F_y*S_x) * [(L_b - L_p) / (L_r - L_p)] \leq M_p$ *(F2-2)*

Conservatively setting $C_b = 1$

$M_n =$ 25,453.7 k-in = **2,121.1 k-ft**

3) Moment Factoring & Check:

$M_{max} =$ 284.83 k-ft

$\phi\alpha M_n =$ 1,622.67 k-ft $\longrightarrow$ ***OK***

4) Deflection Check: Simple Beam $\Delta_{max} = (5*w*l^4) / (384*E*I_x)$

Max allowable deflection $\Delta_{allow} = L/240 =$ 2.1 in

Distributed load = 1291.76 lb/ft = 107.65 lb/in

Span length = 42 ft = 504 in

$\Delta_{max} =$ 0.549 in $\longrightarrow$ ***OK***

PROJECT	**Project #**		**Sheet**	of
Maurepas Swamp	**Computed By**	SJW	**Date**	December-20
River Road Roller Gate Design	**Checked By**	JMH	**Date**	December-20

Top&Bottom Girder Design

Load Case: *Construction + wind load*

Reference:
AISC Steel Const Manual 15th Ed.

MATERIAL PROPERTIES

Material: A992

F_y = 50 ksi

E = 29000 ksi

ϕ = 0.9 for bending

α = 0.85 from USACE ETL 1110-2-584

Top Girder Design

Top Girder	Designation	Area	Depth	Web Thickness	Flange Width	Flange Thickness	Nominal Wt. Per ft.	Elastic Properties Axis X-X I	S	r	Z	Axis Y-Y I	S	r	h_0	J	C_w
		A	d	t_w	b_f	t_f											
		in^2	in	in	in	in	lb	in^4	in^3	in	in^3	in^4	in^3	in	in	in^4	in^6
	W16x100	29.4	16.97	0.585	10.425	0.985	100	1490	175	7.1	198	186	35.7	2.51	16	7.73	11900

$b_f/2t_f$ = 5.3 < 9.2 $= 0.38\sqrt{(E / F_y)}$ *(AISC Table B4.1a)*

h/t_w = 29.0 < 90.6 $= 3.76\sqrt{(E / F_y)}$

Compact Section

Following AISC Section F2 - Doubly Symmetric Compact I-shaped Members…

1) Yield: $M_n = M_p = F_yZ_x$ = 9,900.0 k-in = **825.0 k-ft** *(F2-1)*

2) Lateral-Torsional Buckling:

L_b = 11.000 ft = 132 in

$L_p = 1.76r_y\sqrt{(E / F_y)}$ = 106.39 in *(F2-5)*

$L_r = 1.95r_{ts} * E/(0.7F_y) * \sqrt{\{(J*c / S_xh_0) + \sqrt{[(J*c / S_xh_0)^2 + 6.76(0.7*Fy / E)^2]}}$

r_{ts}^2 = $\sqrt{(I_y * C_w)} / S_x$ = 8.50

r_{ts} = 2.92

L_r = 392.46 in

(b) Lp < Lb < Lr

$M_n = C_b * \{M_p - (M_p - 0.7*F_y*S_x) * [(L_b - L_p) / (L_r - L_p)] \leq M_p$ *(F2-2)*

Conservatively setting $C_b = 1$

$M_n =$ 9,562.0 k-in = **796.8 k-ft**

3) Moment Factoring & Check:

$M_{max} =$	28.27	k-ft	
$\phi\alpha M_n =$	609.58	k-ft	$\longrightarrow$ ***OK***

4) Deflection Check:

Simple Beam $\Delta_{max} = (5*w*l^4) / (384*E*I_x)$

Max allowable deflection $\Delta_{allow} = L/240 =$ 2.1 in

Distributed load = 128.19 lb/ft = 10.68 lb/in

Span length = 42 ft = 504 in

$\Delta_{max} =$	0.208	in	$\longrightarrow$ ***OK***

Bottom Girder Design

Bottom Girder	Designation	Area	Depth	Web Thickness	Flange Width	Flange Thickness	Nominal Wt. Per ft.	Elastic Properties Axis X-X				Axis Y-Y					
		A	d	tw	bf	tf		I	S	r	Z	I	S	r	h_0	J	C_w
		in2	in	in	in	in	lb	in4	in3	in	in^3	in4	in3	in	in	in^4	in^6
	W24x176	51.7	25.24	0.75	12.89	1.34	176	5680	450	10.5	511	479	74.3	3.04	24	23.9	68400

$b_f/2t_f =$ 4.8 < 9.2 $= 0.38\sqrt{(E / F_y)}$

(AISC Table B4.1a)

$h/t_w =$ 33.7 < 90.6 $= 3.76\sqrt{(E / F_y)}$

<u>Compact Section</u>

Following AISC Section F2 - Doubly Symmetric Compact I-shaped Members…

1) Yield:

$M_n = M_p = F_y Z_x =$ 25,550.0 k-in = **2,129.2 k-ft** *(F2-1)*

2) Lateral-Torsional Buckling:

$L_b =$ 11.000 ft = 132 in

$L_p = 1.76 r_y \sqrt{(E / F_y)} =$ 128.85 in *(F2-5)*

$L_r = 1.95 r_{ts} * E/(0.7F_y) * \sqrt{\{(J^*c / S_x h_0) + \sqrt{[(J^*c / S_x h_0)^2 + 6.76(0.7^*Fy / E)^2]}\}}$

$r_{ts}^2 =$ $\sqrt{(I_y * C_w)} / S_x =$ 12.72

$r_{ts} =$ 3.57

$L_r =$ 448.85 in

(b) Lp < Lb < Lr

$M_n = C_b * \{M_p - (M_p - 0.7^*F_y{}^*S_x) * [(L_b - L_p) / (L_r - L_p)] \leq M_p$ *(F2-2)*

Conservatively setting $C_b = 1$

$M_n =$ 25,453.7 k-in = **2,121.1 k-ft**

3) Moment Factoring & Check:

$M_{max} =$ 52.57 k-ft

$\phi\alpha M_n =$ 1,622.67 k-ft ⟶ ***OK***

4) Deflection Check:

Simple Beam $\Delta_{max} = (5^*w^*l^4) / (384^*E^*I_x)$

Max allowable deflection $\Delta_{allow} = L/240 =$ 2.1 in

Distributed load = 238.41 lb/ft = 19.87 lb/in

Span length = 42 ft = 504 in

$\Delta_{max} =$ 0.101 in ⟶ ***OK***

AECOM Imagine it. Delivered.

JOB TITLE

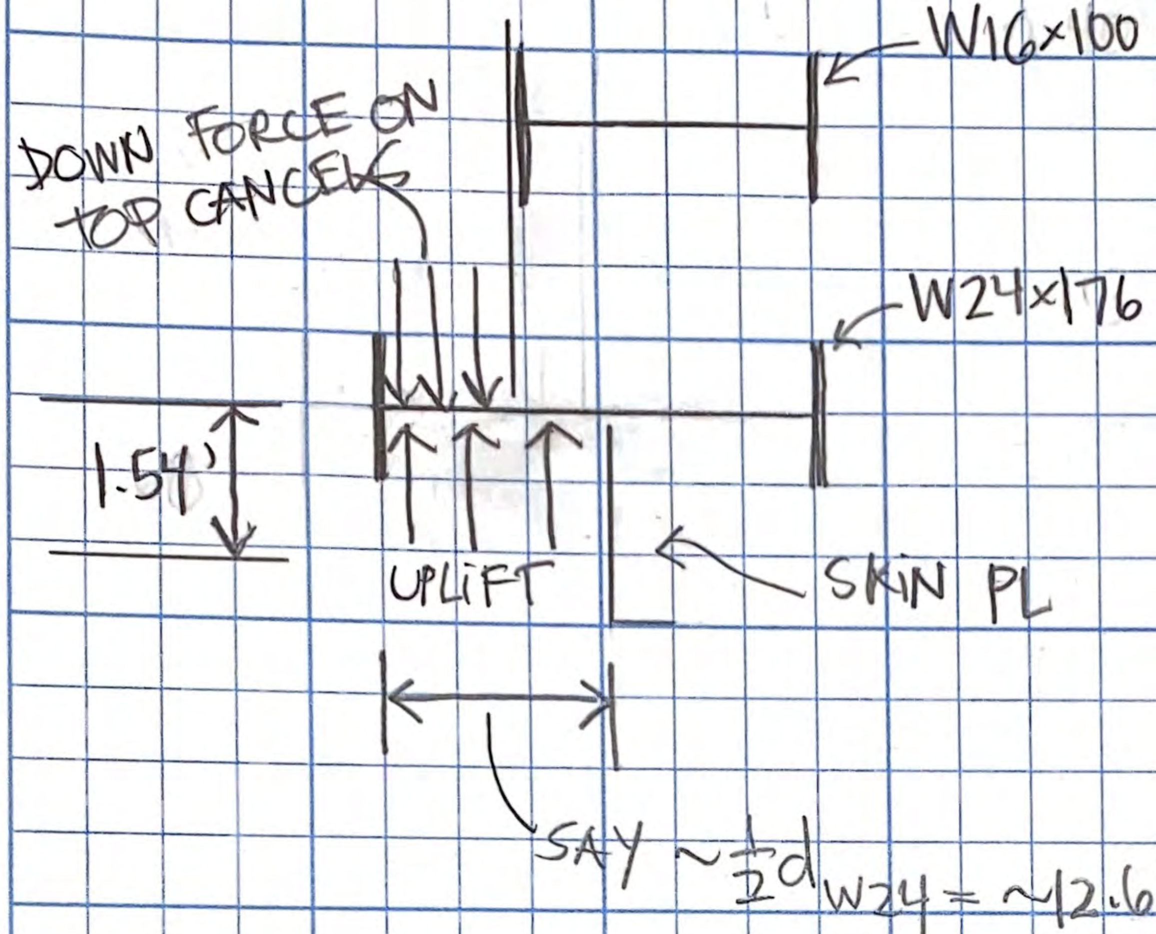
PROJECT/JOB NO. CALCULATION NO.

COMPUTED BY SJW DATE DEC-2020

VERIFIED BY JMH DATE DEC-2020

SCALE SHEET NO. 4 OF

B) CHECK RESISTANCE TO FLOATATION:



↳ NET UPLIFT FOR WATER TO T.O. WALL

$= 64_{pcf}(16.13' - 10.49' - 1.54')\left(\frac{12.6"}{12} - \frac{\sim 6.3"}{12}\right) \times 42'$

$= 5{,}785.9$ lb

↳ APPROX. WT. OF GATE

$= (100\ lb/ft + 176\ lb/ft) \times 42'$ GATE (GIRDERS)

$+ \left[\frac{1/4"}{12} \times 5.64'h \times 42'L\right] \times 490\ lb/ft^3$ (SKIN PL)

$= 14{,}010.2$ lb × 1.05 FOR MISC. STIFFENERS, WELDS, ETC.

$= 14{,}710.7$ lb $> 5{,}785.9$ lb OK ✓

4x4 = 1 in

AECOM Imagine it. Delivered.

JOB TITLE

PROJECT/JOB NO. CALCULATION NO.

COMPUTED BY SJW DATE DEC-2020

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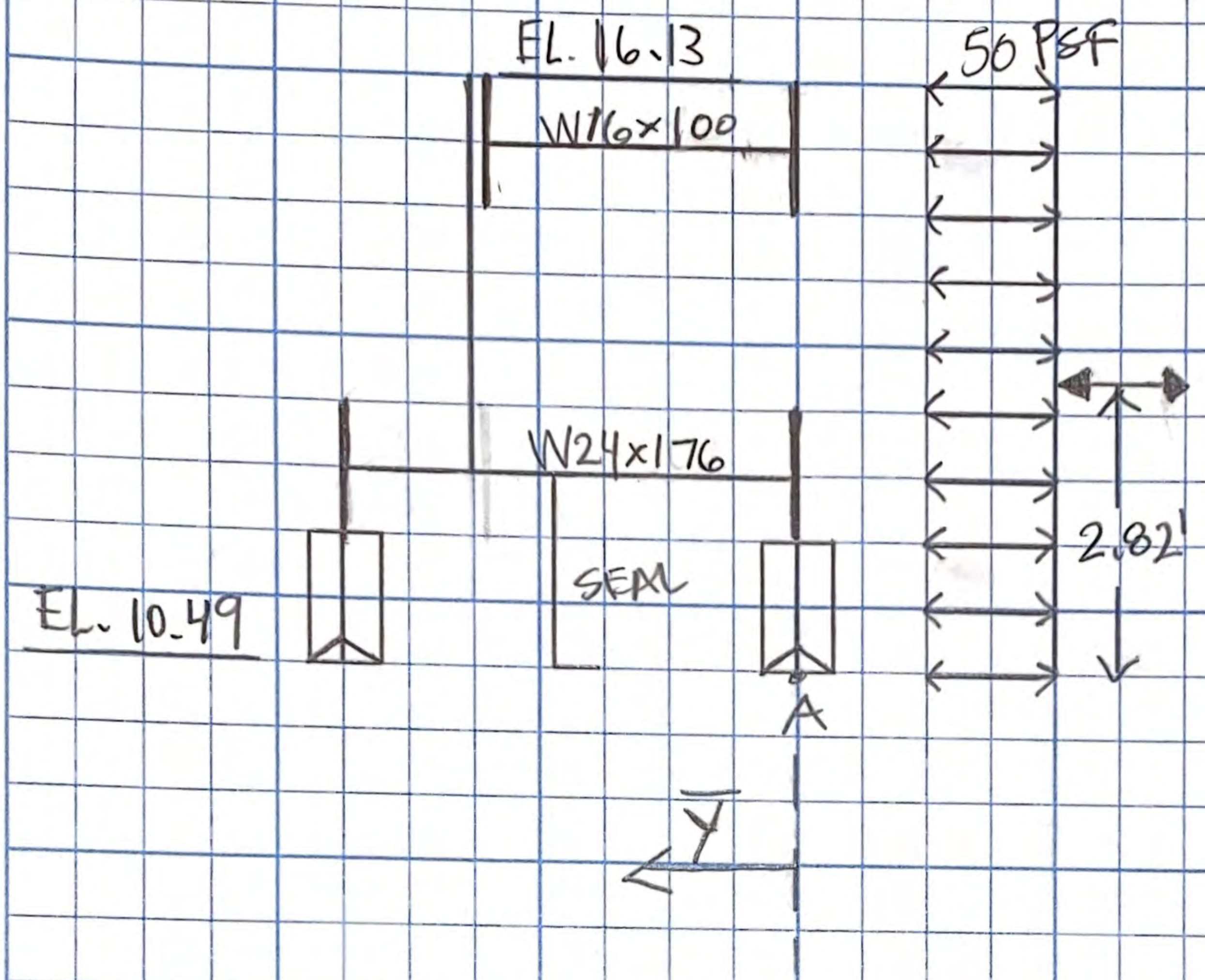
SCALE SHEET NO. 5 OF

C) CHECK WIND LOAD STABILITY:



GATE WT. W/O 5% INCREASE = 14,010.2 lb

CENTROID ($\bar{Y}$):

$$\frac{\left[100^{lb} \times \frac{17''}{2} + 176^{lb} \times \frac{25.2''}{2}\right]}{(100+176)} \rightarrow \bar{Y} = 11.11''$$

→ ASSUME GATE CLOSED BUT UNLATCHED, SUBJECT TO 15 PSF WIND LOAD (STD. OPERATION LOAD PER ETL SEC. F.4; HURRICANE WIND WOULD NOT BE ALLOWED TO COINCIDE W/ UNLATCHED GATE)

→ FORCE OVER 40' OPENING = 15 PSF × 40' × (16.13' − 10.49')

= 3,384 lb

4x4 = 1 in

AECOM Imagine it. Delivered.

JOB TITLE ______

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SCALE ______ SHEET NO. 6 OF ______

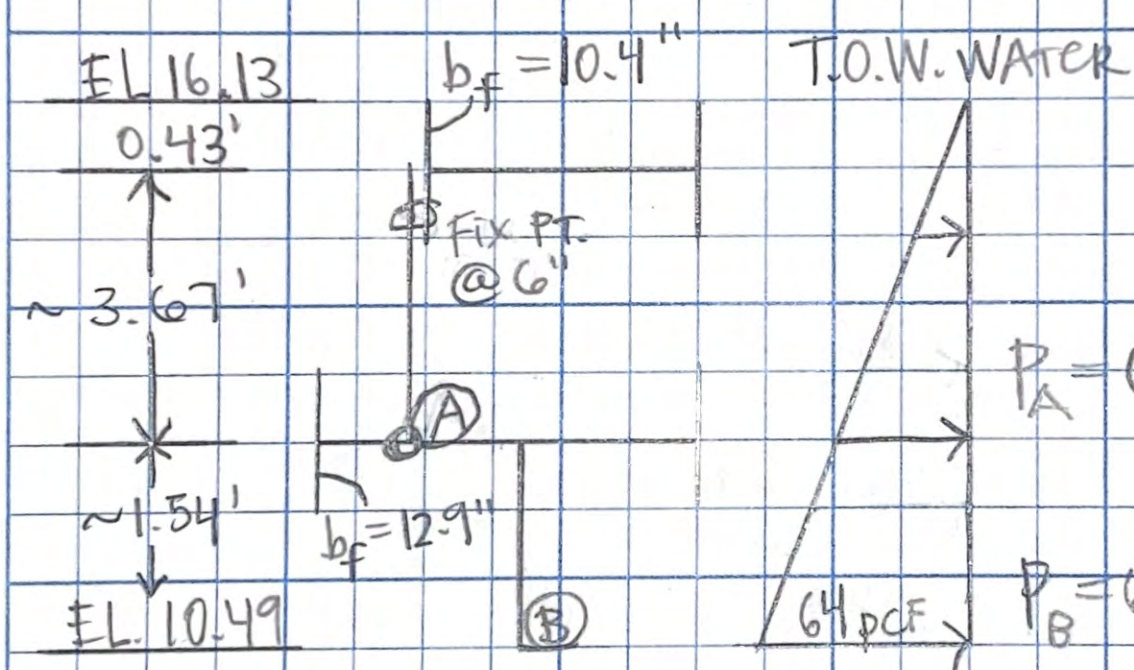
→ OVERTURNING ABT. POINT A:

$$\frac{14{,}010.2\,lb \times 11.11''}{3{,}384\,lb \times (2.82' \times 12''/')} = 1.36 > 1.0 \checkmark \text{ OK}$$

→ ∴ GATE STABLE UNDER OPERATIONAL WIND LOADS (AND HIGHER) WHEN UNLATCHED

* GATE SHOULD ALWAYS BE LATCHED WHEN CLOSED.

D) SKIN PL:



- ASSUME 1/4" PL (MINIMUM ALLOWED PER ETL)

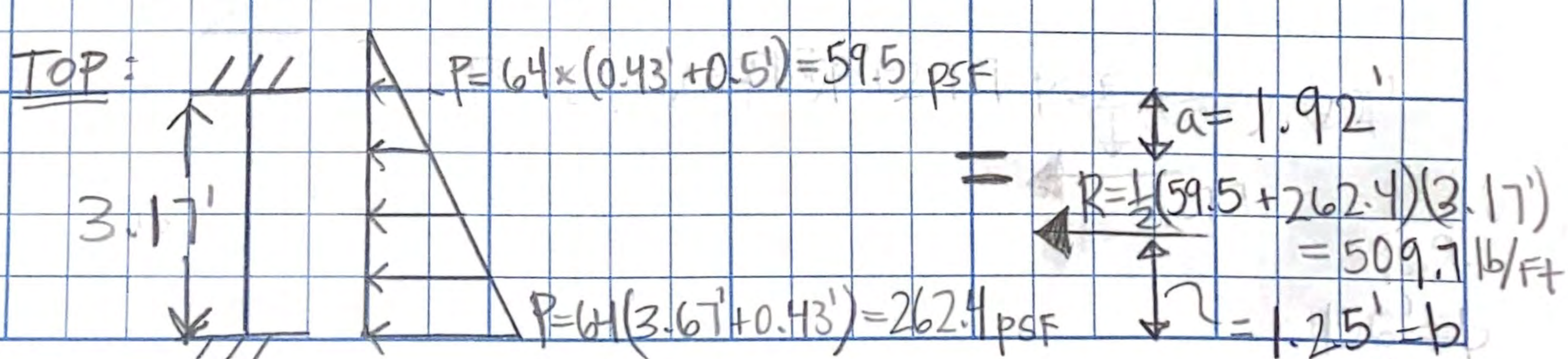
$P_A = 64\text{ pcf} \times 4.1' = 262.4\text{ psf}$

$P_B = 64\text{ pcf} \times 5.64' = 361\text{ psf}$

- ASSUME PL FIXED @ ℄ INTERCOSTALS & @ 6" FROM ℄ WEB

- STIFF. PL ~ 3'-8" SPACING, TRIB. WIDTH = 3'-8" = 44"

TOP:



4x4 = 1 in

JOB TITLE	
PROJECT/JOB NO.	CALCULATION NO.
COMPUTED BY SJW	DATE DEC-2020
VERIFIED BY JMH	DATE DEC-2020
SCALE	SHEET NO. 7 OF

↳ BEAM FIXED BOTH ENDS W/ PT. LOAD:

$$M_{MAX} = \frac{Pa^2b}{l^2} = \frac{(509.7\ lb/ft)(1.92')^2(1.25')}{(1.92'+1.25')^2}$$

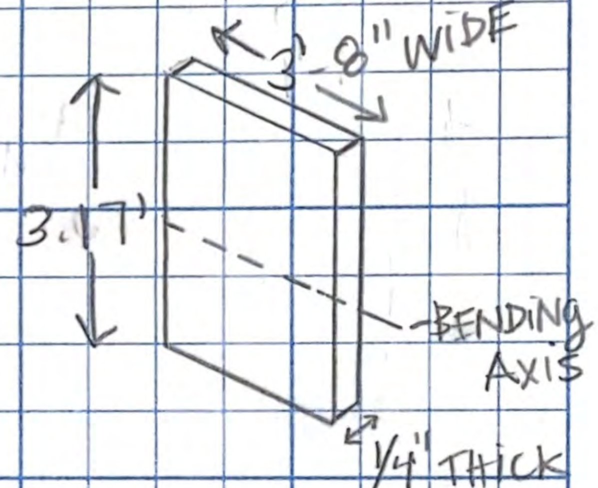
@ PT. A

$$= 233.4\ lb\text{-}ft/ft \times 3'\text{-}8''$$

$$= \underline{\underline{855.7\ lb\text{-}ft}}$$

$$STRESS = \sigma_{BEND} = \frac{M \cdot c}{I}, \text{ where } c = 1/4''/2 = 0.125''$$

$$I = \frac{bh^3}{12} = \frac{(3'\text{-}8'')(12''/1')(1/4'')^3}{12} = 0.0573\ in^4$$



$$\sigma = \frac{(855.7\ lb\text{-}ft)(12''/1') \times (1/4''/2)}{0.0573\ in^4}$$

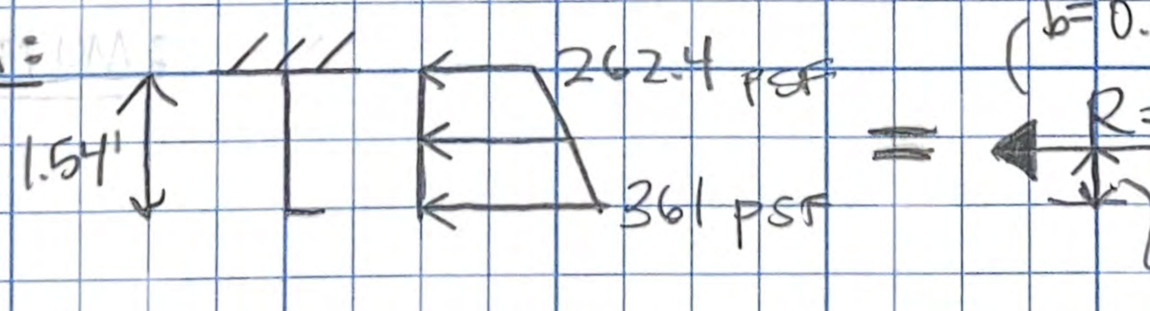
$$= 22{,}404\ psi$$

$\sigma_{LIMIT} = \alpha \phi F_y$ PER ETL SECT. F.4.3.1

$$= 0.85(0.9)(50\ ksi) = 38.25\ ksi > 22.4\ ksi$$

✓ OK

BOTTOM:



$$R = \tfrac{1}{2}(262.4+361)(1.54') = 480\ lb/ft$$

↳ CANTILEVER FIXED W/ POINT LOAD:

$$M_{MAX} = Pb = (480\ lb/ft)(0.81') = 389.1\ \frac{lb\text{-}ft}{ft} \times 3'\text{-}8'' = \underline{\underline{1{,}426.7\ lb\text{-}ft}}$$

4x4 = 1 in

AECOM Imagine it. Delivered.

JOB TITLE

PROJECT/JOB NO. CALCULATION NO.

COMPUTED BY SJW DATE DEC-2020

VERIFIED BY JMH DATE DEC-2020

SCALE SHEET NO. 8 OF

$$\sigma = \frac{(1{,}426.7\ \text{lb-ft})(12''/')\times(1/4''/2)}{0.0573\ \text{in.}^4} = 37{,}354\ \text{psi}$$

$37.3\ \text{ksi} < 38.25\ \text{ksi}$ ✓ OK

4x4 = 1 in

Reference: AISC Steel Const Manual 15th Ed.

INTERCOSTAL DESIGN

The intercostals are designed as simple beams spanning between girders for hydrostatic loading only.

Material: A992 Steel F_y = 50 ksi φ = 0.9 for bending
α = 0.85 from USACE ETL 1110-2-584

Skin Plate and Stiffener treated as a T-section.

t_f =	0.25	in	Skin plate thickness
b =2*(t*95/(Fy)^0.5) =	6.72	in	Effective width of skin plate, *(ETL 1110-2-584 pg. C-6)*
TRY t_w =	0.250	in	
$d_{max} = t_w\,(127/\sqrt{F_y})$ =	4.49	in	d/t = 127/(Fy)^0.5 (Non-Compact Section, AISC)
TRY d' =	4.00	in	Depth of stem

Check if Trial Section is Noncompact d/t= 17.00 **NONCOMPACT**

TRY SECTION

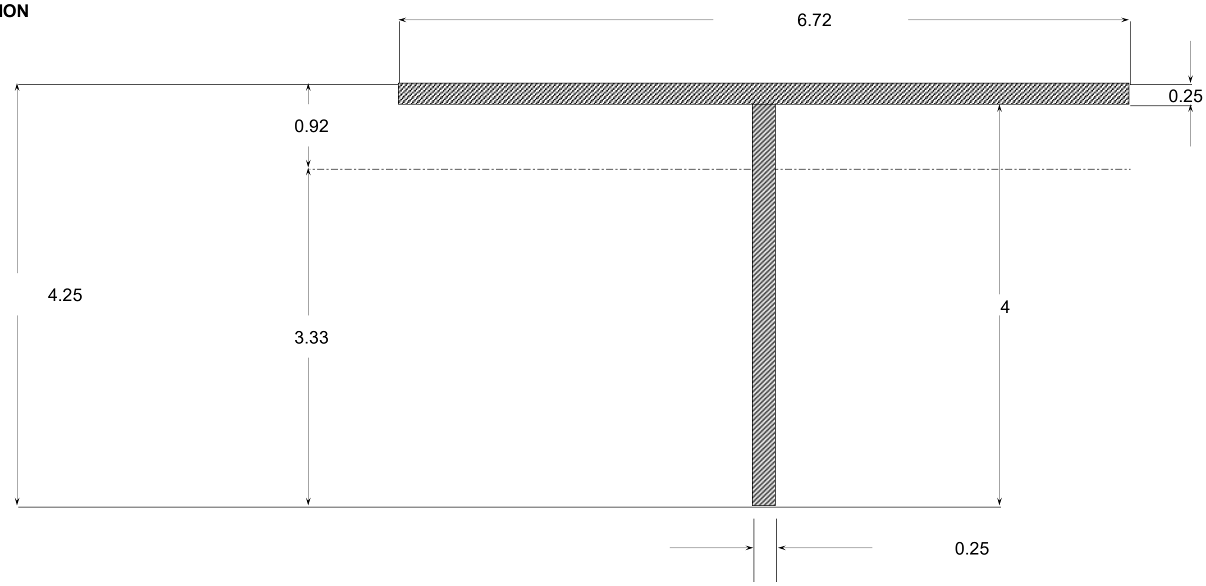


Plate	A	y	Ay	Ix	Ad^2	Iy	J ($1/3*b*t^3$)
Flange	1.68	0.13	0.21	0.01	1.06	6.32	0.03
Web	1.00	2.25	2.25	1.33	1.77	0.14	0.02

∑A 2.68 ∑Ay 2.5 in^2 ∑J = 0.06 in^4

y = 0.92 in

Ix = 4.2 in^4 Iy = 6.5 in^4

S_T = (section modulus) 4.54 in^3

S_C = (Section Modulus) 1.25 in^3

Limit States

$M_{max} \le \alpha\phi M_n$ *ETL 1110-2-584, Sect. F.4.3.2*

**Note: Intercostals designed using LC1 only

1) Yielding

Mn = Mp = FySx = 62.61 k-in *(F9-3)*

2) Lateral Torsional Buckling (stem is in compression)

B = - 2.3 $(d/L_b)*(Iy/J)^{0.5}$ -2.39 *(F9-12)*

$M_n = M_{cr} = \frac{1.95E}{L_b}\sqrt{I_yJ}(B+\sqrt{1+B^2})$ 154.95 ksi *(F9-10)*

Yielding Controls	***Mn =***	***62.6***	**k-in**
	αϕMn =	***47.9***	**k-in**

See AISC Eqn. F1-2

Lb = (unbraced length of intercostals) = 3.67 ft see sketch

$\frac{76\,b_f}{\sqrt{F_y}} =$ 72 in $\frac{20000}{(d/A_f)F_y} =$ 158 in

Lc = 6.02 ft

Since Lb < Lc no lateral stiffening required.

For LC1, Water to T.O.W.:

Max moment occurs at zero shear point (Y)

$P_1 = \frac{1}{2}\gamma Y^2 = R_T$

Y = 2.04 ft

M_{max} = (Rt(Y-0.46)-P1*Y/3) = 0.1 ft-k /ft

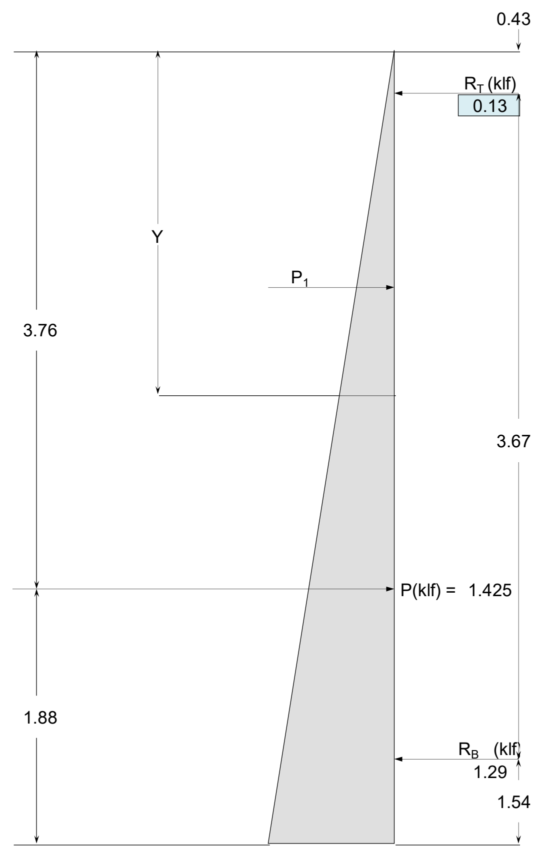
Intercostal Spacing = 3.67 ft o/c

M_{max} = (Int. Spacing*Mmax) = 5.4 k-in

CHECK TRIAL SECTION

M_{max} = 5.4 k-in
αϕMn = 47.9 k-in → **OK**

→ Use 1/4" thick x 4" long intercostals



Maurepaus Swamp

CN Railroad Crossing

Steel Roller Gate Design

AECOM Project : 60632162

AECOM

1555 Poydras Street

Suite 1200

New Orleans, LA 70112

(504) 586-8111

Computed by:	SJW	Checked by:	JMH
Date:	20-Dec	Date:	20-Dec

General Info/Assumptions:

1) Steel roller gate is being designed using USACE ETL 1110-2-584, "Design of Hydraulic Steel Structures" (30 June 2014), including Appendix F, "Closure Gates".

2) Top of Gate is EL +16.13. Top of slab is at EL +11.98.

4) As per EM 1110-2-584, skin plate is designed as a fixed end beam spanning between intercostals. In order to ensure that the flat plate theory is applicable, deflection will be limited to 0.4 times thickness.

5) Also per same EM, intercostals are designed as simple beams spanning between girders.

6) Also per same EM, girders are designed as simple beams, spanning between hinges on one side of the opening and bearings on the other.

7) A992, Grade 50 steel used for all steel members

8) For the 15% Design, two (2) load cases are examined. The specific cases have been chosen because engineering judgement dictates they will likely be the worst case conditions for the gate

Case 1) Water to TOW EL 16.13:
Flood water to Top of Wall EL 16.13

Case 2) Construction with Wind:
50 psf wind load on Protected Side of gate

- Impact, IM3, Extreme Load. May be neglected unless the Engineer has reason to believe this load may exist.

- Earthquake, not considered for the design of closure gates, but should be considered for gate support columns and walls.

- Environmental, W, Wind, See ASCE for recurrence interval, in lieu of site-specific data, use 15 psf during operation and up to 50 psf when not in operation (fully closed or fully open).

F.4.2. Design Load Cases. The following load cases shall be evaluated using the load factors listed in Table F-1.

- Case 1: Strength I, Gate not operating:

$$\Sigma\gamma i Q_{m} = \gamma_{D2} D + \gamma_{Hs2} H_{s2} \quad \text{(F-1)}$$

- Case 2: Strength I, Gate not operating, Gate subjected to the upper level Wind pressure of up to 50 psf:

$$\Sigma\gamma_i Q_{m} = \gamma_{D2} D + \gamma_{EV2} W_2 \quad \text{(F-2)}$$

- Case 3: Strength II, Gate operating, Hinged gate subjected to Dead and Wind (lower level of 15 psf), operating load is treated as a reaction:

$$\Sigma\gamma_i Q_{m} = \gamma_{D2} D + \gamma_{EV2} W_1 \quad \text{(F-3)}$$

- Case 4: Strength II, Gate operating, Wheeled gate subjected to Dead and Operating load:

$$\Sigma\gamma_i Q_{m} = \gamma_{D2} D + \gamma_{EV2} Q_2 \quad \text{(F-4)}$$

Table F-1. Load Factors for Closure Gates.

	Load Cases		Loads/Load Factors							
	Limit State	Description	γD	γG	γHs	γHd	γQ	γEV	γIM	γEQ
TOW CASE	Strength I	Gate Closed	0	0	1.4	0	0	0	0	0
CONST. + WIND	Strength I	Gate Closed	1.2	0	0	0	0	1.3	0	0
	Strength II	Gate Open	1.2	0	0	0	0	1.3	0	0
	Strength II	Gate Open	0	0	0	0	1.3	0	0	0

F.4.3. Design for Individual Members. The following paragraphs include a brief description of design assumptions and design considerations.

F.4.3.1. Skin plate. Skin plates shall be sized such that the maximum calculated stress is less than the yield limit state of $\alpha\phi F_y$. Skin plates shall be designed for hydrostatic loading only. Stresses shall be determined based on small deflection thin plate theory and by using Equation F-1. Deflection shall be limited to 0.4 of the plate thickness to prevent the development of significant membrane stresses. More than one thickness of plate may be desirable for taller gates. The minimum plate thickness shall be ¼ in. Appendix C provides additional guidance on skin plate design.

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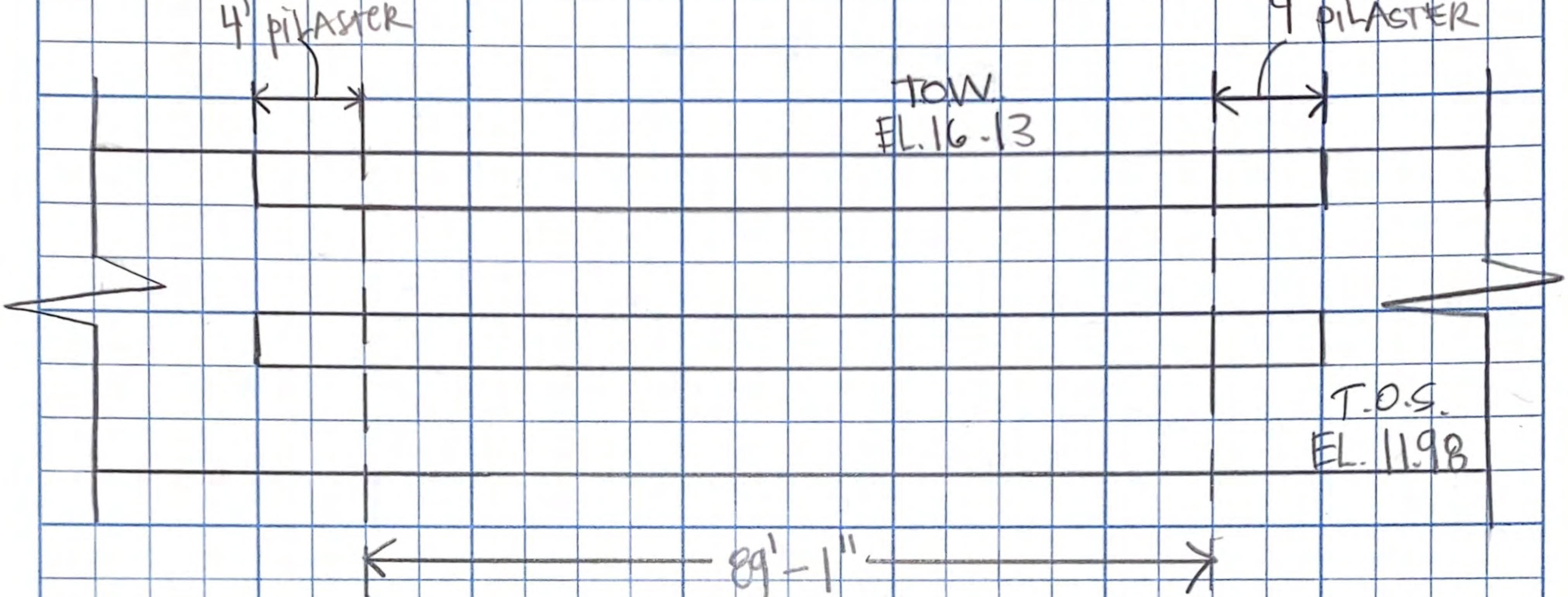
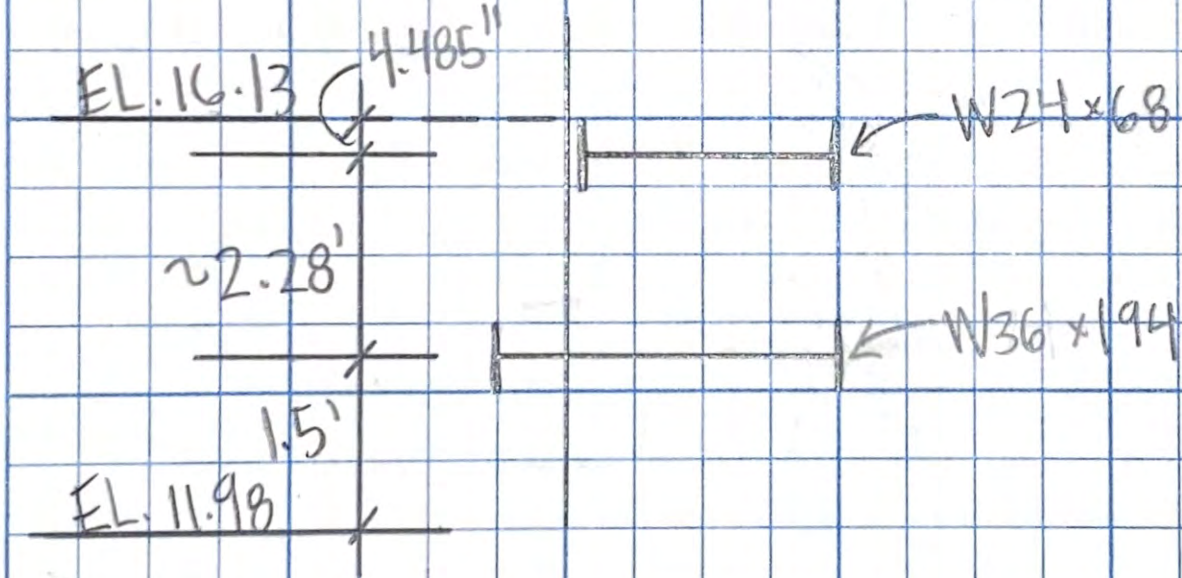
JOB TITLE CN ROLLER GATE - STEEL DESIGN
PROJECT/JOB NO. ______ CALCULATION NO. ______
COMPUTED BY SJW DATE 12/21/20
VERIFIED BY JMH DATE DEC-2020
SCALE ______ SHEET NO. 1 OF ______

A) TOP & BOTTOM GIRDER DESIGNS:

TRY W24×68 TOP
W36×194 BOTTOM





LOAD CASES FOR 15% SUBMITTAL:

LC1: WATER TO T.O. WALL EL. 16.13

LC2: CONSTRUCTION + WIND

4x4 = 1 in

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JOB TITLE ______

PROJECT/JOB NO. ______ CALCULATION NO. ______

COMPUTED BY SJW DATE DEC-2020

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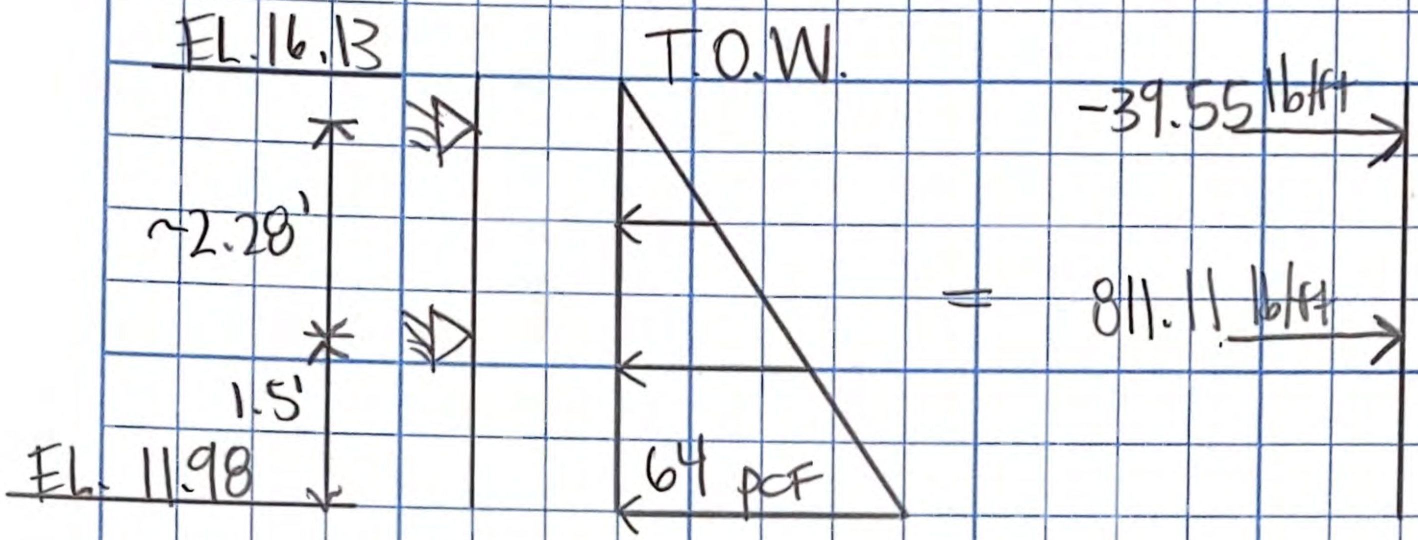
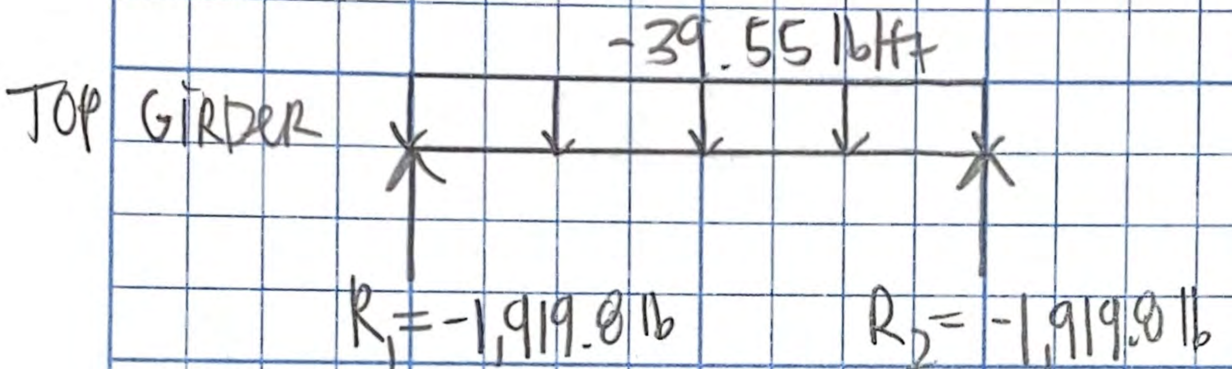
SCALE ______ SHEET NO. 2 OF ______

LC1, WATER TO T.O.W.: (0D + 1.4H_s)

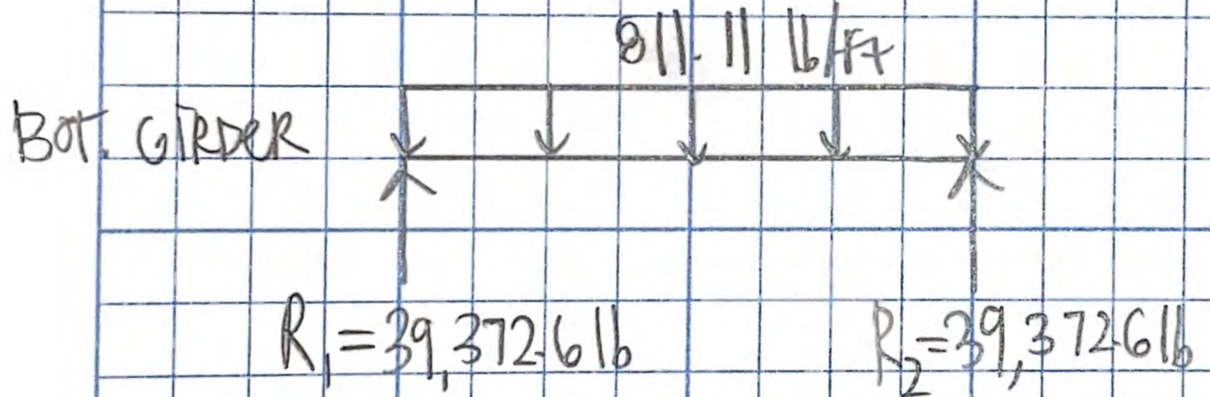




$R_1 = R_2 = \frac{wL}{2} = \frac{(-39.55)(97.08')}{2}$

$M_{max,top} = \frac{wL^2}{8} = \frac{(39.55)(97.08')^2}{8}$

$= 46,595.7$ lb-ft

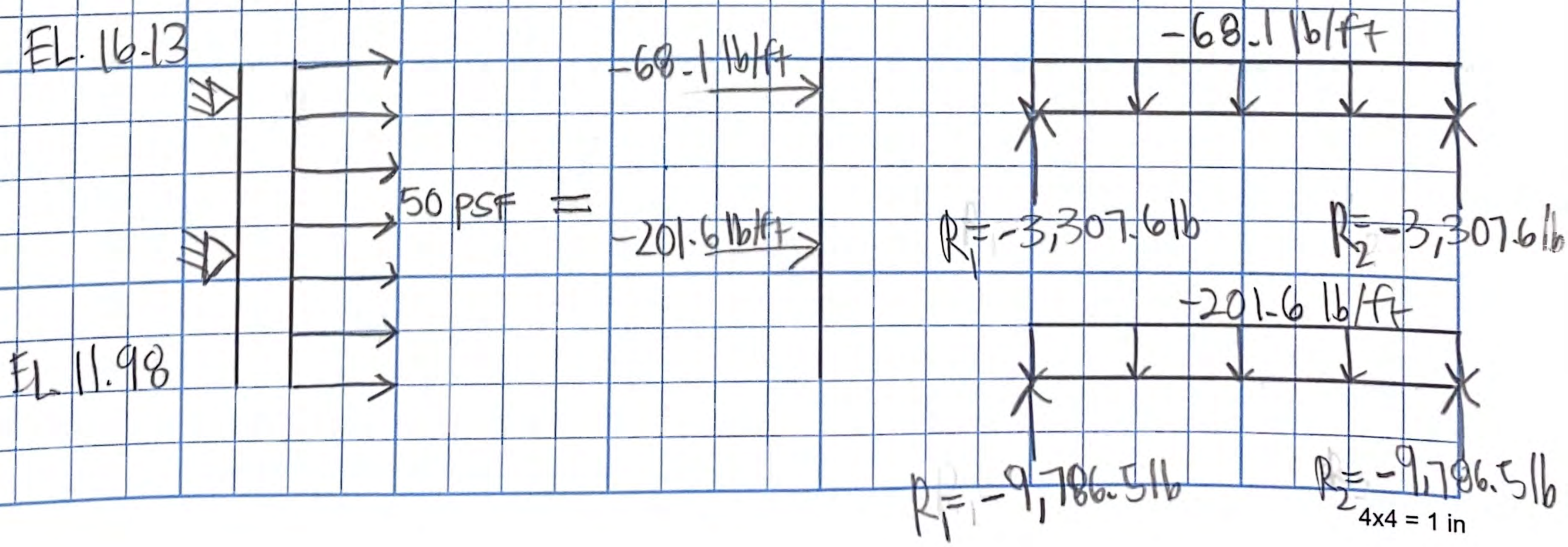


$R_1 = R_2 = \frac{wL}{2} = \frac{(811.11)(97.08')}{2}$

$M_{MAX,BOT} = \frac{wL^2}{8} = \frac{(811.11)(97.08')^2}{8}$

$= 955,606.6$ lb-ft

LC2, CONST. + WIND: -50 PSF WIND (EXTREME) ON PROTECTED SIDE PER ETL
(1.2D + 1.3W)



4x4 = 1 in

AECOM Imagine it. Delivered.

JOB TITLE

PROJECT/JOB NO. CALCULATION NO.

COMPUTED BY SJW DATE DEC-2020

VERIFIED BY JMH DATE DEC-2020

SCALE SHEET NO. 3 OF

$$M_{MAX,TOP} = \frac{(68.1)(97.08')^2}{8} = \underline{80{,}231.8 \text{ lb-ft}}$$

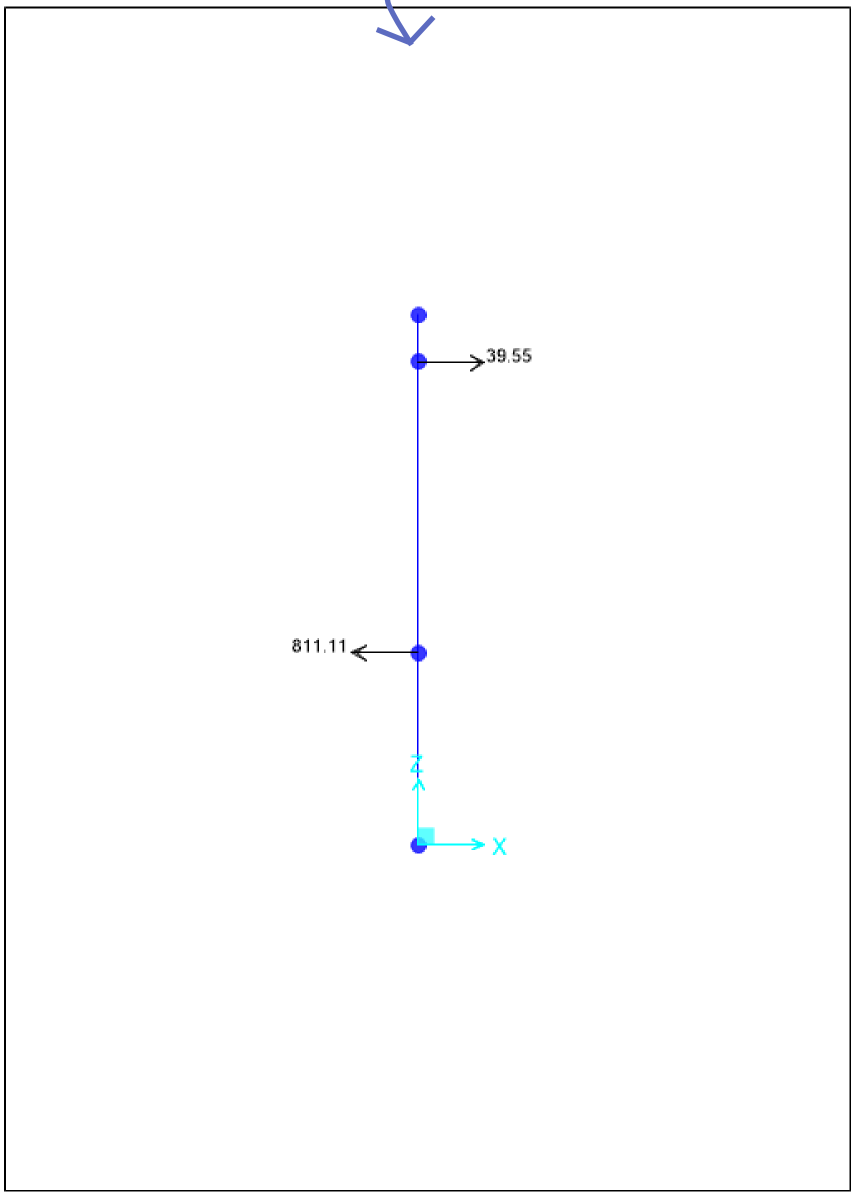
$$M_{MAX,BOT.} = \frac{(201.6)(97.08')^2}{8} = \underline{237{,}526.2 \text{ lb-ft}}$$

4x4 = 1 in

Factored loads
LC1 = 0D +1.4Hs

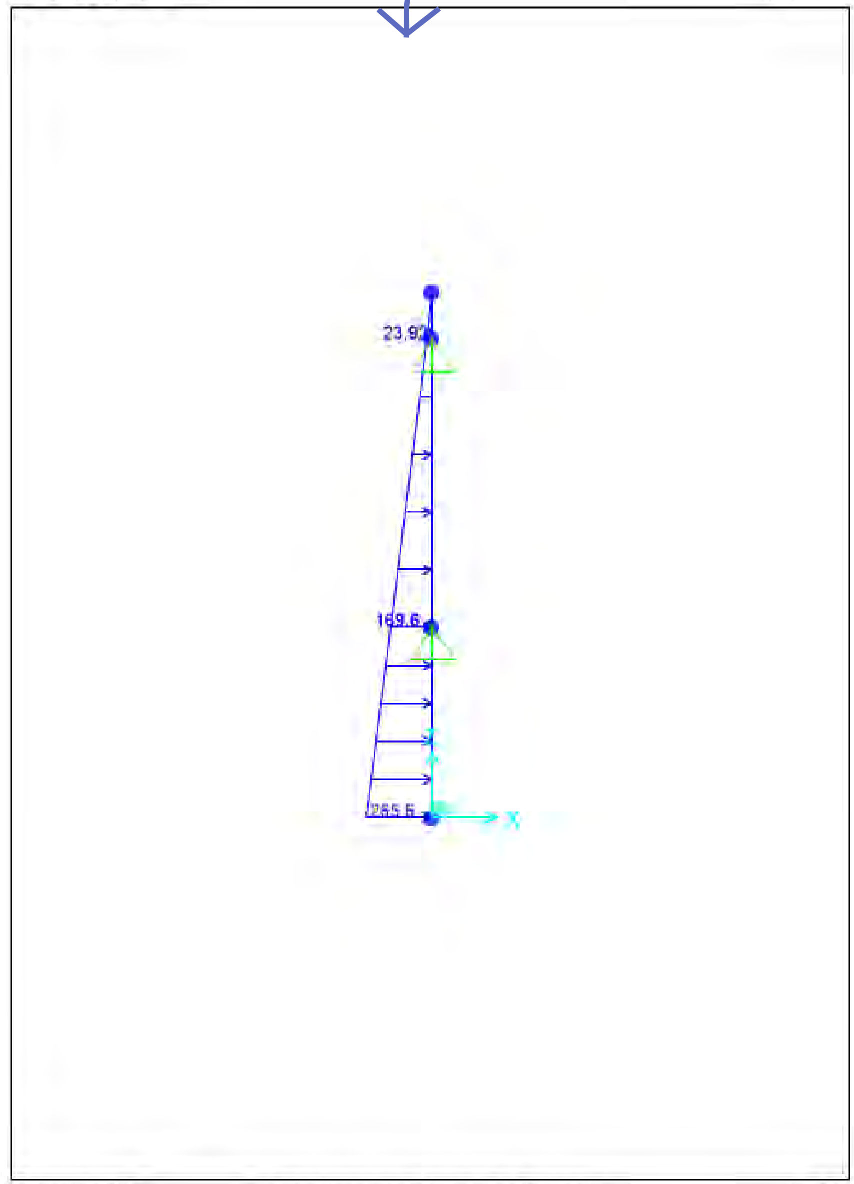
Unfactored load

Steel Design (CN).sdb 12/22/2020



SAP2000 20.1.0 Joint Reactions (COMB1) lb, ft, F

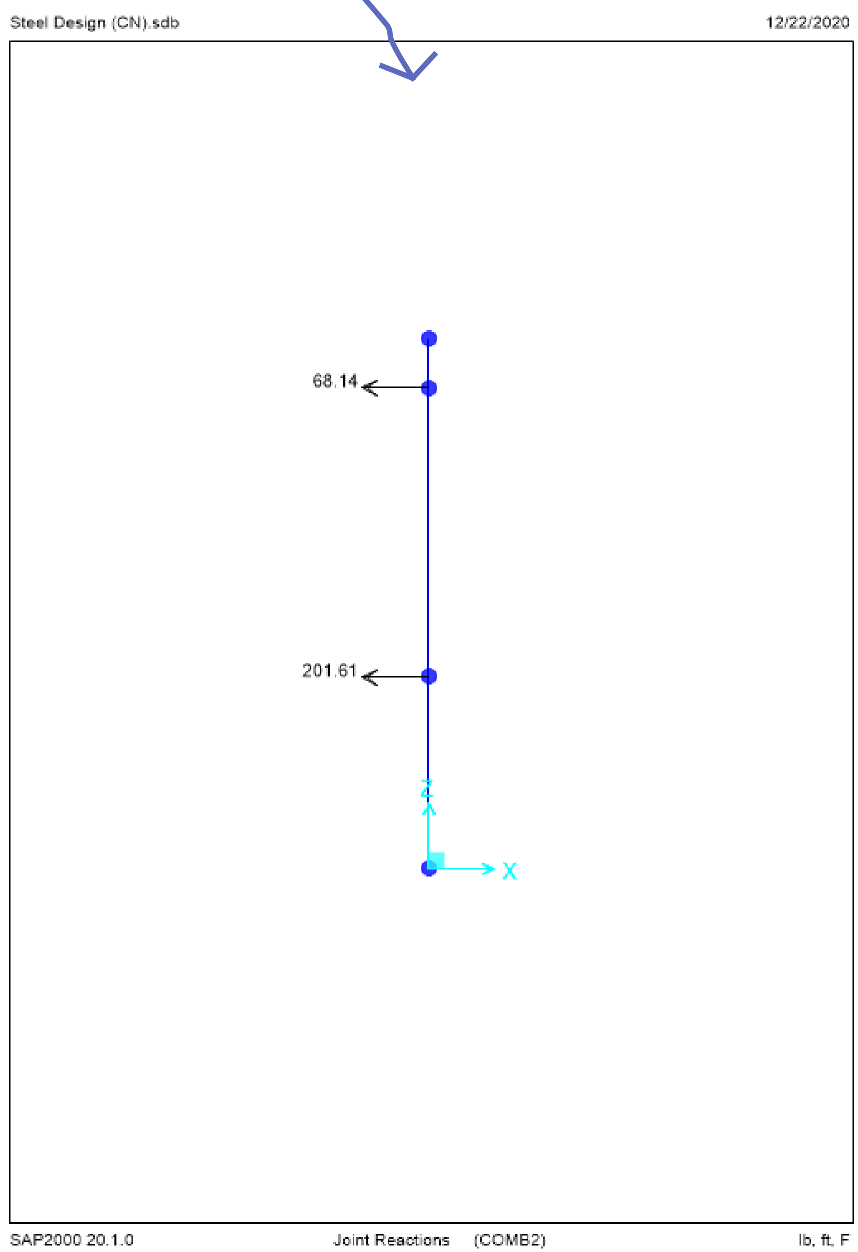
Steel Design (CN).sdb 12/22/2020

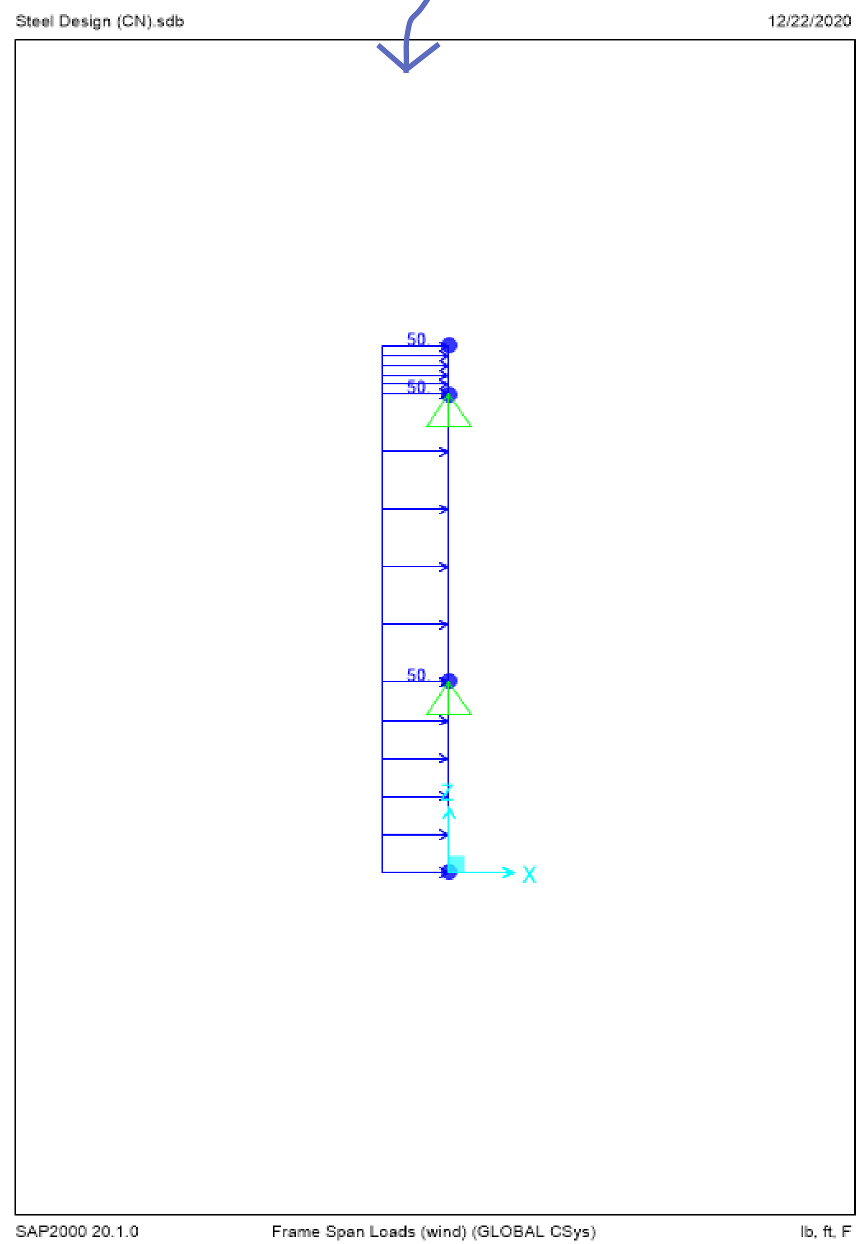


SAP2000 20.1.0 Frame Span Loads (TOW) (GLOBAL CSys) lb, ft, F

Factored loads
LC2 = 1.2D + 1.3W

Unfactored load





PROJECT		**Project #**	60632162	**Sheet**	of
Maurepas Swamp		**Computed By**	SJW	**Date**	December-20
CN Roller Gate Design		**Checked By**	JMH	**Date**	December-20

Top&Bottom Girder Design

Load Case: *Water to T.O. Wall*

Reference:
AISC Steel Const Manual 15th Ed.

MATERIAL PROPERTIES

Material: *A992*

F_y = 50 ksi

E = 29000 ksi

ϕ = 0.9 for bending

α = 0.85 from USACE ETL 1110-2-584

Top Girder Design

Top Girder	Designation	Area	Depth	Web Thickness	Flange Width	Flange Thickness	Nominal Wt. Per ft.	Elastic Properties Axis X-X				Axis Y-Y					
		A	d	t_w	b_f	t_f		I	S	r	Z	I	S	r	h_0	J	C_w
		in^2	in	in	in	in	lb	in^4	in^3	in	in^3	in^4	in^3	in	in	in^4	in^6
	W24x68	20.1	23.73	0.415	8.965	0.585	68	1830	154	9.55	177	70.4	15.7	1.87	23	1.87	9430

$b_f/2t_f$ = 7.7 < 9.2 $= 0.38\sqrt{(E / F_y)}$ *(AISC Table B4.1a)*

h/t_w = 57.2 < 90.6 $= 3.76\sqrt{(E / F_y)}$

Compact Section

Following AISC Section F2 - Doubly Symmetric Compact I-shaped Members…

1) Yield: $M_n = M_p = F_yZ_x$ = 8,850.0 k-in = **737.5 k-ft** *(F2-1)*

2) Lateral-Torsional Buckling:

L_b = 12.500 ft = 150 in

$L_p = 1.76r_y\sqrt{(E / F_y)}$ = 79.263 in *(F2-5)*

$L_r = 1.95r_{ts} * E/(0.7F_y) * \sqrt{\{(J^*c / S_xh_0) + \sqrt{[(J^*c / S_xh_0)^2 + 6.76(0.7^*Fy / E)^2]}\}}$

r_{ts}^2 = $\sqrt{(I_y * C_w)} / S_x$ = 5.29

r_{ts} = 2.30

L_r = 226.28 in

(b) Lp < Lb < Lr

$M_n = C_b * \{M_p - (M_p - 0.7*F_y*S_x) * [(L_b - L_p) / (L_r - L_p)] \leq M_p$ *(F2-2)*

Conservatively setting $C_b = 1$

$M_n =$ 7,185.3 k-in = **598.8 k-ft**

3) Moment Factoring & Check:

$M_{max} =$	46.60	k-ft		
$\phi\alpha M_n =$	458.06	k-ft	⟶	***OK***

4) Deflection Check: Simple Beam $\Delta_{max} = (5*w*l^4) / (384*E*I_x)$

Max allowable deflection $\Delta_{allow} = L/240 =$ 4.85 in

Distributed load =	39.55	lb/ft =	3.30	lb/in
Span length =	97.08	ft =	1165	in

$\Delta_{max} =$	1.490 in	⟶	***OK***

Bottom Girder Design

Bottom Girder	Designation	Area	Depth	Web Thickness	Flange Width	Flange Thickness	Nominal Wt. Per ft.	Elastic Properties Axis X-X				Axis Y-Y					
		A	d	tw	bf	tf		I	S	r	Z	I	S	r	h_0	J	C_w
		in2	in	in	in	in	lb	in4	in3	in	in^3	in4	in3	in	in	in^4	in^6
	W36x194	57	36.49	0.765	12.115	1.26	194	12100	664	14.6	767	375	61.9	2.56	35	22.2	116000

$b_f/2t_f =$ 4.8 < 9.2 $= 0.38\sqrt{(E / F_y)}$ *(AISC Table B4.1a)*

$h/t_w =$ 47.7 < 90.6 $= 3.76\sqrt{(E / F_y)}$

<u>Compact Section</u>

Following AISC Section F2 - Doubly Symmetric Compact I-shaped Members…

1) Yield: $M_n = M_p = F_y Z_x =$ 38,350.0 k-in = **3,195.8 k-ft** *(F2-1)*

2) Lateral-Torsional Buckling:

$L_b =$ 12.500 ft = 150 in

$L_p = 1.76 r_y \sqrt{(E / F_y)} =$ 108.51 in *(F2-5)*

$L_r = 1.95 r_{ts} * E/(0.7F_y) * \sqrt{\{(J*c / S_x h_0) + \sqrt{[(J*c / S_x h_0)^2 + 6.76(0.7*Fy / E)^2]}\}}$

$r_{ts}^2 =$ $\sqrt{(I_y * C_w)} / S_x =$ 9.93

$r_{ts} =$ 3.15

$L_r =$ 331.12 in

(b) Lp < Lb < Lr

$M_n = C_b * \{M_p - (M_p - 0.7*F_y*S_x) * [(L_b - L_p) / (L_r - L_p)] \leq M_p$ *(F2-2)*

Conservatively setting $C_b = 1$

$M_n =$ 35,533.8 k-in = **2,961.1 k-ft**

3) Moment Factoring & Check:

$M_{max} =$ 955.61 k-ft

$\phi\alpha M_n =$ 2,265.28 k-ft ⟶ ***OK***

4) Deflection Check: Simple Beam $\Delta_{max} = (5*w*l^4) / (384*E*I_x)$

Max allowable deflection $\Delta_{allow} = L/240 =$ 4.8541667 in

Distributed load = 811.11 lb/ft = 67.59 lb/in

Span length = 97.08 ft = 1165 in

$\Delta_{max} =$ 4.620 in ⟶ ***OK***

PROJECT
Maurepas Swamp
River Road Roller Gate Design

Project # 60632162 **Sheet** ____ of ____
Computed By SJW **Date** December-20
Checked By JMH **Date** December-20

Top&Bottom Girder Design
Load Case: *Construction + wind load*

Reference:
AISC Steel Const Manual 15th Ed.

MATERIAL PROPERTIES

Material: A992 F_y = 50 ksi
E = 29000 ksi

ϕ = 0.9 for bending
α = 0.85 from USACE ETL 1110-2-584

Top Girder Design

Top Girder	Designation	Area	Depth	Web Thickness	Flange Width	Flange Thickness	Nominal Wt. Per ft.	Elastic Properties Axis X-X				Axis Y-Y					
		A	d	t_w	b_f	t_f		I	S	r	Z	I	S	r	h_0	J	C_w
		in^2	in	in	in	in	lb	in^4	in^3	in	in^3	in^4	in^3	in	in	in^4	in^6
	W24x68	20.1	23.73	0.415	8.965	0.585	68	1830	154	9.55	177	70.4	15.7	1.87	23	1.87	9430

$b_f/2t_f$ = 7.7 < 9.2 $= 0.38\sqrt{(E / F_y)}$ *(AISC Table B4.1a)*

h/t_w = 57.2 < 90.6 $= 3.76\sqrt{(E / F_y)}$

Compact Section

Following AISC Section F2 - Doubly Symmetric Compact I-shaped Members…

1) Yield: $M_n = M_p = F_yZ_x$ = 8,850.0 k-in = **737.5 k-ft** *(F2-1)*

2) Lateral-Torsional Buckling:

L_b = 12.500 ft = 150 in

$L_p = 1.76r_y\sqrt{(E / F_y)}$ = 79.263 in *(F2-5)*

$L_r = 1.95r_{ts} * E/(0.7F_y) * \sqrt{\{(J*c / S_xh_0) + \sqrt{[(J*c / S_xh_0)^2 + 6.76(0.7*Fy / E)^2]}}$

r_{ts}^2 = $\sqrt{(I_y * C_w)} / S_x$ = 5.29
r_{ts} = 2.30

L_r = 226.28 in

(b) Lp < Lb < Lr

$$M_n = C_b * \{M_p - (M_p - 0.7*F_y*S_x) * [(L_b - L_p) / (L_r - L_p)] \le M_p \qquad \textit{(F2-2)}$$

Conservatively setting $C_b = 1$

$M_n =$ 7,185.3 k-in = **598.8 k-ft**

3) Moment Factoring & Check:

$M_{max} =$ 80.28 k-ft

$\phi\alpha M_n =$ 458.06 k-ft ⟶ ***OK***

4) Deflection Check: Simple Beam $\Delta_{max} = (5*w*l^4) / (384*E*I_x)$

Max allowable deflection $\Delta_{allow} = L/240 =$ 4.85 in

Distributed load = 68.14 lb/ft = 5.68 lb/in
Span length = 97.08 ft = 1165 in

$\Delta_{max} =$ 2.566 in ⟶ ***OK***

Bottom Girder Design

Bottom Girder	Designation	Area	Depth	Web Thickness	Flange Width	Flange Thickness	Nominal Wt. Per ft.	Elastic Properties Axis X-X I	S	r	Z	Axis Y-Y I	S	r	h_0	J	C_w
		A	d	tw	bf	tf		I	S	r	Z	I	S	r	h_0	J	C_w
		in2	in	in	in	in	lb	in4	in3	in	in^3	in4	in3	in	in	in^4	in^6
	W36x194	57	36.49	0.765	12.115	1.26	194	12100	664	14.6	767	375	61.9	2.56	35	22.2	116000

$b_f/2t_f =$ 4.8 < 9.2 $= 0.38\sqrt{(E / F_y)}$

(AISC Table B4.1a)

$h/t_w =$ 47.7 < 90.6 $= 3.76\sqrt{(E / F_y)}$

<u>Compact Section</u>

Following AISC Section F2 - Doubly Symmetric Compact I-shaped Members…

1) Yield:

$M_n = M_p = F_y Z_x =$ 38,350.0 k-in = **3,195.8 k-ft** *(F2-1)*

2) Lateral-Torsional Buckling:

$L_b =$ 12.500 ft = 150 in

$L_p = 1.76 r_y \sqrt{(E / F_y)} =$ 108.51 in *(F2-5)*

$L_r = 1.95 r_{ts} * E/(0.7F_y) * \sqrt{\{(J*c / S_x h_0) + \sqrt{[(J*c / S_x h_0)^2 + 6.76(0.7*Fy / E)^2]}\}}$

$r_{ts}^2 = \sqrt{(I_y * C_w)} / S_x =$ 9.93

$r_{ts} =$ 3.15

$L_r =$ 331.12 in

(b) Lp < Lb < Lr

$M_n = C_b * \{M_p - (M_p - 0.7*F_y*S_x) * [(L_b - L_p) / (L_r - L_p)] \leq M_p$ *(F2-2)*

Conservatively setting $C_b = 1$

$M_n =$ 35,533.8 k-in = **2,961.1 k-ft**

3) Moment Factoring & Check:

$M_{max} =$	237.53 k-ft	
$\phi\alpha M_n =$	2,265.28 k-ft	→ ***OK***

4) Deflection Check:

Simple Beam $\Delta_{max} = (5*w*l^4) / (384*E*I_x)$

Max allowable deflection $\Delta_{allow} = L/240 =$ 4.85 in

Distributed load = 201.61 lb/ft = 16.80 lb/in

Span length = 97.08 ft = 1165 in

$\Delta_{max} =$	1.148 in	→ ***OK***

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JOB TITLE

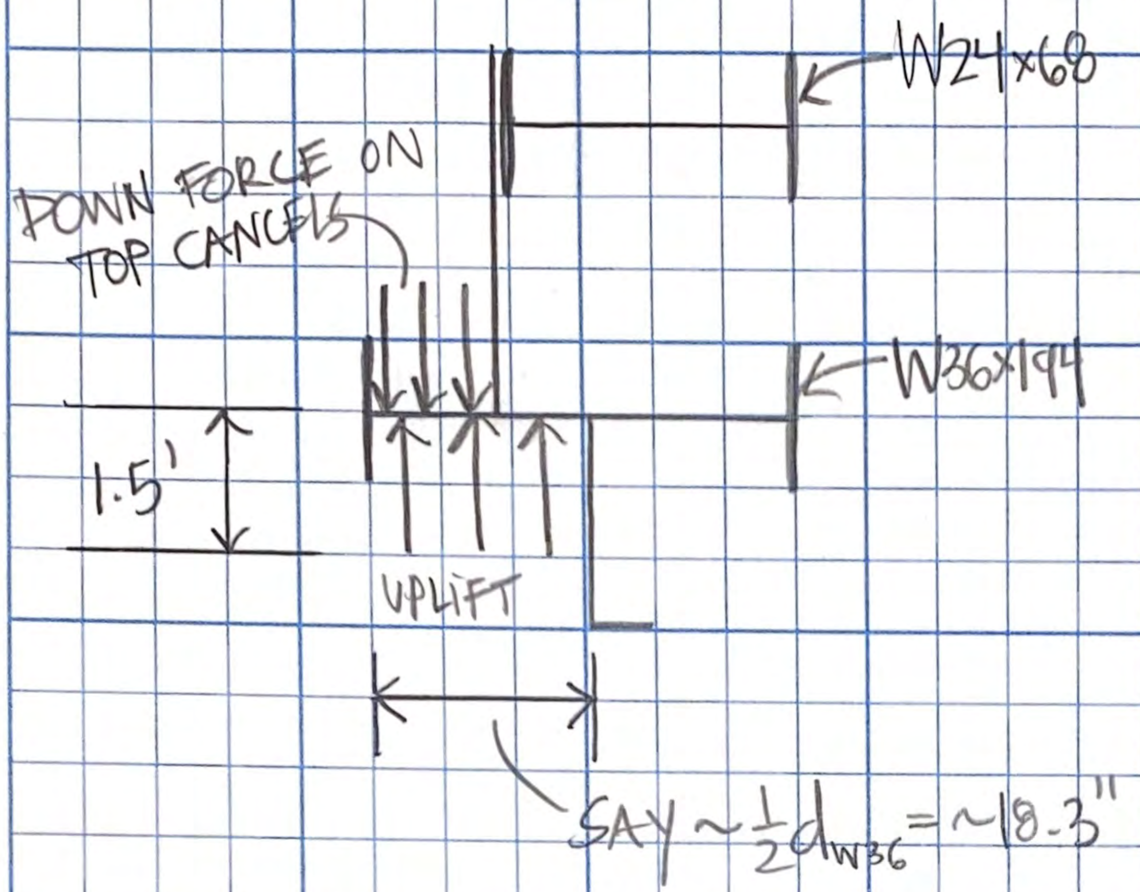
PROJECT/JOB NO. CALCULATION NO.

COMPUTED BY SJW DATE DEC-2020

VERIFIED BY JMH DATE DEC-2020

SCALE SHEET NO. 4 OF

B) CHECK RESISTANCE TO FLOATATION:



↳ NET UPLIFT FOR WATER TO T.O. WALL

$$= 64\,\text{pcf}\,(16.13' - 11.98' - 1.5')\left(\frac{18.3''}{12} - \frac{9.15''}{12}\right)(97.08')$$

$$= 12{,}554.8\ \text{lb}$$

↳ APPROX. WT. OF GATE

$$= (68\ \text{lb/ft} + 194\ \text{lb/ft}) \times 97.08'\ \text{GATE} \qquad \text{(GIRDERS)}$$

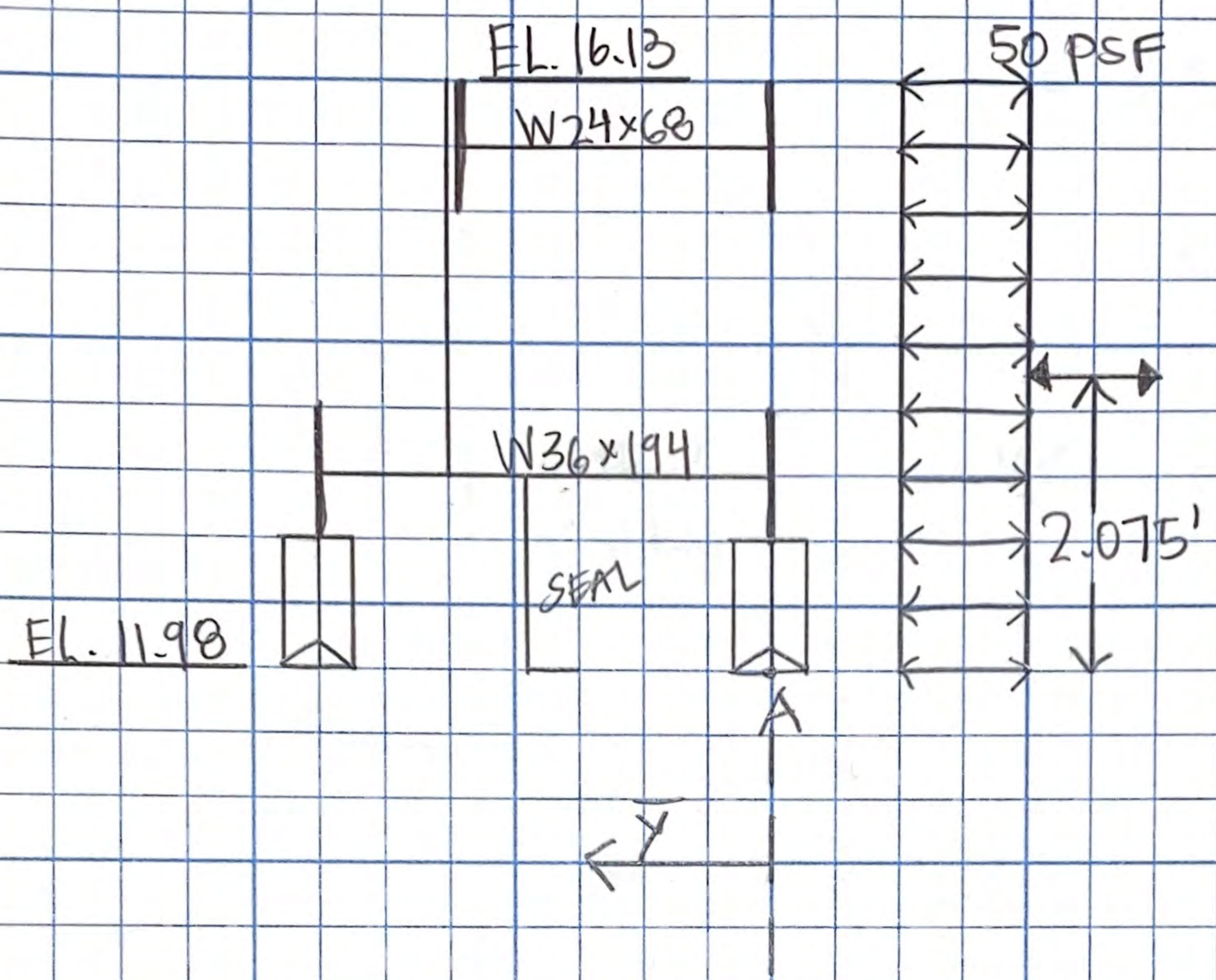
$$+ \left[\frac{1/4''}{12} \times 4.15'\,h \times 97.08'\,L\right] \times 490\ \frac{\text{lb}}{\text{ft}^3} \qquad \text{(SKN PL)}$$

$= 29{,}548.7$ lb $\times 1.05$ FOR MISC. STIFFENERS, WELDS, ETC.

$= 31{,}026.2$ lb $> 12{,}554.8$ lb OK ✓

4x4 = 1 in

C) CHECK WIND LOAD STABILITY:



GATE WT. WITHOUT 5% INCREASE = 29,548.7 lb

CENTROID ($\bar{Y}$):

$$\frac{\left[68^{lb} \times \frac{23.7''}{2} + 194^{lb} \times \frac{36.5''}{2}\right]}{(68+194)} \rightarrow \bar{Y} = 16.59''$$

→ ASSUME GATE CLOSED BUT UNLATCHED, SUBJECT TO 15 PSF WIND LOAD (STD. OPERATION LOAD PER ETL SEC. F-4; HURRICANE WIND WOULD NOT BE ALLOWED TO COINCIDE W/ UNLATCHED GATE)

→ FORCE OVER 89'-1" OPENING = 15 psf x (89'-1") x (16.13'-11.98')

= 5,545.4 lb

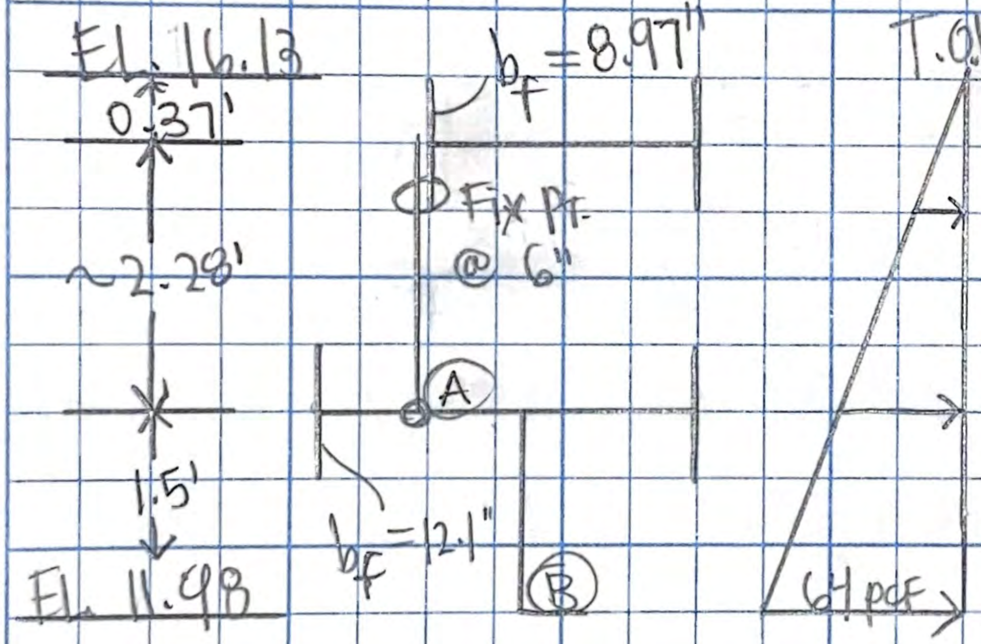
→ OVERTURNING ABT POINT A:

$$\frac{29{,}548.7^{lb} \times 16.59''}{5{,}545.4^{lb} \times (2.075' \times 12''/')} = 3.55 > 1.0 \checkmark \text{ OK}$$

→ ∴ GATE STABLE UNDER OPERATIONAL WIND LOADS (AND HIGHER) WHEN UNLATCHED

* GATE SHOULD ALWAYS BE LATCHED WHEN CLOSED.

D) SKIN PL:



- ASSUME 1/4" PL (MINIMUM ALLOWED PER EM)

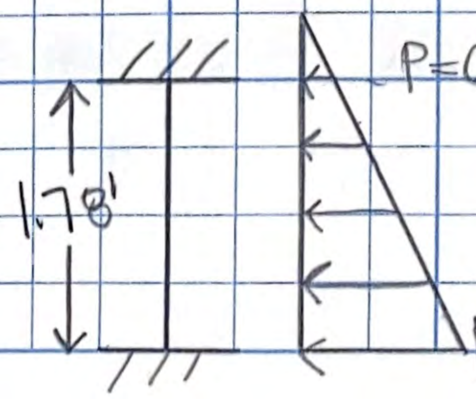
$P_A = 64\text{ pcf} \times 2.65' = 169.6\text{ psf}$

$P_B = 64\text{ pcf} \times 4.15' = 265.6\text{ psf}$

- ASSUME PL FIXED @ ℄ INTERCOSTALS & @ 6" FROM ℄ WEB

- STIFF. PL ~4'-2" SPACING, TRIB. WIDTH = 4'-2" = 50"

TOP:



$P = 64 \times (0.37' + 0.5') = 55.9\text{ psf}$

$P = 64(2.28' + 0.37') = 169.6\text{ psf}$

=

$a = 1.04'$

$R = \frac{1}{2}(55.9 + 169.6)(1.78') = 200.3\text{ lb/ft}$

$0.74' = b$

↳ BEAM FIXED BOTH ENDS W/ PT. LOAD:

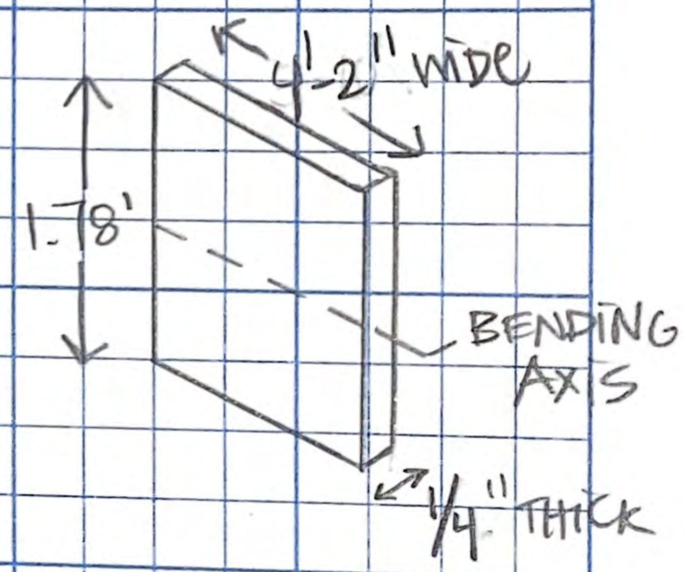
$$M_{MAX} = \frac{Pa^2 b}{\ell^2} = \frac{(200.3\ \text{lb/ft})(1.04')^2(0.74')}{(1.04'+0.74')^2}$$
@ Pt. A

$$= 50.48\ \text{lb-ft/ft} \times 4'\text{-}2''$$

$$= \underline{\underline{210.3\ \text{lb-ft}}}$$

$$\text{STRESS} = \sigma_{BEND} = \frac{M \cdot c}{I}, \text{ where } c = (1/4'')/2 = 0.125''$$

$$I = \frac{bh^3}{12} = \frac{(4'\text{-}2'')(12''/1')(1/4)^3}{12} = 0.0651\ \text{in}^4$$



$$\sigma = \frac{(210.3\ \text{lb-ft})(12''/1') \times (1/4''/2)}{0.0651\ \text{in}^4}$$

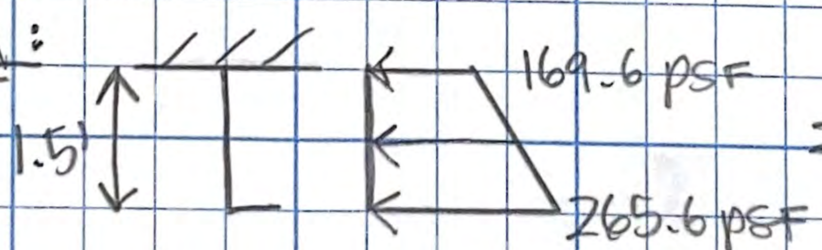
$$= 4{,}846.1\ \text{psi}$$

$\sigma_{LIMIT} = \alpha \phi F_y$ PER ETL SECT. F.4.3.1

$$= 0.85(0.9)(50\ \text{ksi}) = 38.25\ \text{ksi} > 4.86\ \text{ksi}$$

OK

BOTTOM:



$=$ b = 0.81'

$$R = \tfrac{1}{2}(169.6 + 265.6)(1.5') = 326.3\ \text{lb/ft}$$

0.69' = a

↳ CANTILEVER FIXED W/ POINT LOAD:

$$M_{MAX} = Pb = (326.3\ \text{lb/ft})(0.81') = 264.3\ \frac{\text{lb-ft}}{\text{ft}} \times 4'\text{-}2'' = \underline{\underline{1{,}101.3\ \text{lb-ft}}}$$

AECOM Imagine it. Delivered.

JOB TITLE

PROJECT/JOB NO.

CALCULATION NO.

COMPUTED BY SJW DATE DEC-2020

VERIFIED BY JMH DATE DEC-2020

SCALE

SHEET NO. 8 OF

$$\sigma = \frac{(1{,}101.3\ \text{lb-ft})(12''/1) \times (1/4''/2)}{0.0651\ \text{in}^4} = 25{,}377\ \text{psi}$$

$25.4\ \text{ksi} < 38.25\ \text{ksi}$ ✓ OK

4x4 = 1 in

PROJECT		**Project #**	60632162	**Sheet**	of
Maurepas Swamp		**Computed By**	SJW	**Date**	Dec-20
CN Roller Gate Design		**Checked By**	JMH	**Date**	Dec-20

Reference: AISC Steel Const Manual 15th Ed.

INTERCOSTAL DESIGN

The intercostals are designed as simple beams spanning between girders for hydrostatic loading only.

Material: A992 Steel **F_y =** 50 ksi **ϕ =** 0.9 for bending

α = 0.85 from USACE ETL 1110-2-584

Skin Plate and Stiffener treated as a T-section.

t_f = 0.25 in Skin plate thickness

b =2*(t*95/(Fy)^0.5) = 6.72 in Effective width of skin plate, *(ETL 1110-2-584 pg. C-6)*

TRY t_w = 0.250 in

$d_{max} = t_w\ (127/\sqrt{F_y})$ = 4.49 in d/t = 127/(Fy)^0.5 (Non-Compact Section, AISC)

TRY d' = 4.00 in Depth of stem

Check if Trial Section is Noncompact d/t= 17.00 **NONCOMPACT**

TRY SECTION

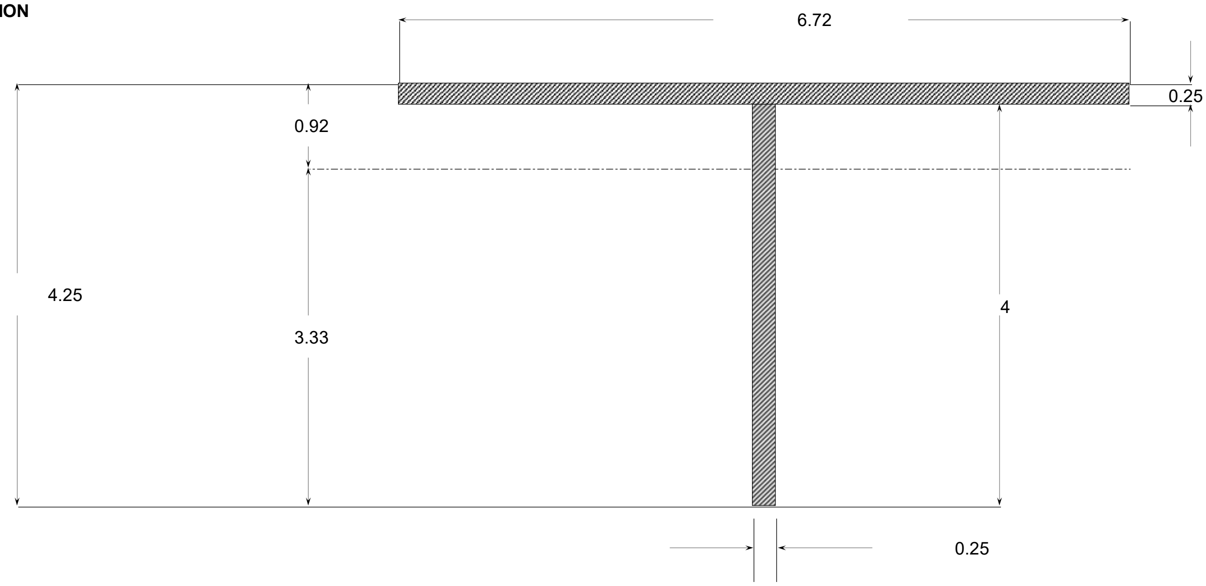


Plate	A	y	Ay	Ix	Ad^2	Iy	J (1/3*b*t^3)
Flange	1.68	0.13	0.21	0.01	1.06	6.32	0.03
Web	1.00	2.25	2.25	1.33	1.77	0.14	0.02

∑A 2.68 ∑Ay 2.5 in^2 ∑J = 0.06 in^4

y = 0.92 in

Ix = 4.2 in^4 Iy = 6.5 in^4

S_T = (section modulus) 4.54 in^3

S_C = (Section Modulus) 1.25 in^3

Limit States

$M_{max} \le \alpha\phi M_n$ *ETL 1110-2-584, Sect. F.4.3.2*

**Note: Intercostals designed using LC1 only

1) Yielding

Mn = Mp = FySx = 62.61 k-in *(F9-3)*

2) Lateral Torsional Buckling (stem is in compression)

$B = -2.3\,(d/L_b)^*(Iy/J)^{0.5}$ -3.85 *(F9-12)*

$M_n = M_{cr} = \frac{1.95E}{L_b}\sqrt{I_y J}(B + \sqrt{1+B^2})$ 158.83 k-in *(F9-10)*

Yielding Controls ***Mn =*** ***62.6*** **k-in**
αϕMn = ***47.9*** **k-in**

See AISC Eqn. F1-2

Lb = (unbraced length of intercostals) = 2.28 ft see sketch below

$\frac{76\,b_f}{\sqrt{F_y}} =$ 72 in $\frac{20000}{(d/A_f)F_y} =$ 158 in

Lc = 6.02 ft

Since Lb < Lc no lateral stiffening required.

For LC1, Water to T.O.W.:

Max moment occurs at zero shear point (Y)

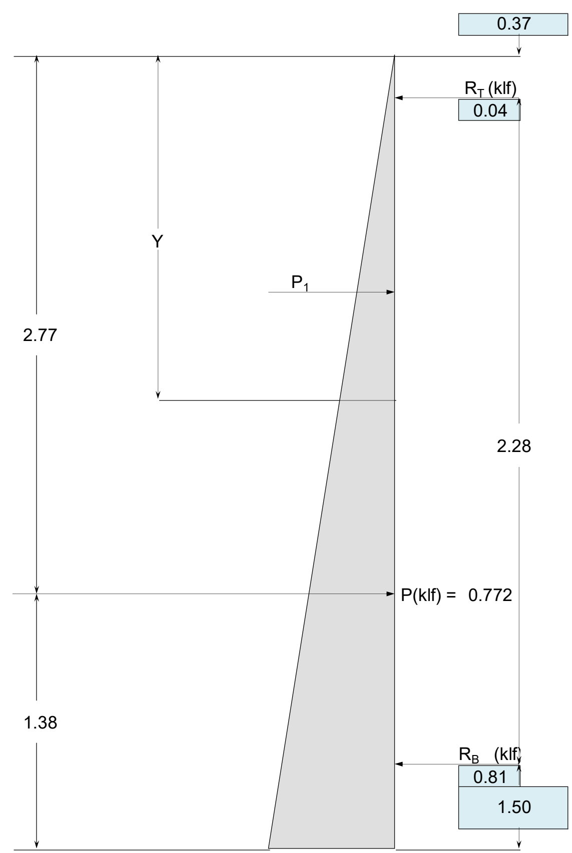
$P_1 = ½\,\gamma\,Y^2 = R_T$

Y = 1.11 ft

M_{max} = (Rt(Y-0.46)-P1*Y/3) = 0.015 ft-k /ft

Intercostal Spacing = 4.17 ft o/c

M_{max} = (Int. Spacing*Mmax) = 0.73 k-in



CHECK TRIAL SECTION

M_{max} = 0.7 k-in
αϕMn = 47.9 k-in → **OK**

→ Use 1/4" thick x 4" long intercostals

Maurepaus Swamp

KCS Railroad Crossing

Steel Swing Gate Design

AECOM Project : 60632162

1555 Poydras Street
Suite 1200
New Orleans, LA 70112
(504) 586-8111

Computed by:	SJW	Checked by:	JMH
Date:	20-Dec	Date:	20-Dec

General Info/Assumptions:

1) Steel swing gate is being designed using USACE ETL 1110-2-584, "Design of Hydraulic Steel Structures" (30 June 2014), including Appendix F, "Closure Gates".

2) Top of Gate is EL +16.13. Sill is at EL +9.89.

3) Assume Main Girder Flanges 11" wide and 5" gap at bottom. Therefore, top & bottom hinges at approximately:

   16.13' - (11" flange / 2) / 12" per ft = Top Hinge Elevation = 15.672 ft

   9.89' + (5" gap + 11" / 2) / 12" per foot = Bottom Hinge Elevation = 10.77 ft

4) As per EM 1110-2-584, skin plate is designed as a fixed end beam spanning between intercostals. In order to ensure that the flat plate theory is applicable, deflection will be limited to 0.4 times thickness.

5) Also per same EM, intercostals are designed as simple beams spanning between girders.

6) Also per same EM, girders are designed as simple beams, spanning between hinges on one side of the opening and bearings on the other.

7) A992, Grade 50 steel used for all steel members

8) For the 15% Design, two (2) load cases are examined. The specific cases have been chosen because engineering judgement dictates they will likely be the worst case conditions for the gate

   Case 1) Water to TOW EL 16.13:

   Flood water to Top of Wall EL 16.13

   Case 2) Construction with Wind:

   50 psf wind load on Protected Side of gate

EXTRACT FROM

- Impact, IM3, Extreme Load. May be neglected unless the Engineer has reason to believe this load may exist.

- Earthquake, not considered for the design of closure gates, but should be considered for gate support columns and walls.

- Environmental, W, Wind, See ASCE for recurrence interval, in lieu of site-specific data, use 15 psf during operation and up to 50 psf when not in operation (fully closed or fully open).

F.4.2. Design Load Cases. The following load cases shall be evaluated using the load factors listed in Table F-1.

- Case 1: Strength I, Gate not operating:

$$\Sigma\gamma i Q_{m} = \gamma_{D2}D + \gamma_{Hs2}H_{s2} \tag{F-1}$$

- Case 2: Strength I, Gate not operating, Gate subjected to the upper level Wind pressure of up to 50 psf:

$$\Sigma\gamma_i Q_{m} = \gamma_{D2}D + \gamma_{EV2}W_2 \tag{F-2}$$

- Case 3: Strength II, Gate operating, Hinged gate subjected to Dead and Wind (lower level of 15 psf), operating load is treated as a reaction:

$$\Sigma\gamma_i Q_{m} = \gamma_{D2}D + \gamma_{EV2}W_1 \tag{F-3}$$

- Case 4: Strength II, Gate operating, Wheeled gate subjected to Dead and Operating load:

$$\Sigma\gamma_i Q_{m} = \gamma_{D2}D + \gamma_{EV2}Q_2 \tag{F-4}$$

Table F-1. Load Factors for Closure Gates.

Load Cases		Loads/Load Factors							
Limit State	Description	γD	γG	γHs	γHd	γQ	γEV	γIM	γEQ
Strength I	Gate Closed	0	0	1.4	0	0	0	0	0
Strength I	Gate Closed	1.2	0	0	0	0	1.3	0	0
Strength II	Gate Open	1.2	0	0	0	0	1.3	0	0
Strength II	Gate Open	0	0	0	0	1.3	0	0	0

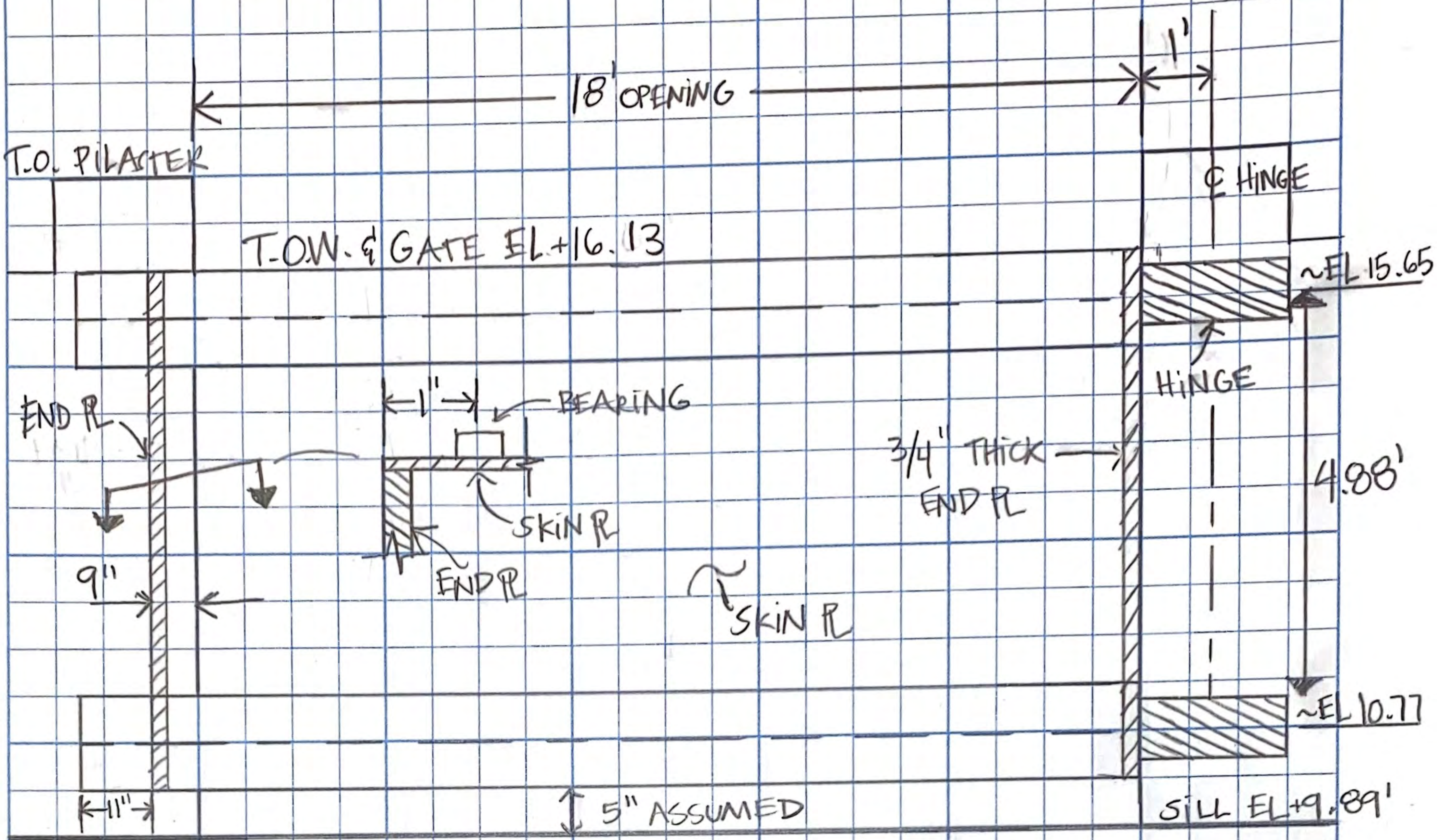
TOW CASE
CONST. + WIND

F.4.3. Design for Individual Members. The following paragraphs include a brief description of design assumptions and design considerations.

F.4.3.1. Skin plate. Skin plates shall be sized such that the maximum calculated stress is less than the yield limit state of $\alpha\phi F_y$. Skin plates shall be designed for hydrostatic loading only. Stresses shall be determined based on small deflection thin plate theory and by using Equation F-1. Deflection shall be limited to 0.4 of the plate thickness to prevent the development of significant membrane stresses. More than one thickness of plate may be desirable for taller gates. The minimum plate thickness shall be ¼ in. Appendix C provides additional guidance on skin plate design.

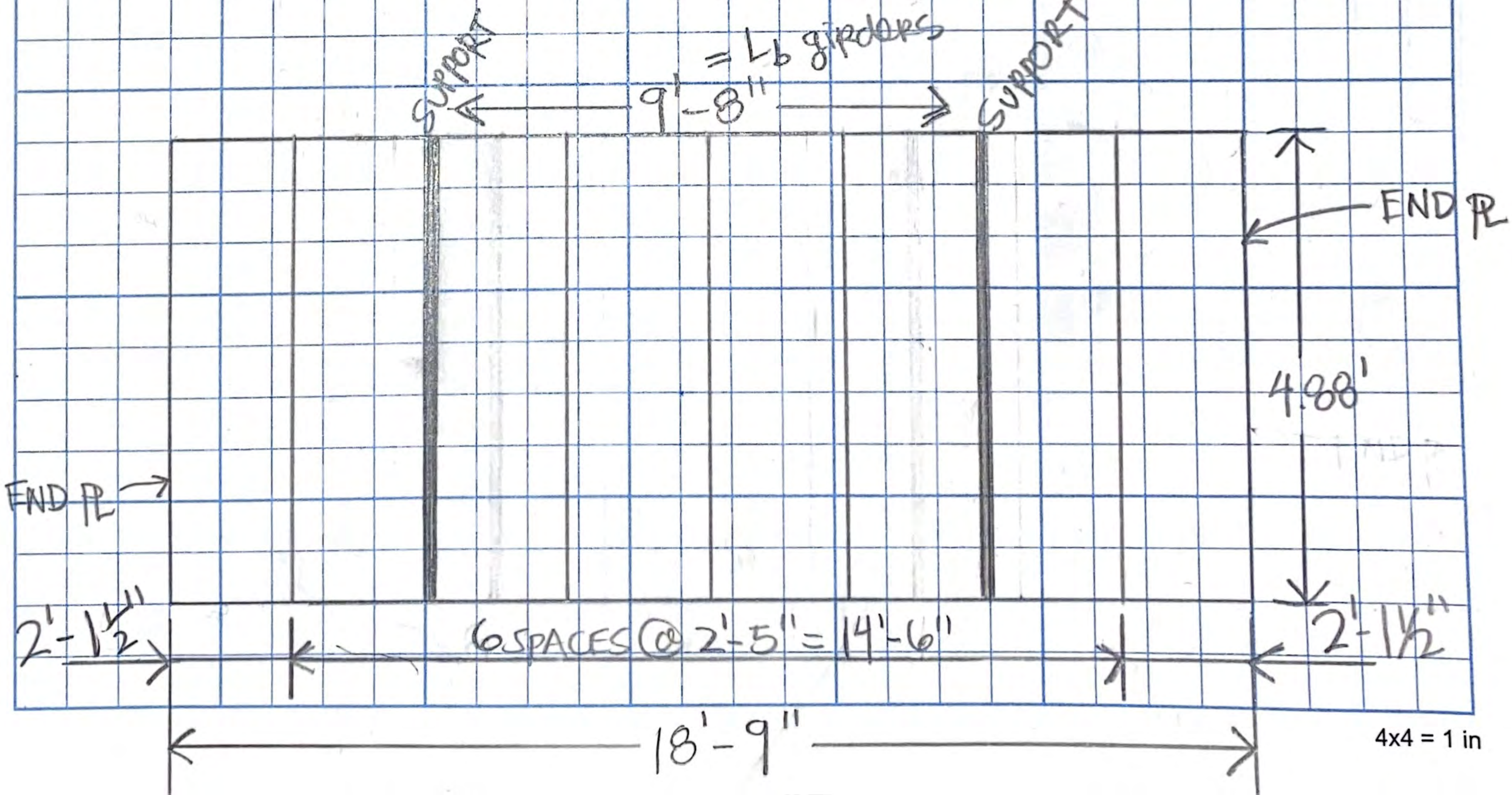
AECOM Imagine it. Delivered.

JOB TITLE KCS SWING GATE-STEEL DESIGN
PROJECT/JOB NO. CALCULATION NO.
COMPUTED BY SJW DATE 12/16/20
VERIFIED BY JMH DATE DEC-2020
SCALE SHEET NO. 1 OF



OUT-TO-OUT GATE DIM: $18' + \frac{9''}{12} = 18'-9''$

GIRDER CHORD LEN.: $18' + 9''/12 + 11''/12 = 19'-8''$



4x4 = 1 in

PROJECT
Maurepas Swamp
KCS Railroad Crossing Swing Gate Design

Project #	60632162		
Computed By	SJW	**Date**	Dec-20
Checked By	JMH	**Date**	Dec-20

Reference: AISC Steel Const Manual 15th Ed.

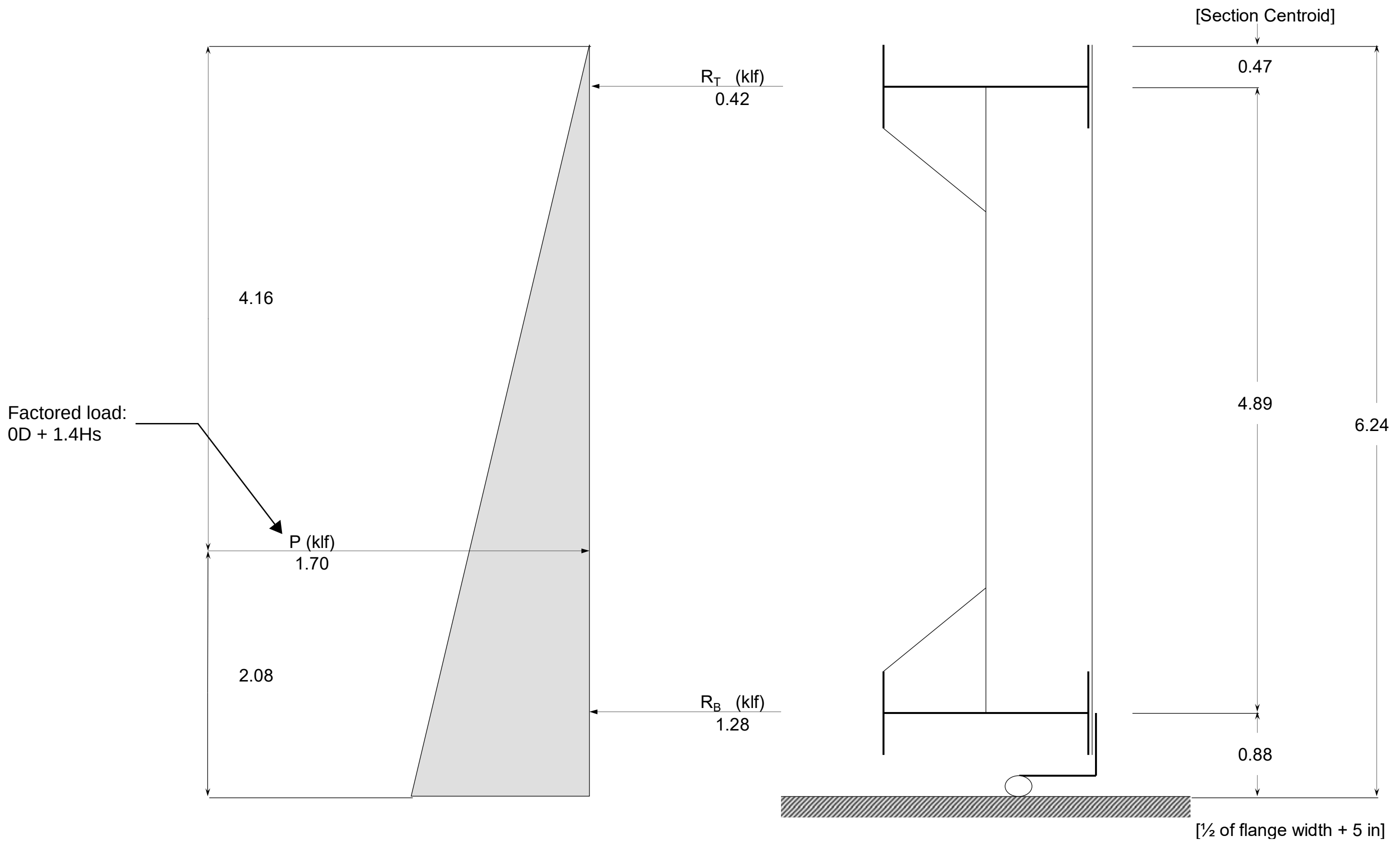
SWING GATE DESIGN

Note: Although we are confident in the results of this spreadsheet, engineers using it should be sure to check all design calculations.

Top Elevation:	16.13
Bottom Elevation:	9.89
Gate Opening:	18.00

REACTIONS

These calculations were made with the assumption that wide flange beams will be used as girders. The section centroid is calculated using this shape. If any other shape is to be used for the girders, please calculate the centroid and enter it.



MATERIAL PROPERTIES

Girder	Designation	Area	Depth	Web Thickness	Flange Width	Flange Thickness	Nominal Wt. Per ft.	Elastic Properties Axis X-X I	Axis X-X S	Axis X-X r	Axis Y-Y I	Axis Y-Y S	Axis Y-Y r
		A	d	t_w	b_f	t_f		I	S	r	I	S	r
		in^2	in	in	in	in	lb	in^4	in^3	in	in^4	in^3	in
Top	W18x106	31.1	18.73	0.59	11.2	0.94	106	1910	204	7.84	220	39.4	2.66
Bottom	W18x106	31.1	18.73	0.59	11.2	0.94	106	1910	204	7.84	220	39.4	2.66

SKIN PLATE DESIGN

The skin plate is designed as a fixed end beam, spanning between intercostals. In order to ensure that the flat plate theory is applicable, deflection will be limited to 0.4 of thickness.

Critical Load Case: 4a/4b - Water to Top of Wall **Material:** A992 Steel

F_y =	50	ksi
ϕ =	0.9	for bending
α =	0.85	from USACE ETL 1110-2-584

TRY **1/4"** **Skin Plate**

t =	0.25	in	Skin Plate Thickness
$I = t^3/12$ =	0.00130	in4 /in	Moment of Inertia
S = 2I/t =	0.0104	in3 /in	Section Modulus
$F_b = \alpha\phi F_y$ =	38.25	ksi	ETL 1110-2-584, Sect. F.4.3.1
h =	4.39		Water depth @ 6 in. above bottom flange
$P_{max} = \gamma_w h$ =	0.281	ksf	→ 0.0020 kli /in Water Pressure @ 6 in. above bottom flange
$M_{max} = S F_b$ =	0.398	in-k /in	Max. moment that skin plate can carry
$\Delta_{max} = 0.4\ t$ =	0.1	in	Max. deflection is limited to 0.4 of thickness See ETL

FIND MAX. ALLOWABLE SPACING B/W INTERCOSTALS USING MOMENT EQ.

$L_{max} = (12*M_{max}/P_{max})^{0.5}$

L_{max} = 49.5 in → 4.13 ft

FIND MAX. ALLOWABLE SPACING B/W INTERCOSTALS USING DEFLECTION CRITERIA

$L_{max} = 384EI*\Delta_{max}/P_{max}$

L_{max} = 29.4 in → 2.45 ft Smaller value controls maximum spacing

TRY **L = 2.417 ft**
Intercostal Spacing

FIND BENDING STRESS AND DEFLECTION IN SKIN PLATE

M =	0.137	in-k /in			
f_b =	13.13	ksi	<	F_b	**OK**
Δ =	0.095	in	<	Δ_{max}	**OK**

TRY 2.417 ft Spacing

Skin plate thickness and spacing are designed for hydrostatic loading only, per ETL Sect. F.4.3.1.

INTERCOSTAL DESIGN

The intercostals are designed as simple beams spanning between girders for hydrostatic loading only.

Material: A992 Steel **F_y =** 50 ksi **ϕ =** 0.9 for bending
α = 0.85 from USACE ETL 1110-2-584

Skin Plate and Stiffener treated as a T-section.

	t_f =	0.25	in	Skin plate thickness
	b =2*(t*95/(Fy)^0.5) =	6.72	in	Effective width of skin plate, (ETL 1110-2-584 pg. C-6)
TRY	t_w =	0.250	in	
	$d_{max} = t_w\ (127/\sqrt{F_y})$ =	4.49	in	d/t = 127/(Fy)^0.5 (Non-Compact Section, AISC)
TRY	d' =	4.00	in	Depth of stem

Check if Trial Section is Noncompact d/t= 17.00 **NONCOMPACT**

TRY SECTION

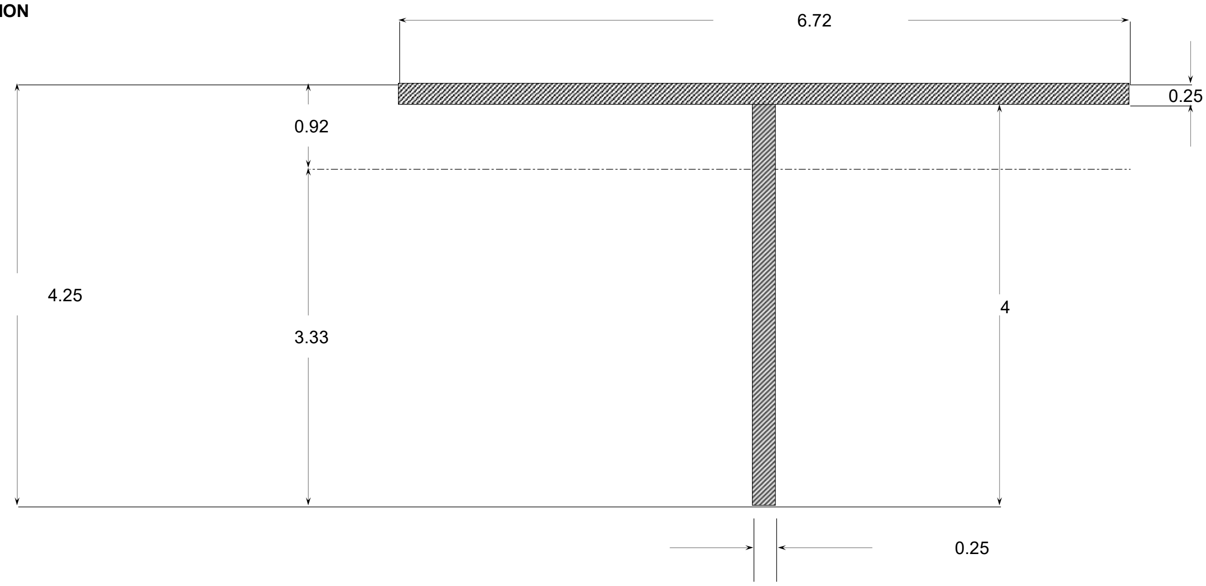


Plate	A	y	Ay	Ix	Ad^2	Iy	J ($1/3*b*t^3$)
Flange	1.68	0.13	0.21	0.01	1.06	6.32	0.03
Web	1.00	2.25	2.25	1.33	1.77	0.14	0.02

∑A 2.68 ∑Ay 2.5 in^2 ∑J = 0.06 in^4

y = 0.92 in

Ix = 4.2 in^4 Iy = 6.5 in^4

S_T = (section modulus) 4.54 in^3

S_C = (Section Modulus) 1.25 in^3

Limit States

$M_{max} \le \alpha\phi M_n$ ETL 1110-2-584, Sect. F.4.3.2

**<u>Note:</u> Intercostals designed using LC1 only

1) Yielding

Mn = Mp = FySx = 62.61 k-in (Eqn. AISC F9-3)

2) Lateral Torsional Buckling (stem is in compression)

$B = -2.3\,(d/L_b)^*(Iy/J)^{0.5}$ -1.80 (Eqn. AISC F9-12)

$M_n = M_{cr} = \frac{1.95E}{L_b}\sqrt{I_y J}(B + \sqrt{1+B^2})$ 150.57 ksi (Eqn. AISC F9-10)

<u>Yielding Controls</u>	***Mn =***	***62.6***	**k-in**
	αϕMn =	***47.9***	**k-in**

See AISC Eqn. F1-2

Lb = (unbraced length of intercostals) = 4.88 ft see sketch

$\frac{76\,b_f}{\sqrt{F_y}} =$ 72 in $\frac{20000}{(d/A_f)F_y} =$ 158 in

Lc = 6.02 ft

Since Lb < Lc no lateral stiffening required.

<u>For LC1, Water to T.O.W.:</u>

Max moment occurs at zero shear point (Y)

$P_1 = \frac{1}{2}\gamma Y^2 = R_T$

Y = 3.61 ft

M_{max} = (Rt(Y-0.46)-P1*Y/3) = 0.8 ft-k /ft

Intercostal Spacing = 2.42 ft o/c

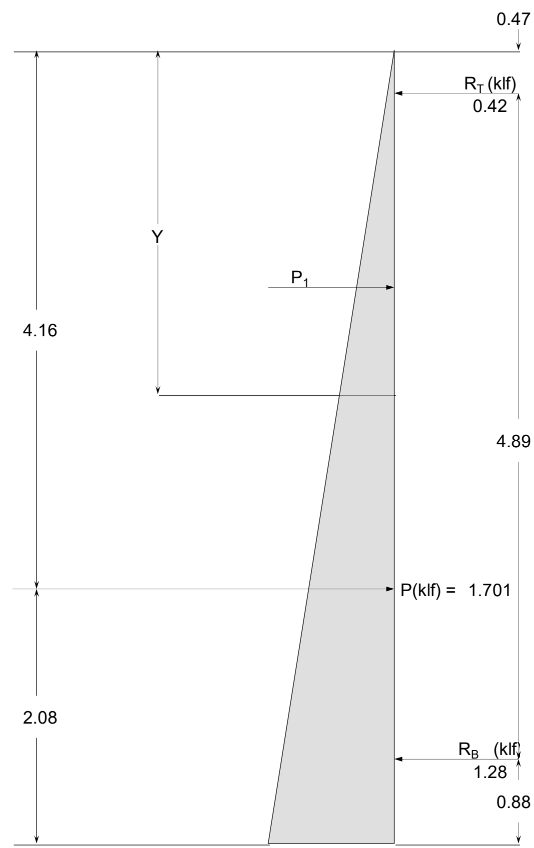
M_{max} = (Int. Spacing*Mmax) = 23.4 k-in

<u>CHECK TRIAL SECTION</u>

M_{max} = 23.4 k-in

αϕMn = 47.9 k-in → **OK**

→ Use 1/4" thick x 4" long intercostals



GIRDER DESIGN

Girders are designed as simple beams, spanning between hinges on one side and wall bearings on the other side of the opening.

Critical Load Case: Top of Wall Case **Material:** A992 Steel **F_y =** 50 ksi

Girder	Designation	Area	Depth	Web Thickness	Flange Width	Flange Thickness	Nominal Wt. Per ft.	Elastic Properties Axis X-X I	Axis X-X S	Axis X-X r	Axis Y-Y I	Axis Y-Y S	Axis Y-Y r
		A	d	t_w	b_f	t_f		I	S	r	I	S	r
		in^2	in	in	in	in	lb	in^4	in^3	in	in^4	in^3	in
Top	W18x106	31.1	18.73	0.59	11.2	0.94	106	1910	204	7.84	220	39.4	2.66
Bottom	W18x106	31.1	18.73	0.59	11.2	0.94	106	1910	204	7.84	220	39.4	2.66

Span = 19.833 ft From centerline of bearing to centerline of hinge **ϕ =** 0.9 for bending

α = 0.85 from USACE ETL 1110-2-584

DESIGN OF TOP GIRDER

$b_f/2t_f =$ 6.0 < 9.2 $= 0.38\sqrt{(E/F_y)}$

$d/t_w =$ 31.7 < 90.6 $= 3.76\sqrt{(E/F_y)}$

AISC Table B4.1a

Compact Section

$F_b = \alpha\phi F_y$ 38.25 ksi ETL Sect. F.4.3.1.

$M_{max}(R_T) = 1/8 \cdot R_T \cdot Span^2$ 20.5 ft-k → 245.6 in-k

$f_b = M_{max}/S$ 1.20 ksi < F_b **OK**

$\frac{76 b_f}{\sqrt{F_y}} =$ 120 $\frac{20000}{(d/A_f)F_y} =$ 225

$L_c =$ 10.03 ft Use Lb < Lc see sketch (Lb = 9.67 ft, unbraced length for girders)

DESIGN OF BOTTOM GIRDER

$b_f/2t_f =$ 6.0 < 9.2 $= 0.38\sqrt{(E/F_y)}$

$d/t_w =$ 31.7 < 90.6 $= 3.76\sqrt{(E/F_y)}$

AISC Table B4.1a

Compact Section

$F_b = \alpha\phi F_y$ 38.25 ksi ETL Sect. F.4.3.1.

$M_{max}(R_B) = 1/8 \cdot R_B \cdot Span^2$ 63.2 ft-k → 758.0 in-k

$f_b = M_{max}/S$ 3.72 ksi < F_b **OK**

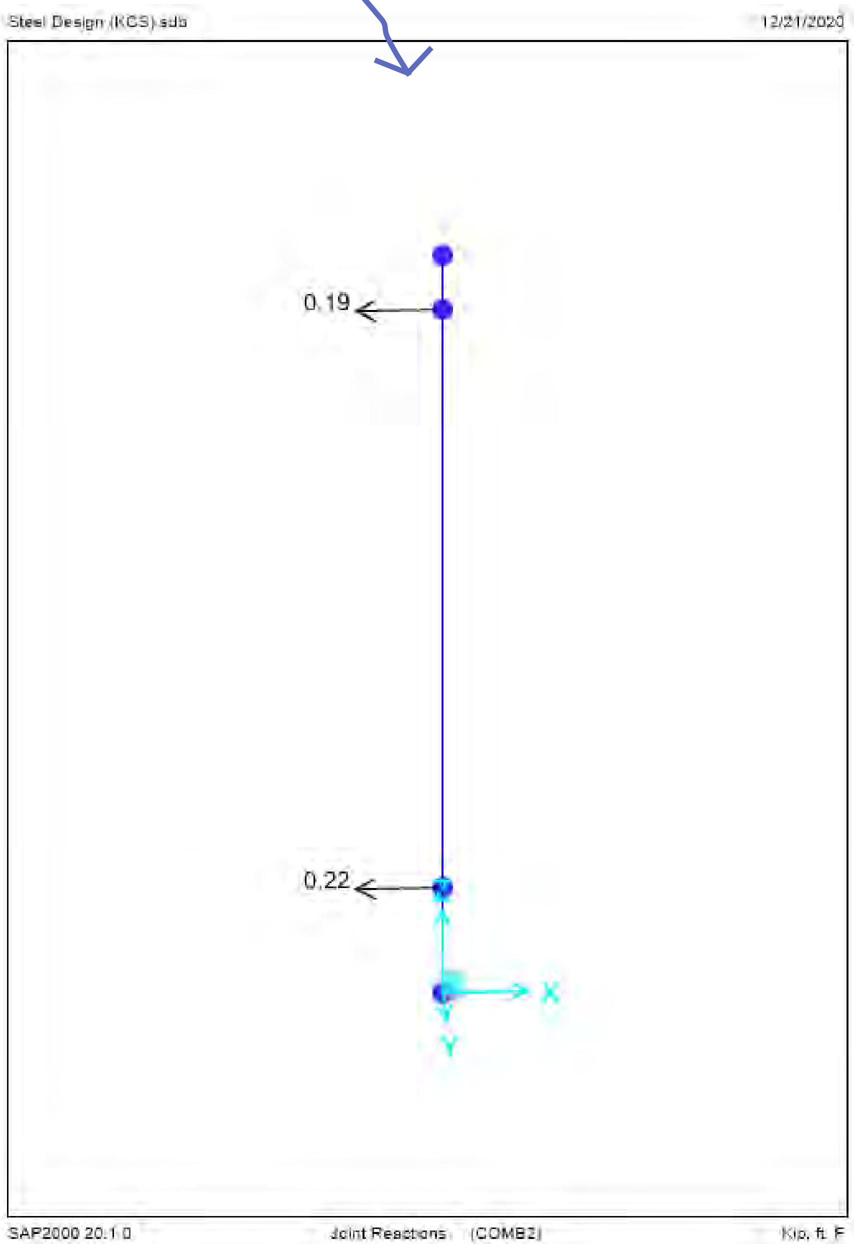
$\frac{76 b_f}{\sqrt{F_y}} =$ 120 $\frac{20000}{(d/A_f)F_y} =$ 225

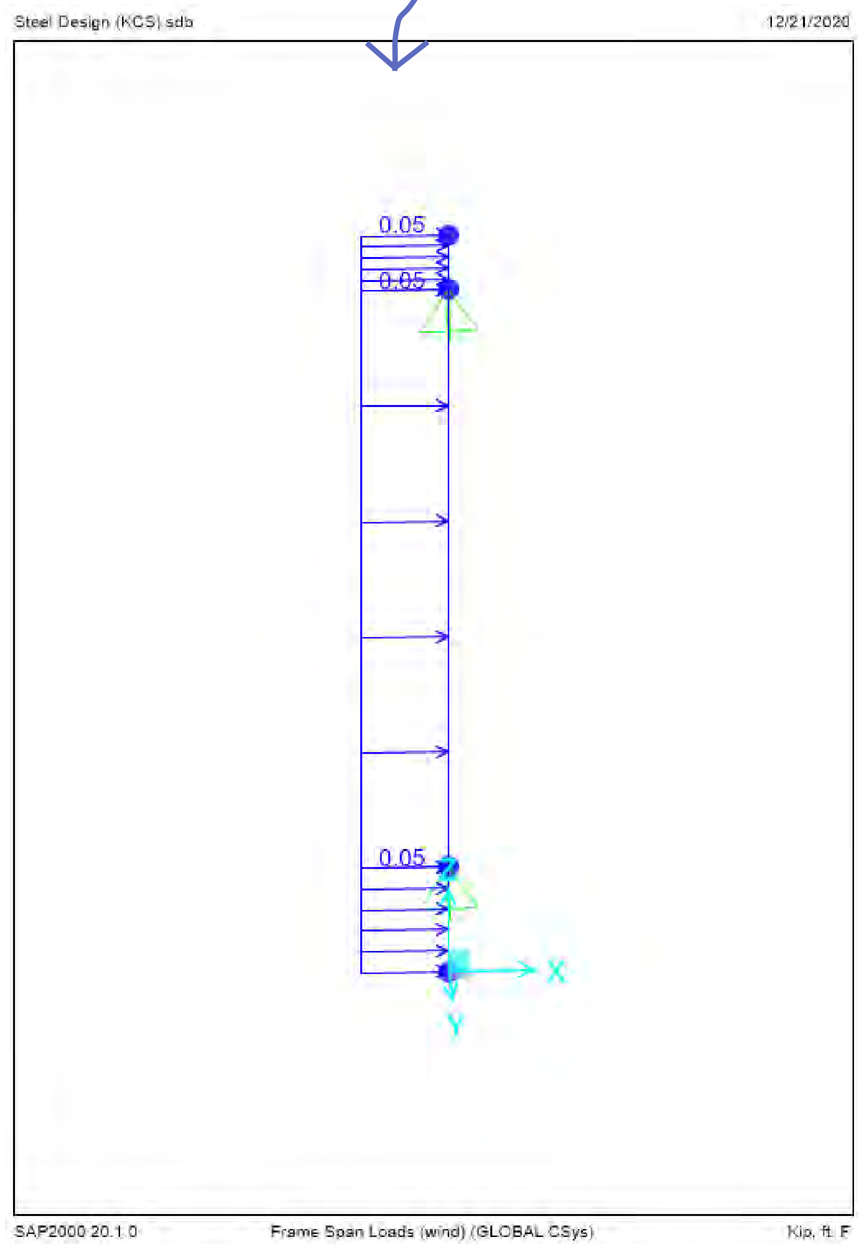
$L_c =$ 10.03 ft Use Lb < Lc see sketch (Lb = 9.67 ft, unbraced length for girders)

Girders will also be checked for load case 2 as well.

Factored loads
LC2 = 1.2D + 1.3W

Unfactored load





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JOB TITLE

PROJECT/JOB NO. CALCULATION NO.

COMPUTED BY SJW DATE DEC-2020

VERIFIED BY JMH DATE DEC-2020

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GIRDER CHECK FOR LC2, CONSTRUCTION + WIND:

$R_T = 0.19$ K/FT, < $R_T = 0.40$ K/FT FOR T.O.W. CASE PREVIOUSLY CHECKED

$R_B = 0.22$ K/FT, < $R_B = 1.30$ K/FT FOR T.O.W. CASE

∴ CASE DOES NOT CONTROL

4x4 = 1 in

PROJECT		**Project #**	60632162	**Sheet**	of
Maurepas Swamp		**Computed By**	SJW	**Date**	Dec-20
KCS Railroad Crossing Swing Gate Design		**Checked By**	JMH	**Date**	Dec-20

QUANTITY TAKEOFF

Determine Gate Weight and Center of Gravity
(for gate from EL +9.89 to EL +16.13)

Unit Weight o 0.28 **lb/in^3**

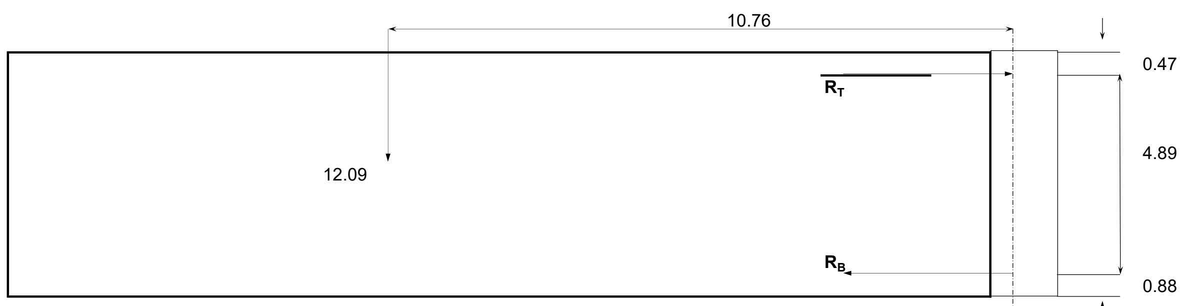
	Thick (in)	Size (in)	No.	Wt/ft	Length (ft)	Wt	y (in)	Wt*y	x (ft)	Wt*x
Skin Pl	0.2500	74.88	1	63.7	18.75	1195	4.13	4929	9.38	11202
Vertical Stiff	0.250	4.00	5	3.4	4.89	83	2.00	166	9.38	780
Web Diaphragms	0.500	17.79	2	30.3	4.89	296	0.13	37	9.38	2776
Flange Diaphragm	0.500	4.00	2	6.8	4.89	67	-8.90	-592	9.38	624
Top Chord		W18x106	1	106.0	19.67	2085	0.00	0	9.83	20499
Bottom Chord		W18x106	1	146.0	19.67	2871	0.00	0	9.83	28235
Ties		2" dia	8	10.7	9.00	770	-8.90	-6846	9.38	7215
End Pl1	0.750	17.79	1	45.4	4.89	222	0.00	0	18.38	4081
End Pl2	0.750	17.79	1	45.4	4.89	222	0.00	0	1.50	333
Bearing Bar	1.500	1.50	2	7.7	4.89	75	4.88	365	18.75	1405
Seal Angle		8x6x1/2	1	23.8	18.75	447	2.13	949	9.38	4189
Side Seal Bars	0.313	2.00	2	2.1	4.89	21	2.13	44	9.38	195
Bottom Seal Bar	0.313	2.00	1	2.1	18.75	40	2.13	85	9.38	375
						8393		-862		81910

Dead Load 12.09 kips — For Design Weight ADD Load Factor 1.2 and 20% for Welds Misc. Steel, etc.

yavg -0.01 ft — y_{avg} and x_{avg} stay the same assume uniform increase in the weight

xavg 9.76 ft

Note: Input highlighted values. Positive y is measured from center line hinge towards protected side (skin plate)
Positive x is measured from the outside of the hinge end plate positive towards opposite end of gate (in plane of gate)



Free Body of Swing Gate

SWING GATE HINGE REACTIONS

AECOM Imagine it. Delivered.

JOB TITLE

PROJECT/JOB NO. CALCULATION NO.

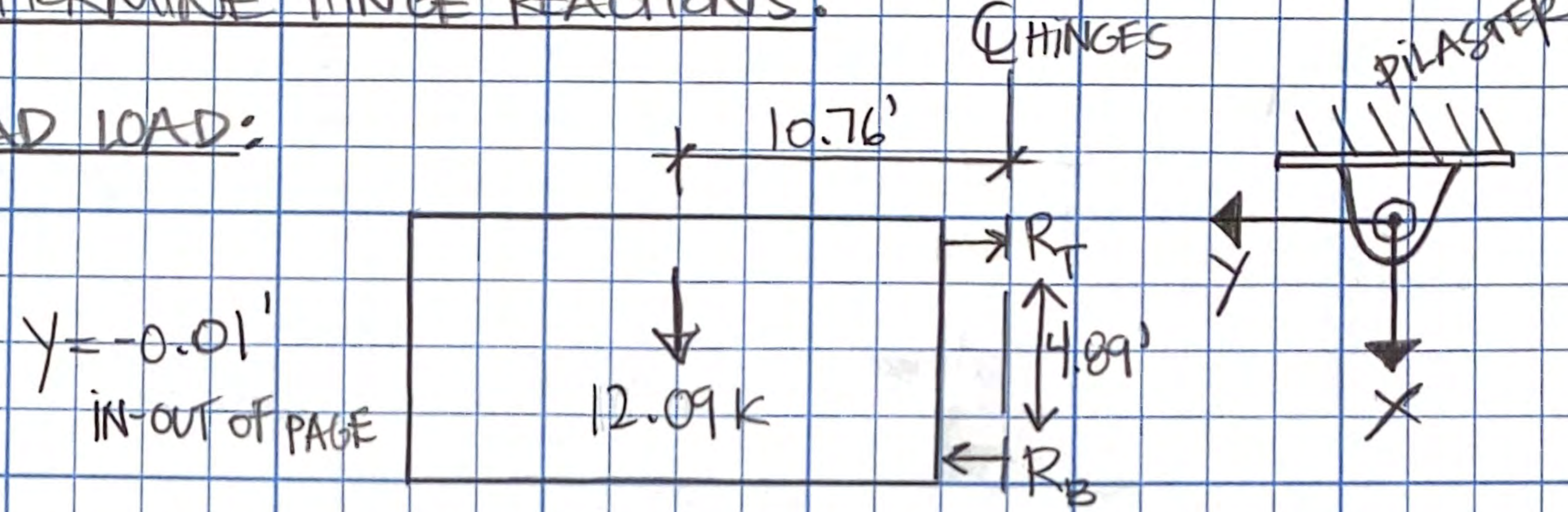
COMPUTED BY SJW DATE DEC-2020

VERIFIED BY JMH DATE DEC-2020

SCALE SHEET NO. OF

* DETERMINE HINGE REACTIONS:

DEAD LOAD:



$R_T = -R_B = \frac{12.09^k \times 10.76'}{4.89'} = \underline{26.6^k}$ (IN PLANE OF THE GATE)

$R_T' = -R_B' = \frac{10.07^k \times (-0.01')}{4.89'} = \underline{-0.02^k}$ ($\perp$ TO PLANE OF GATE)

CONT...

4x4 = 1 in

AECOM Imagine it. Delivered.

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SCALE SHEET NO. OF

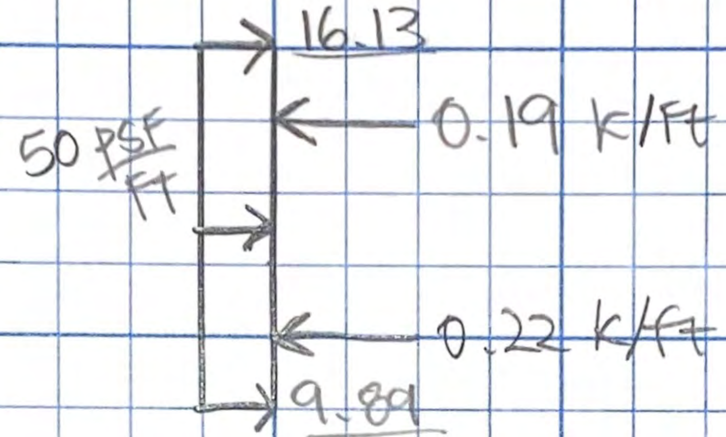
① T.O.W.: FROM EXCEL @ BEGINNING: $R_T = 0.42$ k/ft

$R_B = 1.28$ k/ft

$$R_{T,TOW} = 0.42 \times 19.83/2 = 4.17 \text{ k}$$

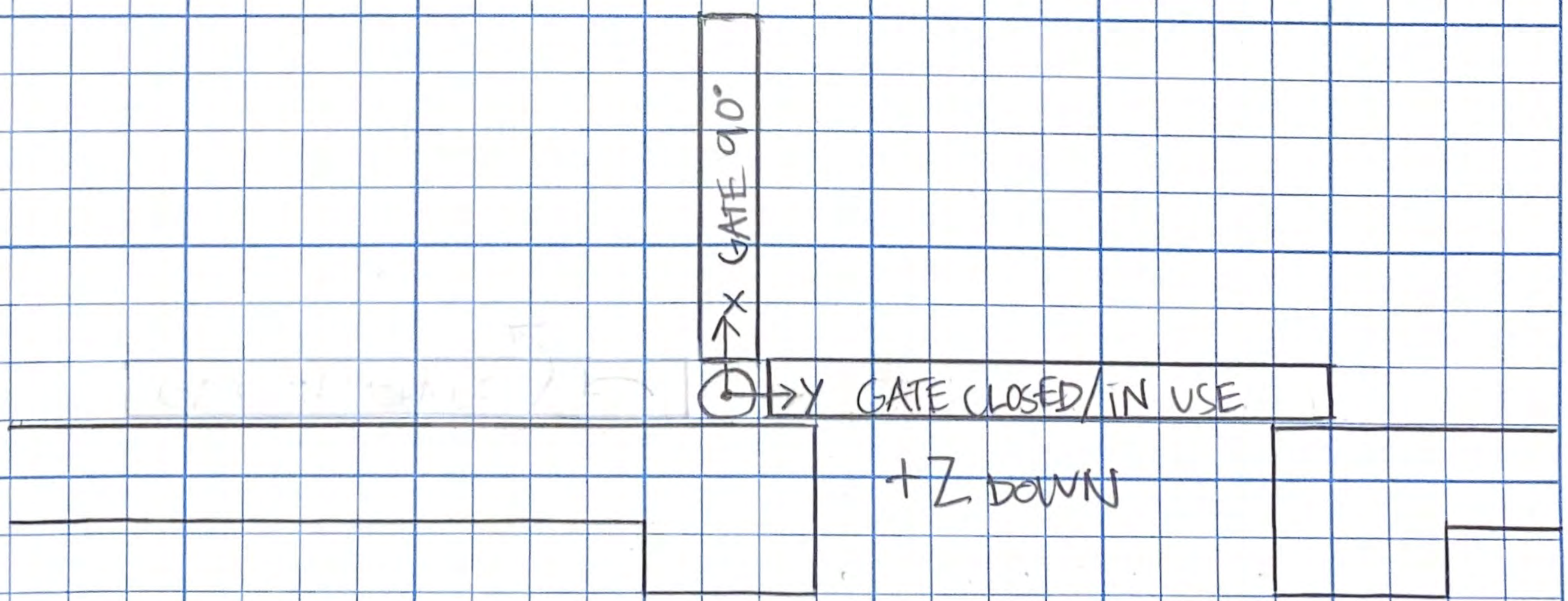
$$R_{B,TOW} = 1.28 \times 19.83/2 = 12.69 \text{ k}$$

② DEAD + WIND LOAD:



$$R_{T,WIND} = 0.19 \times 19.83/2 = 1.88 \text{ k}$$

$$R_{B,WIND} = 0.22 \times 19.83/2 = 2.18 \text{ k}$$



4x4 = 1 in

TOP HINGE REACTIONS

			18' W x 6.24' H Swing Gate						
			DL		**LL**		**Total**		**R**
		Load Case Name	X	Y	X	Y	**X**	**Y**	
		Dead Load, Open @ 90°	26.6	-0.02	0	0	**26.6**	**-0.02**	26.6
		Dead Load, Closed, plus Wind on Protected Side	0.02	26.6	1.88	0	**1.9**	**26.6**	26.7
		Water to Top of Wall (impervious & pervious)	0	0	-4.17	0	**-4.17**	**0**	4.2

BOTTOM HINGE REACTIONS

			18' W x 6.24' H Swing Gate								
			DL			**LL**			**Total**		
		Load Case Name	X	Y	Z	X	Y	Z	**X**	**Y**	**Z**
		Dead Load, Open @ 90°	-26.6	0.02	10.07	0	0	0	**-26.6**	**0.02**	**10.07**
		Dead Load, Closed, plus Wind on Protected Side	-0.02	-26.6	10.07	-2.18	0	0	**-2.2**	**-26.6**	**10.07**
		Water to Top of Wall (impervious & pervious)	0	0	0	-12.69	0	0	**-12.69**	**0**	**0**