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FINAL DELIVERABLE

Title	Webster City Bridge and Park Complex
Completed By	Mitchell Allenback, Guadalupe Muñoz Rocha, Shelby Humes
Date Completed	May 2019
UI Department	Civil and Environmental Engineering
Course Name	Senior Design - CEE:3084:0001
Instructor	Tim Mattes
Community Partners	City of Webster City

This project was supported by the Provost's Office of Outreach and Engagement at the University of Iowa. The Office of Outreach and Engagement partners with rural and urban communities across the state to develop projects that university students and faculty complete through research and coursework. Through supporting these projects, the Office of Outreach and Engagement pursues a dual mission of enhancing quality of life in Iowa while transforming teaching and learning at the University of Iowa.

Provost's Office of Outreach and Engagement
The University of Iowa
111 Jessup Hall
Iowa City, IA, 52241
Phone: 319.335.0684
Email: outreach-engagement@uiowa.edu
Website: http://outreach.uiowa.edu/

BRIDGE AND PARK COMPLEX

Webster City, Iowa

Submitted to : Lindsay Henderson and Kent Harfst

Submitted on: April 12,2019

MGS Engineering Ltd.
Mitchell Allenback, Project Manager; Guadalupe Muñoz Rocha, Editor; Shelby Humes, Technical Support

Table of Contents

List of Figures and Tables

Section I Executive Summary

MGS Engineering is a team of three students enrolled in the capstone design course at the University of Iowa. They were requested to provide Webster City, Iowa with a design plan for developing Kendall Young Park. The goal of the project was to provide designs for a bridge to cross White Fox Creek and a parking lot within the park. The bridge will provide access to the North Side of the park where a lodge is located and inaccessible by vehicle.

The site locations suggested to MGS Engineering was west of the existing spillway for the location of the bridge and within the confines of the park for the location of a single parking lot. The bridge was designed for the suggested location and the parking lot location was chosen to minimize environmental impact and to maximize the number of stalls in the lot.

Components of the final design of the development of Kendall Young Park include the bridge, the abutments, the parking lot, a bio-infiltration swale, the access road, the abutment armoring, and the vehicle gate to limit access to the bridge.

The estimated total cost of the work to be done on this site is $605,452 MGS Engineering, Ltd will provide designs for the pre-fabricated bridge, the abutments, the abutment armoring, the access road, the vehicle gate, the 16-stall parking lot, a bio-infiltration swale, and post-construction landscaping to increase park appeal.

Section II Organization Qualifications and Experience

Name of Organization

MGS Engineering Ltd.- 103 S Capitol St, Iowa City, Iowa, 52240

Organization Location and Contact Information

Mitchell Allenback
Email: mitchell-allenback@uiowa.edu (Preferred method of contact)
Phone : (515) 447-5548
Available Monday-Friday from 8 a.m.-5p.m.

Organization and Design Team Description

MGS Engineering Ltd. is a student run civil and environmental design team from the University of Iowa participating in the Capstone design class. We are currently located in the Seaman Center for the Engineering Arts and Sciences on 103 S Capitol St. Our organization works with clients via emails, phone calls, video calls and in person meeting at the office of our Clients. Thus, MGS Engineering Ltd. is willing to provide our services from headquarters or at Webster City's Municipal Building.

Experience with Similar Projects

Our team is composed of three civil engineers with specialization in structural and environmental engineering with 10 years of combined engineering experience. The design team includes:

- **Mitchell Allenback**: Project Manager, Structural focus, lead for the structural analysis of the bridge. Mitchell is proficient in AutoCAD's Robot Structural Analysis extension due to his experience as a student and teaching assistant for Principals of Structural Engineering. Mitchell also has structural and transportation design experience through his internships. As an undergrad, he has also done research mixing and analyzing asphalt. Relevant education includes Principles of Transportation Engineering, Design of Steel Structures, Introduction to Bridge Engineering, Structural Systems, and Design of Concrete Structures.

- **Guadalupe Muñoz Rocha**: Editor, Environmental focus, lead for the environmental assessment and transportation design. Guadalupe has relevant experience implementing AutoCAD Civil 3D through project-based classes. Relevant knowledge also comes from her experience as a student and teaching assistant for the Mechanics of Deformable Bodies provided at the university. Through her internship and a class project, Guadalupe is knowledgeable on threatened and endangered species surveys as well as ecological risk assessments. Relevant knowledge comes from Sustainable Systems, Natural Environmental Systems and Geomechanics

- **Shelby Humes**: Tech Specialist, Environmental focus, lead for the hydrological analysis of the White Fox Creek. Shelby is proficient with GIS due to her co-op with JACOBS Engineering. She also has experience in water resources design through her co-op. Relevant education includes Principles of Hydraulics and Hydrology as well as Water Resources Engineering.

Section III Design Services

Project Scope

Kendall Young Park is located North of Webster City, Iowa. Webster City is home to the Boone River which meanders along the east side of the city. White Fox Creek, which runs through almost all of Kendall Young Park, feeds into the Boone River a few miles down from the spill way. The project consists of developing a river crossing structure meant to facilitate vehicle and pedestrian traffic to the North Side of the park. The crossing structure is to be designed along with a parking lot and a path from the parking lot to the bridge.

To be able to construct the bridge recommended to the client, bridge, a hydraulic analysis of the creek will be completed before the design of the bridge or alterations to the park are done. A structural analysis will be done using the appropriate software and presented based on various traffic scenarios including the need for heavy dump trucks to cross. A pavement and drainage design will be generated for the parking lot recommended. The parking lot recommended shall have all elements requested in the Request for Proposal. An ecological risk assessment and threatened species survey will be done to determine the best way to minimize impacts on animals and plants inhabiting the area near or at the site. Specific options for materials and methods for each task will be discussed in Section V Alternative Solutions Considered

The major tasks taken to complete the project are listed in the following table.

Table 1. Major Tasks Taken to Complete Project Design

Task #	Task	Description
1	Hydraulic analysis of creek	100 year flood height will be used to determine elevation of the bridge
2	Determine alternatives and criteria for decision matrix	Alternatives will be provided for both the bridge and the parking lot
3	Parking design	The parking lot design should have stall orientation, aisle width and all other characteristics
4	Parking lot pavement design	A cross section of the parking lot should include layers, slope and all other appropriate measurements and characteristics
5	Bridge design	Recommended bridge should include all necessary design specifications appropriate for the location
6	Landscape design	Any plants or landscape features needed to be added should be specified in type, amount, and location.
7	Cost Analysis	Should provide cost analysis for recommended design
8	Final design drawings, report and presentation	Should include all design elements

Work Plan

The project schedule is shown in the figure below.

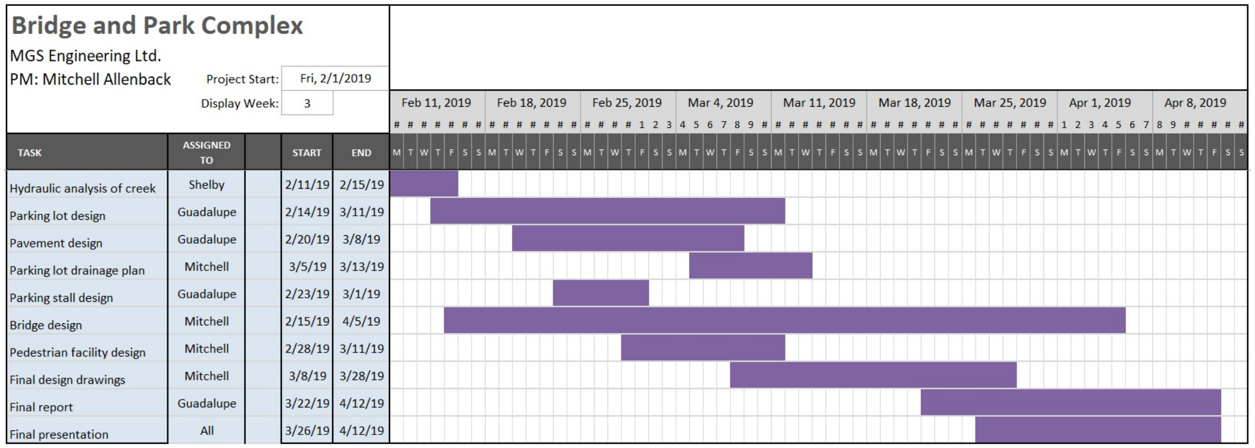


Figure 1: Project Gantt chart

Section IV Constraints, Challenges and Impacts

Constraints

This project is limited in a few ways. After consulting advisors, communicating with the client, and doing research, our team has compiled a list of several those constraints and the details pertaining to certain aspects of the project.

1. ***Quality***
   Like any other project the quality of our work is constrained by other constrains such as costs, deadlines and scope. The quality metrics of the customer must be in conformance with quality standards. Gravel was the preferred material of the client for the parking lot, however frequent maintenance suggests faster decline in quality. Quality of a project can be compromised when it is wanted to be done fast and cheap.

2. ***Resources***
   The client never specified a budget, which made it both easier and harder on identifying the kind of materials and designs for both the parking lot and bridge. The client mentioned in our initial meeting, the whole project was to be cost effective and was preferred to be more sustainable while maintaining a rustic aesthetic look. Initially a flat railroad car bridge was preferred, but such bridge would have required extensive calculations needed to retrofit the bridge. Such calculations are beyond the scope of knowledge of our team and specifications and design considerations for such bridge are limited. Furthermore, our team does not have the resources to hire a third-party for the identification of utilities in the site. Such plans are also not publicly available.

3. ***Legal***
   The client originally asked for a gravel parking lot to be considered, but in accordance with Webster's City's ordinances—new driveways, parking lots or roads are not to have gravel surfaces. These gravel surfaces are made of loose material and are not in compliance with ADA Guidelines.

4. ***Sustainability***
   There are three parts to sustainability: social, environmental and economical. Cities and counties are considered the major leaders in sustainability since it is easier to manage and implement policies for a smaller population. Webster City being selected as a new member of the Iowa Initiative for Sustainable Communities is indicative of the city's commitment to enhance their sustainability practices. The major constraint in terms of sustainability would be creating a parking lot and a bridge that will allow patrons to enjoy the park and its greenery while reducing the area of greenery and maintaining low emissions and pollution during the construction and use of the bridge and the parking lot.

Challenges

Several challenges presented themselves during the design process. In doing the hydraulic analysis of the White Fox Creek, our team found it difficult to process old data sets.

The major challenge in this project is the fact that Webster City's location overlaps the critical habitat for the Topeka Shiner. Our team is dedicated to minimizing the environmental impact of our designs. Thus, though not requested we found it essential to do an ecological risk assessment. Our primary findings identified possible ways our design could impact the Topeka Shiner living in the stream. The quality of our design, improper gravel removal (if any) near the bank of the stream, and timber clearing operations can change the stream's temperature, flow, and general hydrology thus resulting in habitat degradation.

Societal Impact within the Community and State of Iowa

Webster City is a growing community with many opportunities. This project will provide access to an events lodge that has been inaccessible for years. Children and parents will enjoy camping and staying at the lodge within proximity to the town center. The bridge will also provide pedestrians with a walkable path across the stream waters and a structure to fish off in order to reach the center of the creek itself. Improved parking within the park will also promote more visitors to utilize the parks and recreation in Webster City.

Section V Alternative Solutions Considered

After research and consulting advisors, our team was able to identify alternatives that would satisfy the requirements of the client before considering other criteria besides functionality.

Bridge Design

The initial alternatives we considered for the bridge design were a prefabricated steel bridge and a recycled railroad flat car bridge because of the constraint of a rapidly constructed bridge. A railroad flat car bridge is made of retired retrofitted railroad flat cars. These cars become retired for multiple reasons including derailments and old age. Because the condition of these cars vary, extensive retrofits are necessary. In addition, because these cars can be up to 75 years old, fatigue failure can become an issue in higher traffic applications. These cars come in a maximum length of 89'. For our project, the bridge would need to span 150'. This means that the railroad flat car alternative would need multiple spans and a pier in the center of the creek. The addition of a pier would add a significant amount to the project cost, would impact the floodplain, and could disturb the Topeka Shiner, an endangered species in the area. The prefabricated bridge option can come in a wide range of span lengths and is able to span more then 150', which means that no piers are required for this alternative. Also, there are multiple different styles and models of prefabricated bridges, allowing us to select an aesthetically pleasing structure for this natural site. In addition, this alternative would have a longer lifespan because it is made from new materials that are accurately rated for the required load.

Table 2 shows a detailed decision matrix which lays out the positives and negatives of each alternative. The alternatives were evaluated based on cost, construction time, lifespan and aesthetics. Each of these criteria were given a weight to develop a score. In this matrix, the lower the score corelates to the better design alternative.

Table 2. Bridge Alternative Decision Matrix

Decision Matrix								
		Amount			Rank		Score	
Criteria	Weights (1-5)	RRFC	Prefabricated	Total	RRFC	Prefabricated	RRFC	Prefabricated
Costs ($/sq.ft)	5	$40	$40	80	0.5	0.5	2.5	2.5
Construction Time (weeks)	5	5	4	9	0.555556	0.444444444	2.777778	2.222222222
Lifespan	-2	4	5	9	0.4	0.6	-0.9	-1.1
Aesthetics	-1	1	3	4	0.25	0.75	-0.25	-0.75
						Total	4.1	2.9

Parking Lot Design

To determine the final design, our team identified possible locations for the parking. Below are the two locations considered for the parking lot (**Figure 2**). Initially our client had requested that the parking lot be placed along the road in front of the bridge, which is the image show to the left on Figure 2. The second location considered was that on the right image of **Figure 2**. This location was considered after the neighboring buildings were identified as a bathroom, a picnic site and storage unit.

Figure 2. Parking lot alongside the road across spillway and bridge location (Left) and the parking lot location south of the spillway (Right)

Table 3 shows a list of pros and cons of each location. In summary, the first location would be ideal due to its design and proximity to the bridge. However, traffic and possible direct runoff into the waterway. The second location would be ideal due to its location near the bathrooms and distance away from the bridge. However, it does require additional road to be built. Both alternatives would require some land to be cleared including trees. Their locations were carefully selected to minimize the clearing of trees and prevent additional grading from being needed.

Table 3. Advantages and Disadvantages of Location Alternatives

Location	Pros	Cons
Location #1- Alongside Road	• Near bridge and spillway • Easier for cars to navigate parking lot	• Would require additional safety and traffic signage and analysis • Reduces amount of park area more typically used
Location #2- South of Spillway	• Closer to picnic area and restrooms • Allows immediate access from entrance of park • Encourages patrons to walk	• Will require a road to be build off the pre-existing gravel road.

In addition to identifying the location of the parking lot, out team used a decision matrix alongside previous concerns to determine the material of the parking lot. The client initially requested that we do a simple gravel parking lot due to its low cost and fast construction. However, to reduce possible respiratory issues in young children, the elderly and those with disabilities and frequent maintenance requirements, our team decided to look at asphalt and concrete as potential materials for the parking lot. **Table 4** shows the detailed decision matrix. The material that has the lowest score is the one seen as best fit. The criteria looked at for the material chosen were: cost, lifespan, construction time, climate, aesthetics. Operation and maintenance and environmental impact. Cost and construction time were given the maximum weight while operation and maintenance and environmental impact were given the lowest. The reason for this was that the more environmentally friendly and the less the parking lots required maintenance the lower the score. However, the more it cost and the longer it takes to construct. the higher the score.

Table 4. Decision Matrix for Parking Lot Material

Pavement Material Decision Matrix											
		Amount				Rank			Score		
Criteria	Weight	PCC	Asphalt	Gravel	Total	PCC	Asphalt	Gravel	PCC	Asphalt	Gravel
Costs($/sq.ft)	3.0	10.0	6.0	2.0	18.0	0.6	0.3	0.1	1.7	1.0	0.3
Lifespan	2.0	30.0	20.0	5.0	55.0	0.5	0.4	0.1	1.1	0.7	0.2
Construction Time(weeks)	3.0	2.0	1.0	1.0	4.0	0.5	0.3	0.3	1.5	0.8	0.8
Climate	2.0	2.0	3.0	3.0	8.0	0.3	0.4	0.4	0.5	0.8	0.8
Aesthetics *	-1.0	4.0	3.0	1.0	8.0	0.5	0.4	0.1	-0.5	-0.4	-0.1
Operation and Maintenance*	-3.0	4.0	4.0	2.0	10.0	0.4	0.4	0.2	-1.2	-1.2	-0.6
Environmental Impact*	-3.0	4.0	4.0	5.0	13.0	0.3	0.3	0.4	-0.9	-0.9	-1.2
* Numbers assigned for aesthetics is a rank from 1-5 where 5 is the most aesthetically pleasing								Total	2.1	0.7	0.1

Section VI Final Design Details

Hydraulic Analysis

Iowa Dept of Transportation recommends for any bridge construction that a headboard of 3 ft is needed above the 50 year floodplain. To complete this project with the recommended elevation cleared, a hydraulic analysis was necessary of the White Fox Creek basin. The floodplain elevation was determined to reach 1032.77 ft above sea-level. With data produced in HEC-HMS for stream channel analysis, **Figure 3** below represents the stream discharge frequency. The post-construction flows in the channel were modelled in HEC-RAS and determined no significant increase of discharge into Boone River (**Figure 4**).

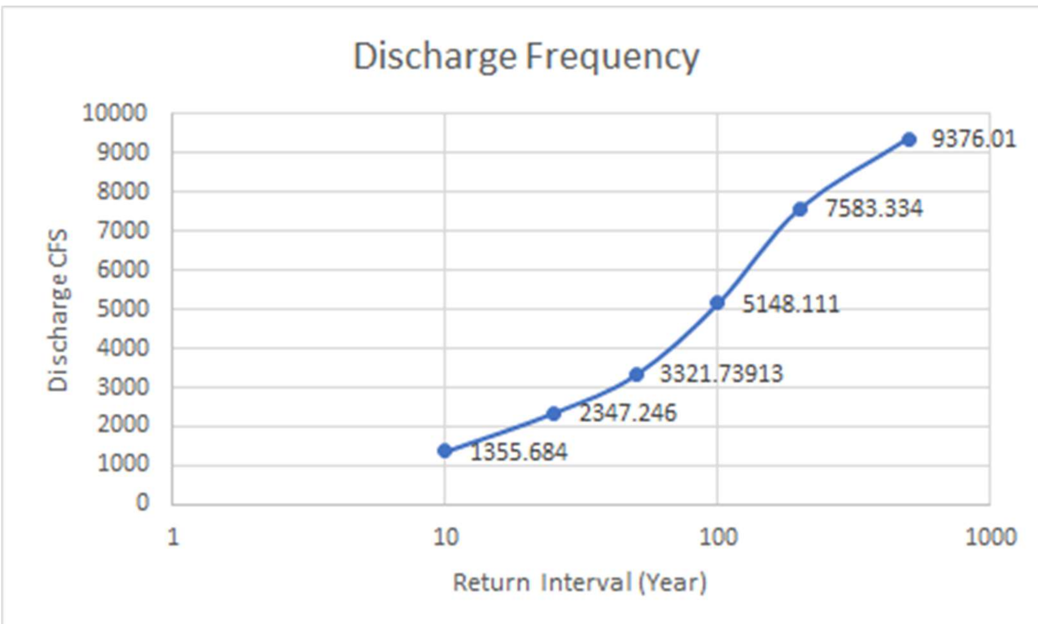


Figure 3. Stream Discharge Frequency

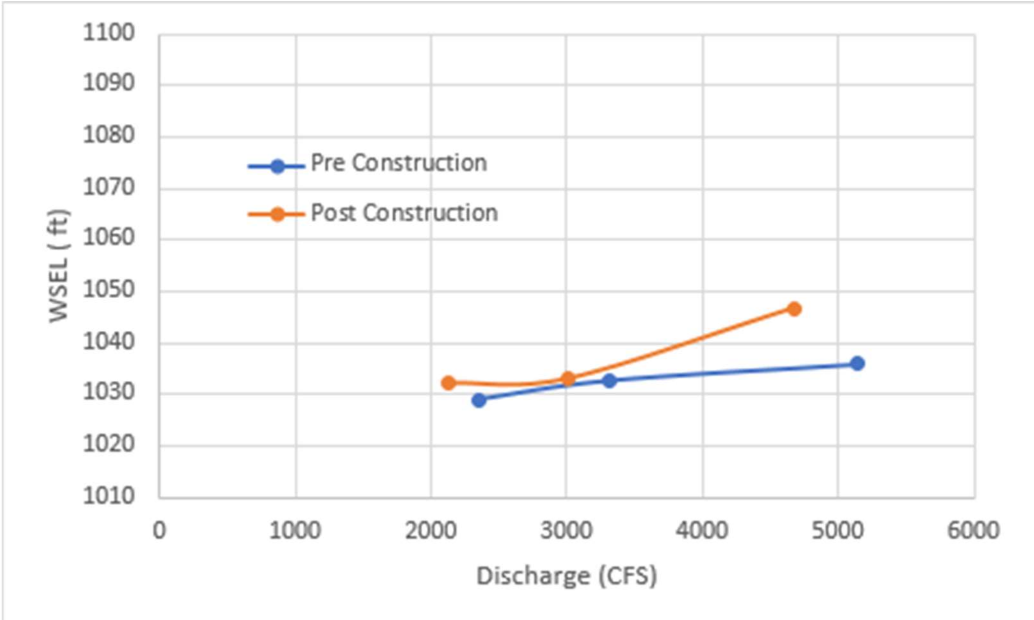


Figure 4. Pre and Post Construction Flows in Channel

Bridge Design

Following Iowa DOT LRFD guidelines, the recommended freeboard is 3 feet between the Water Surface Elevation of White Fox Creek's 50-year recurrence interval floodplain and the bottom of the bridge at midspan. With a floodplain elevation of 1032.77 feet above sea level, the bottom of the midspan of the bridge should be at the elevation of around 1036 feet above sea level. Therefore, the bridge must span a distance of 150 feet. Using the bridge decision matrix, a prefabricated bridge was selected. For the prefabricated bridge, US Bridge was consulted. Upon reviewing the available bridge designs, a Cambridge Series truss bridge was selected because of its ability to span long distances and its aesthetic appeal. The Cambridge Series truss is a Warren Truss on steel girders. The steel is weathered to protected from corrosion. The bridge is designed to support the live load of a HL-93 design truck which would allow for large dump trucks to use this bridge, which was specified by the client. This bridge will also be utilizing elastomeric bearing pads. A bridge width of 16 feet was determined in order to allow for pedestrians and vehicles to use the bridge simultaneously. A guardrail is attached to the truss of the bridge to protect the truss from vehicular collisions and to keep pedestrians safe. A 3D rendering of the Cambridge Series Bridge is shown below in Figure 5.

Figure 5. 3D Rendering of Bridge

Abutment Design

Because the majority of prefabricated bridge manufactures do not design the bridge's abutments, we designed them ourselves. We decided to design non-integral abutments without piles in order to save on material and construction costs. A non-integral abutment is also known as seat abutment because the bridge sits on the abutment seat and acts independently from the abutment through the use of an expansion joint. The design of the abutments were based off AASHTO LRFD Bridge Design Specifications and the Iowa DOT LRFD Bridge Design Manual. The loads that were considered were dead loads, live loads, wind loads, impact loads, and earth loads.

The main components of a non-integral abutment are back wall, stem, wing walls, and foundation. The width of the abutment foundation is 10 feet and the length is 16 feet. The stem is 3 foot wide. In this type of abutment, the stem resists the lateral soil pressure. The seat of the abutment is 2 feet allowing for adequate bearing capacity. The reinforcing steel in the abutments is A. 572 Gr. 60 steel. The reinforcing in the foundation of the abutment is # 7 bar with a 12-inch spacing on center. The reinforcing that connects the stem to the foundation is #7 bars with a 9-inch spacing on center. The main stem reinforcing is #7 bars and #5 bars with a 12-inch spacing on center. The top stem reinforcing is using #5 bars with 10-inch spacing on center. In addition, the abutment was designed with wing walls at 45 degrees to protect the abutment from erosion high flow waters.

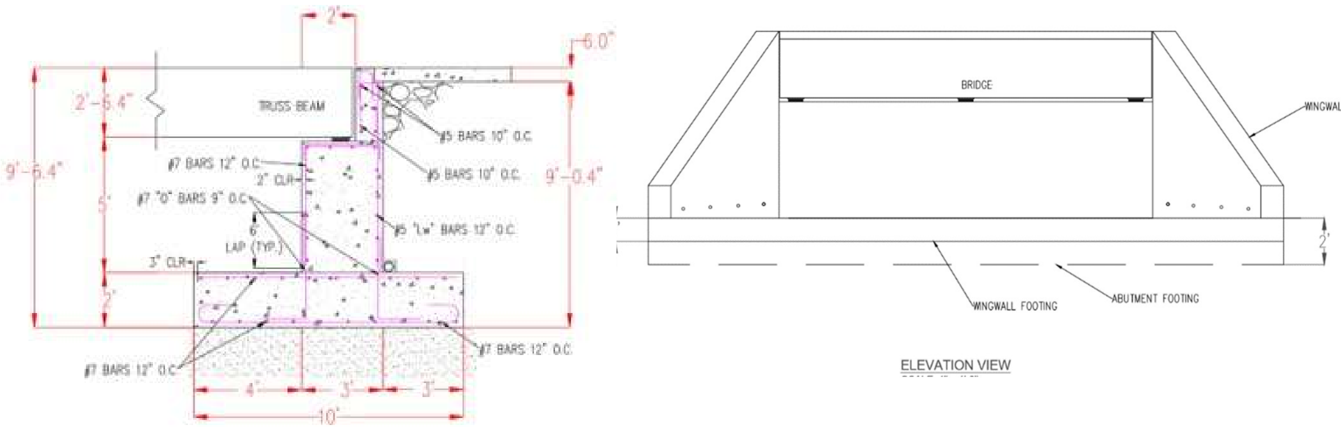
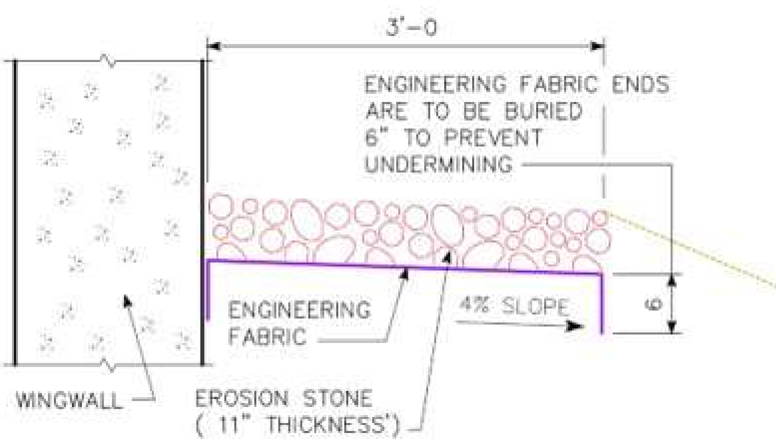


Figure 6. Abutment Design

Rip Rap Design

In order to protect a bridge from failure, all possibilities must be accounted for. In a high velocity event such as a flood or storm event, waters can erode the soil base below the abutment of the bridge and cause collapse. Abutment armoring can prevent fast waters from eroding the banks of a channel in many ways and the simplest and cheapest option is to place rip-rap along the banks surrounding the abutments. Following the Federal Highway Association's guidelines for sizing and placement of the rip-rap, the project requires 5.5" diameter or Class A rip rap to surround the abutment in a layer of no less than 11inches thick to prevent erosion.



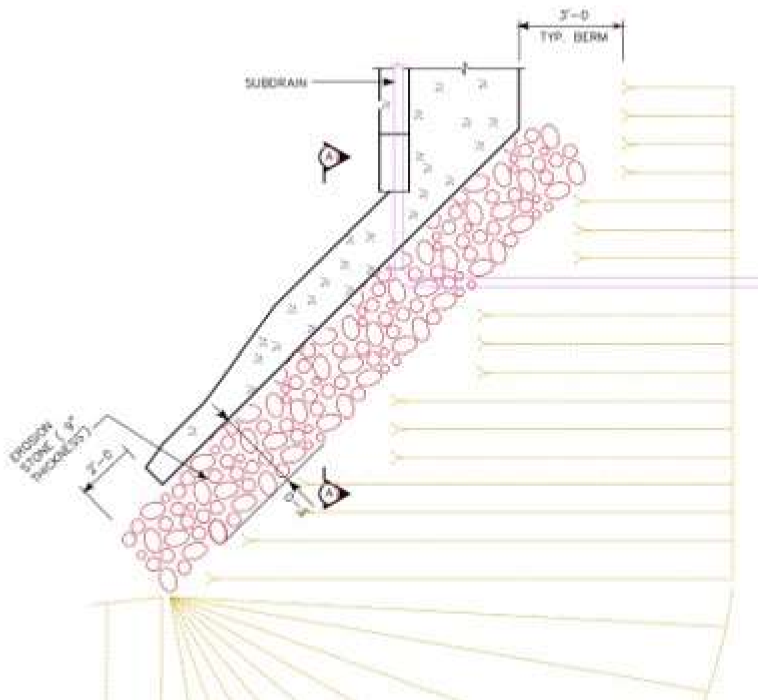


Figure 7. Wing Wall Armoring Drawings

Parking Lot Location

The location of the parking lot was determined based on practicality, and feasibility and environmental impact. Our team recommends that the parking lot be construction south of the spillway next to the restrooms and picnic site. It would be easier to allow traffic coming from the entrance of the park to enter immediately to the parking lot. Also, its proximity to the picnic area and the bathroom would make it ideal for patrons to host their events. Based on previous discussions and observations, most patrons currently park their cars on the cross and on the edge of the road. Although farther than the other alternative location, out team believes patrons will still be more inclined to parking their car instead of actively driving their car around to several locations along the park. Thus, it would encourage patrons to walk and reduced traffic and greenhouse gas emissions within the park. Moreover, this also allows park maintenance crews to complete their task much quicker. Although not initially included in our presentation and cost, we do believe that city staff will seek the opportunity to place garbage cans of some sort along the painted islands to reduce trash from both patrons in the picnic site and others using the parking lot. This location is also ideal for infiltration of runoff water. Its distance is an additional barrier for chemicals to seep into the soil and enter the waterway.

Parking Lot Design

The number of stalls was determined by consulting Iowa SUDAS Design Manual Chapter 8C-1. Although there are no minimum parking space standards for recreational areas, we assumed that there would be a maximum of 15 patron cars at one time throughout the day. We were unable to accurately determined the amount of people that visit the park and even less be able to determine how many cars are usually in the park. Based on this assumption, using the SUDAS Design Manual we determined that at least one additional stall be accessible. This is in accordance to the 2010 ADA Standards for Accessible Design. Based on SUDAS Design Manual Chapter 8B-1, a 60° angle one-way parking lot was selected since it will provide a narrower drive aisle and has the same surface area as a perpendicular parking lot. AutoCAD Civil 3D, has integrated parking lot design standards that are similar to SUDAS. Those were used to automatically produce the design. The road design was based on SUDAS Design Manual Chapter 5. The width of the road was selecting assuming that it would be the same width as a class D residential road, which is 10 ft. However, since there is additional freedom due to the fact there were no guidelines for recreational areas, the road width selected was 10.5ft. The parking lot blocks were selected based on material and the goal to reduce environmental impact. Our team recommends using recycled plastic parking blocks for all stalls. Moreover, according to Iowa DOT, to ensure public safety, the parking lot and parking road would require signage. Such signage according to Chapter 2B-4 of the Iowa DOT Traffic and Safety Manual, would be Do Not Enter, Wrong Way and One-Way signs. These signs will allow traffic to pass through the one-way parking lot with minimal traffic accidents.

Parking Lot Landscaping

Parking lot landscaping was designed to serve two purposes: aesthetics and runoff water infiltration. The client requested that minimal tree clearing be done when installing the bridge and construction the parking lot. Thus, when selecting the plants recommended to be planted alongside the new parking lot, we selected the oak tree. In the search of endangered species in the area, it was determined that the prairie bush clover and the western prairie fringes orchid were some of those species. In our efforts to minimize our environmental impact, we searched for possible ways to get ahold some of these endangered species to grow more along the park. However, due to its rareness, there is only certain agencies allowed to buy such plants. Therefore, we concluded that plants of prairie bush clover and the western prairie fringed orchid be identified. Due to the fact they are prairie plants that their removal will require digging in order to prevent damage to the roots. However, there were several prairie plants native to Iowa selected(See Appendix E). These plants were seen as ideal due to their vibrant colors, height and ability to grow each year.

Bio-Infiltration Swale Design

The swale sizing was achieved by estimating the runoff of the new surface. The runoff of the new construction surface was estimated for a 100 year 15 minute storm duration to minimize flooding during common rain events. The rain intensity of the project location was estimated using NOAA’s data tables available online. The runoff coefficient was given a conservative estimate of asphalt pavement of 0.8 which is within the recommended runoff levels from Iowa SUDAS manual. The swale provides a retention basin for any runoff water to infiltrate the ground instead of pollution White Fox Creek. The location of the parking lot near the Creek provides a perfect opportunity to introduce bio-infiltration which provides habitat biodiversity and improves the filtration potential of the basin compared to conventional concrete-lined basins. The required volume of the swale is 90 ft^3.We decided to make the swale slightly larger to account for the increased frequency of large rain events. The final design of the bio-infiltration swale has a volume of around 130 ft^3.

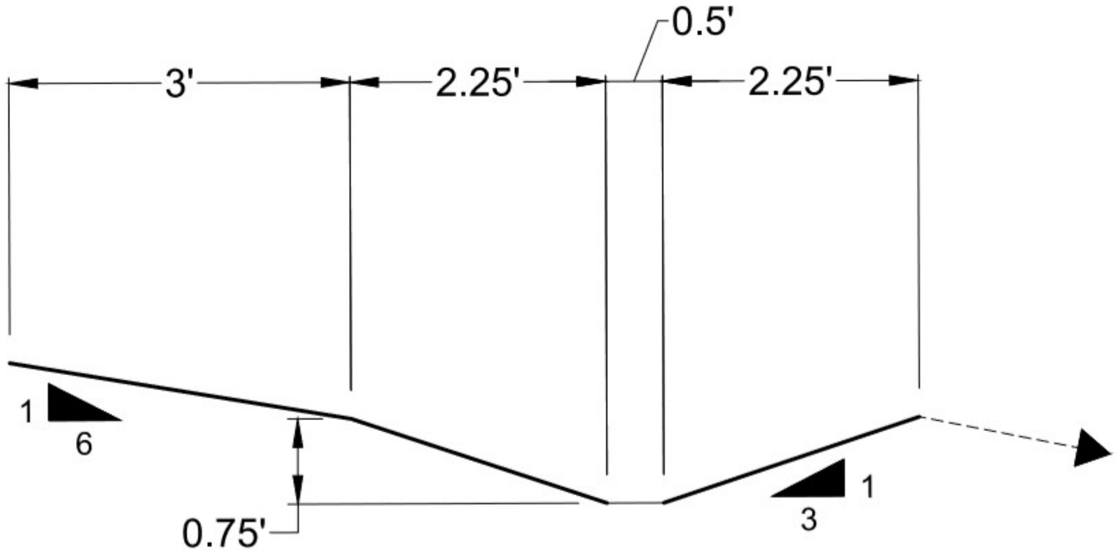


Figure 8. Bio Infiltration Cross Section

Section VII Engineer's Cost Estimate

For the project's engineer's cost estimate, we primarily referenced RSMeans Light Construction Manual 2016 and US Bridge Consultants.

Table 5. Detailed Cost Estimates

Quanties and Cost Estimate					
Catagory	Item	Cost/Unit	Unit	Quantity	Total
Parking Lot	Asphalt	$4.01	s.f.	8466	$33,949
	Gravel	$5.10	s.y.	940.7	$4,798
	Recycled Plastic Parking blocks	$46.00	each	16	$736
	Parking Stall Striping	$8.40	each	16	$134
	Handicap Stall Striping	$267.00	each	1	$267
	Signage	$72.00	each	6	$432
Landscaping	Oak Tree	$818.00	each	5	$4,090
	Wood Lily	$13.00	each	40	$520
	False Indigo	$27.00	each	20	$540
	Yello Gentian	$5.00	each	40	$200
	Green Needlegrass	$16.00	each	80	$1,280
Swale	Sod	$1.29	s.f.	504	$650
	Excavation	$96.00	c.y.	130	$12,480
Access Road	Asphalt	$4.01	S.F.	3160	12671.6
	Gravel	$5.10	S.Y.	351.11	1790.661
Bridge & Abutments	Pre-Fab Bridge	$313,850	each	1	$313,850
	Abutments and Concrete Deck (including reinforcing steel, paving, excavation, and backfill)	$215,400	each	1	$215,400
	Wing Wall Armoring	$81.76	c.y.	10.63	$869
	Gate	$795.00	each	1	$795
				sub-total	$605,452

Sub-total	$605,452
10% Contigency	$60,545.2
20% Engineering and Admin	$121,090.4
Total Project Cost	$787,087.81

Appendix A: Abutment Design Calculations

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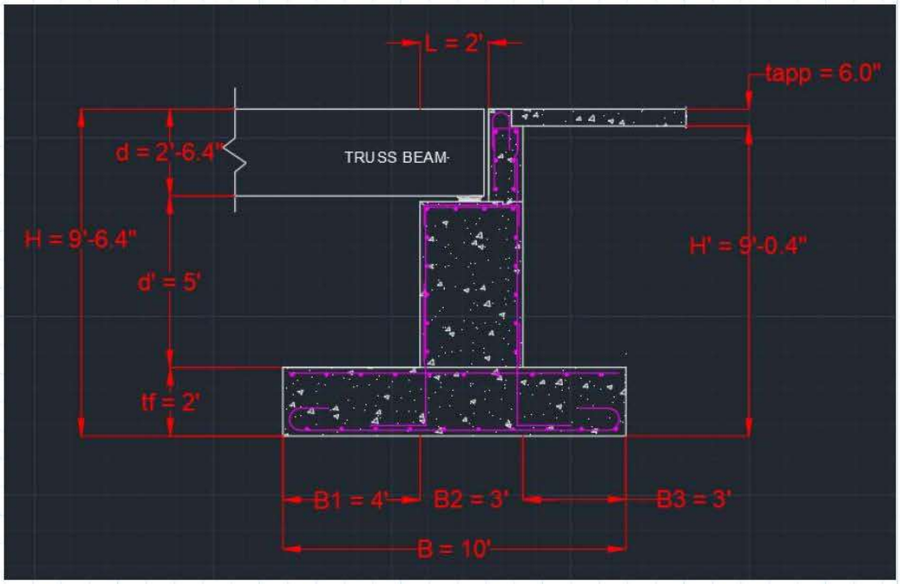
Abutment Design Calculations

Summary of Abutment Dimensions



$W_{abut} := 16\ ft$

$t_{app} := 6\ in$

$t_f := 2\ ft$

$d := 30.4\ in$

$H := 5\ ft + d + t_f = 114.4\ in$

$d' := H - d - t_f = 5\ ft$

$H' := H - t_{app} = 9.033\ ft$

$B_1 := 4\ ft$

$B_2 := 3\ ft$

$B_3 := 3\ ft$

$B := B_1 + B_2 + B_3 = 10\ ft$

$L := 2\ ft$

$L' := B_2 - L = 1\ ft$

$h := H'$

Weight of Materials

$W_c := 0.15\ \frac{kip}{ft^3}$ Weight of Concrete

Weight of Soils

Backfill:

$\gamma_b := 120\ pcf$

$K_{ab} := 0.33$

$K_{pb} := 3$

$\phi' := 29\ deg$

In Situ:

$\gamma := 120\ pcf$

$\gamma_{sat} := 135\ pcf$

$\gamma' := \gamma_{sat} - 62.4\ pcf = 72.6\ pcf$

$K_a := 0.42$

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Abutment Design Calculations

Loads on Abutment from Bridge

$$DL := \frac{94\ \mathbf{kip}}{W_{abut}} = 5.875\ \mathbf{klf}$$ Dead Load

$$LL := \frac{116\ \mathbf{kip}}{W_{abut}} + \frac{22\ \mathbf{kip}}{W_{abut}} = 8.625\ \mathbf{klf}$$ Live Load

$$IM := \frac{22\ \mathbf{kip}}{W_{abut}} = 1.375\ \mathbf{klf}$$ Impact Load

$$WL := \frac{34\ \mathbf{kip}}{W_{abut}} = 2.125\ \mathbf{klf}$$ Wind Load

Excel File Input

Variable	ft	Variable	Unit	
H	9.533	tapp	0.5	ft
d	2.533	wc	0.15	kcf
d'	5	γ	0.12	kcf
H'	9.033	h	9.033	
B1	4	Wabut	16	ft
B2	3	ϕ'	29	
B3	3	Kab	0.33	
B	10	Wc	0.15	kip/ft^3
L	2	Ws	0.49	kip/ft^3
L'	1			
tf	2			

Abutment Loads and Moments

Vertical Load			
Item	V kip/ft	Arm(ft)	Moment Mv
selfweight 1	3	5	15
selfweight 2	2.25	5.5	12.375
selfweight 3	0.38	6.5	2.47
Backfil soil 4	3.252	8.5	27.642
DL	5.875	5	29.375
LL	7.25	5	36.25
IM	1.375	5	6.875
VD	1.2	8.5	10.2

Horizontal Load			
Item	H kip/ft	Arm (ft)	Moment, Mh
Pe	1.616	3.011	4.865
Hd	0.224	4.517	1.010
Hl	0.447	4.517	2.020
WL	2.125	7.000	14.875
LF	0.000		0.000
RST	0.000		0.000

Service Load Combinations

	DC,DD,DW	LL,IM	WA	WS	WL	FR
Service I	1	1	1	0.3	1	1
Service II	1	1.3	1	0	0	1
Service III	1	0.8	1	0	0	1
Service IV	1	0	1	0.7	0	1
Service V	0	0.75	0	0	0	0

CEE:4850

Abutment Design Calculations

Service Loads

Service Vertical Loads									
Item	selfweight 1	selfweight 2	selfweight 3	backfill soil 4	DL	LL	IM	VD	Sum
I	3	2.25	0.38	3.252	5.875	7.25	1.375	1.2	24.582
II	3	2.25	0.38	3.252	5.875	9.425	1.7875	1.2	27.1695
III	3	2.25	0.38	3.252	5.875	5.8	1.1	1.2	22.857
IV	3	2.25	0.38	3.252	5.875	0	0	1.2	15.957
V	0	0	0	0	0	5.4375	1.03125	0	6.46875

Service Horizontal Loads								
Item	Pe	Hd	Hl	WL		LF	RST	Sum
I	1.615702	0.223575	0.44715	0		0	0	2.286427
II	0.223575	0.223575	0.44715	0		0	0	0.8943
III	0.44715	0.223575	0.44715	0		0	0	1.117875
IV	2.125	0.223575	0.44715	0		0	0	2.795725
V	0	0	0	0		0	0	0

Service Moments

Service Vertical moments									
Item	selfweight 1	selfweight 2	selfweight 3	backfill soil 4	DL	LL	IM	VD	Sum
M	15	12.375	2.47	27.642	29.375	36.25	6.875	10.2	
I	15	12.375	2.47	27.642	29.375	36.25	6.875	10.2	140.187
II	15	16.0875	2.47	27.642	29.375	47.125	8.9375	10.2	156.837
III	15	9.9	2.47	27.642	29.375	29	5.5	10.2	129.087
IV	15	0	2.47	27.642	29.375	0	0	10.2	84.687
V	0	9.28125	0	0	0	27.1875	5.15625	0	41.625

Service Horizontal moments								
Item	Pe	Hd	Hl	WL		LF	RTS	Sum
M	4.865058244	1.00981375	2.0196275	14.875		0	0	
I	4.865058244	1.00981375	2.0196275	4.4625		0	0	12.357
II	4.865058244	1.00981375	2.0196275	0		0	0	7.894499
III	4.865058244	1.00981375	2.0196275	0		0	0	7.894499
IV	4.865058244	1.00981375	2.0196275	10.4125		0	0	18.307
V	0	0	0	0		0	0	0

Eccentricity, Bearing Capacity, and Sliding Checks

Eccentricity Check										
Service	V	H	Mv	Mh	xo	e	emax	qt	q (Ksf)	Check
I	24.582	2.286427	140.187	12.35699949	5.200146	0.200146	1.666667	2.7534	2.363587	Pass
II	27.1695	0.8943	156.837	7.894499494	5.481974	0.481974	1.666667	3.50265	2.478076	Pass
III	22.857	1.117875	129.087	7.894499494	5.302205	0.302205	1.666667	2.70015	2.155424	Pass
IV	15.957	2.795725	84.687	18.30699949	4.15993	0.84007	1.666667	2.4	1.917941	Pass
V	*6.46875*	*0*	*41.625*	*0*	*6.434783*	*1.434783*	*1.666667*	*1.20375*	*0.502639*	*Pass*

CEE:4850

Abutment Design Calculations

Bearing Capacity Check							
Service	V	H	q	qn	FS	Fsreq	Check
I	24.582	2.286427	0.1536375	1	6.508828	3	Pass
II	27.1695	0.8943	0.169809375	1	5.888956	3	Pass
III	22.857	1.117875	0.14285625	1	7.000044	3	Pass
IV	15.957	2.795725	0.09973125	1	10.02695	3	Pass
V	6.46875	0	0.040429688	1	24.7343	3	Pass

Sliding check						
Service	V	H	Vn	FS	Fsreq	Check
I	24.582	2.286427	245.7808	107.4955815	1.5	Pass
II	27.1695	0.8943	245.7808	274.8303701	1.5	Pass
III	22.857	1.117875	245.7808	219.8642961	1.5	Pass
IV	15.957	2.795725	245.7808	87.91308158	1.5	Pass
V	6.46875	0	245.7808	#DIV/0!	1.5	#DIV/0!

Factored Load Combinations

	DC	EH	EV	ES	LL,IM,CEPL,LS,BR	WA	WL	FR
Strength I	1.25	1.5	1.3	1.5	1.75	1	0	1
Strength II	1.25	1.5	1.3	1.5	1.35	1	0	1
Strength III	1.25	1.5	1.3	1.5	0	1	1.4	1
Strength IV	1.5	1.5	1.3	1.5	0	1	0	1
Strength V	1.25	1.5	1.3	1.5	1.35	1	0.4	1

Factored Service Loads

Factored Vertical Loads									
Item	selfweight 1	selfweight 2	selfweight 3	backfill soil 4	DL	LL	IM	VD	Sum
I	3.75	2.8125	0.475	4.2276	7.34375	12.6875	2.40625	1.5	35.2026
II	3.75	2.8125	0.475	4.2276	7.34375	9.7875	1.85625	1.5	31.7526
III	3.75	2.8125	0.475	4.2276	7.34375	0	0	1.5	20.10885
IV	4.5	3.375	0.57	4.2276	8.8125	0	0	1.8	23.2851
V	3.75	2.8125	0.475	4.2276	7.34375	9.7875	1.85625	1.5	31.7526

Factored Horizontal Loads								
Item	Pe	Hd	Hl	WL		LF	RST	Sum
I	2.423553	0.3353625	0.670725	0		0	0	3.429641
II	2.423553	0.3353625	0.670725	0		0	0	3.429641
III	2.423553	0.3353625	0.670725	2.975		0	0	6.404641
IV	2.423553	0.3353625	0.670725	0		0	0	3.429641
V	2.423553	0.3353625	0.670725	0.85		0	0	4.279641

Factored Service Moments

Factored Vertical moments									
Item	selfweight 1	selfweight 2	selfweight 3	backfill soil 4	DL	LL	IM	VD	Sum
M	15	12.375	2.47	27.642	29.375	36.25	6.875	10.2	
I	18.75	15.46875	3.0875	35.9346	36.71875	63.4375	12.03125	12.75	198.1784
II	18.75	15.46875	3.0875	35.9346	36.71875	48.9375	9.28125	12.75	180.9284
III	18.75	15.46875	3.0875	35.9346	36.71875	0	0	12.75	122.7096
IV	22.5	18.5625	3.705	35.9346	`	0	0	15.3	96.0021
V	18.75	15.46875	3.0875	35.9346	36.71875	48.9375	9.28125	12.75	180.9284

CEE:4850

Abutment Design Calculations

Factored Horizontal moments								
Item	Pe	Hd	Hl	WL		LF	RTS	Sum
M	4.865058244	1.00981375	2.0196275	14.875		0	0	
I	7.297587367	1.514720625	3.02944125	0		0	0	11.84175
II	7.297587367	1.514720625	3.02944125	0		0	0	11.84175
III	*7.297587367*	*1.514720625*	*3.02944125*	*20.825*		*0*	*0*	*32.66675*
IV	7.297587367	1.514720625	3.02944125	0		0	0	11.84175
V	*7.297587367*	*1.514720625*	*3.02944125*	*5.95*		*0*	*0*	*17.79175*

Eccentricity, Bearing Capacity, and Sliding Checks

Eccentricity Check										
Service	V	H	Mv	Mh	xo	e	emax	Check	qt	q (Ksf)
I	35.2026	3.4296405	198.17835	11.84174924	5.293262	0.293262	1.666667	Pass	0.403311	0.323963
II	31.7526	3.4296405	180.92835	11.84174924	5.325126	0.325126	1.666667	Pass	0.409868	0.322024
III	20.10885	6.4046405	122.7096	32.66674924	4.477772	0.522228	1.666667	Pass	0.841145	0.715159
IV	23.2851	3.4296405	96.0021	11.84174924	3.614344	1.385656	1.666667	Pass	0.628102	0.474449
V	31.7526	4.2796405	180.92835	17.79174924	5.13774	0.13774	1.666667	Pass	0.463333	0.416491

Bearing Capacity Check							
Service	V	H	q	qn	FS	Fsreq	Check
I	35.2026	3.4296405	0.22001625	1	4.545119	3	Pass
II	31.7526	3.4296405	0.19845375	1	5.038957	3	Pass
III	20.10885	6.4046405	0.125680313	1	7.956696	3	Pass
IV	23.2851	3.4296405	0.145531875	1	6.871347	3	Pass
V	31.7526	4.2796405	0.19845375	1	5.038957	3	Pass

Sliding check						
Service	V	H	Vn	FS	Fsreq	Check
I	35.2026	3.4296405	245.7808	71.66372102	1.5	Pass
II	31.7526	3.4296405	245.7808	71.66372102	1.5	Pass
III	20.10885	6.4046405	245.7808	38.37542482	1.5	Pass
IV	23.2851	3.4296405	245.7808	71.66372102	1.5	Pass
V	31.7526	4.2796405	245.7808	57.43024443	1.5	Pass

Settlement Check

Settlement check (center)		Unit
B'	5	in
α	4	
N	10	
M	1.6	
I1	0.597	
I2	0.025	
μs	0.35	
Es	290.076	ksf
Is	0.608538	
B/L	0.625	
Df/B	0.903333	
If	0.7	
q	0.220016	ksf
Se	0.068044	in

Formulas:

$$B' := \frac{B}{2}$$

$$M := \frac{L}{B} = 0.2$$

$$N := \frac{5 \cdot B}{B'} = 10$$

I_1 and I_2 are from Table 5-2

$$I_S = I_1 + \left(\frac{1 - 2 \cdot \mu_s}{1 - \mu_s}\right) \cdot I_2$$

I_f is interpolated from Table 5.10

$$S_e = q \cdot \alpha \cdot B' \cdot \left(\frac{1 - {\mu_s}^2}{E_S}\right) \cdot I_S \cdot I_f$$

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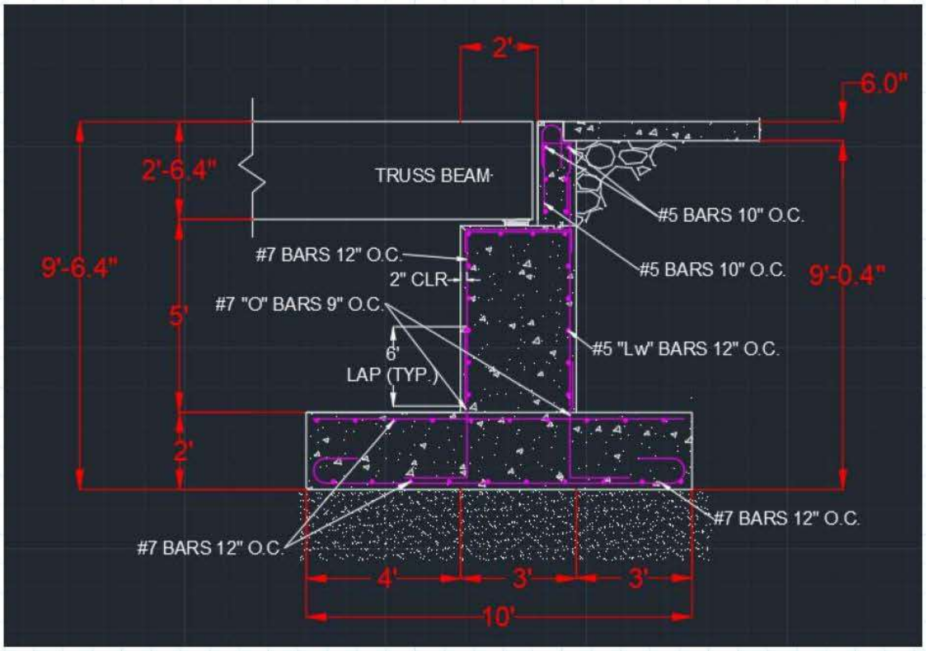
Abutment Design Calculations

Abutment Reinforcing Steel Summary



$f'_c := 4\ ksi$ $\beta_1 := 0.85$ *#7 bar:*

$F_y := 6\ ksi$ $d_b := 0.875\ in$

$A_7 := 0.6\ in^2$

$P_e := 1.62\ \frac{kip}{ft}$ $cover := 2\ in$

$s := 12\ in$

$H_l := 0.447\ \frac{kip}{ft}$

$H_d := 0.224\ \frac{kip}{ft}$

Stem Bars:

$$M_u := \left(P_e \cdot \frac{h}{3} + H_l \cdot h \cdot 0.5 + H_d \cdot h \cdot 0.5\right) \cdot ft = 7.909\ kip \cdot ft$$

$$d_s := B_2 - cover - \frac{d_b}{2} = 2.797\ ft$$

$$c := \frac{A_7 \cdot F_y}{0.85 \cdot f'_c \cdot \beta_1 \cdot B_2} = 0.003\ ft \qquad \frac{c}{d_s} = 0.001 \qquad a := \beta_1 \cdot c = 0.029\ in$$

$$\varepsilon_t := 0.003 \cdot \left(\frac{d_s}{c} - 1\right) = 2.907$$

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Abutment Design Calculations

$\phi M_n := 0.9 \cdot A_7 \cdot F_y \cdot \left(d_s - \frac{a}{2}\right) = 9.058\ \mathbf{kip \cdot ft}$

$\phi M_n > M_u = 1$ *ok*

Stem "O" Bars:

$d := 0.5 \cdot B_1 = 2\ \mathbf{ft}$
$b := B_1 = 4\ \mathbf{ft}$
$t := 0.5 \cdot B_2 = 1.5\ \mathbf{ft}$

$V_u := 1.7 \cdot P_e = 2.754\ \frac{\mathbf{kip}}{\mathbf{ft}}$

$M_u := \mathbf{ft} \cdot \left(V_u \cdot \frac{h}{3}\right) = 8.293\ \mathbf{kip \cdot ft}$

$C_1 := 1.7 \cdot f'_c \cdot b \cdot \frac{d}{2 \cdot F_y} = 652.8\ \mathbf{in}^2$

$C_2 := 6.8 \cdot f'_c \cdot b \cdot \frac{M_u}{4 \cdot 0.9 \cdot {F_y}^2} = \left(1.002 \cdot 10^3\right)\ \mathbf{in}^4$

$A_s := C_1 - \left({C_1}^2 - C_2\right)^{0.5} = 0.768\ \mathbf{in}^2$

Use #7 bars @ 9"

$A_7 = 0.6\ \mathbf{in}^2$ $s := 9\ \mathbf{in}$

$A_s stem := A_7 \cdot \frac{12\ \mathbf{in}}{s} = 0.8\ \mathbf{in}^2$

$A_s stem \geq A_s = 1$ *ok*

Longitudinal Steel Ratio

$\rho_w := \frac{A_s}{b \cdot d_s} = 4.769 \cdot 10^{-4}$

Check Shear

$P_u := \frac{P_e \cdot \left(h - d_s\right)^2}{h^2} = 0.772\ \mathbf{klf}$

$\lambda := 0.85$

$V_u := \left(P_u \cdot 1.7\right) \cdot \mathbf{ft} = 1.313\ \mathbf{kip}$

Appendix B: Hydraulic Analysis Calculations

Hydraulic Analysis

The following calculations were completed within the HEC-HMS and HEC-RAS softwares. More detailed coefficients and values were utilized within the software for every subbasin for the design calculations, but for ease-of understanding the example calculations within this appendix utilize averaged values for the entire basin.

Pre-Construction Analysis

Peak Runoff Calculation

Rainfall Intensity $i := 1.047 \frac{in}{hr} = \left(2.424 \cdot 10^{-5}\right) \frac{ft}{s}$

Runoff Coefficient $C := 0.1065$

Watershed Surface Area $A := 1.361 \cdot 10^{9}\ ft^{2}$

Peak Discharge

$Q := C \cdot i \cdot A = \left(2.108 \cdot 10^{5}\right) cfm$

Open-Channel Flow Calculation

Cross-sectional Area $a := 1373\ ft^{2}$

Wetted Perimeter $p := 622\ ft$

Hydraulic Radius $R := \frac{a}{p} = 2.207\ ft$

Channel Slope $S := 0.002 \frac{ft}{ft}$

Manning's Coefficient- retrieved value for a stream that is winding, clean, with some weeds and stones from SUDAS Table 2B-3.03

$n := 0.048$

Peak Velocity

$V := \frac{1.49}{n} R^{\frac{2}{3}} S^{\frac{1}{2}} = 2.353\ ft^{\frac{2}{3}}$

Post-Construction Analysis

Open-Channel Flow Calculation

Cross-sectional Area $a_{post} := a - 111.3\ ft^{2} = \left(1.262 \cdot 10^{3}\right) ft^{2}$

Wetted Perimeter $p := 622\ ft$

Hydraulic Radius $R := \frac{a_{post}}{p} = 2.028\ ft$

Channel Slope $S := 0.002 \frac{ft}{ft}$

Manning's Coefficient- retrieved value for a stream that is winding, clean, with some weeds and stones from SUDAS Table 2B-3.03 $n := 0.048$

Peak Velocity

$V := \frac{1.49}{n} R^{\frac{2}{3}} S^{\frac{1}{2}} = 2.225\ ft^{\frac{2}{3}}$

Rip-Rap Design

Rip-Rap design was done following the guidlines from the Federal Highway Administration's "Design of Rip Rap Revetment HEC-11" report.

Bank angle with horizontal $\theta := 42\ °$

RipRap material angle of repose $\phi := 43\ °$

Bank angle correction factor $K_1 := \left(1 - \frac{\sin(\theta)^2}{\sin(\phi)^2}\right)^{0.5} = 0.193$

Average Channel Velocity $V_{avg} := 2.22\ \frac{ft}{s} = 2.22\ \frac{ft}{s}$

Average Channel Depth $d_{avg} := 2.5\ ft = 2.5\ ft$

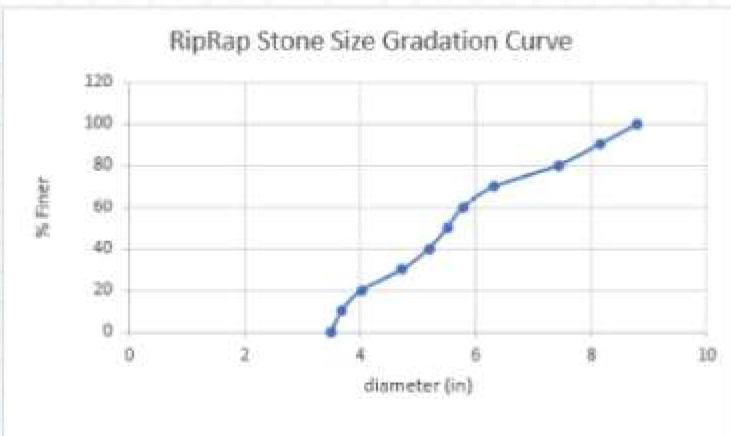
Diameter of Rip Rap $D_{50} := 0.00594\ \frac{s^2}{m^{\frac{1}{2}}} \cdot \frac{V_{avg}^{\ 2}}{\left(d_{avg}^{\ \frac{1}{2}} \cdot K_1^{\ \frac{3}{2}}\right)} = 0.12\ ft$

Correction Factor for rock material $C := 1.12785$

Abutment rip-rap correction factor $C_{abut} := 3.38$

$$D' := D_{50} \cdot C \cdot C_{abut} = 5.501\ in$$

Layer thickness $T := D' \cdot 2 = 11.001\ in$



$$V = \frac{1.49\left(r^{\frac{2}{3}}\right)\left(s^{\frac{1}{2}}\right)}{n}$$

where:

V = average velocity, ft/s

R = hydraulic radius, ft
= a/P
a = cross-sectional areas of flow, ft^2
P = wetted perimeter, ft

s = slope of the hydraulic grade line (channel slope), ft/ft

n = Manning's value for open channel flow

Type of Channel and Description	n
A. Closed Conduits Flowing Partly Full	
1. Steel - Riveted and Spiral	0.016
2. Cast Iron - Coated	0.013
3. Cast Iron - Uncoated	0.014
4. Corrugated Metal - Subdrain	0.019
5. Corrugated Metal - Storm Drain	0.024
6. Concrete Culvert, straight and fee of debris	0.011
7. Concrete Culvert, with bends, connections, and some debris	0.013
8. Concrete Sewer with manholes, inlet, etc., straight	0.015
9. Concrete, Unfinished, steel form	0.013
10. Concrete, Unfinished, smooth wood form	0.014
11. Wood - Stave	0.012
12. Clay - Vitrified sewer	0.014
13. Clay - Vitrified sewer with manholes, inlet, etc.	0.015
14. Clay - Vitrified subdrain with open joints	0.016
15. Brick - Glazed	0.013
16. Brick - Lined with cement mortar	0.015
B. Lined or Built-Up Channels	
1. Corrugated Metal	0.025
2. Wood - Planed	0.012
3. Wood - Unplaned	0.013
5. Concrete - Trowel finish	0.013
6. Concrete - Float finish	0.015
7. Concrete - Finished, with gravel on bottom	0.017
8. Concrete - Unfinished	0.017
9. Concrete Bottom Float Finished with sides of:	
a. Random stone in mortar	0.020
b. Cement rubble masonry	0.025
c. Dry ruble or rip rap	0.030
10. Gravel Bottom with sides of:	
a. Formed concrete	0.020
b. Dry rubble or rip rap	0.033
11. Brick - Glazed	0.013
12. Brick - In cement mortar	0.015
13. Masonry Cemented Rubble	0.025
14. Dry Rubble	0.032
15. Smooth Asphalt	0.013
16. Rough Asphalt	0.016
C. Excavated or Dredged Channel	
1. Earth, straight and uniform	
a. Clean, after weather	0.022
b. Gravel, uniform section, clean	0.025
c. With short grass, few weeds	0.027
2. Earth, winding and sluggish	
a. No vegetation	0.025
b. Grass, some weeds	0.030
c. Dense weeds or aquatic plants in deep channels	0.035
d. Earth bottom and rubble sides	0.030
e. Stony bottom and weedy banks	0.040
3. Channels not maintained, weeds and brush uncut	
a. Dense weeds, high as flow depth	0.080
b. Clean bottom, brush on sides	0.050
D. Natural Streams	
1. Clean, straight bank, full stage, no rifts or deep pools	0.030
2. As D.1 above, but some weeds and stones	0.035
3. Winding, some pools and shoals, clean	0.040
4. As D.3 above, but lower stages, more ineffective slope and sections	0.045
5. As D.3 above, but some weeds and stones	0.048
6. As D.4 above, but with stony sections	0.050
7. Sluggish river reaches, rather weedy or with very deep pools	0.070
8. Very weedy reaches	0.100

Appendix D: Bridge Cost Estimate Memo

U.S. BRIDGE®
BRIDGING AMERICA SINCE 1936

BRIDGE SCOPE

Date: April 1, 2019 **Estimate Number:** B19043318

To: Mitchell Allenback , Engineer
MGS Engineering

Project: Kendall Young Park , Webster City , IA

Estimate: $ 315,000 - $ 348,000 Including freight

This estimate is a U.S. Bridge Engineer's Cost Estimate for the subject project. This estimate is intended for preliminary estimating purposes only and should not be interpreted as a final quotation. The information presented is based on the most current data made available to U.S. Bridge.

Bridge Length:	150 ft	**Bridge Style:**	Cambridge Series
Roadway Width:	16 ft	**Bridge Deck:**	Steel Bridge Plank (Asphalt)
Bridge Loading:	HL-93	**Bearing Pads:**	Elastomeric Bearing Pad
Bridge Railing:	W Beam Attached Directly to Truss	**Steel Finish:**	Uncoated Weathering

Depth Of Structure: 30.4 in Note: A 2% crown is considered.

Preliminary Reactions for:	Truss Shoe Reactions
Dead Load:	94 k
Live Load:	116 k
Impact:	22 k
Abutment Horizontal Wind Load:	34 k

U.S. Bridge is factory direct and that means you benefit from;

- Factory direct pricing that ensures you are receiving the most competitive pricing available in the market today.
- Direct communication with our team that provides you with peace of mind that your project will be delivered on time and to your specifications.
- Knowing that your product is manufactured to the highest quality standards and in compliance with state and local regulations.

Thank you for considering U.S. Bridge to be your partner on this important project.

Should you have any questions, please contact your U.S. Bridge Representative.

U.S. BRIDGE

By: ______________________
Dan Rogovin, CEO

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Appendix E: Plants Chosen For Landscape

Oak Tree

Wood Lily

False Indigo

Yellow Gentian

Green Needlegrass

Design Drawings

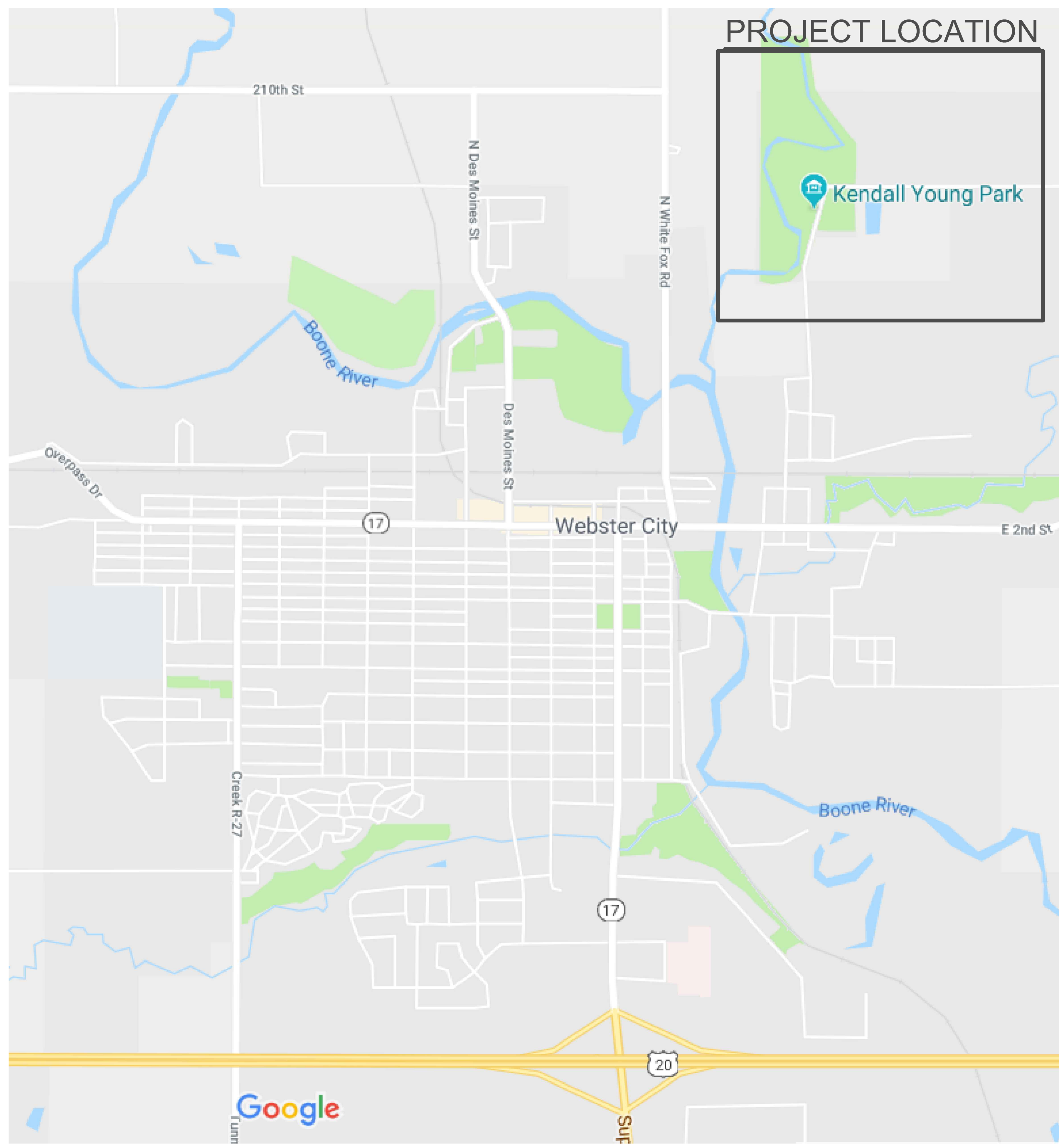
KENDALL YOUNG PARK NORTH ACCESS BRIDGE PROJECT

HAMILTON COUNTY - WEBSTER CITY

BRIDGE AND PARKING LOT CONSTRUCTION

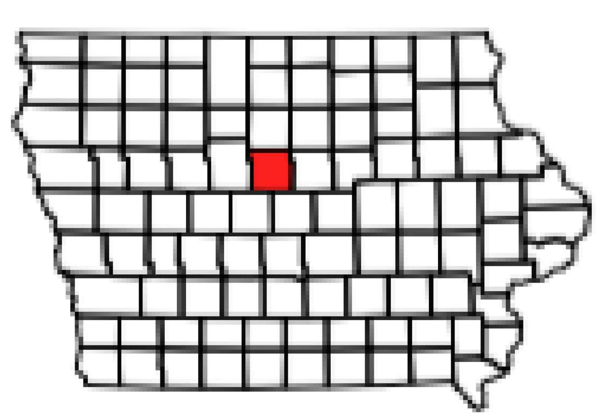
PREPARED BY MGS ENGINEERING, LTD.

PARK MAP



LOCATION MAP

COUNTY KEY



MGS Engineering, Ltd.

PROJECT: CEE: 4850
DATE : 4/10/2019
DRAWN BY: MPA
REVISION:

THE UNIVERSITY OF IOWA
CIVIL AND ENVIRONMENTAL ENGINEERING
4105 SEAMANS CENTER FOR THE ENGINEERING ARTS AND SCIENCES
103 S CAPITOL ST
IOWA CITY, IOWA 52242
PHONE: 319.335.5647
FAX: 319.335.5660
EMAIL: civil-hawks@uiowa.edu

EDUCATIONAL - NOT FOR CONSTRUCTION

KENDALL YOUNG PARK

JANE YOUNG RD
WEBSTER CITY, IOWA 50595

SHEET NAME

ABUTMENT ELEVATION

SHEET NO.

01

Quanties and Cost Estimate

Catagory	Item	Cost/Unit	Unit	Quantity	Total	Notes
Parking Lot	Asphalt	$4.01	s.f.	8466	$33,949	Cost includes materal and labor
	Gravel	$5.10	s.y.	940.7	$4,798	Cost includes materal and labor
	Recycled Plastic Parking blocks	$46.00	each	16	$736	Cost includes materal and labor
	Parking Stall Striping	$8.40	each	16	$134	Cost includes materal and labor
	Handicap Stall Striping	$267.00	each	1	$267	Cost includes materal, labor, post and signage
	Signage	$72.00	each	6	$432	Cost includes materal and labor
Landscaping	Oak Tree	$818.00	each	5	$4,090	Cost includes plants and labor
	Wood Lily	$13.00	each	40	$520	Cost includes plants and labor
	False Indigo	$27.00	each	20	$540	Cost includes plants and labor
	Yello Gentian	$5.00	each	40	$200	Cost includes plants and labor
	Green Needlegrass	$16.00	each	80	$1,280	Cost includes plants and labor
Swale	Sod	$1.29	s.f.	504	$650	Cost inclludes sod and labor
	Excavation	$96.00	c.y.	130	$12,480	Cost includes equipment, labor, and removal
Access Road	Asphalt	$4.01	S.F.	3160	12671.6	Cost includes materal and labor
	Gravel	$5.10	S.Y.	351.11	1790.661	Cost includes materal and labor
Bridge & Abutments	Pre-Fab Bridge	$313,850	each	1	$313,850	Cost includes freight
	Abutments and Concrete Deck (including reinforcing steel, paving, excavation, and backfill)	$215,400	each	1	$215,400	Cost developed with abutment design tool from Contech Engineered Solutions.
	Wing Wall Armoring	$81.76	c.y.	10.63	$869	Cost includes materal and labor
	Gate	$795.00	each	1	$795	Cost includes materal and labor
				sub-total	$605,452	

Sub-total	$605,452
10% Contigency	$60,545.2
20% Engineering and Admin	$121,090.4
Total Project Cost	$787,087.81

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KENDALL YOUNG PARK

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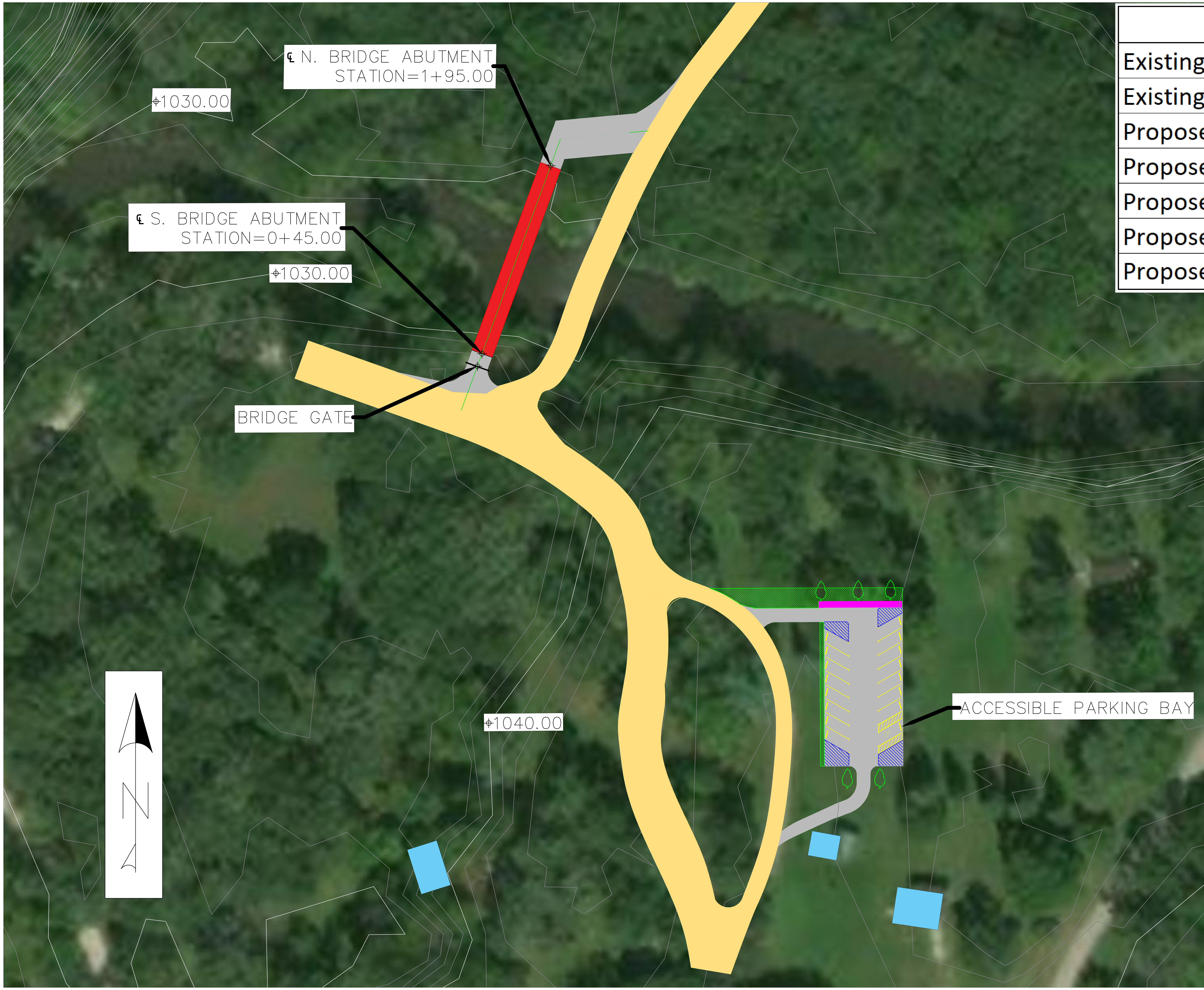
WEBSTER CITY, IOWA 50595

SHEET NAME
ABUTMENT ELEVATION

SHEET NO.
01



Legend	
Existing Road	
Existing Structures	
Proposed Parking Lot	
Proposed Access Road	
Proposed Landscaping	
Proposed Bio-Swale	
Proposed Bridge	

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KENDALL YOUNG PARK

JANE YOUNG RD
WEBSTER CITY, IOWA 50595

SHEET NAME
PROPOSED SITE PLAN

SHEET NO.
03

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PROJECT: CEE:4850
DATE : 4/10/2019
DRAWN BY: MPA
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SHEET NAME

PARKING LOT PLAN

SHEET NO.

04

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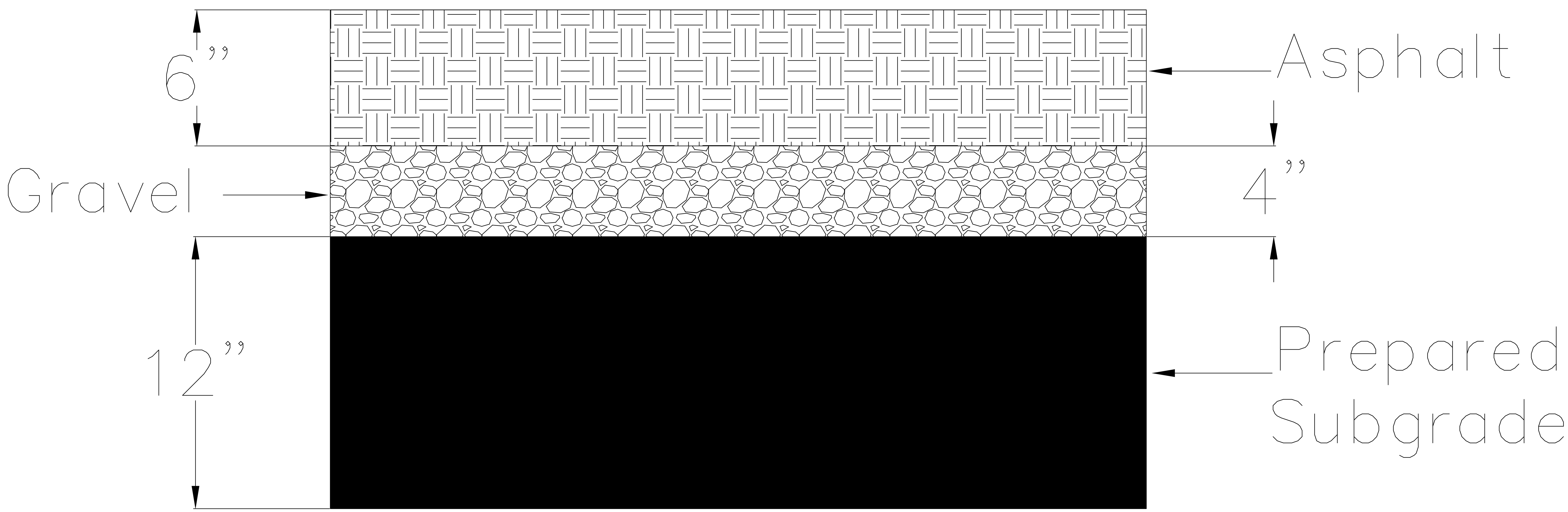

PAVEMENT CROSS SECTION

THE UNIVERSITY OF IOWA
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4105 SEAMANS CENTER FOR THE ENGINEERING ARTS AND SCIENCES
103 S CAPITOL ST
IOWA CITY, IOWA 52242
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PROJECT: CEE:4850
DATE : 4/10/2019
DRAWN BY: MPA
REVISION:

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KENDALL YOUNG PARK

JANE YOUNG RD
WEBSTER CITY, IOWA 50595

SHEET NAME
PAVEMENT DESIGN

SHEET NO.
05

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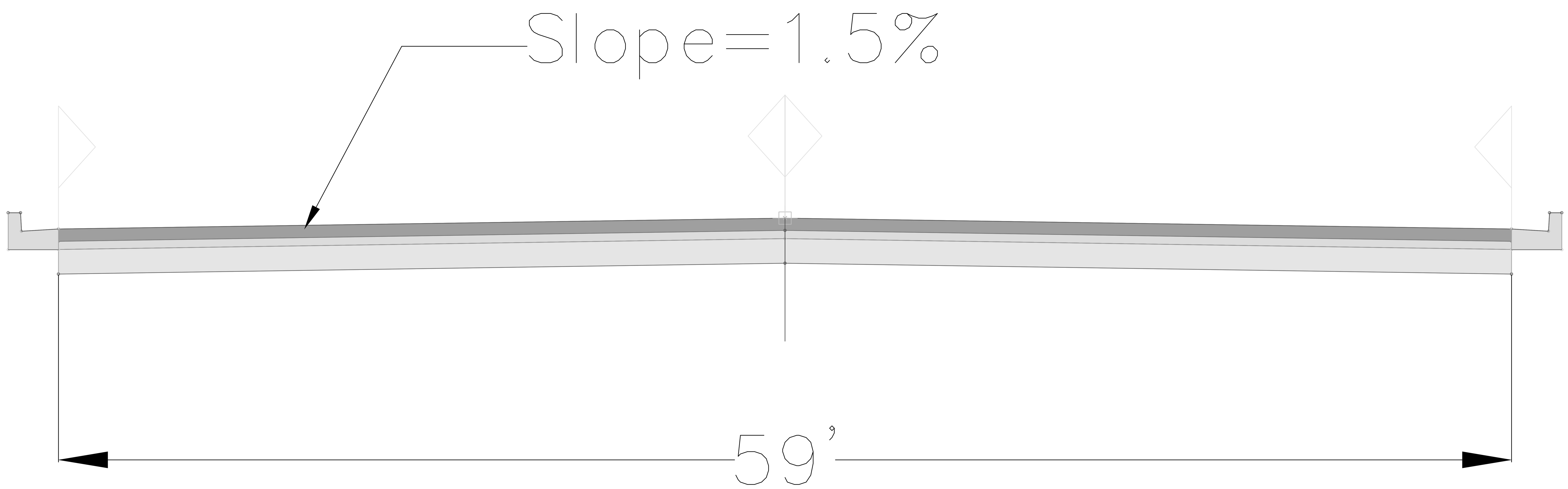
PRODUCED BY AN AUTODESK STUDENT VERSION
PRODUCED BY AN AUTODESK STUDENT VERSION



PARKING LOT CROSS SECTION

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PROJECT: CEE: 4850
DATE : 4/10/2019
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SHEET NAME
PARKING LOT CROSS SECTION

SHEET NO.
06

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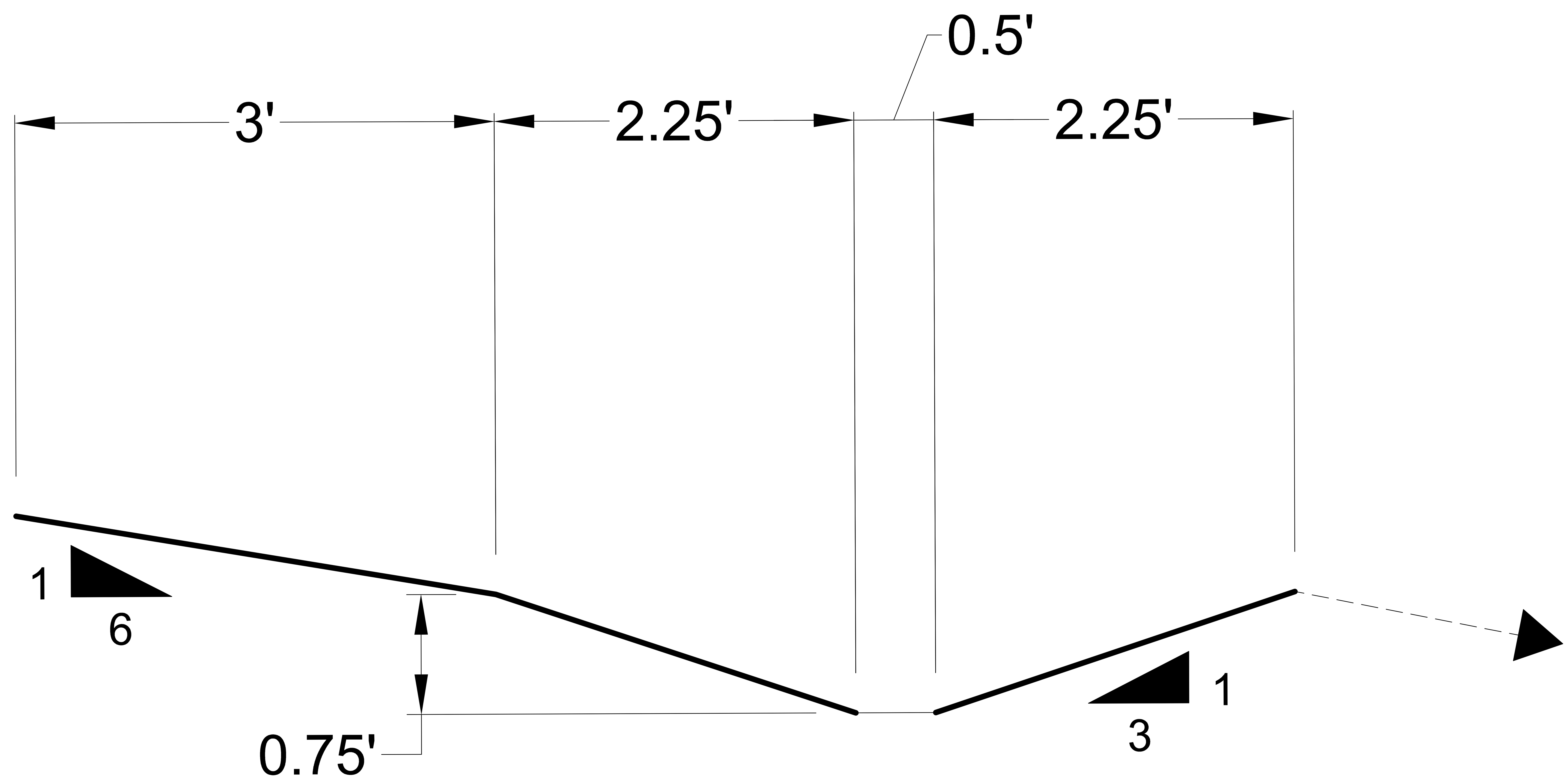
PRODUCED BY AN AUTODESK STUDENT VERSION



BIO-INFILTRATION CROSS SECTION

PROJECT: CEE: 4
DATE : 4/10/2
DRAWN BY:
REVISION:

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4105 SEAMANS CENTER FOR THE
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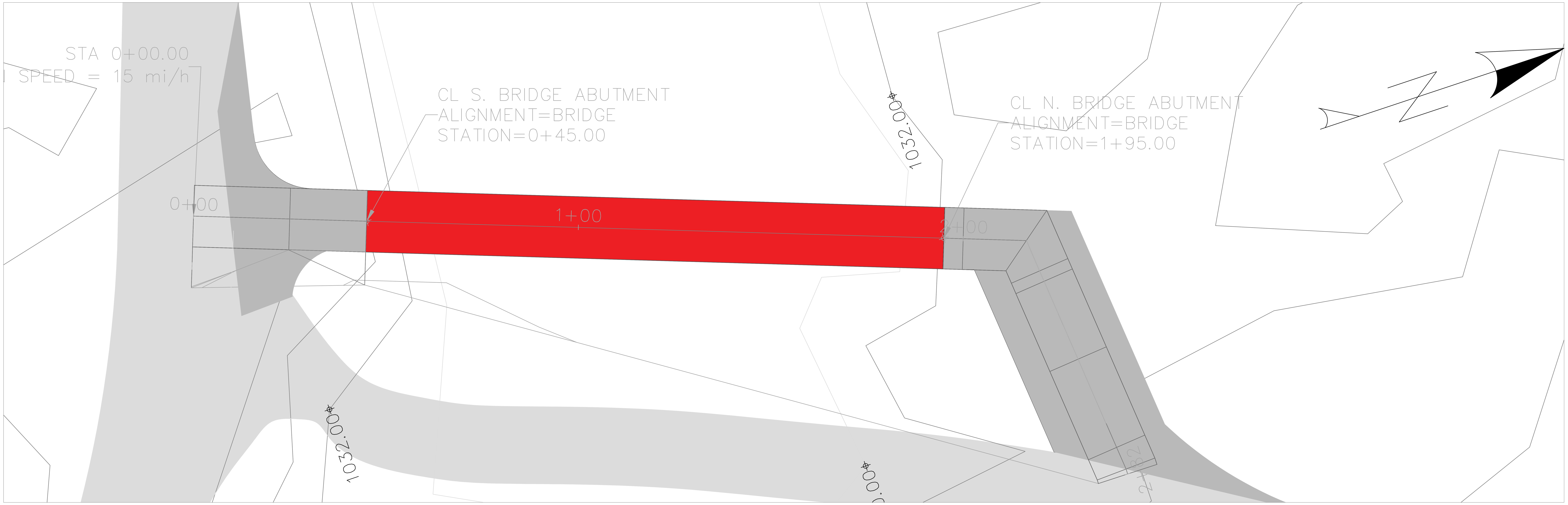
SHEET NAME

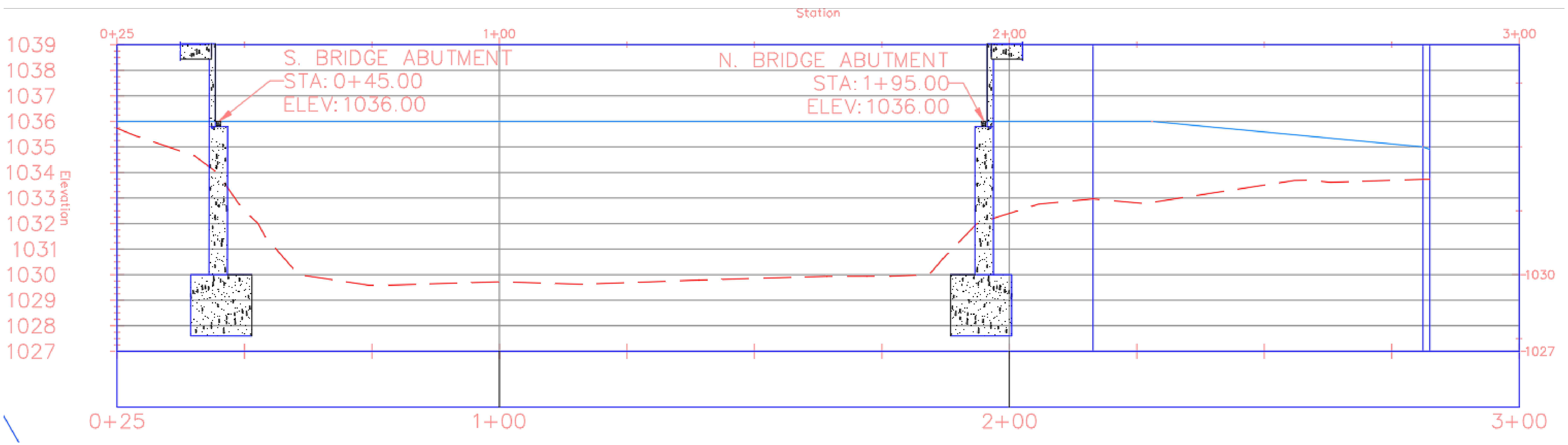
BIO-INFILTRATION CROSS SECTION

SHEET NO.

07



BRIDGE PLAN



BRIDGE PROFILE

PROJECT: CEE: 4850
DATE : 4/10/2019
DRAWN BY: MPA
REVISION:

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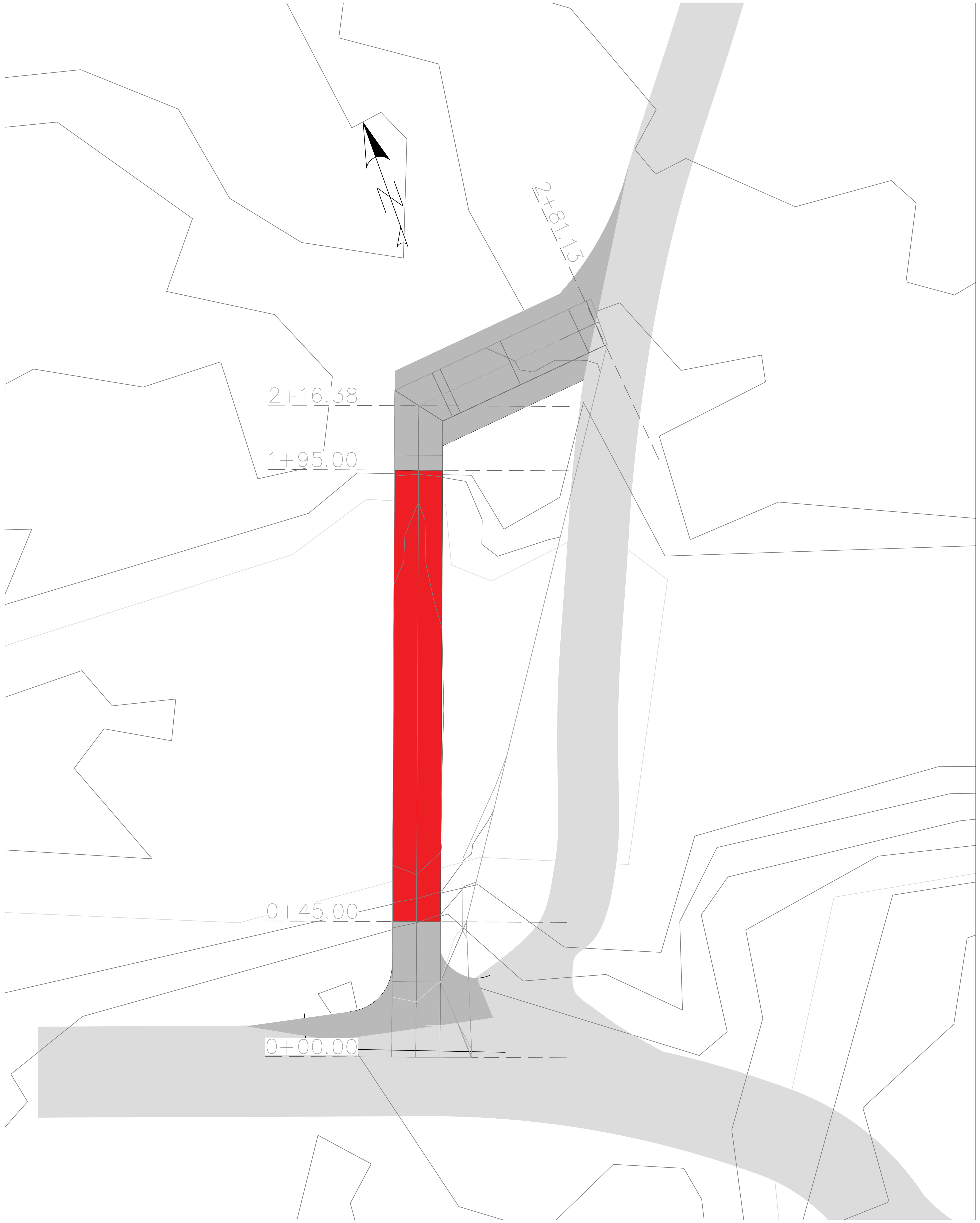
SHEET NAME

BRIDGE PLAN AND PROFILE

SHEET NO.

08



CROSS SECTION PLAN

PROJECT: CEE: 4850
DATE : 4/10/2019
DRAWN BY: MPA
REVISION:

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PHONE: 319.335.5647
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SHEET NAME
CROSS SECTION PLAN

SHEET NO.
09

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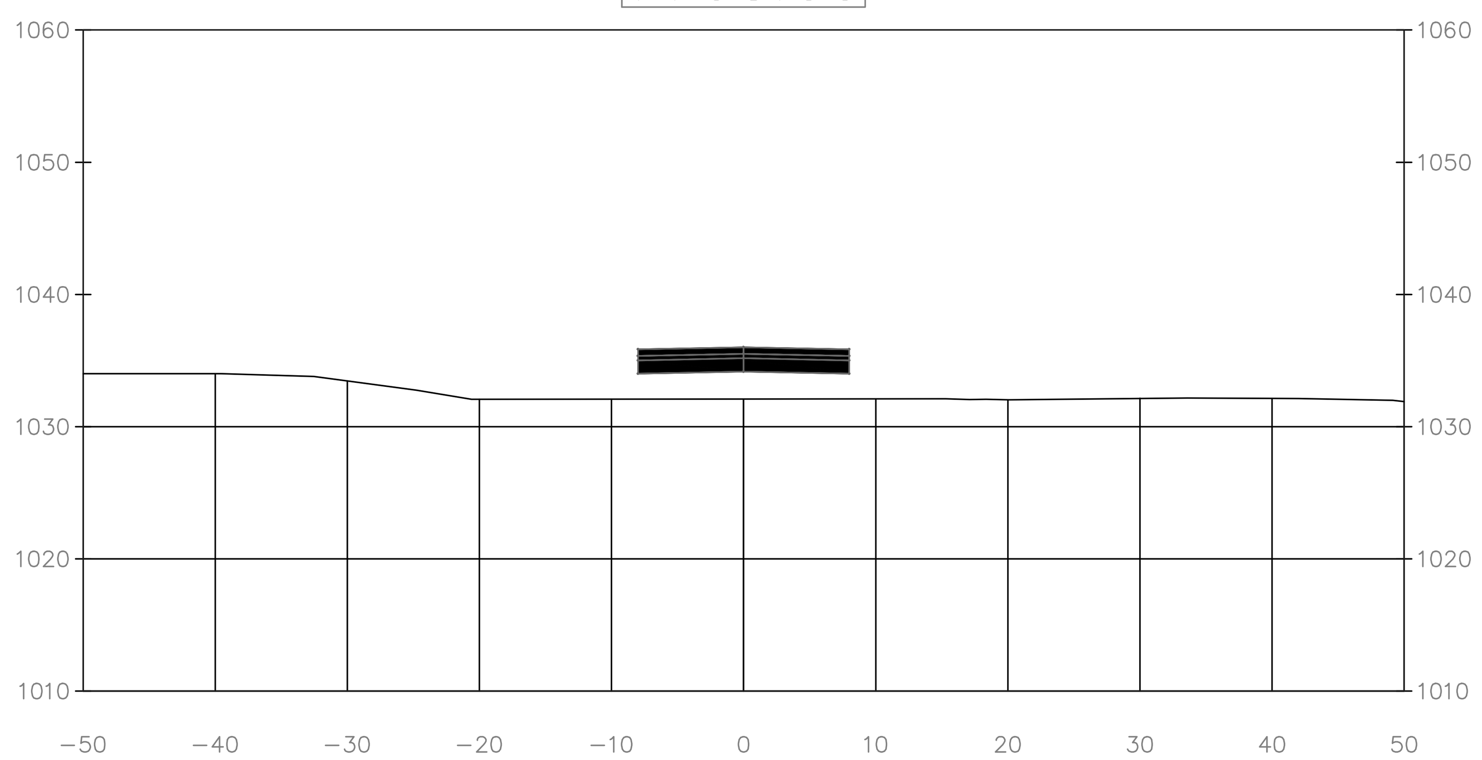
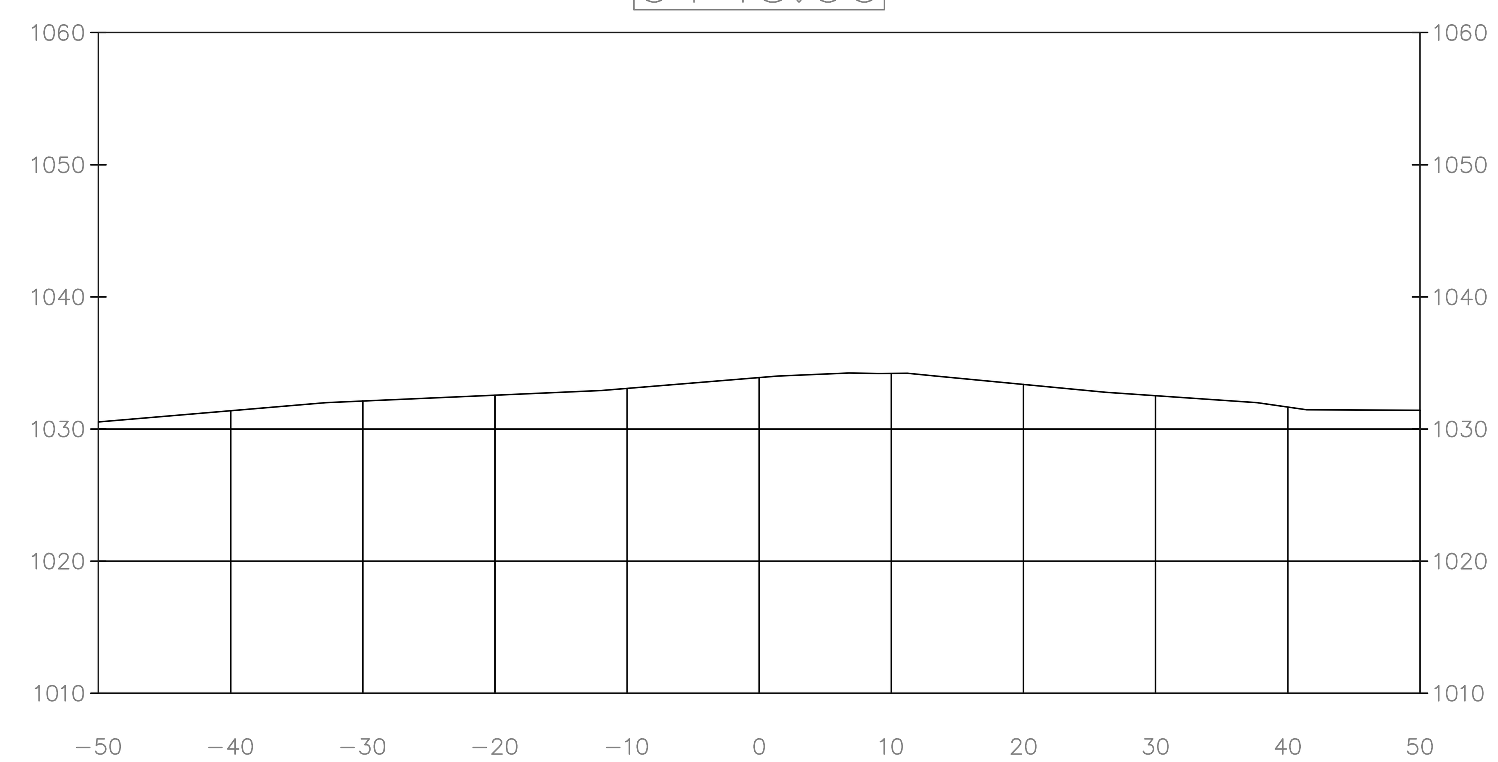
PRODUCED BY AN AUTODESK STUDENT VERSION

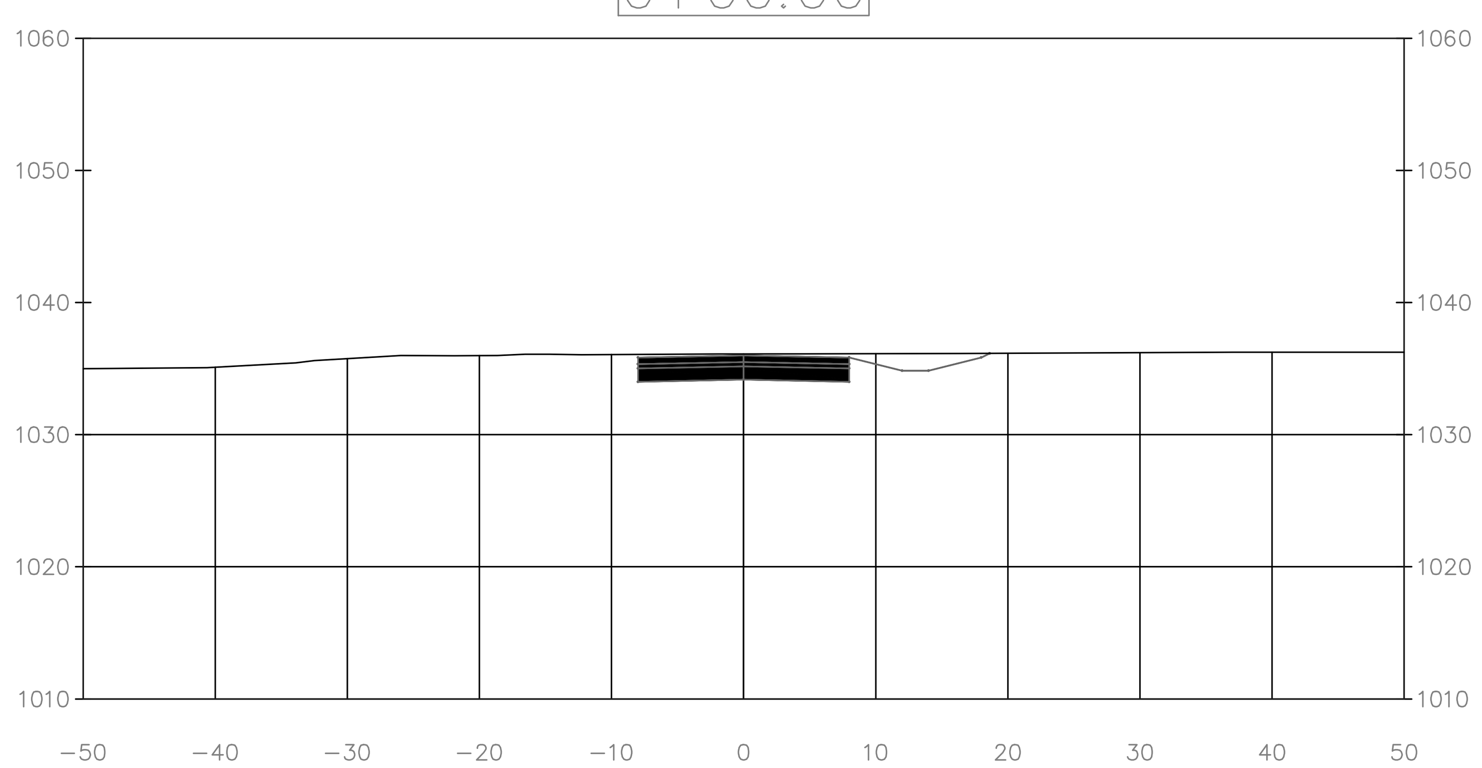
1+95.00



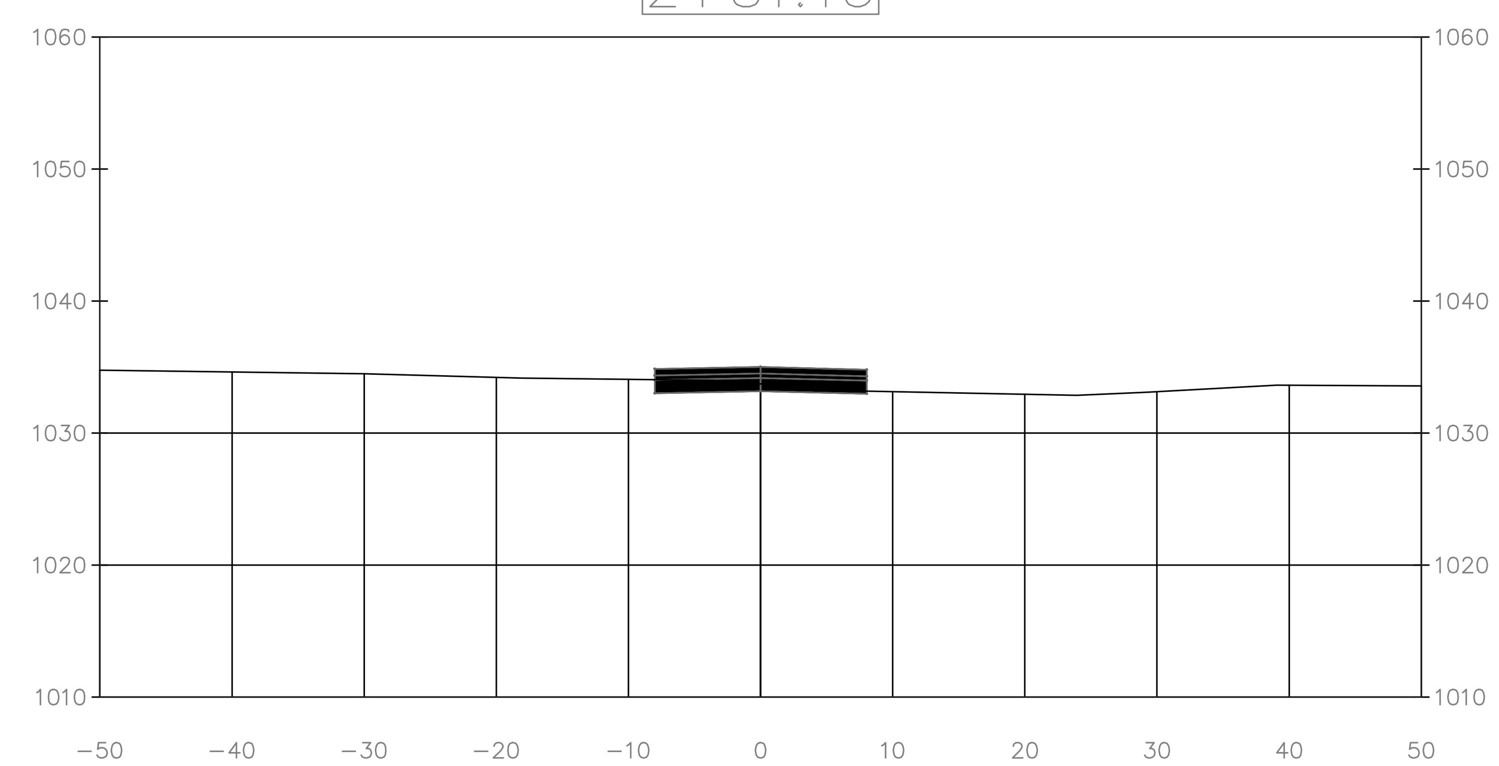
0+45.00



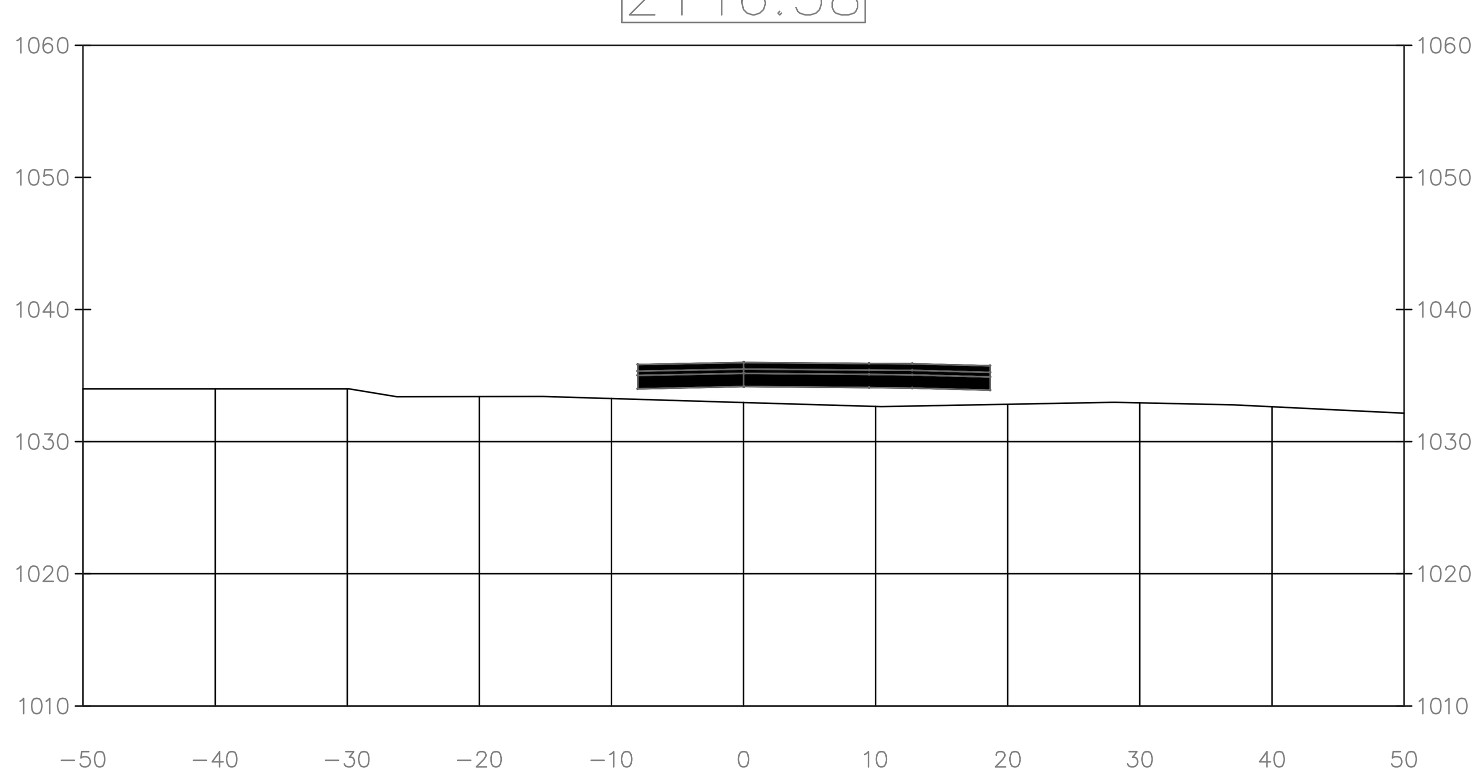
0+00.00



2+81.13



2+16.38



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KENDALL YOUNG PARK

JANE YOUNG RD
WEBSTER CITY, IOWA 50595

SHEET NAME

BRIDGE CROSS SECTIONS

SHEET NO.

10

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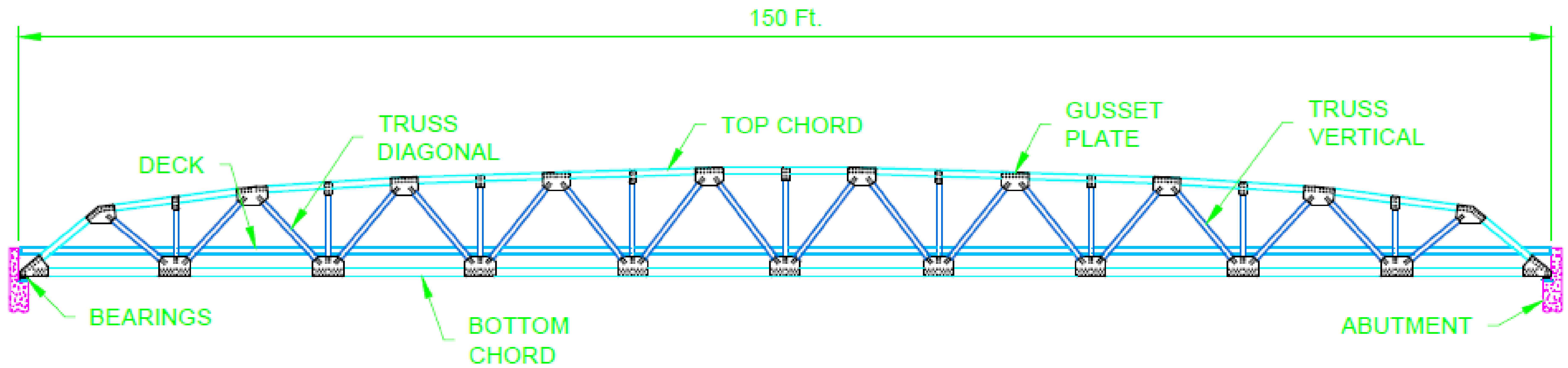
PRODUCED BY AN AUTODESK STUDENT VERSION
PRODUCED BY AN AUTODESK STUDENT VERSION



BRIDGE ELEVATION

The graphical information and details contained in these plans is schematic in nature. The plans, elevations and sections have been developed automatically in a way that demonstrates your current input in a relative and proportional manner. The details included in these plans have been selected to represent commonly built construction assemblies. These are not engineering drawings, and as such, the details may vary in the final design for your project depending on your final scope of work and specifications.

PRELIMINARY
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U.S. BRIDGE
BRIDGING AMERICA SINCE 1936
201 Wheeling Ave., Cambridge, Ohio 43725
1-888-872-7434 / www.usbridge.com

STYLE: Cambridge Series
LENGTH: 150 Ft.
WIDTH: 16 Ft.

MGS Engineering
Kendall Young Park
Webster City
Hamilton, IA

AISC CERTIFIED FABRICATOR

PROJECT: CEE: 4850
DATE : 4/10/2019
DRAWN BY: MPA
REVISION:

THE UNIVERSITY OF IOWA
CIVIL AND ENVIRONMENTAL ENGINEERING
4105 SEAMANS CENTER FOR THE ENGINEERING ARTS AND SCIENCES
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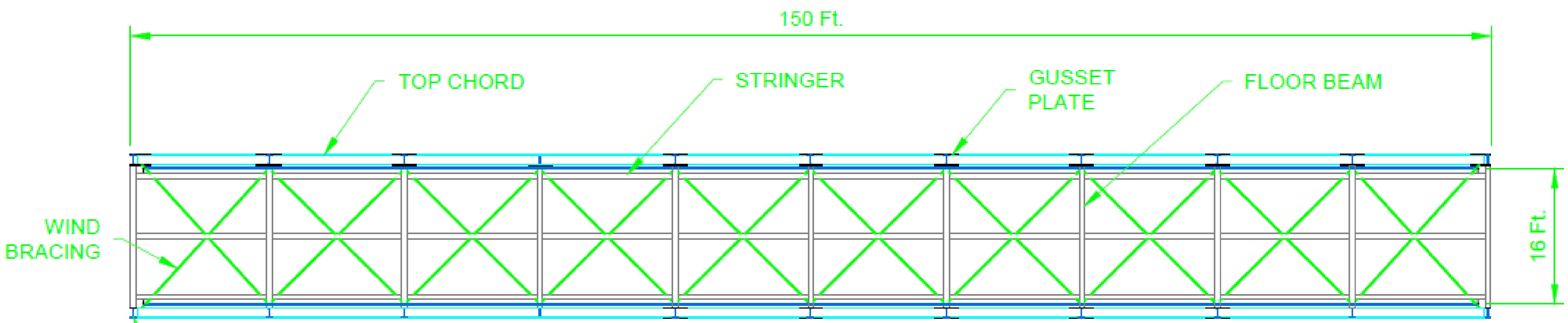
EDUCATIONAL - NOT FOR CONSTRUCTION

KENDALL YOUNG PARK
JANE YOUNG RD
WEBSTER CITY, IOWA 50595

SHEET NAME
BRIDGE ELEVATION

SHEET NO.
11



BEARING SEAT
WITH REACTIONS (TYP)
DEAD LOAD = *94 k*
LIVE LOAD = *116 k*
IMPACT LOAD = *22 k*
WIND LOAD = *34 k*

BRIDGE PLAN

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BRIDGING AMERICA SINCE 1986
201 Wheeling Ave., Cambridge, Ohio 43725
1-888-872-7434 / www.usbridge.com

STYLE: Cambridge Series
LENGTH: 150 Ft.
WIDTH: 16 Ft.

MGS Engineering
Kendall Young Park
Webster City
Hamilton, IA

AISC CERTIFIED FABRICATOR

PROJECT: CEE: 4850
DATE : 4/10/2019
DRAWN BY: MPA
REVISION:

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SHEET NAME
BRIDGE PLAN

SHEET NO.
12

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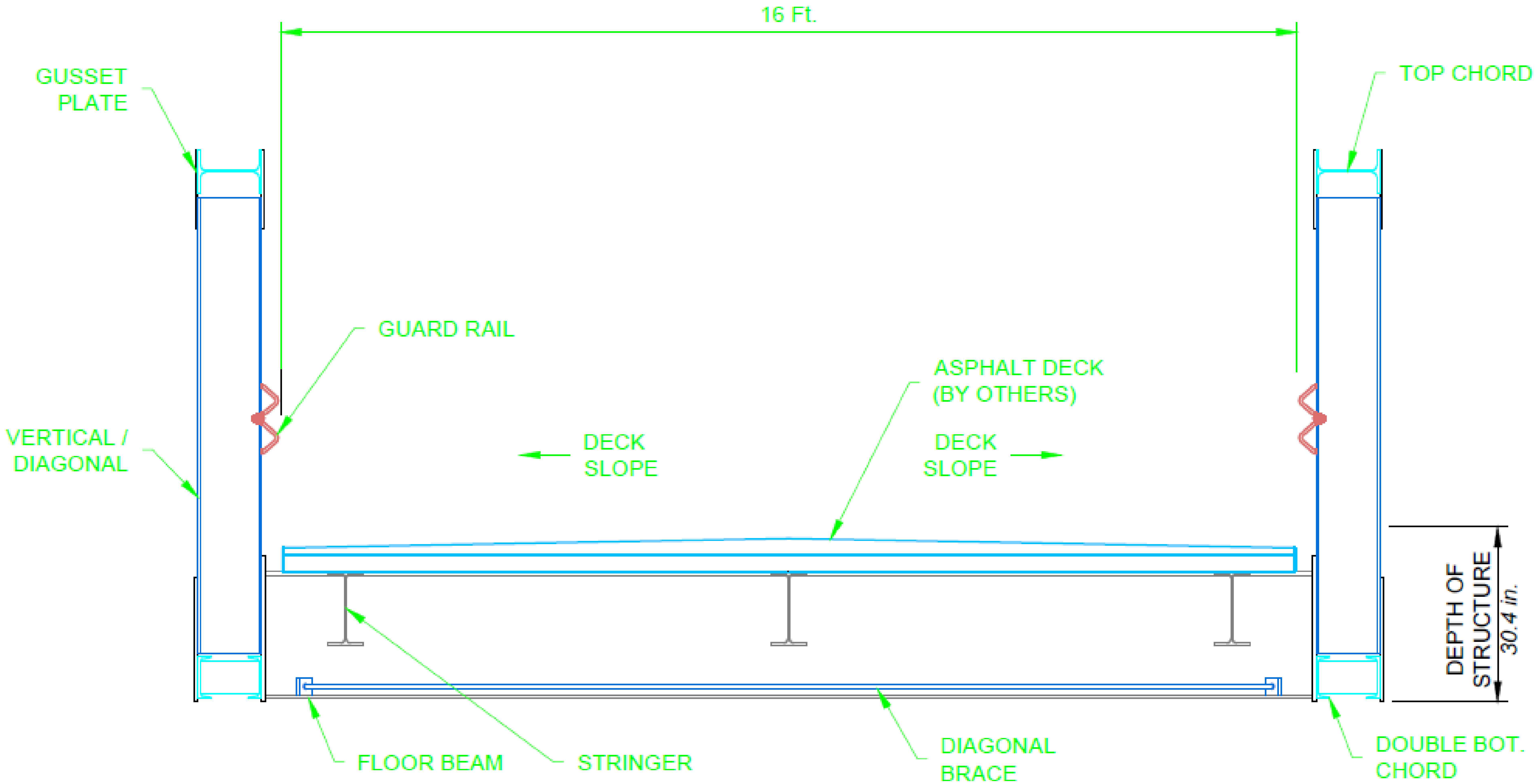

BRIDGE SECTION

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LENGTH: 150 Ft.
WIDTH: 16 Ft.

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Kendall Young Park
Webster City
Hamilton, IA

AISC CERTIFIED FABRICATOR

PROJECT: CEE: 4850
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SHEET NAME
BRIDGE SECTION

SHEET NO.
13

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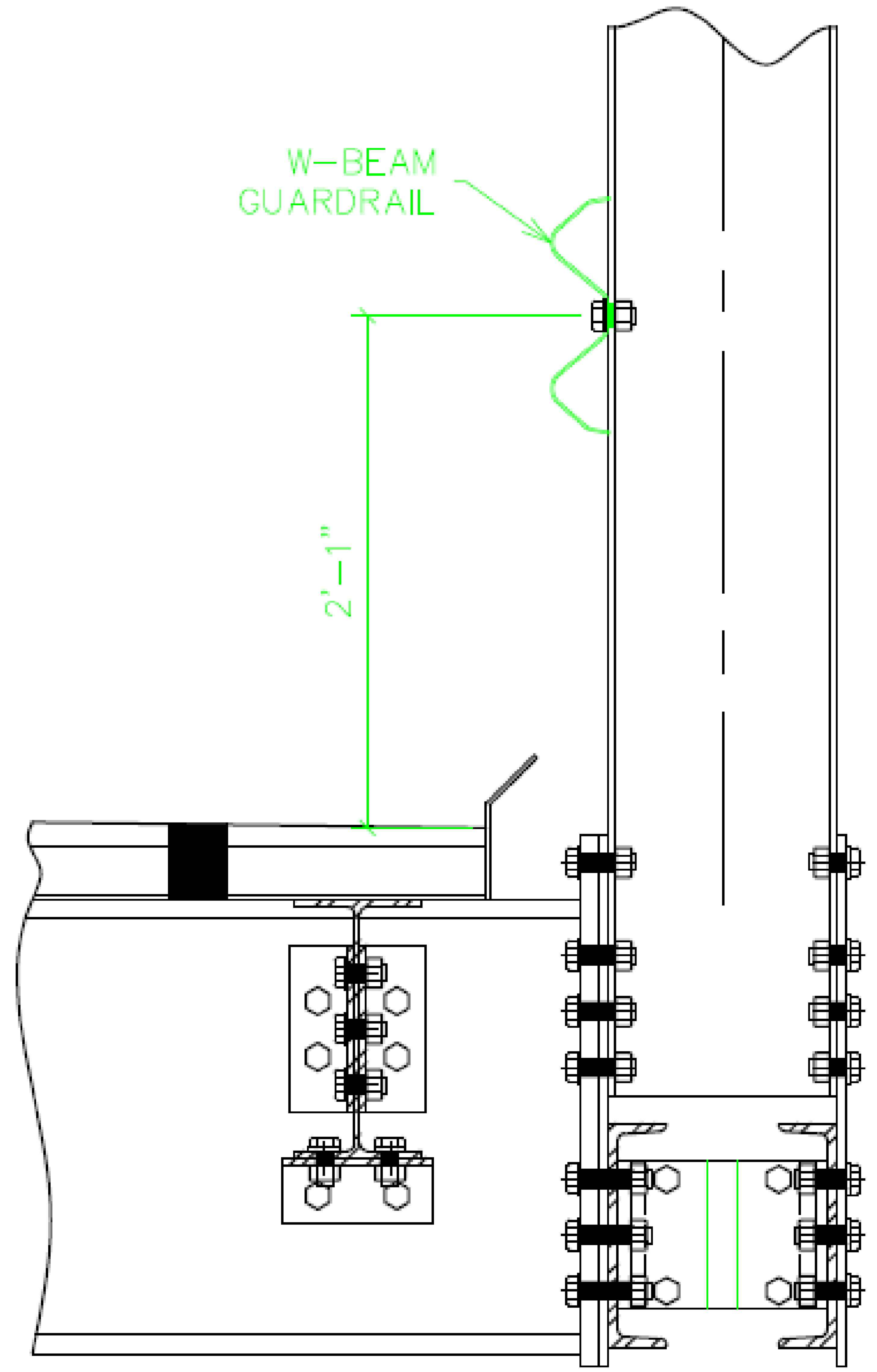

W-BEAM GUARDRAIL CONNECTION

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PROJECT: CEE: 4850
DATE: 4/10/2019
DRAWN BY: MPA
REVISION:

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4105 SEAMANS CENTER FOR THE ENGINEERING ARTS AND SCIENCES
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IOWA CITY, IOWA 52242
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SHEET NAME
W-BEAM RAIL CONNECTIONS

SHEET NO.

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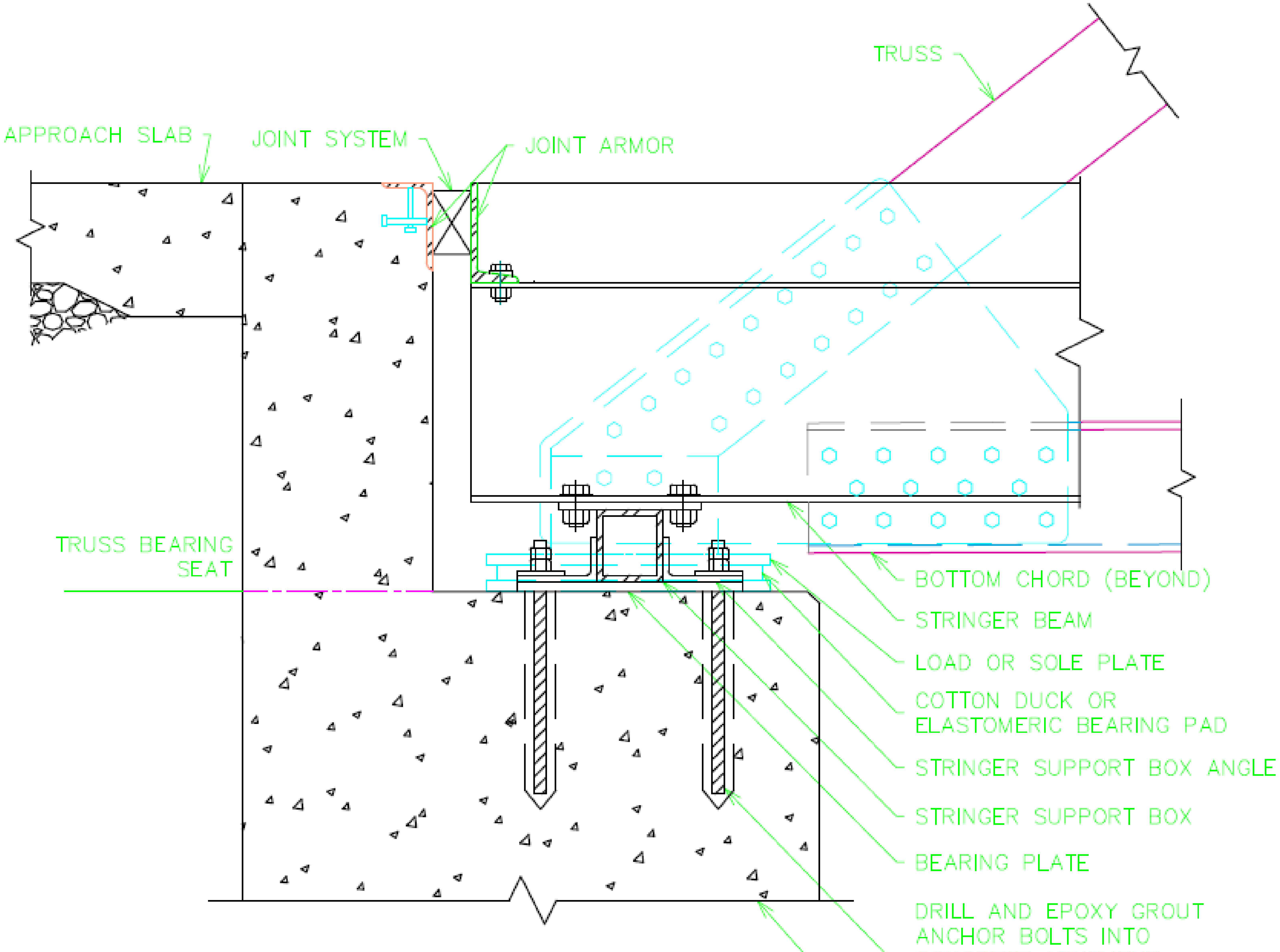

SECTION VIEW

TRUSS STRINGERS WITH RISER BOX

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1-888-872-7434 / www.usbridge.com

STYLE: Cambridge Series
LENGTH: 150 Ft.
WIDTH: 16 Ft.

MGS Engineering
Kendall Young Park
Webster City
Hamilton, IA

AISC CERTIFIED FABRICATOR

PROJECT: CEE: 4850
DATE : 4/10/2019
DRAWN BY: MPA
REVISION:

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EMAIL: civil-hawks@uiowa.edu

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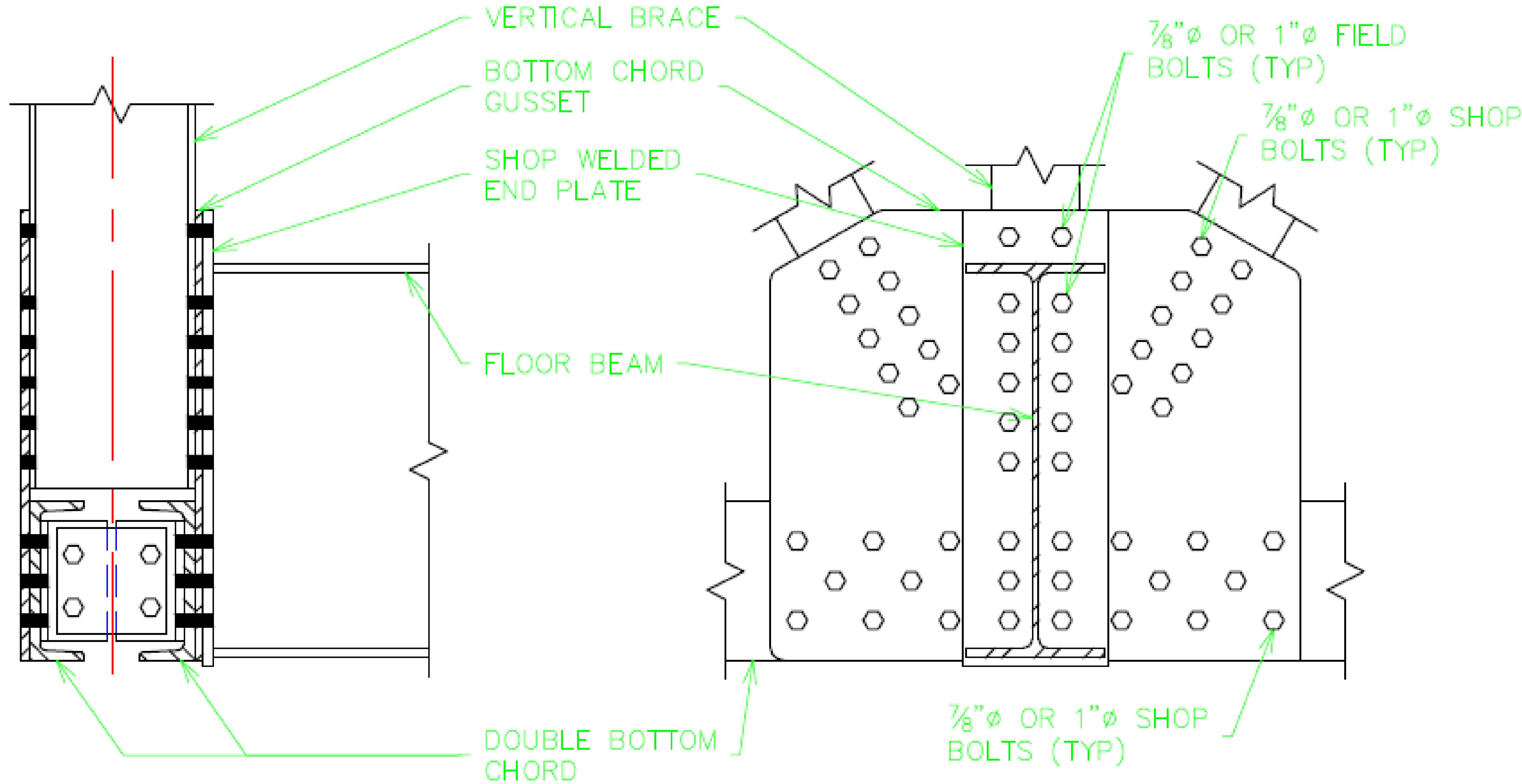
KENDALL YOUNG PARK
JANE YOUNG RD
WEBSTER CITY, IOWA 50595

SHEET NAME
TRUSS STRINGER W/ RISER BOX

SHEET NO.
15



SECTION THROUGH TRUSS

SECTION THROUGH FLOOR BEAM

FRAMED FLOOR BEAM TO TRUSS CONNECTIONS

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PROJECT: CEE: 4850
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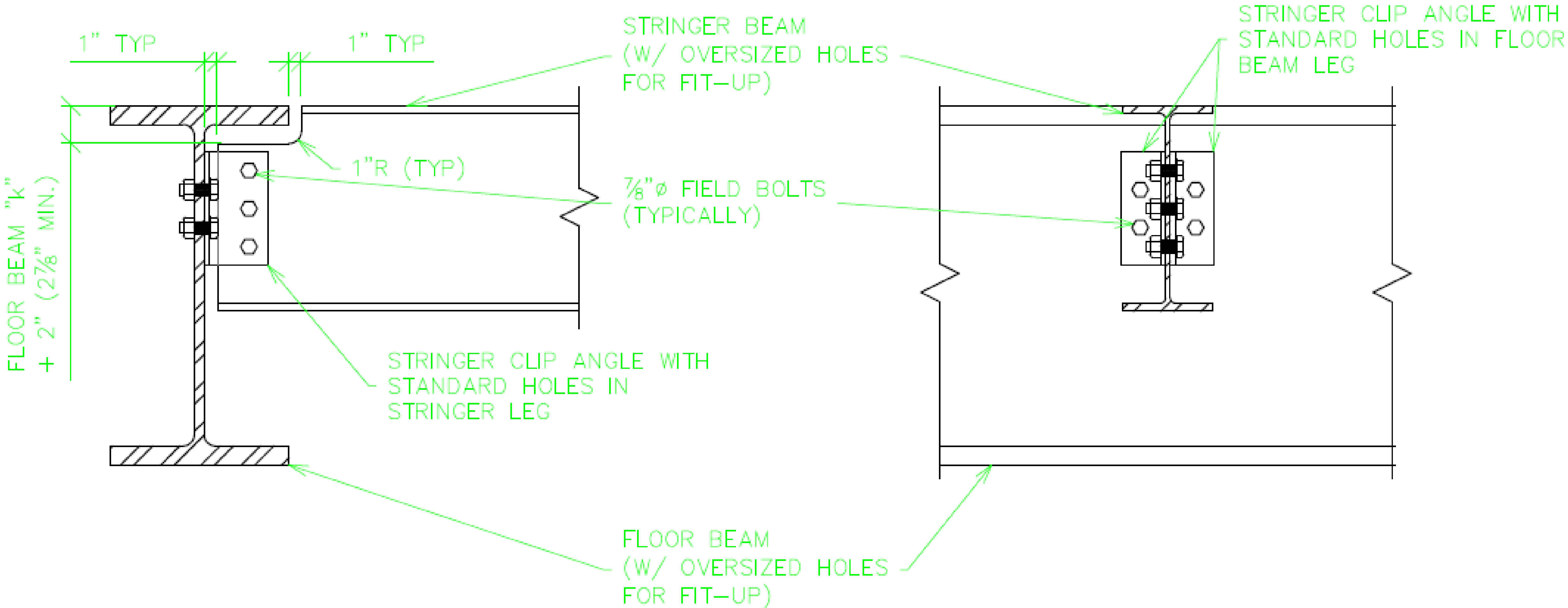
SHEET NAME
TRUSS CONNECTION - 1

SHEET NO.
16



SECTION THROUGH FLOOR BEAM

SECTION THROUGH STRINGER BEAM

FRAMED STRINGER TO FLOOR BEAM

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U.S. BRIDGE
BRIDGING AMERICA SINCE 1936
201 Wheeling Ave., Cambridge, Ohio 43725
1-888-872-7434 / www.usbridge.com

STYLE: Cambridge Series
LENGTH: 150 Ft.
WIDTH: 16 Ft.

MGS Engineering
Kendall Young Park
Webster City
Hamilton, IA

AISC CERTIFIED FABRICATOR

PROJECT: CEE: 4850
DATE : 4/10/2019
DRAWN BY: MPA
REVISION:

THE UNIVERSITY OF IOWA
CIVIL AND ENVIRONMENTAL ENGINEERING
4105 SEAMANS CENTER FOR THE ENGINEERING ARTS AND SCIENCES
103 S CAPITOL ST
IOWA CITY, IOWA 52242
PHONE: 319.335.5647
FAX: 319.335.5660
EMAIL: civil-hawks@uiowa.edu

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SHEET NAME
TRUSS CONNECTIONS - 2

SHEET NO.
17

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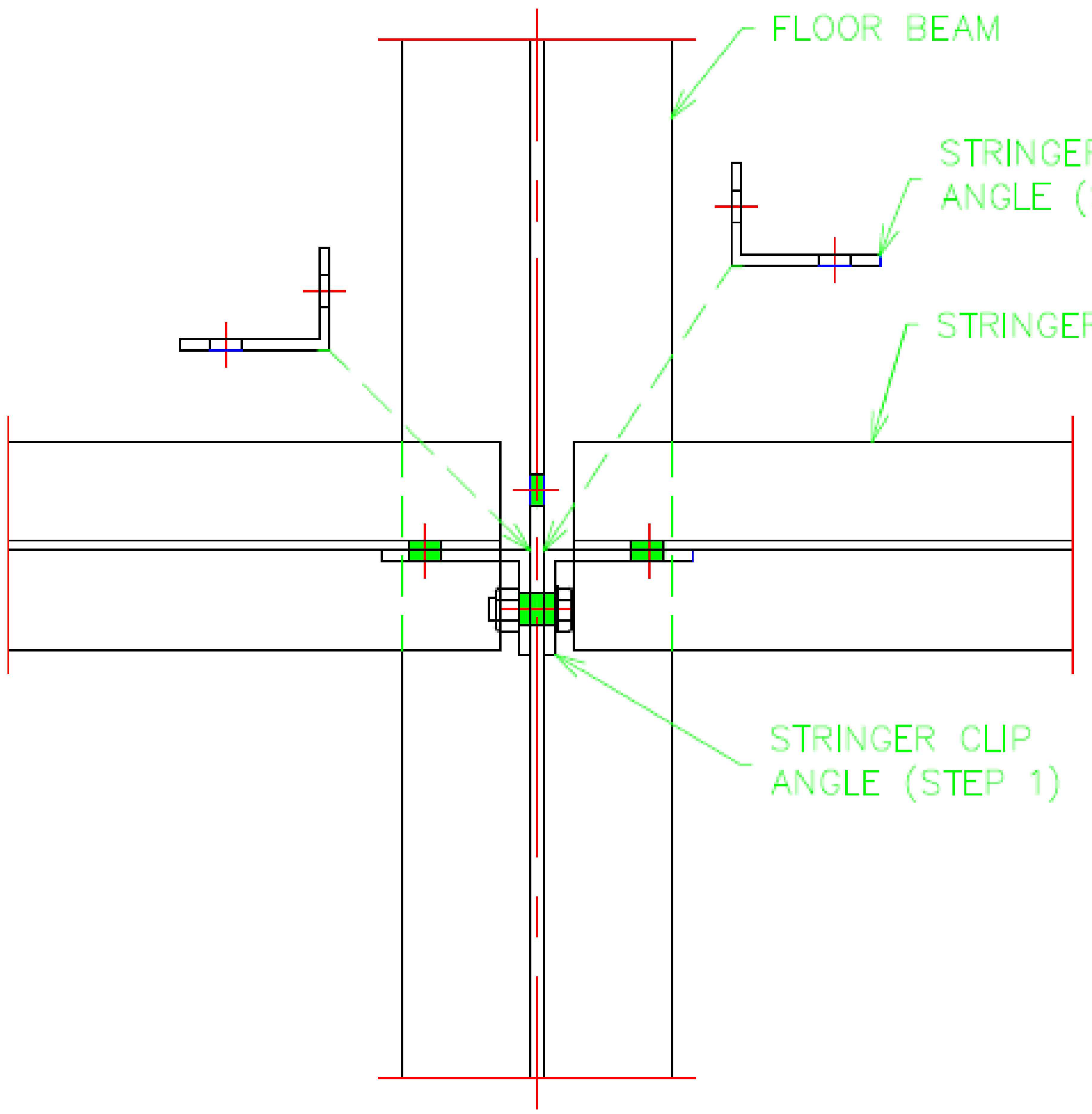

BOLTED STRINGER TO FLOOR BEAM CONNECTION

STRINGER INSTALLATION PROCEDURE

1) ATTACH 2 EA. STRINGER CONNECTION ANGLES TO FLOOR BEAM AS SHOWN.
2) INSTALL STRINGER AND PIN STRINGER TO ANGLES WITH DRIFT PINS
3) INSTALL REMAINING TWO ANGLES AND INSTALL BOLTS THRU STRINGER WEB.

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SHEET NAME
TRUSS CONNECTIONS - 3

SHEET NO.
18

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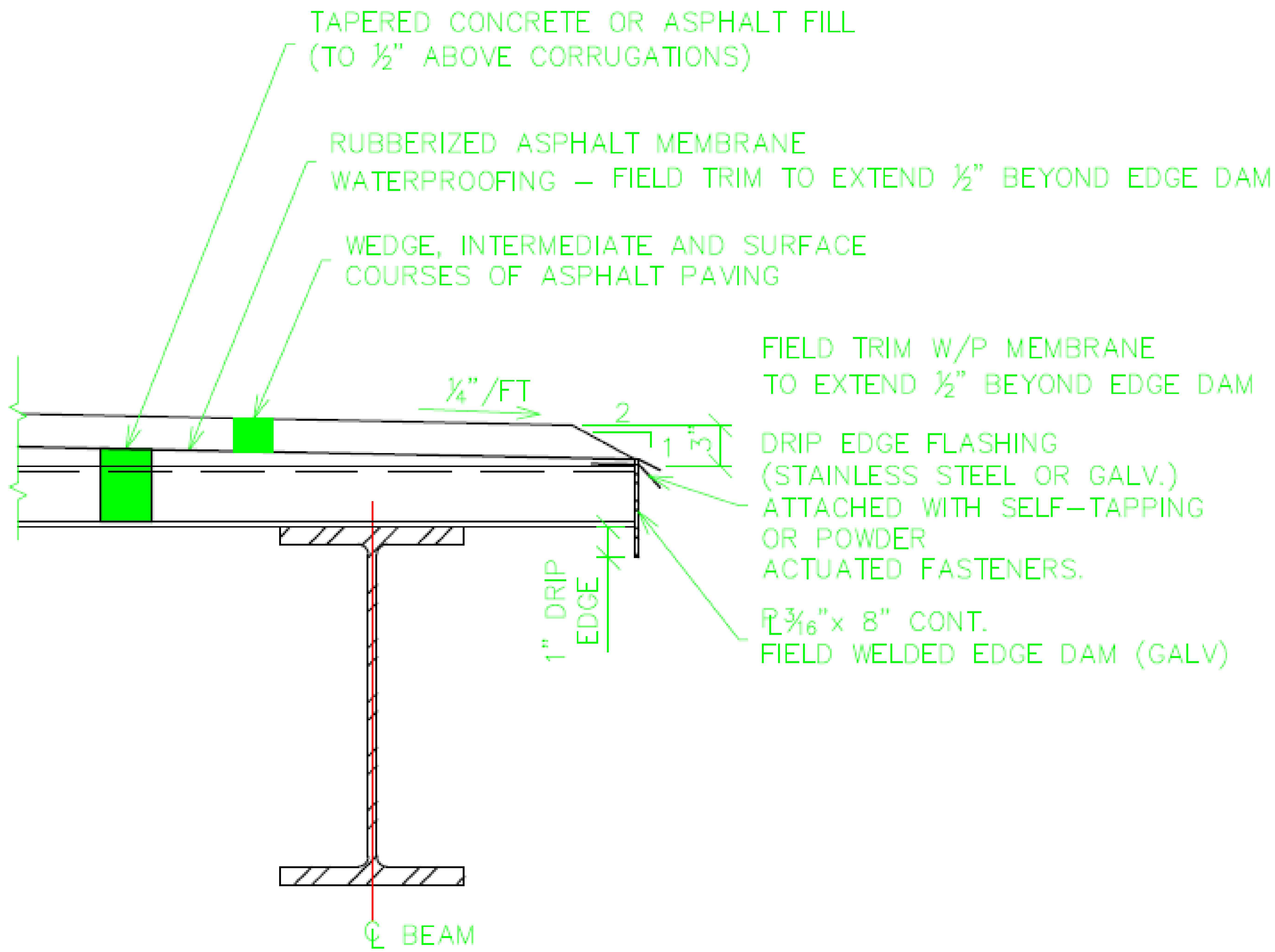

PAVING WITH WATERPROOFING ON CORRUGATED STEEL FLOORING

The graphical information and details contained in these plans is schematic in nature. The plans, elevations and sections have been developed automatically in a way that demonstrates your current input in a relative and proportional manner. The details included in these plans have been selected to represent commonly built construction assemblies. These are not engineering drawings, and as such, the details may vary in the final design for your project depending on your final scope of work and specifications.

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SHEET NAME
DECK PAVING DETAILS

SHEET NO.
19

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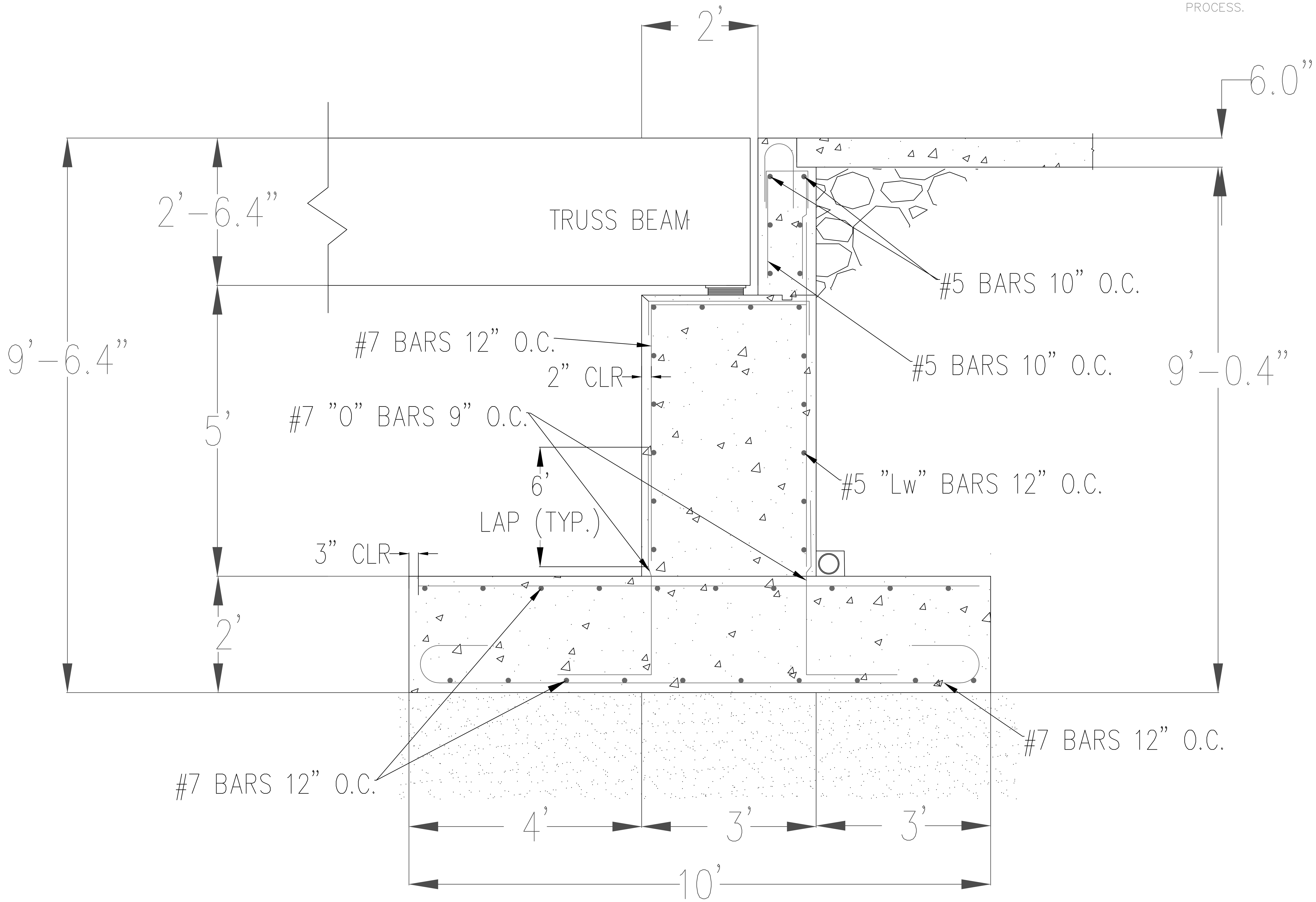
NOTES

1. BACKFILL SOIL SHALL BE GRANULAR WITH A WITH THE FOLLOWING SOIL PROPERTIES
   - γ_b = 120 pcf
   - K_{ab} = 0.33
   - K_{pb} = 3
   - ϕ = 29 deg
2. CONCRETE IS NORMAL WEIGHT (150 PCF)
3. A CHECK SHALL BE MADE AT THE SUBDRAIN OUTLET TO INSURE THAT IT IS DRAINING PROPERLY DURING THE BACKFILL FLOODING PROCESS.



ELEVATION VIEW

SCALE: 1" = 1'-0"

PROJECT:	CEE:4850
DATE :	4/10/2019
DRAWN BY:	MPA
REVISION:	

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SHEET NAME
ABUTMENT ELEVATION

SHEET NO.
20

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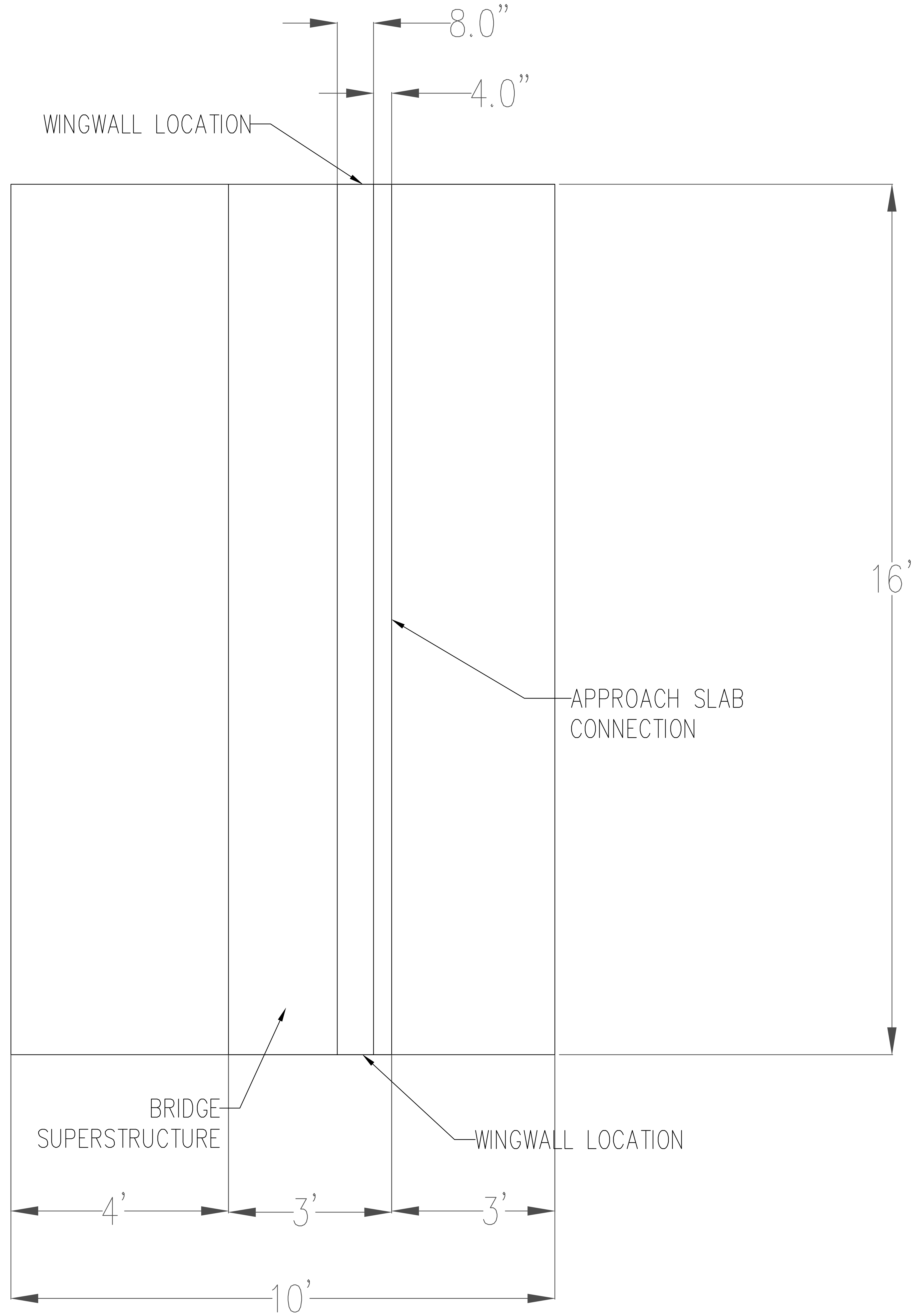

PLAN VIEW

SCALE: $\frac{3}{4}$" = 1'-0"

PROJECT: CEE: 4850
DATE : 4/10/2019
DRAWN BY: MPA
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SHEET NAME
ABUTMENT PLAN

SHEET NO.
21

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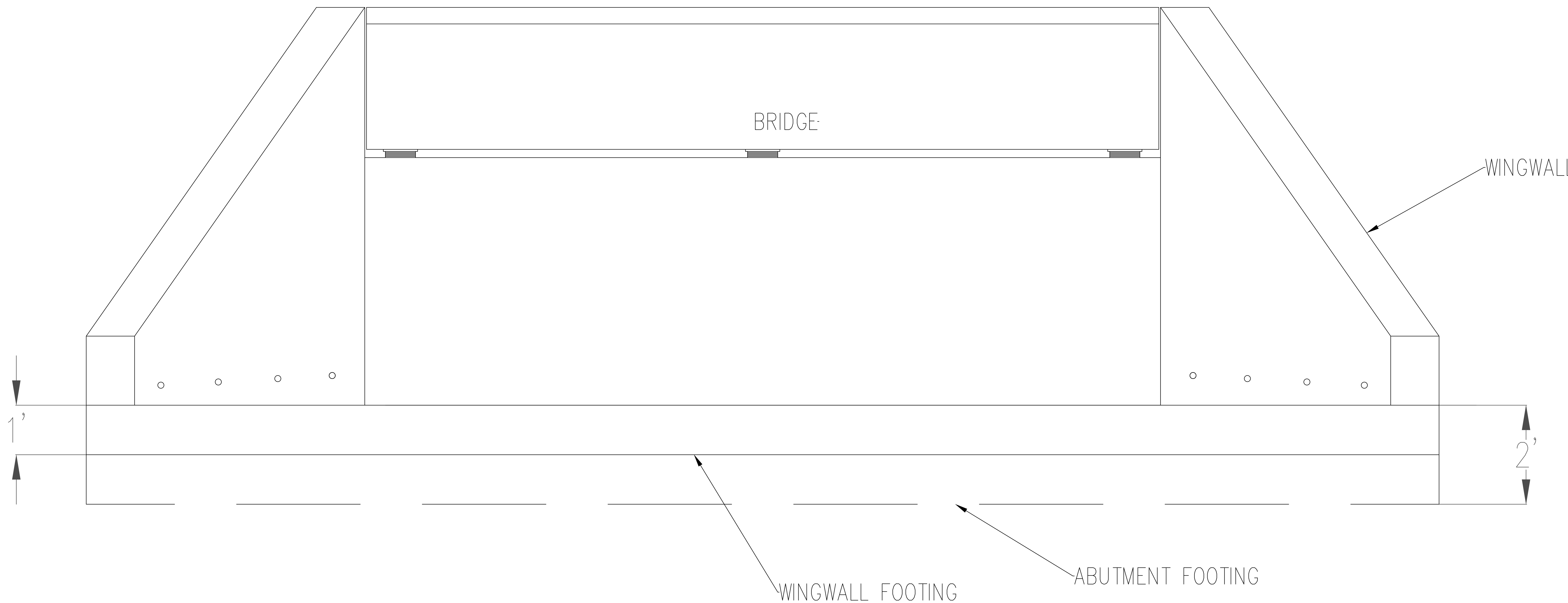

ELEVATION VIEW

SCALE: 1" = 1'-0"

PROJECT: CEE: 4850
DATE : 4/10/2019
DRAWN BY: MPA
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SHEET NAME
WING WALL ELEVATION

SHEET NO.
22

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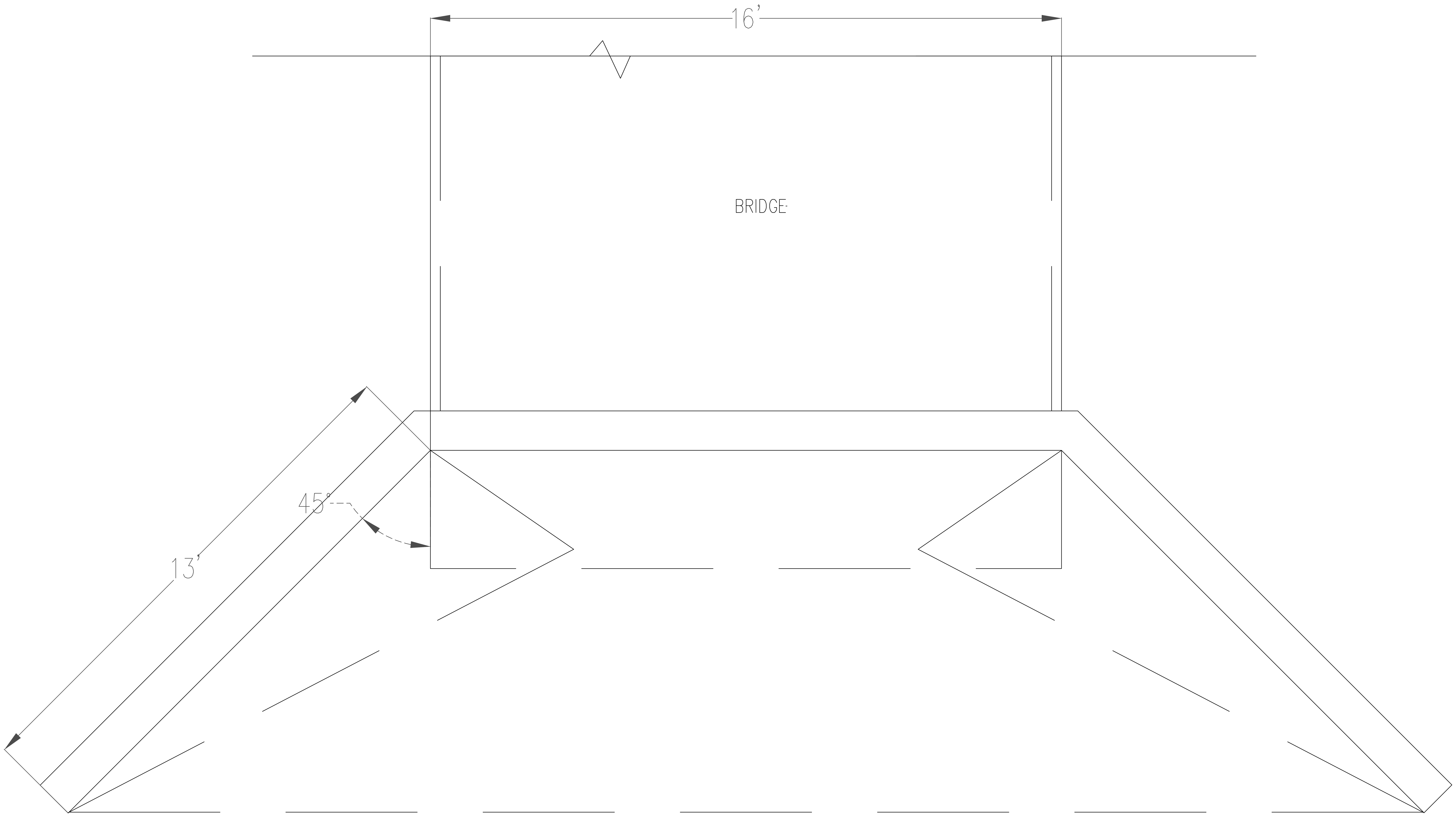

PLAN VIEW

SCALE: $\frac{3}{4}$" = 1'-0"

PROJECT: CEE: 4850
DATE : 4/10/2019
DRAWN BY: MPA
REVISION:

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SHEET NAME
WING WALL PLAN

SHEET NO.
23

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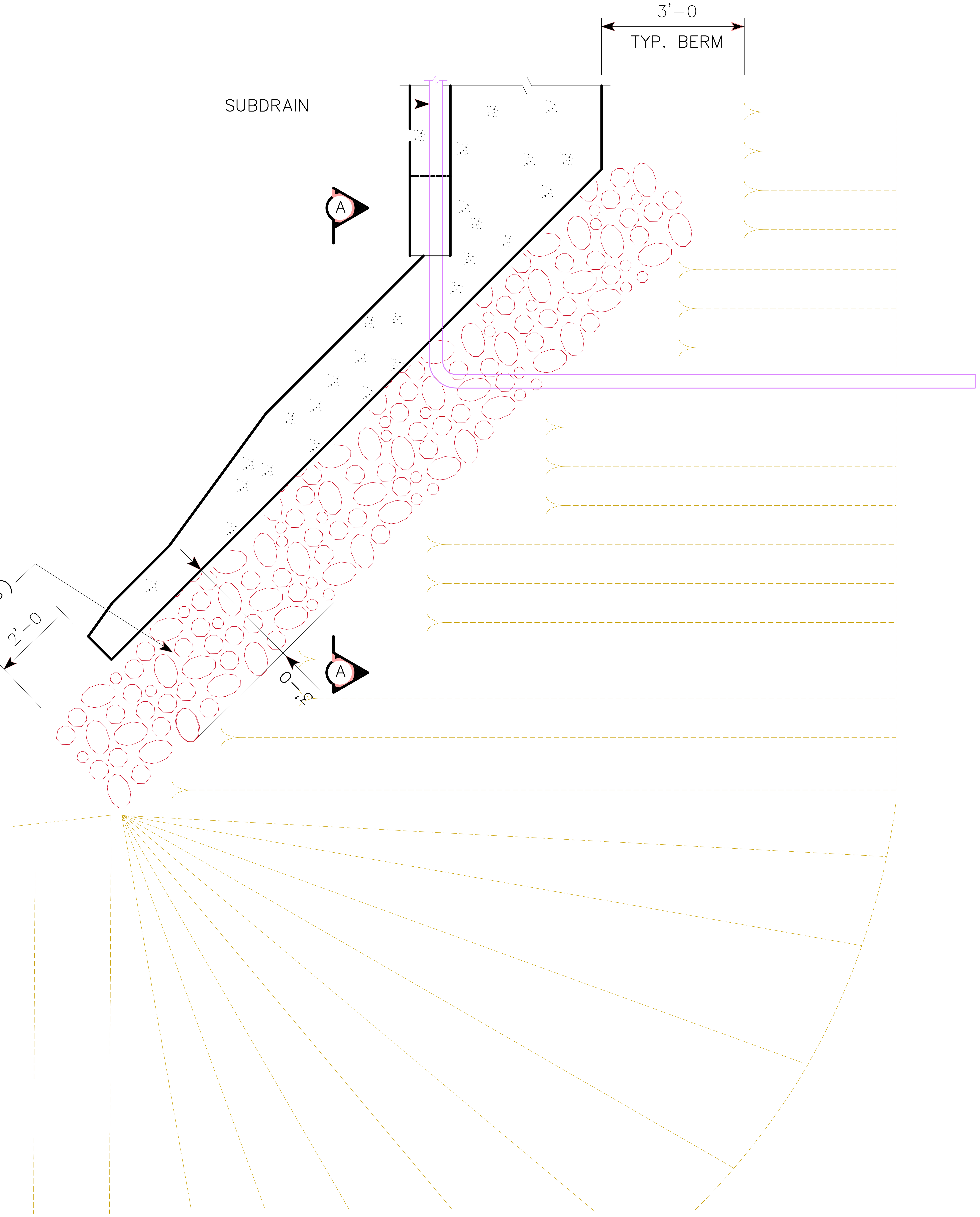
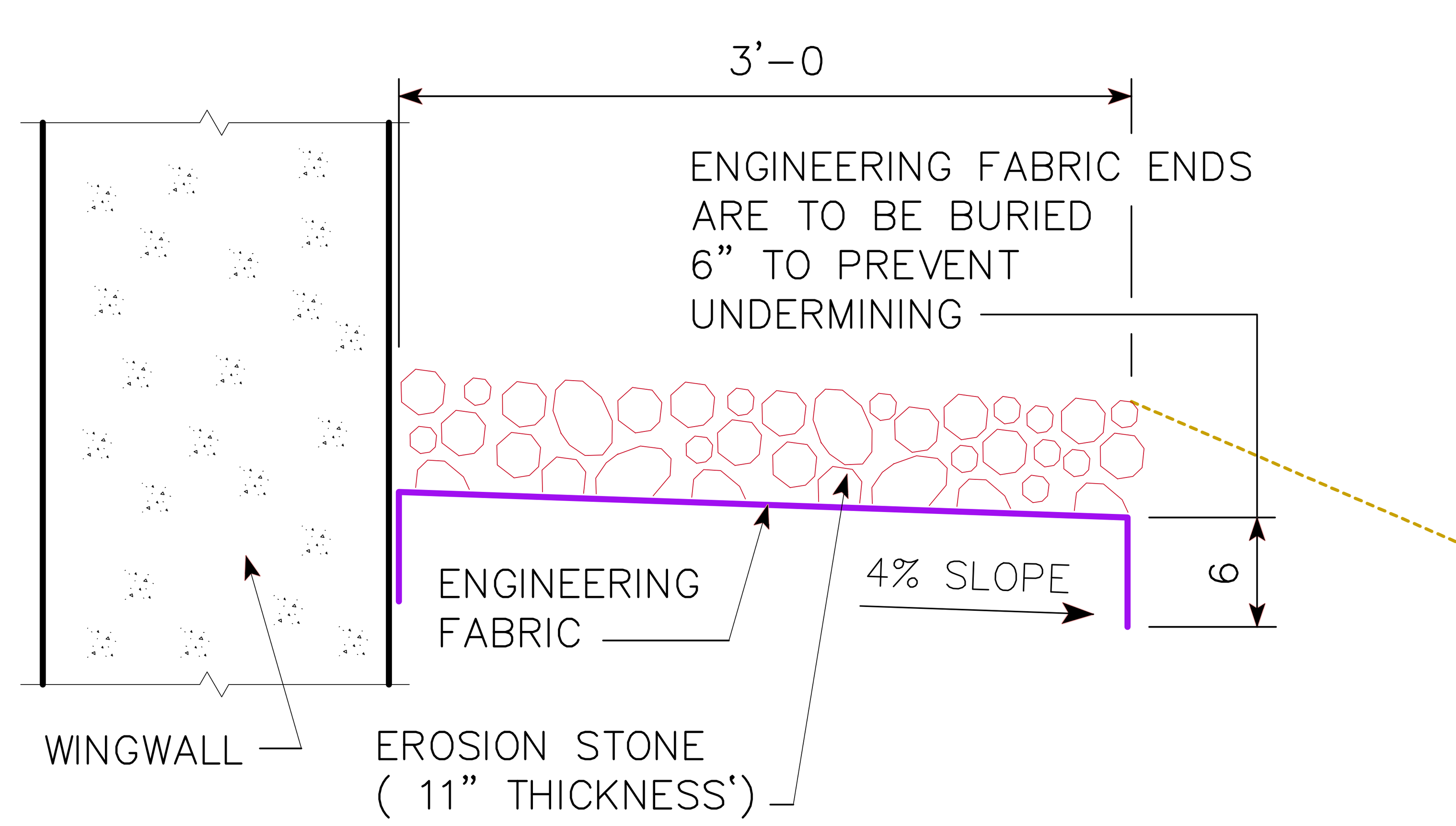
NOTE: A CHECK SHALL BE MADE AT THE SUBDRAIN OUTLET TO INSURE THAT IT IS DRAINING PROPERLY DURING THE BACKFILL FLOODING PROCESS.



TOP VIEW



SECTION A–A

PROJECT: CEE: 4850
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SHEET NAME
WING WALL ARMORING

SHEET NO.
24

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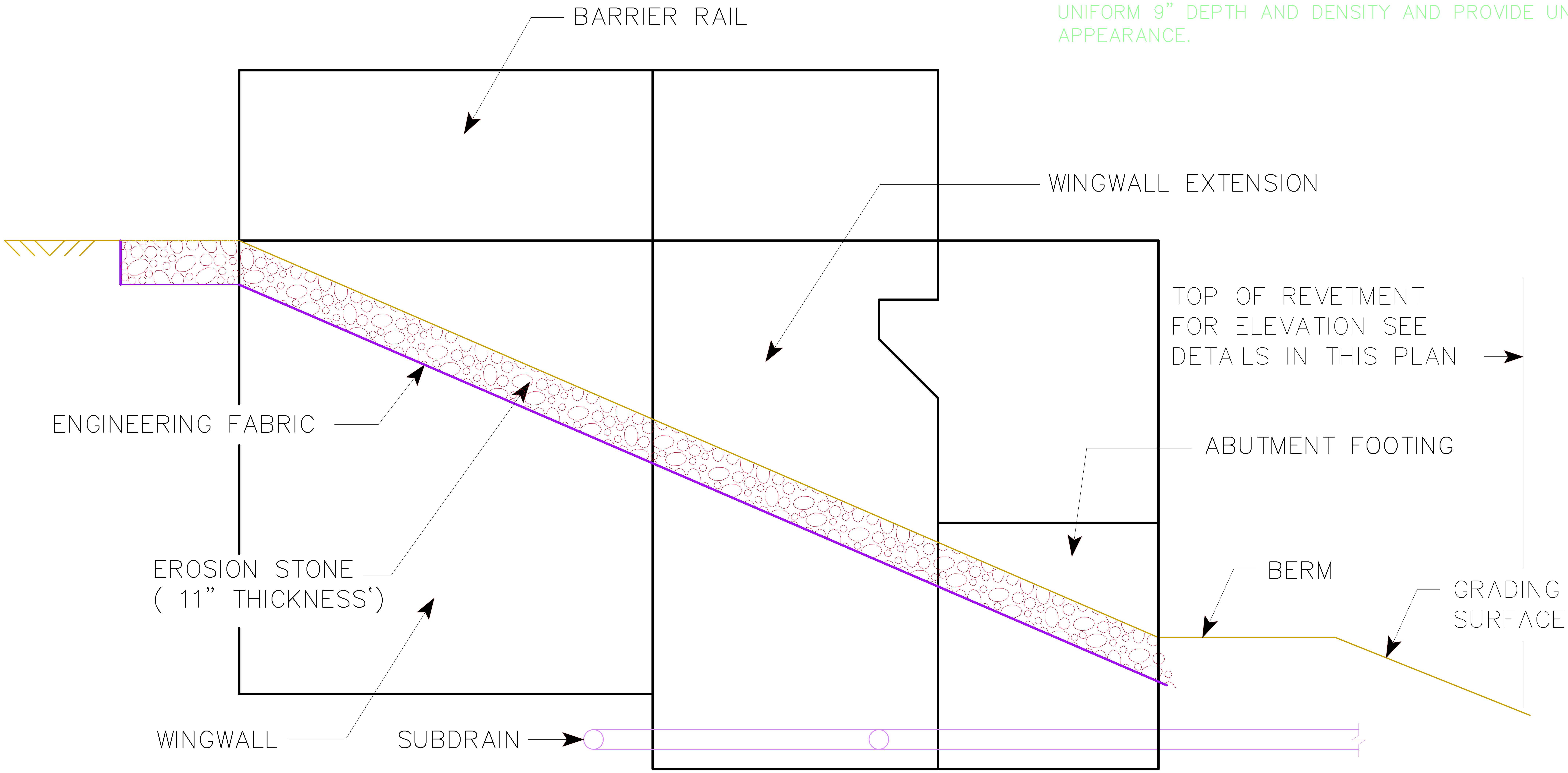
NOTES:

EROSION STONE SHALL BE PLACED ALONG THE SIDES OF THE WINGS AND ABUTMENT FOOTING AS SHOWN IN SECTION A–A. THIS IS TYPICAL AT EACH CORNER OF THE BRIDGE UNLESS OTHERWISE NOTED IN THE PLANS. THE EROSION STONE AT THESE LOCATIONS SHALL BE UNDERLAYED WITH ENGINEERING FABRIC IN ACCORDANCE WITH ARTICLE 4196.01, B, 3, OF THE STANDARD SPECIFICATIONS.

THE EROSION STONE SHALL BE IN ACCORDANCE WITH SECTION 4130, OF THE STANDARD SPECIFICATIONS. MATERIAL PASSING THE 3 INCH SCREEEN BUT 100% RETAINED ON A 1 INCH SCREEN MAY BE USED AS CHOKE STONE.

THE EROSION STONE SHALL BE DEPOSITED, SPREAD, CONSOLIDATED AND SHAPED BY MECHANICAL OR HAND METHODS THAT WILL PROVIDE UNIFORM 9" DEPTH AND DENSITY AND PROVIDE UNIFORM SURFACE APPEARANCE.



PROFILE VIEW

PROJECT:	CEE: 4850
DATE :	4/10/2019
DRAWN BY:	MPA
REVISION:	

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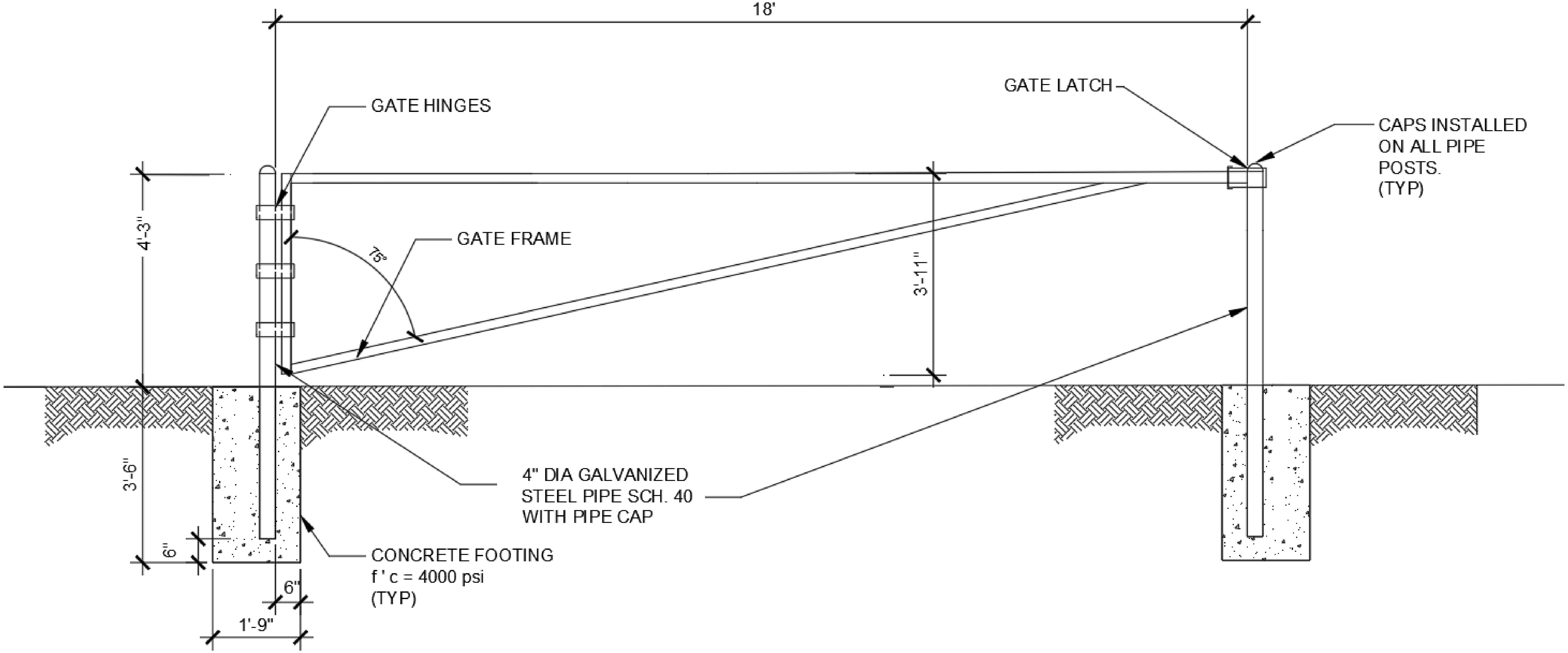
SHEET NAME

WING WALL ARMORING

SHEET NO.

25



GATE ELEVATION

PROJECT: CEE:4850
DATE : 4/10/2019
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SHEET NAME

BRIDGE GATE ELEVATION

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