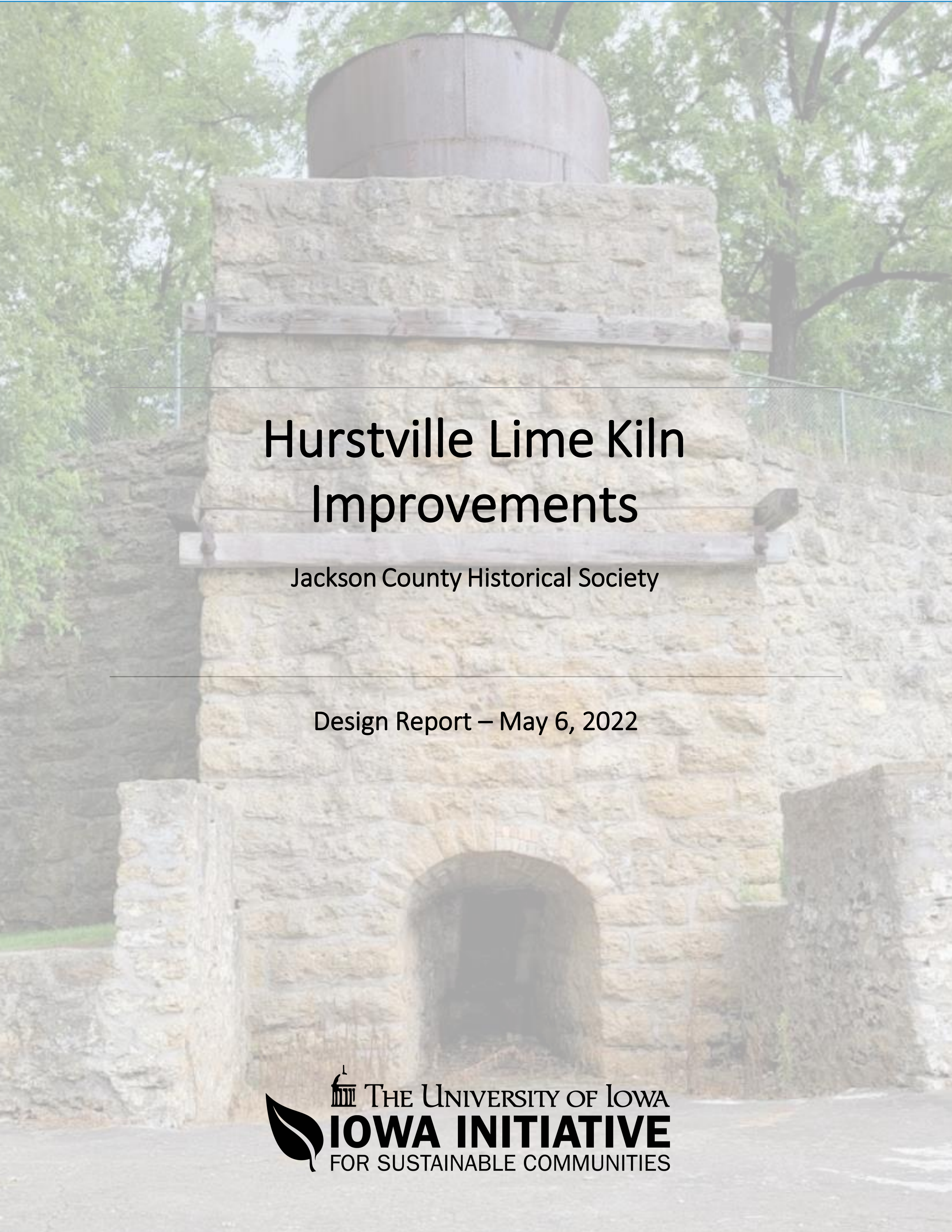

Hurstville Lime Kiln Improvements

Jackson County Historical Society

Design Report – May 6, 2022

The University of Iowa
IOWA INITIATIVE FOR SUSTAINABLE COMMUNITIES

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Section I Executive Summary

The Hurstville Lime Kilns are located in Maquoketa, Iowa. The site they occupy is maintained by the Jackson County Historical Society. The purpose of this project is to make improvements to the site in order to better preserve and showcase its history.

The main objectives of this design project are flood control, drainage, and the beautification/safety of the project site. Specific tasks related to these objectives include implementing a new drainage plan, parking lot redesign, evaluation of ADA accessibility to reach the top of the kilns, and the addition of trails and lighting to the site.

First and foremost, a small dry retention basin will be dug in the northeast corner of the site that has enough capacity to store runoff from a 10-year design storm. The primary design goals of the basin became about excavating enough depth to create a channel while maintaining enough elevation to achieve scouring velocity in the culvert. Since the volume of runoff is very minimal, a low-profile basin was designed with shallow slopes that will allow for easy maintenance and usage of the green space when not flooded.

At the bottom of the newly installed retention basin a culvert will be added to drain the building effluent to the small creek residing directly north of the site. This creek fills up quickly after a rain event but then returns to a shallow baseflow soon after. This matches up well with the design problem as with the main source of water is coming from groundwater infiltration and persists at a much slower rate than surface flow. The lack of overlap with each system's hydrograph makes this stream a perfect candidate for drainage. In addition, a flap gate will be added at the outlet to prevent backflow when the stream is high.

A grass swale will also be dug around the perimeter of the northwest corner of the site connecting the existing swale along Hurstville Road to the newly dug dry retention basin. And lastly with the addition of the parking lot, the ground level around the kilns will be raised to match the cooling pads in front of the kilns encouraging water to drain away from the kilns and either towards the collector swale or retention basin.

For the redesign of the parking lot, there were three main goals to be accomplished. These were pulling the parking lot away from the kilns, the addition of lighting for site safety, and creating additional parking spaces. With those goals in mind, the parking lot was designed along the west side of the property line with two separate sections of parking. The first section is located directly in line with the northernmost kiln (kiln 1) and the second being directly on the north side of the pavilion. Separate parking sections allow for multiple access points to the sidewalk and direct access to the pavilion. The lighting for the parking lot is placed on the back side of the curb of the parking stalls. Adequate lighting will allow for all parking stalls and surrounding areas to be illuminated at night to deter vandalism and promote the safety of visitors. A curb was installed on the east/inner side of the parking lot to lower the risk of vehicles dropping off pavement or driving into property structures.

Regarding the addition of the trail system, the main objectives were to improve the connectivity and accessibility of the site. Firstly, the existing staircase on site that is the primary route of access to view the tops of the kilns has been evaluated for ADA compliance. Due to the lack thereof, our team recommends that this staircase be closed. With this closure in mind, the new trail design incorporates two other alternative routes to view the tops of the kilns. The first alternative wraps around the north end of the site while the second route wraps around the south end. Both segments of the trail connect to the parking lot as well as the picnic shelter. Further trail specifications include a width of 5 ft, inclusion of a 2 ft clear zone on either side, and finally a cross-section that consists of 4” of Plain Cement Concrete (PCC) or Hot Mix Asphalt (HMA) on a 6” gravel subbase. A 6” gravel subbase alone is another alternative but would require maintenance to stay compact, providing a firm surface. Material selection is ultimately up to the client, so we have included all three options in our cost estimate.

At the conclusion of our site design, a project cost estimation was performed. This estimation includes material costs, construction costs, as well as a portion for contingencies as well as engineering administration. Total project costs were broken down into each of the three components of this site design. The site drainage total estimated cost is $87,000. For the parking lot, the total estimated costs for the PCC, HMA, and gravel material options are $171,500, $127,000, and $97,500 respectively. Lastly, for the trail, the total estimated costs for the PCC, HMA, and gravel material options are $74,000, $34,700, and $24,300 respectively.

Section II Organization Qualifications and Experience

1. **Organization and Design Team Description**

   Our team consists of students at the University of Iowa who were enrolled in the capstone design class. Team members include Matt Brimeyer, Peter Rauch, and Alexis Morales-Foote. Matt was the team’s project manager and specialized in civil practice. Peter was the team’s tech support and specialized in structural engineering. Lastly, Alexis was the team’s editor and completed a self-tailored EFA to accompany her major in art.

4. Description of Experience with Similar Projects

All three members have experience with design using Civil 3D and navigating the Iowa Statewide Urban Design and Specifications manuals (SUDAS). Alexis and Peter are also well rounded in ArcGIS and Revit as another outlet for design. Matt has several years of experience in the field of construction and will bring that knowledge into the design of the project.

Section III Design Services

1. Project Scope

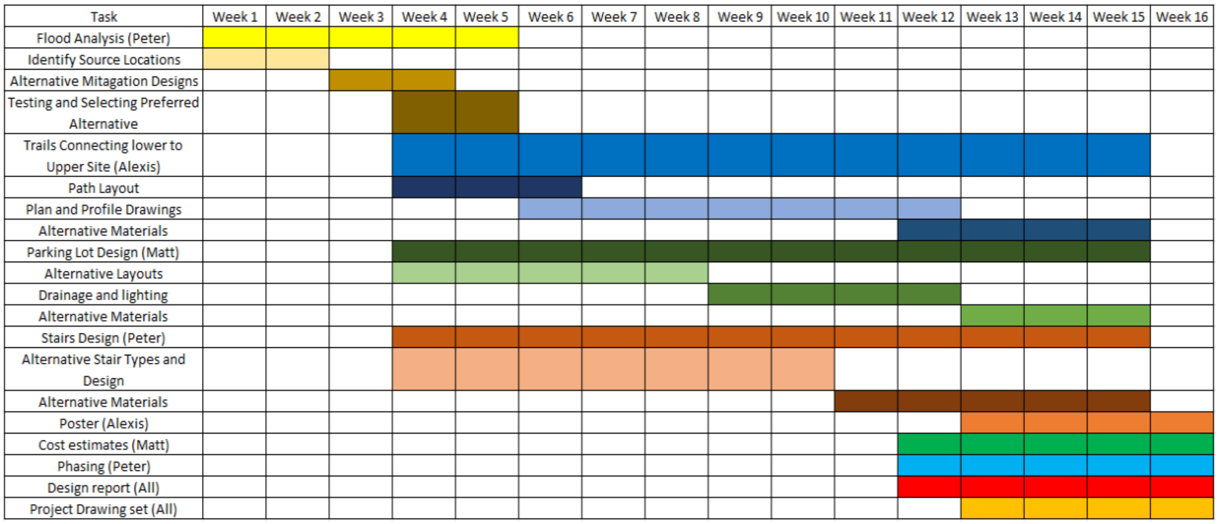
The main objectives of this design project are flood control, drainage, and the beautification/safety of the project site. Specific tasks related to these objectives include implementing a new drainage plan, parking lot redesign, evaluation of ADA accessibility to reach the top of the kilns, and the addition of trails and lighting to the site.

The flood control design's main goal is to identify the source of water infiltration onto the site and prevent water from pooling up after a rainstorm. The source was identified through local testimony and evidence found on the site to suggest that most of the water was coming through groundwater infiltration. After doing analysis on the drainage basin, it only confirmed those findings. Solutions to these problems are discussed further within the document.

The redesign of the parking lot was done with the goal of pulling the parking lot away from the kilns, keeping within property lines, and being ADA compliant. Lighting was added to each section of parking to help ensure the safety of visitors and the safety of the kilns from vandalism. The material for the parking lot will have three different alternatives with pricing for each.

The main goal of the trail system addition is to improve the connectivity of the site. In doing so, visitors can easily access and experience each component of the site. Another goal of the trail is to provide an alternative route to view the tops of the kilns. Current conditions include a staircase located north of the kilns, which fails to be ADA compliant. Due to safety concerns, our team recommends this staircase be closed. With the closing of the primary staircase on site, two alternative routes will be provided that allow access to the tops of the kilns. Similar to the parking lot, three material options for the trail will be provided in the design cost estimate.

2. Work Plan



<u>Section IV</u> Constraints, Challenges, and Impacts

1. Constraints

Constraints of this design project include property boundaries and project deadlines. Due to surrounding landowners and the placement of Hurstville Road adjacent to the property, the site is rather small resulting in minimal design options. Because of the predetermined project deadlines, our team has a limited amount of time to complete the tasks associated with this project.

2. Challenges

The biggest challenge that we faced was designing the site without a great representation of current conditions. Our data for the existing conditions came from publicly available LIDAR data that lost definition around the known structures throughout the site casting doubt on the accuracy of other fine details such as the existing swale along Hurstville Road. Assumptions were made about the conditions and layout of the existing site and thus all phases of the project should be reevaluated with the completion of a proper site survey. Because of this additional engineering fees were added to each phase.

An additional challenge was space and budgetary constraints. It quickly became apparent that acquiring more land or obtaining easements were outside of the scope of available options to our client and the site itself is quite small with only a small portion of land connecting to a local drainage way. In addition, the rock crusher on the back side of the site butted up against their property line and left little room to walk around the site without trespassing which will hamper our trail designs.

3. **Societal Impact within the Community and/or State of Iowa**

   Improvements to the Hurstville Lime Kilns Historical Site will have a direct impact on the Maquoketa community. By improving the safety and accessibility of the site, visitors are more welcome to experience and learn about the history of the kilns being preserved.

<u>Section V</u> Proffer of Alternative Solutions

An alternative drainage design was briefly considered trying to divert the water to other areas around the site and feeding it into other local wetland areas. This consisted of adding a spillway to reduce the level of the bounding creek and carving out a channel to feed water into a wetland site south of the kilns. Once the source of water infiltration was properly identified though, this alternative we deemed unsuitable and thus not pursued any further.

For the lighting of the parking lot, the color of light was chosen by the client with a color of 4000K(Neutral/LED) coming from the range of 2000K-10000K (Warm-Cold). Layout 1 of the parking lot had a rectangular shape running north to south along the west side of the property line. This specific design offered more parking but required the removal of more trees and a disruption of the drainage system. Layout 2 was designed with two separate sections of parking with the first being in front of the cooling pad for lime kiln 1 and the second on the north side of the pavilion. This allowed for less removal of trees, multiple access points to sidewalk, and direct access to pavilion. Both layouts offered an adequate amount of ADA accessible parking per number of parking spaces.

Figure 1. Layout 1 of parking lot

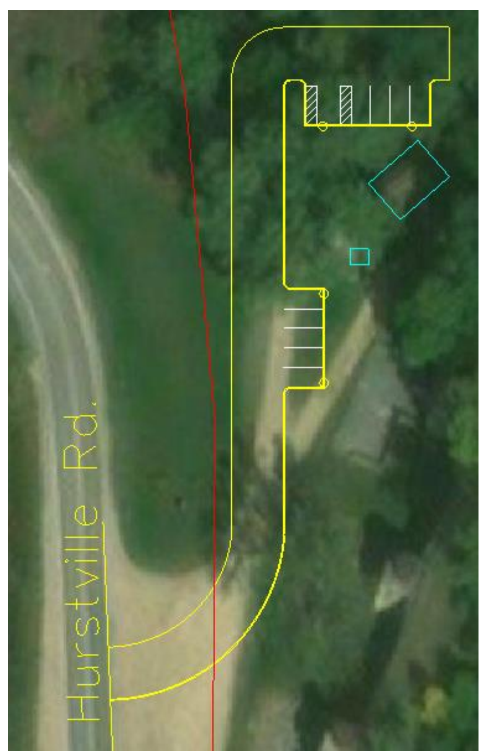


Figure 2. Layout 2 of parking lot

Both the parking lot and the trail can be designed using gravel, concrete, or asphalt. Gravel will have a smaller up-front cost but will have issues with it being maintained properly. Concrete will be expensive at the beginning but will have a longer life expectancy. Lastly, as an intermediate option, asphalt is slightly sturdier than gravel while being cheaper than concrete. Like gravel, however, asphalt would require more frequent maintenance than concrete. We have provided a cost estimate for each of the three materials and will leave the final decision up to the client.

Additionally, as the existing set of stairs on site will be closed, two trail alternatives to view the tops of the kilns include routes along the north and south ends of the site. Figure 3 illustrates the final trail alignment. The north segment of the trail begins at the picnic shelter, wraps around the north parking stalls, then continues onto the berm by ramp. From there, it leads east, wrapping around the rock crusher then up to the kilns. The south segment of the trail also begins at the picnic shelter, connects to the south parking stalls, then wraps around the south-most kiln. From there, it runs along the property boundary to meet the north trail segment then continues to the tops of the kilns. This layout of the final trail design, however, was not our primary alternative. Initially, our team considered providing access to the top of a limestone structure near the rock crusher instead of running along the property line. As an important component of the site's history, this structure supported the rail carts that carried limestone from the nearby quarry to the kilns. Unfortunately, this alternative was ruled out due to its lack of accessibility (as it would require two additional sets of stairs) as well as the lack of information available to us within our model.

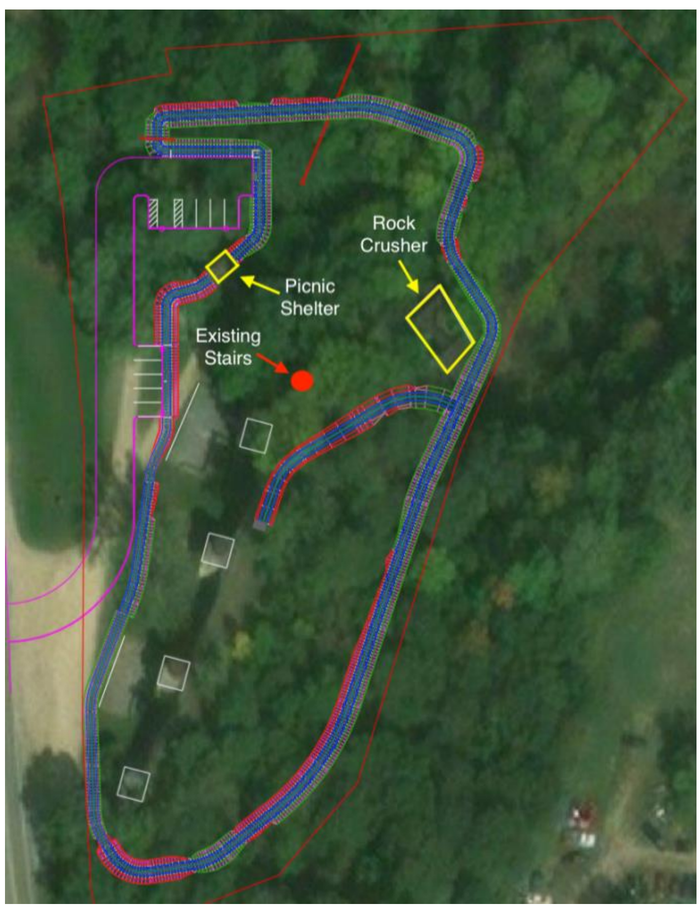


Figure 3. Final trail alignment

Section VI Final Design Details

Site Drainage

To achieve proper site drainage a shallow dry retention basin will be added to the northeastern corner of the site, south of the berm. The sides of the basin will slope inward at a grade of 1:4. The bottom of the basin will sit 2 feet below the elevation of the nearby pavilion and proposed adjacent parking lot. The culvert will stretch roughly 80 feet to the base of the stream on the north side of the berm (Appendix A_Fig.1). At the tail end of the culvert a flap gate valve will be installed in-between the pipe and the apron. This will prevent backflow of water during rain events and allow the site to drain after. Lastly, a grass swale was added around the base of the berm and western edge of the site connecting into the existing swale and culvert along Hurstville Road.

Culvert Design
The size of the culvert was based on a hydraulic analysis using Hydraflow Express within the Autodesk Civil 3D software suite (Appendix A_Fig.2). With a 12-inch pipe under the design conditions a minimum scouring velocity of 3 feet per second is reached under 8 inches of head water while still adequately supporting the drainage demand under rare conditions (Appendix A_Fig.3). Corrugated steel was chosen as the desired material for price and durability considerations. Aprons were added to the head and tail of the pipe to prevent vegetative growth and debris from blocking inflow and conversely prevent erosion downstream. Matching the same material design choices as the culvert, a durable steel flap gate was chosen.

Grass Swale Design
The dimensions of the grass swale stretching around the northwest perimeter shall follow the minimum design standards outlined in ISWMM Chapter 9 Section 3. Following these design standards calls for a 2-foot-wide basin and sidewall slopes of 4:1. The preferred slope along the length of the channel for water quality is 1%. The basin of the swale should comprise of a 30-inch-thick planting soil bed, consisting of 50% soil/50% sand mix. An in-situ soil sample should be taken upon excavation to determine if the existing soil is suitable for this task.

Additional Culvert
On the northern edge of the grass swale, it crosses path with the existing/proposed trail. An additional culvert of similar size shall be installed along the base of the swale. With a 5-foot trail, 2 feet of clear zone on either side and a 4:1 slope to the top of the culvert the total length of pipe will stretch 17 feet. A minimum depth of 12 inches of cover soil on top of the pipe must be maintained. Additionally, this cover can double as the subbase of the proposed trail.

Parking Lot

Following the design standards in SUDAS, Section 8B-1 the dimensions of the parking lot are as follows. Driving lane with a width of 24 feet, parking space width and length of 9 feet by 18 feet, curb width of 6 inches, ADA stall width of 11 feet, and ADA marking width of 5 feet. Depths of different materials for the parking lot were pulled from SUDAS Section 5F-1 and were determined to be either 6 inches of PCC or 7 inches of HMA on 12 inches of a gravel subbase, or 12 inches of the gravel subbase alone. Per SUDAS, Section 11C-1 – Facility Design, the luminaire spacing was determined to be 41 feet with an initial lamp lumen of 2,079 and a mounting height of 25 feet. Type III lateral light distribution and medium vertical light distribution were determined from SUDAS Section 11B-1. Refer to Appendix B for further details on the lighting calculations as well as the material quantity estimates.

Trail

Following the design standards outlined in SUDAS, Section 12A-2 – Accessible Sidewalk Requirements, the designed trail is 5 feet wide, has a cross slope of 1.5%, and a max running slope of 5% with the exception of the ramp located at the north end of the site which has a max allowable slope of 8.3%. Per SUDAS, Section 12A-1 – General Sidewalk Requirements, the trail material consists of 4 inches of PCC or HMA on top of a 6-inch gravel subbase. The gravel material option consists of 6 inches of the gravel subbase alone. Refer to sheets S.1 through S.11 in the project drawing set for further detail on the trail cross-sections as well as the plan and profile views. A 2-foot grass clear zone was also incorporated on both sides of the pavement before grading to the existing ground. The grading used in the trail corridor was constrained to a 5:1 slope and a 3-foot maximum width. From our corridor model, the total trail material volumes were found to be roughly 612 cubic yards cut/fill, 837 square yards of pavement (to be either PCC or HMA), and 835 square yards of subbase. Refer to Appendix C for further details on the material quantity estimates.

Section VII Engineer’s Cost Estimate

Construction Cost Estimate				
Item	Quantity	Unit	Unit Price	Total
Site Drainage				
Clearing and Grubbing	0.20	ACRE	$ 2,848.73	$ 600.00
Cut/Fill, Excavation Class - 10	580.00	CY	$ 22.57	$ 13,000.00
Hydraulic Seeding	0.20	ACRE	$ 1,035.39	$ 200.00
Pipe - Trenchless Construction	80.00	LF	$ 750.00	$ 60,000.00
Corrugated Pipe Culvert - 12" Dia	80.00	LF	$ 40.00	$ 3,200.00
Metal Apron - 12" Dia	2.00	EACH	$ 490.00	$ 1,000.00
Outlet Control/Flap Gate - 12"	1.00	EACH	$ 800.00	$ 800.00
Drainage Subtotal				$ 78,800.00
Parking Lot				
Clearing and Grubbing	0.48	ACRE	$ 2,848.73	$ 1,375.00
Cut/Fill, Excavation Class - 10	2843.00	CY	$ 22.57	$ 64,000.00
Soil Compaction	1928.00	CY	$ 0.55	$ 1,050.00
Granular Subbase	1334.46	SY	$ 8.06	$ 10,800.00
6" PCC	1334.46	SY	$ 50.46	$ 67,500.00
7" Asphalt	525.50	TON	$ 51.11	$ 26,900.00
Topsoil	481.50	CY	$ 6.22	$ 3,000.00
Hydraulic Seeding	0.60	ACRE	$ 1,035.39	$ 620.00
Pavement Marking	2.60	STA	$ 14.58	$ 38.00
Lighting	4.00	EACH	$ 1,600.00	$ 6,400.00
Removal of Lighting	1.00	EACH	$ 700.00	$ 700.00
Option 1 PCC				$ 155,500.00
Option 2 Asphalt				$ 115,000.00
Option 3 Gravel				$ 88,000.00
Trail				
Clearing and Grubbing	0.10	ACRE	$ 2,848.73	$ 295.00
Cut/Fill, Excavation Class - 10	611.89	CY	$ 22.57	$ 13,800.00
Soil Compaction	139.41	CY	$ 0.55	$ 77.00
Granular Subbase	835.60	SY	$ 8.06	$ 6,725.00
4" PCC	836.44	SY	$ 54.20	$ 45,300.00
4" Asphalt	186.32	TON	$ 51.11	$ 9,525.00
Topsoil	111.53	CY	$ 6.22	$ 695.00
Option 1 PCC				$ 67,000.00
Option 2 Asphalt				$ 31,100.00
Option 3 Gravel				$ 21,600.00

Total Project Cost

Component	Material	Construction Subtotal	Contingencies	**TOTAL COST**[1]
Drainage	–	$ 78,800.00	$ 7,875.00	$ 87,000.00
Parking Lot	PCC	$ 155,500.00	$ 15,600.00	$ 171,500.00
	Asphalt	$ 115,000.00	$ 11,500.00	$ 127,000.00
	Gravel	$ 88,000.00	$ 8,800.00	$ 97,500.00
Trail	PCC	$ 67,000.00	$ 6,700.00	$ 74,000.00
	Asphalt	$ 31,100.00	$ 3,100.00	$ 34,700.00
	Gravel	$ 21,600.00	$ 2,150.00	$ 24,300.00

1. Total project cost is the sum of the construction subtotal, 10% contingencies, and $500 in engineering administration for each component.

Abbreviations Key

CY	Cubic Yards
LF	Linear Feet
STA	Station
SY	Square Yards

The project cost estimate has been broken down into subtotals for each component of this site design. Unit prices were taken from the Iowa DOT Bid Tabs of April 19, 2022. These prices include the cost of material, labor, equipment, overhead, and profit, resulting in a construction subtotal for each material option within these two components. Furthermore, 10% of the construction subtotals was apportioned for contingencies. An additional $500 was allocated for engineering administration costs. Our team has found these sums sufficient to cover any extra costs that may be needed in the implementation of this design. Together, the construction subtotal, contingencies, and engineering administration costs make up the total estimated cost for each component.

By reporting these total costs by component, the opportunity for phasing is provided. The implementation of each design component can proceed in the order of interest as funding allows. For example, as the flooding of the site is a major concern, the site drainage design can be completed with the $87,000 our team has estimated. Following, the parking lot and trail can be implemented as the anticipated costs are acquired. Additional phasing plans can include the initial implementation of the gravel surface for either the parking lot or trail before paving in either concrete or asphalt, if desired.

Appendix A Flood Control

Figure 1 - Site Layout

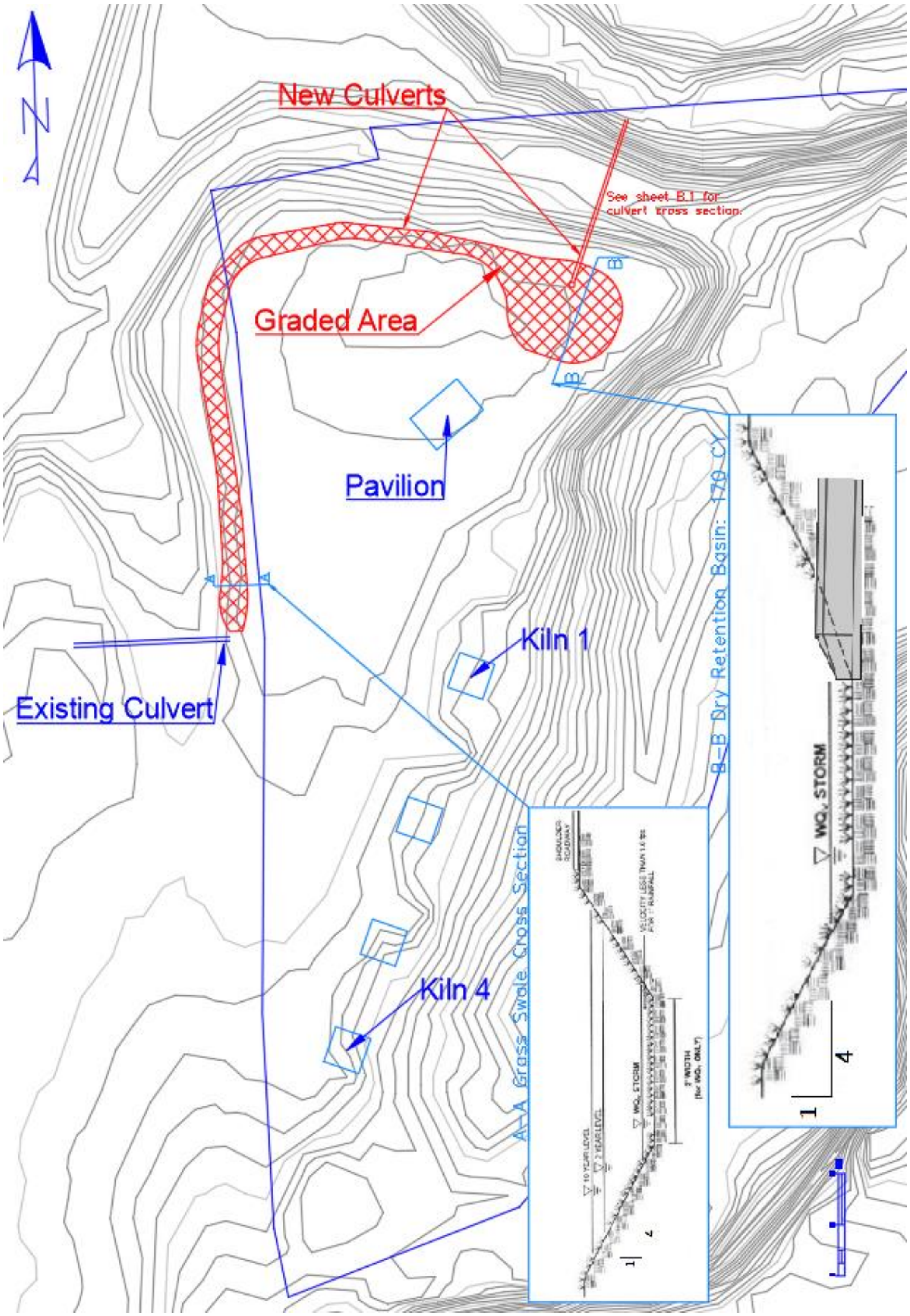


Figure 2 – Scour velocity depth

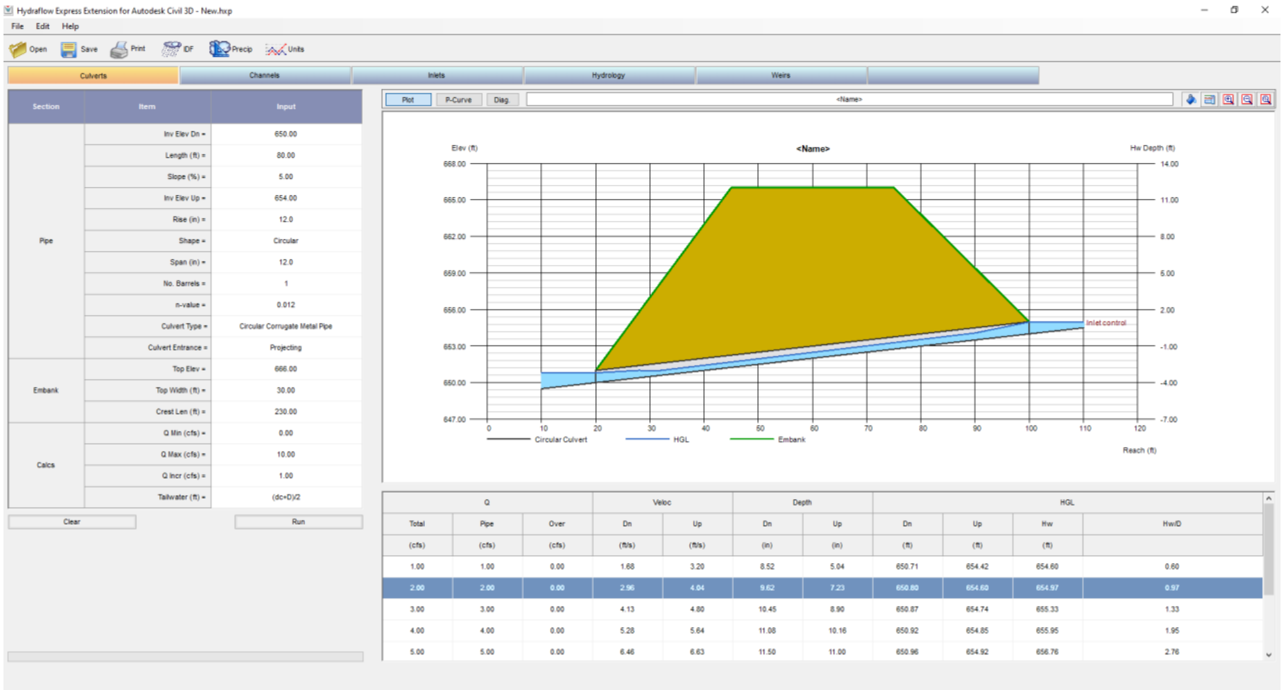
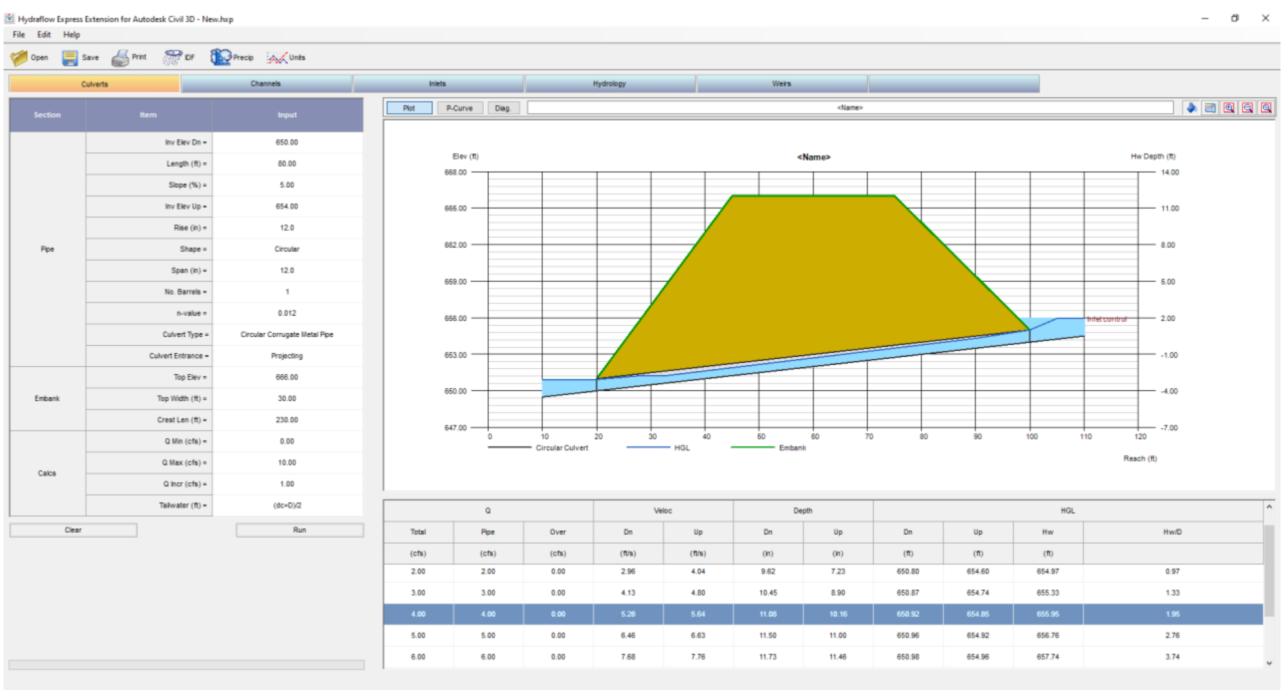


Figure 3 – Dry basin filled



Appendix B Parking Lot Design

Material Cost Estimate Calculations:

Clearing & Grubbing				
	Area =	21000	sq ft	
		0.4821	acres	43560 sqft/acre
Excavation - Cut & Fill				
	Cut	915	cy	
	Fill	1928	cy	
	Total	2843	cy	
Soil Compaction				
	depth	0.5	ft	
	volume	1928	cy	27 cf/cy
Granular subbase				
	depth	1	ft	
	Area	12010.17	sq ft	
		1334.46	sq yrds	
	volume	12010.17	cf	
	density	135	pcf	
	weight	1621372.95	lbs	
		810.69	tons	
Pavement				
	6" pcc			
	depth	0.5	ft	
	volume	6005.085	cf	
		222.4	cy	
	Area	1334.46	sq yrds	
	7"asphalt			
	depth	0.5833	ft	
	volume	7005.9325	cf	
		259.5	cy	
		525.5	ton	
	Area	1334.46	sq yrds	
	12" Gravel			
	depth	1.5	ft	
	volume	18015	cf	

		667.22	cy
		1000.83	tons
	Area	1334.46	sq yrds
Topsoil			
	depth	0.5	ft
	area	26000	sq ft
	volume	13000	cf
		481.5	cy
Seeding			
	area	26000	sq ft
		0.60	acres
Pavement Marking			
	length	260	ft
		2.6	STA

Item Codes: April 19th bids	
HMA	2303-1033750
PCC	2301-1033060
Gravel	2312-8260201
Subbase	2111-8174100
Pavement Marking	2527-9263109
Clearing & Grubbing	2101-0850001
Soil Compaction	2107-0875100
Seeding	2601-2636070
Topsoil	2105-8425015
Excavation - Cut & Fill	2102-2710080

Luminaire Spacing Calculations:

D = Luminaire spacing (36 ft)

LL = Initial lamp lumens

The LL is determined using the photometric data for the luminaire the designer selected.

CU = Coefficient of utilization

Obtain from manufacturer which is specific to the make and model of the luminaire

LLD = Lamp lumen depreciation factor

LLD for design is 0.90.

LDD = Luminaire dirt depreciation factor

LDD for design is 0.90.

Eh = Average maintained level of illumination

Eh see table 8C – 1.05 from SUDAS Design Manual

Eh for design is 0.5

W = Width of lighted area

W is the farthest distance from the luminaire needing illumination. For example, back of stall row to middle of access lane

Table 8C-1.05: Recommended Maintained Illuminance Values and Uniformity Ratios

	Basic	Enhanced Security
Minimum horizontal illuminance on surface	0.2 footcandles	0.5 footcandles
Minimum vertical illuminance at 5 feet above surface	0.1 footcandles	0.25 footcandles
Uniformity ratio (max. to min.)	20:1	15:1

Source: ULI / NPA

LL = (D x Eh x W) / (CU x LLD x LDD)

Start with D= 36’ and W = 18’+27’/2 = 22.5’ estimated from drawing

Assume a CU = 0.3 as a starting value

LL = (45 x 0.5 x 22.5) / (0.3 x 0.9 x 0.9)

LL = 506.25 / 0.243

LL = 2,083.3 Lumens

Look for a luminaire with LL around 2,100 Lumens

Perimeter lighting fixtures

1. Set the poles with 36' lateral separation distance.

2. Calculate the width of pavement the light will illuminate

   W = 18'+27'/2 = 22.5'

3. Select a luminaire type III to keep the light focused on the pavement with little light falling outside the pavement.

Type III: Trace falls between 1.75 mh and 2.75 mh on the street side of the luminaire position.

(mh = luminaire mounting height)

4. Go to a manufacturer product page (https://www.creelighting.com/products/outdoor/area/)

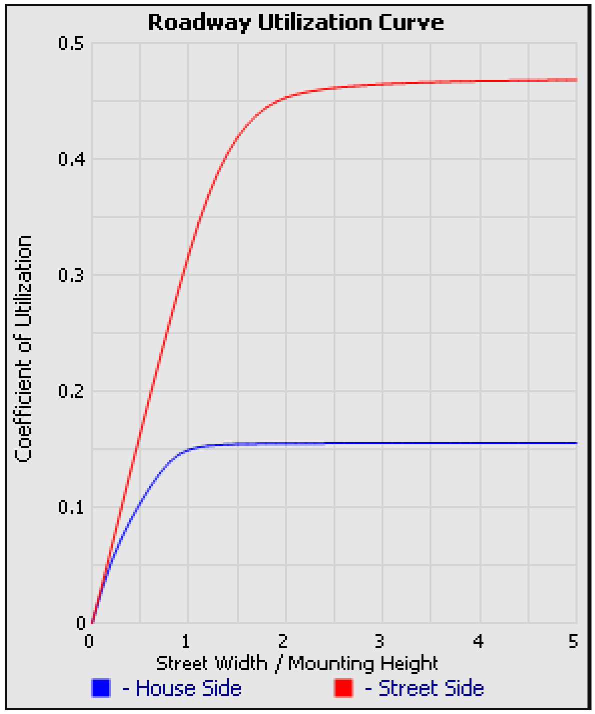
5. Find a luminaire within the 2,100 lumens range

The Edge series 02 4000k Type III Medium distribution w/Partial BLS

LL = 2,079

6. Download the IES file for luminaire type (https://www.creelighting.com/products/outdoor/area/xsp-series/#downloads)

Obtain the CU curve from the file



7. Obtain the CU from the chart with x = 22.5'/27' = 0.833. CU = 0.275

8. Check spacing

D = (LL x CU x LLD x LDD) / (Eh x W)

D= (2079 x 0.275 x 0.9 x 0.9) / (0.5 x 22.5)

D = 41.16'

*Move spacing to 41 ft

Appendix C Trail Design

Material Cost Estimate Calculations:

Clearing & Grubbing				
	area = length trail X width of ROW			
	length =	503.52	ft	
	width =	9	ft	
	Area =	4531.68	sq ft	
		0.104033058	acres	(43560 sqft/acre)

Excavation - Cut & Fill				
	Cut	203.8	cy	
	Fill	408.09	cy	
	Total	611.89	cy	
Soil Compaction				
	length	1505.59	ft	
	depth	0.5	ft	
	width	5	ft	
	volume	3763.975	cubic ft	(27 cf/cy)
		139.4064815	cy	
Granular subbase				
	length	1505.59	ft	
	depth	0.5	ft	
	width	5	ft	
	volume	3763.975	cf	
	Area	7527.95	sq ft	835.60245 sq yrds
Pavement				
	4" pcc			
	length	1505.59	ft	
	depth	0.33	ft	
	width	5	ft	
	volume	2484.2235	cf	
		92.00827778	cy	
	Area	836.4388889	sq yrds	
	4"asphalt			
	length	1505.59	ft	
	depth	0.33	ft	
	width	5	ft	
	volume	2484.2235	cf	
		92.00827778	cy	

	Area	836.4388889	sq yrds
Topsoil			
	length	1505.59	ft
	depth	0.5	ft
	width	4	ft
	volume	3011.18	cf
		111.5251852	cy
Item Codes: April 19th bids			
HMA	2303-1033750		
PCC	2511-7526004		
Subbase	2111-8174100		
Clearing & Grubbing	2101-0850001		
Soil Compaction	2107-0875100		
Topsoil	2105-8425015		
Excavation - Cut & Fill	2102-2710080		

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