Department of Civil Engineering
Senior Design Project
Fall 2014

Final Report

The University of Toledo Main Campus
River Pathway Design

Submitted To:

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Disclaimer

This report is student work. The contents of this report reflect the views of the students who are responsible for the facts and the accuracy of the data presented. The contents do not necessarily reflect the views of the University of Toledo or the Ohio Department of Transportation. The recommendations, drawings and specifications in this report should not be used without consulting a professional engineer.

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Department of Civil Engineering
Senior Design Project
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University of Toledo Main Campus
River Pathway Design

Fall Semester 2014

Team Members:
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Problem Statement

To facilitate pedestrian travel between Main Campus and Engineering Campus, this project aims to design a pathway that is an efficient form of travel between campuses and to highlight the improving condition of the Ottawa River.

Objectives

- Determine an effective pathway
- Develop pavement and pathway design
- Create cost estimates for the desired route
- Incorporate outlooks into the design and costing

Solution Approach

The design of the pathway will follow methods and standards set by the Ohio Department of Transportation and the University of Toledo.

Constraints

- ODOT Regulations
- University of Toledo Regulations
- Separation of project into stages
- University of Toledo and Surrounding Area Aesthetics

Economics

There is no limit on the cost of the project. No funds have been allocated to the completion of the pathway. Funds will be raised using this design as an example.

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Deliverables

The project deliverables will include, but are not limited to:

- Final Presentation and Report
- Pathway Route and Pavement Design
- Aesthetic Renderings
- Cost Analysis for Desired Pathway

Conclusions and Recommendations

In addressing the issues of traveling between Main Campus and Engineering Campus, multiple alternatives will be analyzed. These paths should showcase the Ottawa River and provide an efficient and aesthetically pleasing means of transportation for students to their destination.

University of Toledo Background Information

The University of Toledo is a well-known major college in western Toledo, Ohio. The campus contains many obstacles that make it difficult to easily and safely guide the public throughout Campus. Near the south side of campus there is a rail line that travels through campus dividing it into two parts. On the north side of campus the Ottawa River also cuts through the campus dividing the campus again. Over the years the University has overcome these obstacles by putting in multiple safe rail crossing and multiple bridges over the river in order to create safe pathways for the students and public to navigate campus. As the University continued to grow and their need for space grew they built an engineering campus on the east side of Douglas Road. Students now are required to cross four lanes of traffic to travel between the campuses. The designated crosswalk to cross the street is in an inefficient location, which causes students to jaywalk across Douglas Rd. This is by no means a safe way to cross this street; therefore the university began looking into solutions. After multiple ideas they decided to place a pedestrian bridge over Douglas Road and have the students go up and over the road. The location of this bridge will be north of the engineering college and come down on main campus near savage arena, where there is a defined walking path cut into the grass. After construction of the pedestrian bridge is the completed the plan is to put in a path that follows the river across campus and makes a safe, efficient route for students to navigate to their destination, whether that is the parking garage, Student Union, Carlson Library, dorms, or any other buildings on main campus for class. A site layout can be seen below in Figure 1.

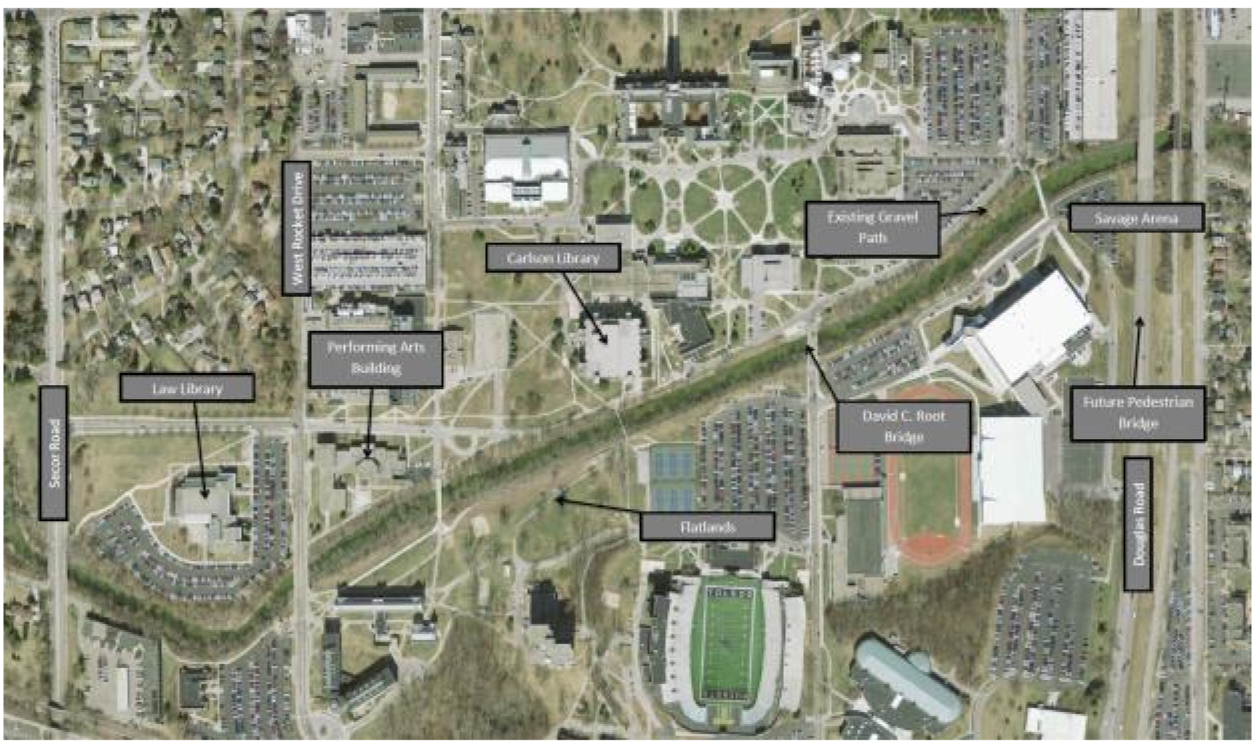

Figure 1: Site Layout

Objective and Problem Statement

This goal of this pathway design project is to make it more efficient for students to get to their destination. In many places on campus, the existing pathways that run along the river do not provide a direct route and is not aesthetically pleasing. There are a few existing problem areas along the river that this project will encounter. On the east end of campus (between Douglas road and the David C. Root Bridge) there is currently one existing pathway made from gravel that runs about one third the length of this section of the river along the North side. This current path is made of gravel, which winds through the trees and has a steep incline which makes it difficult for students to navigate. This pathway also experiences flooding during significant rainfall events. Photo 1 below shows this current pathway after there was three inches of rain.

Photo 1: Gravel Pathway along North Side of River

As shown in the picture above, this path is not in the most useful location for students. In this same section of river on the South side has a levy that runs the length of it where there is a path worn in the grass where students have been walking. Photo 2 shows this worn walkway. This shows that there is a clear need for a path, and in addition to the path that's worn there is a beautiful outlook on the river that could be easily integrated into the pathway to allow for better access to the river.

Photo 2: Worn Walking Path on South Side of River

To the East of West Rocket Drive Bridge there are newly placed fish habitats in the river that may be desirable to have better access to or an improved view of. Also to the South of the Law Library there is an area that is desired to have access to walk down part of the river bank to get closer to the river. Photo 3 below shows this area.

Photo 3: River Bank by Law Library

Alternative Routes

Multiple routes for this possible pathway along the Ottawa River have been considered. Three possible options have been analyzed for this project. None of these three options travel across the river by the East parking garage where the gravel path is located because of the issues that were mentioned above. Figures of these three alternatives can be found in Appendix A. The options that have been looked at follow, including the selected alternative that will be used going forward.

Pathway 1

The first alternative route that we looked at can be seen by looking at Figure 2 in Appendix A. The path would start where the future pedestrian bridge over Douglas Road will come down on the main campus side of Douglas Rd. It will then run down past Savage Arena to existing pathway along the south side of the Ottawa River. It would continue to follow the South Side of the river until the David C. Root Bridge, which will be widened to allow for safer travel in a future project. The path would then cross the bridge and continue along the North side of the Ottawa River until Secor Road allowing for a walkway down the bank of the river by the Law Library. A table of the advantages and disadvantages for this alternative can be seen below in Table 1.

Table 1: Pathway 1 Advantages and Disadvantages

ADVANTAGES	DISADVANTAGES
• Allows for use of existing overlooks by Savage Arena and Snyder Memorial	• There are space constraints by Savage Arena and Carlson Library
• The tree line on the North side of the river is more open allowing for a better view	• This route travels through the Performing Arts Amphitheater which deviates from the river
• This route passes the courtyard in front of Carlson Library	• This route travels by loading docks and exposed dumpsters.
• This route allows for access to fish habitats	• There is a lack of visible foot traffic around the Performing Arts building

Pathway 2

The second alternative route that we looked can be seen in Figure 3 in Appendix A. This route crosses the Ottawa River at the pedestrian bridge by the Carlson Library. The pathway would begin similarly to Pathway 1. It would continue running along the south side of the Ottawa River until the pedestrian bridge by Carlson Library. The path would cross the bridge and continue running along the North side of the river and ending at Secor Road. This option would also use the same pathway down the river bank by the Law Library. A table of the advantages and disadvantages can be seen below in Table 2.

Table 2: Pathway 2 Advantages and Disadvantages

ADVANTAGES	DISADVANTAGES
• Allows for use of existing overlook by Savage Arena	• There is a space constraint by Savage Arena
• The tree line on the North side of the river is more open allowing for a better view	• This route travels through the Performing Arts Amphitheater which deviates from the river
• This route passes the courtyard in front of Carlson Library	• This route travels by loading docks and exposed dumpsters.
• This route allows for access to fish habitats	• There is a lack of visible foot traffic around the Performing Arts building

Pathway 3

This pathway's route can be seen in Figure 4 in Appendix A. This path will begin the same way as Pathway's 1 and 2 starting by the Savage Arena outlook. Once the path reaches The David C. Root Bridge, it will then follow the bridge to the north side of the Ottawa River and run to the north side of the Carlson Library Bridge. Then the path will then continue running along the South side of the Ottawa River and will run past the flatlands area until West Rocket Drive. The path will then cross the bridge on West Rocket Drive and will follow the same proposed pathway on the South end of the Law Library and on the North side of the river until Secor Road. A list of the advantages and disadvantages are listed below in Table 3.

Table 3: Pathway 3 Advantages and Disadvantages

ADVANTAGES	DISADVANTAGES
• Easy to tie into existing pathways	• Space constraint by Savage Arena
• This route shows a clear need based on visible foot traffic	• The south side of the river has a thicker tree line reducing visibility
• Runs close to river allowing more opportunities for outlook locations	
• Avoids unappealing loading docks and dumpsters	
• Allows for use of existing outlook near Savage Arena	

Preferred Pathway

The pathway that was selected as the best option is Pathway 3. This pathway has the most upside with very little disadvantages to it. This pathway would result in more foot traffic compared to the other routes. This route also runs closer to the river and also uses more existing pathways allowing for less cost. Also this path avoids unappealing areas which the other two paths would travel near. Because of more foot traffic on this route it gives more available points to place outlooks. These aspects make Pathway 3 the best option for this project.

Outlooks

One of the goals of this project is to incorporate outlook points into the pathway's design. These outlooks are to resemble an existing outlook near Savage Arena. A design plan sheet for this example can be found in Appendix B. Photo 4 below and Figure 26 shows what the existing outlooks looks like.

Photo 4: Existing Outlook near Savage Arena

Pathway Design

In areas along the Ottawa River between Douglas Road and Secor Road, there are already existing pathways that may be utilized in the design of the pathway. However, there are certain areas between these existing paths that new pavement construction will be needed to connect these paths. The pavement materials that will be used are stone and permeable surfaces. It is desired to construct this project in phases and is explained below in the Construction Phase Breakdown. There is a space restriction that will be encountered near Savage Arena that will need considered in the pathway design. In this area a retaining wall may be required if grading is not a viable option. An alternative to a retaining wall in this section may be a boardwalk system. These options will be analyzed and the best option will be selected and included in the final cost estimate. Ohio Department of Transportation (Ref. 1,2,3) and University of Toledo Regulations (Ref. 5) will be followed.

Construction Phase Breakdown

The time table for design and construction of the proposed pathway has been broken down into 2 different phases. Phase 1 will consist of designing the proposed pathway to match the gravel path that was already constructed on the north side of the river near lot 1S. The design of the existing gravel path consists of two sections, the bottom layer being of larger aggregate and the top layer being a fine aggregate. Phase 2 is a future plan that consists of designing the pathway after it has already been constructed of gravel to be made of permeable concrete or regular concrete, depending on the existing conditions along the river. The schedule of both phases will be broken down into 5 segments. These segments are called reaches. A reach is the span of the pathway between bridges. Figure 2 shows map of the reaches.

Reach 1

Reach 1 is the span that starts at the West Rocket Drive Bridge and runs west along the river to Secor Road. This part of the pathway will slope down the bank to the bottom area and meet up with the designed path. It will then be come back up the bank by the parking lot and follow the parking lot and dead end into the existing path that leads to Secor Road. Good depictions of how this will look are from the Renderings of Figures 7 and 8 and from the Plan View on Figures 11 and 12.

Reach 2

Reach 2 is the span that starts at the Wolfe Bridge and runs west along the river to the West Rocket Drive Bridge. There is currently a pathway that runs near the river here so a new pathway will not be designed for this reach. However, it is possible to construct an outlook within this reach. Good depictions of how this will look are from the Plan View on Figures 13 and 14.

Reach 3

Reach 3 is the span that starts at the Carlson Library Bridge and runs west along the river to the Wolfe Bridge. There is currently a pathway that runs along the river here so a new pathway will not be designed for this reach. However, it is possible to construct an outlook within this reach. The Plan View of Figures 15 and 16 illustrate this layout well.

Reach 4

Reach 4 is the span that starts at the Root Bridge and runs west along the river to the Carlson Library Bridge. The pathway will be built up on the levy near parking lot 10 and will merge into the intersection that exists with the tennis courts and the Carlson Library Bridge. Since this is a heavy area for student traffic, this is an ideal location for an outlook to be installed. Good depictions of how this will look are from the Plan View on Figures 17 and 18.

Reach 5

Reach 5 is the span that starts at the parking garage bridge and runs west along the river to the Root Bridge. More specifically, this reach will start at the existing outlook by Savage Arena to the Root Bridge. The path will follow the pedestrian foot path that has been created by student traffic. A challenging aspect for this reach will be the design of a retaining wall due to the intensity of the slope down to the parking lot. Good depictions of how this will look are from the Rendering of Figures 9 and 10 and from the Plan View on Figures 19 and 20.

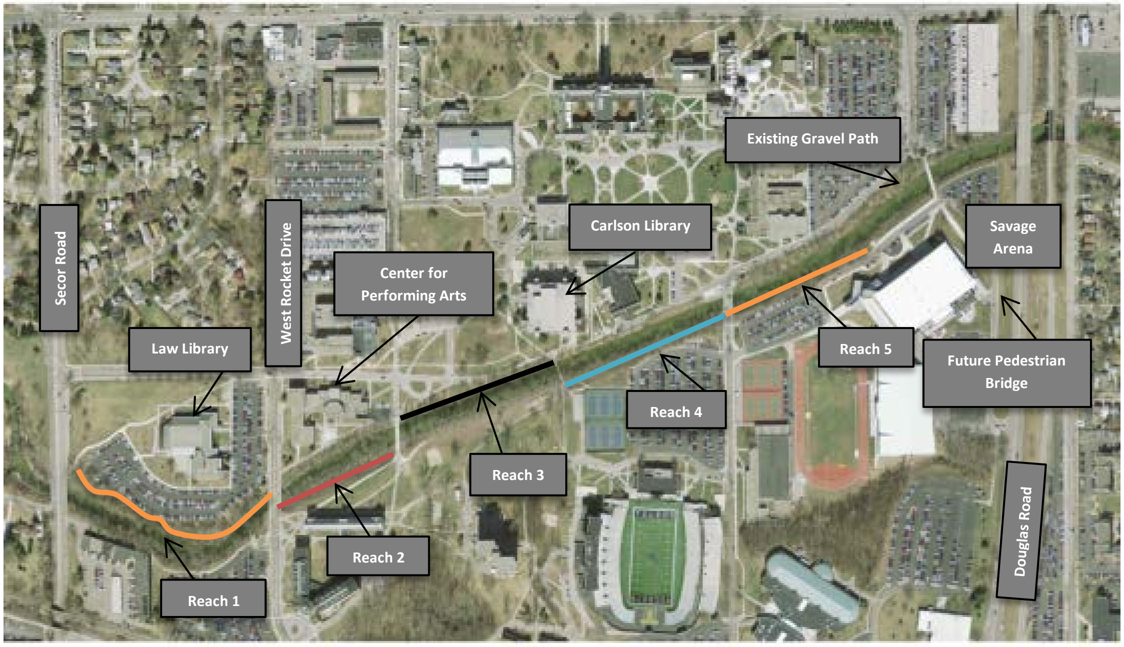

Figure 2: Reach map

Retaining Wall

Due to the space restrictions on top of the levy, a retaining wall is needed for a six foot path to be installed on it. The type of Retaining Wall that is being chosen is called a MSE wall, or known as Mechanically Stabilized Earth Wall. This type of retaining wall was chosen due to location of where the wall is going and the cost and ease of installation. There is not much excavation needed of the existing levy for this new retaining wall to be installed. The only excavation that is really needed is that for the 6” perforated pipe for drainage behind the rock façade.

This kind of wall is reinforced by each layer of Geosynthetic that extends into the soil so it is not needed for a footer to be installed under it. Since we are extending the levy at the base the full distance that is needed for the Geosynthetic material to extend without it failing, it is not needed for excavation to insert the material into the existing levy. This wall is also designed to flex a little without it failing. Referencing the MSE Wall Design Calculations that start on page 38, the Factors of Safety for Overturning, Sliding, and Bearing are 4.2, 1.112, and 1.17 respectively. Figure 30 is the Cross Section of the Retaining Wall that has been designed and the Renderings of Figures 9 and 10 show how the wall may look after installation.

General Considerations

Drainage

The drainage system that will be used for the river pathway is for all new sections of constructed pavement. Due to the use of gravel and a permeable surface design all runoff and drainage will be handled by the permeable surface. The pathway will also be sloped away from the river in the event runoff begins to form. A schematic of how the permeable surface will handle water is shown below in Figure 6.

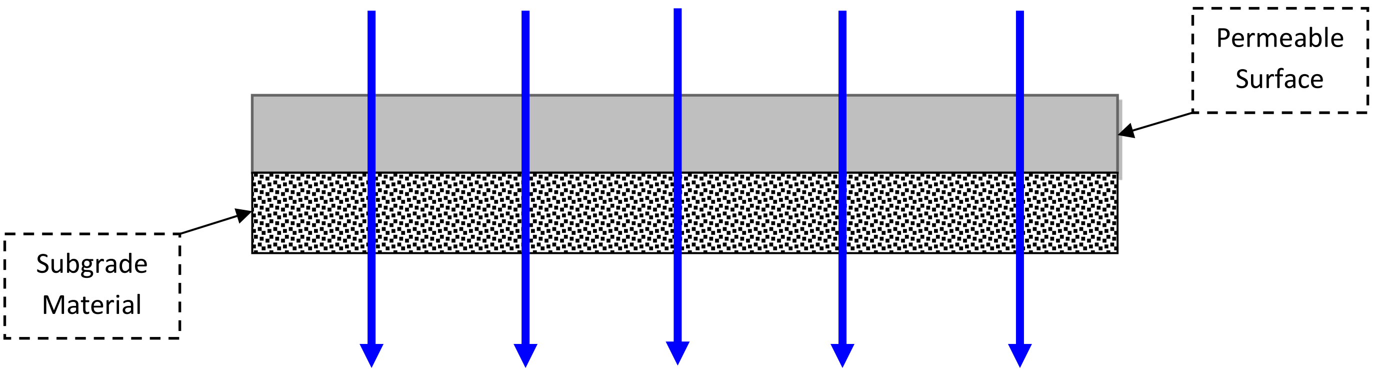

Figure 3: Permeable Pavement

Lighting

It is not desired to include light poles along the entire length of the proposed pathway. Lighting will only be considered for outlook locations and bench locations. Photo 5 below shows an example of a University of Toledo light pole that will be matched.

Photo 5: University of Toledo Light Pole

Plant Life

Options for plant life along the new pathway can be aesthetically pleasing to students and non-students traveling through campus. Such ideas could be planting native plants along the campus side of the pathway without clogging and congesting the pathway. There is a list of native plant types at (Ref. 4).

River Restoration Signs

As of now, there are information signs along the existing pathways near the Ottawa River that provide information on the river and what has been done to improve the river. The goal is to have the pathway connect with the signs as much as possible. An example of one of these signs can be seen below in Photo 6.

Photo 6: Example River Restoration Sign

Emergency Stations

There are currently many emergency station poles along existing pathways everywhere on campus. Currently there is discussion of removing emergency station poles from the campus. The need of adding these poles along the new pavement areas will be evaluated with the universities future plans. Below in Photo 7 is an example of one of these poles.

Photo 7: Example Emergency Station Pole

Aesthetics

Aesthetics will be implemented on this project. Aesthetics will be based off of existing University of Toledo aesthetics and implemented in feasible locations. Some examples of this will be matching the existing outlook style, existing light poles, and using the rock façade that is used widely around campus. A photo of this façade is shown below in Photo 8.

Photo 8: Existing University of Toledo Rock Façade

Cost Breakdown

Table 4: Quantities Used for Cost

Quantities					
			concrete	gravel	
Reach	Length		slab ft^3	course(4")	fine(2")
1A	467.13		1401.39	942.92	467.22
1B	491.27		1473.81	972.71	491.37
2	495.18		1485.54	980.46	495.28
3	N/A				
4	651.59		1954.77	1290.15	651.72
5	632.4		1897.20	1252.15	632.53
	2737.57		8212.71	5438.39	2738.12

Table 5: Stairs Budget

Stairs Budget			
Height of stairs	No. of Steps	Cost Per Step (ODOT)	Total Cost
8	8	$120.00	$960.00
8	8	$120.00	$960.00
14	14	$120.00	$1,680.00
14	14	$120.00	$1,680.00

Table 6: Outlook Cost

Outlook Cost			
Material	yd^3	Cost Per Outlook	Total Cost
Backfill	4	$848.00	$1,696.00
Course Aggregate	3	$636.00	$1,272.00
Rebar (#4 bars @ 1/2"x20')	24	$384.00	$768.00
Concrete	8	$1,696.00	$3,392.00
Labor		$3,650.00	$7,300.00
	Total Cost	$7,214.00	$14,428.00

Table 7: Cost of Gravel Pathway

Entire Pathway laid with Gravel course material on bottom and screenings on top								
Reach	Pathway Width (ft)	Pathway Section Length	Course Material Depth (in)	Fine Material Depth (in)	yd^3 of course material	yd^3 of Fine material	Total Cost Per Reach	Cost of material per foot of path
1A	6	467.13	4	2	34.60	34.60	$4,013.86	$8.59
1B	6	491.27	4	2	36.39	36.39	$4,221.28	$8.59
2	6	495.18	4	2	36.68	36.68	$4,254.88	$8.59
4	6	651.59	4	2	48.27	48.27	$5,598.85	$8.59
5	6	632.4	4	2	46.84	46.84	$5,433.96	$8.59

Table 8: Cost of Permeable Concrete Pathway

Entire Pathway laid with Permeable Concrete								
Reach	Pathway Width (ft)	Pathway Section Length	Base Gravel Depth (in)	Permeable Concterete depth(in)	yd^3 of course material	yd^3 of Pearmeable Concrete	Total Cost Per Reach	Cost of material per foot of path
1A	6	467.13	4	6	34.60	51.90	8,944.67	19.15
1B	6	491.27	4	6	36.39	54.59	9,406.91	19.15
2	6	495.18	4	6	36.68	55.02	9,481.78	19.15
4	6	651.59	4	6	48.27	72.40	12,476.74	19.15
5	6	632.4	4	6	46.84	70.27	12,109.29	19.15

Table 9: Cost of Regular Concrete Pathway

Entire Pathway laid with Concrete								
Reach	Pathway Width (ft)	Pathway Section Length	Base Gravel Depth (in)	Concterete depth(in)	yd^3 of course material	yd^3 of Concrete	Total Cost Per Reach	Cost of material per foot of path
1A	6	467.13	0	6	0.00	51.90	$5,501.75	$9.56
1B	6	491.27	0	6	0.00	54.59	$5,786.07	$9.56
2	6	495.18	0	6	0.00	55.02	$5,832.12	$9.56
4	6	651.59	0	6	0.00	72.40	$7,674.28	$9.56
5	6	632.4	0	6	0.00	70.27	$7,448.27	$9.56

Table 10: Cost of Retaining Wall

Retaining Wall	
Wall Length (ft)	6
Wall Height (ft)	436
Wall square ft (ft^2)	2616
Wall Cost per sq ft per ODOT	$140
Total Wall Installed Cost	**$366,240**

Table 11: Labor Rates

Labor Rates for Prevailing Wage Projects Taken From Davis Bacon Rates For Lucas County	
Title	$/hour
Foreman	$53.82
Operater	$41.38
Finisher	$43.62
Laborer	$37.95
Stone Mason	$42.51

Table 12: Wage Breakdown per Crew Size

Crew Size			
# of ppl	pavement crew	cost rates for prevailing wage.	per
1	foreman/super	53.82	hour
2	opperators	41.38	hour
3	finisher	43.62	hour
4	labors	37.95	hour
2	stone mason	42.51	hour

Table 13: Cost for Labor for Installation

Labor Costing For Pathway Instaltion						
Material	Estimated Pathway FT. per day of Production	Cost of Proposed Crew for 8 hr day	Total Pathway (ft)	Days Required	Total Labor Cost for Pathway	Labor Cost per Foot
Gravel	230	$1,414.16	2737.57	12	$16,832.01	$6.15
Permeable Conctere	90	$1,414.16	2737.57	30	$43,015.13	$15.71
Concrete	130	$1,414.16	2737.57	21	$29,779.71	$10.88

Conclusion

For this project, our recommended solutions were based largely on price, and innovation, while being sure to keep negative environmental impact to a minimum. Available space at each reach was also a limiting factor. The design of this project is done by 2 phases. The first phase is to be designed by implementing a gravel path along the river along the chosen path route. The route chosen for the design is route 3 that will run from Secor Road along the North Side of the river to West Rocket Drive. It will then continue to the South Side of the river and run to the Performance Arts Bridge. It then jumps across to the North Side to the Carlson Library Bridge. From there is continues on the South Side of the river and runs to the David C. Root Bridge. From there, it continues on the South Side of the river and finishes by the existing outlook by Savage Arena. Each run between bridges is called a Reach and will be used in that order for construction. The second Phase will be implementing a more finished look by constructing the path out of either Regular Concrete or Permeable Concrete. Cross sections of each path type are Figures 27, 28, and 29 respectively.

As of now, all prices are an estimation and not finite. The cost estimate has been broken down with the entire pathway being priced out with all three pavements. However, Table 14 shows the cost breakdown per reach, both containing a material price and a labor price. Reach 1 having Gravel pavement costs $14,128, Reach 2 having Permeable Concrete pavement costs $12,513, Reach 4 having Regular Concrete pavement costs $13,314, and Reach 5 having Regular Concrete pavement costs $12,922. The cost determined for the Retaining Wall, Stairs and Outlooks are a combined price of material and labor lumped into one sum. With that being said, the cost for the Retaining Wall is $366,240, the Stairs is $12,000 and the cost of two Outlooks are $14,500. Combining all the numbers together with an inflation factor, the estimated price of this entire project is $472,755. To get a better grasp on how the cost estimate was put together, Tables 4 through 13 above go into more detail for what was considered for each pricing area.

It can be said that for each Reach can be a mix of Gravel, Permeable Concrete, and Regular Concrete. Tables 7, 8, and 9 are the breakdown for Gravel, Permeable, and Regular Concrete respectively and have it broken down per reach. Not every Reach must be done with just Gravel, Permeable, or Regular Concrete. If all conditions meet regulations, then the Reaches can be mixed and matched between any of the options to show different practices are being implemented in consideration of what is best for the environment.

Table 14: Project Cost Summary

TOTAL COSTING FOR UT RIVER PATHWAY ENGINEERS ESTIMATE			
REACH	**PROPOSED MATERIAL**		**ESTIMATED COST**
1	Gravel	Material	$8,235
		Labor	$5,893
2	Permeable Concrete	Material	$4,732
		Labor	$7,781
4	Concrete	Material	$6,226
		Labor	$7,088
5	Concrete	Material	$6,043
		Labor	$6,879
TWO OUTLOOKS	Concrete		$14,500
RETAINING WALL	MECHANICALLY STABALIZED		$366,240
STRAIRS BUDGET	TBD		$12,000
ESTIMATED TOTAL COST			$445,617
INFLATION FACTOR OVER TWO YEARS			$27,138.07
ESTIMATED TOTAL COST			$472,755

Qualifications of Design Team

Within this design team, many diverse qualifications can be utilized. As seen in the following resumes, each member is able to contribute differently to the group. The specific knowledge of each individual allows our team to generate unique ideas from demonstrating the different backgrounds and experiences achieved through our years of study. Along with this, the group works well with one another to fulfill specific aspects of the design. This attribute will also help to produces a well-constructed final product. From these factors our team is able to make a strong and useful design that will fulfill the needs of The University of Toledo.

WILLIAM FRAZIER

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Petersburg, MI 49270
(567) – 277 – 7046
will.frazier@rockets.utoledo.edu

OBJECTIVE	To secure a full time position in the Civil Construction or Engineering Field.
EDUCATION January 2012 – Present	**The University of Toledo**, Toledo, Ohio *Bachelor of Science, Civil Engineering* • Graduation Date: December 2014 • GPA – 3.24
August 2009- December 2011	**Monroe County Community College**, Monroe, Michigan *Associates Degree of Science, Engineering* • Graduating April 2012 • Grade Point Average: 2.73
COMPUTER SKILLS	Microsoft Office Suite AutoCAD
EXPERIENCE August 2012 – Present	**The Rudolph/Libbe Inc.,** Walbridge, OH *Co-op Engineer* • Liaison between Project Manager and field work involved on projects • Point contact between Customer, Engineers, & Subcontractor for Submittals and RFIs • Schedule preparation and resource forecasting for employee job tracking
May 2011 – August 2012	**The Legacy Golf Course,** Ottawa Lake, MI *Maintenance* • Maintained adequate course conditions • Cleaned the shop and sprinkler heads • Cut grass and raked sand traps
November 2011- January 2012	**The Funchion Homes**, Ottawa Lake, MI *Carpenter* • Sustained good work conditions • Built interior and exterior walls • Delivered wood to work site
HONORS & AWARDS	**National Honor Society, Whiteford Agricultural Schools** **Scholar Athlete, Whiteford Agricultural Schools** **College of Engineering Deans List: Spring 2012; Spring 2014**
COLLEGIATE ACTIVITIES	**American Society of Civil Engineers (ASCE)**
REFERNCES	Available upon request

DEREK R. HESS

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OBJECTIVE

Seeking a full-time position as a Structural Engineer in a Structural Engineering department.

EDUCATION

August 2010-Present

University of Toledo — Toledo, Ohio
Bachelor of Science, Civil Engineering
-Expected Graduation Date: December 2014
-Overall GPA: 3.13
-Engineering GPA: 3.57

August 2009-May 2010

Tri Star Career Compact, — Celina, Ohio
One-year Engineering Technology/Computer Aided Drafting Program
- Certificate of Completion, May 2010

COMPUTER SKILLS

-Microstation V8i
-AutoCAD Civil 3D
-LEAP Bridge
-LARS
-Conspan
-MathCAD
-Softplan
-Microsoft Office Suite
-Autodesk Inventor

EXPERIENCE

May 2012-Present

Mannik & Smith Group — Maumee, Ohio
CAD Technician/Co-op
-Prepared detail design drawings
-Assisted in bridge design, bridge inspections, and load ratings

August 2007-December 2013

Brian Kremer Poultry — Maria Stein, Ohio
General Laborer
-Collected eggs and efficiently put them into trays for shipping
-Performed miscellaneous tasks around the farm

ENGINEERING PROJECTS

ODOT Bridges

Interstate 475 over Dorr Street/Hill Avenue (Toledo, Ohio)
-2 Similar Twin Structures featuring bridge widening and rehabilitation

Interstate 475 over Blossman Road (Toledo, Ohio)
-Bridge widening and rehabilitation featuring super elevation and transition on structure

Central Avenue over Interstate 475 (Toledo, Ohio)
-Bridge relocation featuring SPUI design (Currently in design phase)

State Route 66 over Maumee River (Waterville, Ohio)
-1000'+ structure featuring relocation and haunched girders (Currently in design phase)

COLLEGIATE ACTIVITIES

Alpha Sigma Phi Fraternity
-Current Vice-President
-Former Treasurer
-Former Community Service Chairman
-Former Family Relations Chairman

REFERENCES: Available upon request

PETER LOPEZ
317 Reese St.
Sandusky, OH 44870
419-656-0713
osupalj5@gmail.com

OBJECTIVE

To obtain a co-op position in the field of civil engineering that will enhance my academic endeavors through hands-on experience.

EDUCATION
August 2010-Present

The University of Toledo — Toledo, OH
Bachelor of Science, Civil Engineering
- Anticipated Graduation Date: May 2015
- Grade Point Average: 2.326

COMPUTER SKILLS

Microsoft Office
Auto CAD

EXPERIENCE
Summer 2012 and 2013
August 2013-November 2013

Cedar Point — Sandusky, OH
Co-op
- Inspected rides using a safety checklist
- Studied the design and structure of the ride
- Maintained rides to O.H.S.H.A. standards
- Utilized analytical processes to solve problems

Summer 2010 & 2011

Cedar Point — Sandusky, OH
Games Host
- Interacted with customers
- Handled money

Games Supervisor
- Trained employees on operating games
- Managed personnel
- Ensured quality performance and customer satisfaction

COMMUNITY ACTIVITIES
November 2009-February 2010

Biddy Basketball — Sandusky, OH
Volunteer
- Taught second-fourth graders basic basketball skills
- Portrayed leadership and good character (role model)
- Assisted players one-on-one when necessary

HONORS & AWARDS

Rocket Gold Scholarship

REFERENCES

Available upon request

ROSS D. WUEBKER

PERMANENT ADDRESS
308 East 4th St, Minster, Oh. 45865
(567)644-8308

LOCAL ADDRESS
1831 Evansdale Rd.,
Toledo, Ohio 43607
ross.wuebker@rockets.utoledo.edu

OBJECTIVE

To obtain a job in the Civil Engineering field

EDUCATION

The University of Toledo, Toledo, Ohio
Bachelor of Science, Civil Engineering

- Anticipated Graduation Date: December 2014
- Grade Point Average: 3.537

AWARDS AND HONORS

Blue and Gold Scholar Award
Dean's List and Presidential List Recognition
Chi Epsilon

COMPUTER SKILLS

AutoCAD 2010
Microsoft Windows 7/ Vista/xp
Microsoft Office Suite

WORK EXPERIENCE

Ferguson Construction, Co. May 2013-August 2014
Co-op December 2011-May 2012

- Assisted with site layout
- Performed general labor jobs; concrete, metal roofs and siding, and misc. work
- Estimated jobs using computer software and calling subcontractors
- Assisted with project managing

Choice One Engineering August 2012 – January 2013
Co-op

- Surveyed streets and properties
- Staked site lay-out
- Performed operations on Auto-cad
- Reviewed street plans

Riethman Builders, Inc. June 2009–August 2011
Summer help

- Poured concrete driveways and sidewalks
- Constructed homes and repaired roofs
- Performed in miscellaneous capacities on job site

COLLEGIATE ACTIVITIES

Student Member of First Year Engineers (FYRE)
Intramural sports

SPECIAL SKILLS

Possess good communication skills
Ability to work independently, and also with others in a team environment
Strong knowledge of basic tools used for construction and estimating projects

MITCHELL GENE PITSENBARGER

PERMANENT ADDRESS
9648 Pitsenbarger Road.
Versailles, Ohio 45380
(937)564-6058

LOCAL ADDRESS
1831 Evansdale Avenue
Toledo, Ohio 43607
mitch.pitsenbarger@utoledo.edu

OBJECTIVE: To obtain a full time position in the Civil Engineering

EDUCATION:
August 2010 - Present

The University of Toledo, Toledo, Ohio
Bachelor of Science, Civil Engineering
- Anticipated Graduation Date: December 2014
- Grade Point Average: 3.60

Edison Community College, Piqua, Ohio
- *PSEOP transfer credits*

AWARDS & HONORS:
- Rocket Scholar Award
- BOSEF Scholarship (Building Ohio's Sustainable Energy Future)
- Dean's List, The University of Toledo: Fall 2010, 2014 Spring 2011, 2013
- State FFA Degree: 2009; American FFA degree: 2011

COMPUTER SKILLS:
- AutoCAD 2013, AutoCAD Civil 3-D
- Microsoft Office
- Bluebeam PDF Reader

EXPERIENCE:
August 2010-Present

University of Toledo Transit Services
Bus Maintenance and Operation
- Operate Bus for Driving Students on Campus
- Dispatch and Manage Bus Fleet

January 2012 – August 2013

Danis Building Construction
Co-op (Three Co-ops)
- Assist Superintendent in day to day tasks
- Report weekly progress totals for labor audits
- Attend Pre bid meetings and deliver bids
- Bid preparation and Delivery

January 2014 – Present

Mote & Associates
Co-op
- Prepare Feasibility Reports
- Update AutoCAD Block References
- Integrate GIS aerials into Project Location Maps
- Assist in Topographic Survey

COLLEGIATE ACTIVITIES:
- Student Member of American Society of Civil Engineers
- Student Teachers Assistant (TA)
- Secretary of Chi-Epsilon

SPECIAL:
- **Class A CDL**
  Endorsements: Tanker, Passenger, Doubles & Triples

REFERENCES Available Upon Request

Appendix A: Design Calculations

Pathway Quantities

Table 15: Pathway Design Quantities

Reach	Stations		Length (ft)			Slab: Concrete (Ft³)			
1A	1+03.22	5+70.55	467.13			467.13'	(6'x0.5')	=	1401.39
1B	5+85.35	10+77.62	491.27			491.27'	(6'x0.5')	=	1473.81
2	1+13.86	6+09.04	495.18			495.18'	(6'x0.5')	=	1485.54
3	N/A	N/A	N/A			N/A	N/A	=	N/A
4	0+06.49	6+58.08	651.59			651.59'	(6'x0.5')	=	1954.77
5	7+07.12	13+39.52	632.40			632.4'	(6'x0.5')	=	1897.20
		Total	2737.57					Total	8212.71
	Gravel: Coarse (ft³)					Gravel: Fine (ft³)			
1A	467.13'	(6'x0.33')	=	924.92		467.13'	(6'x0.1667')	=	467.22
1B	491.27'	(6'x0.33')	=	972.71		491.27'	(6'x0.1667')	=	491.37
2	495.18'	(6'x0.33')	=	980.46		495.18'	(6'x0.1667')	=	495.28
3	N/A	N/A	=	N/A		N/A	N/A	=	N/A
4	651.59'	(6'x0.33')	=	1290.15		651.59'	(6'x0.1667')	=	651.72
5	632.4'	(6'x0.33')	=	1252.15		632.4'	(6'x0.1667')	=	632.53
		Total		5420.39				Total	2738.12
		Slab	Gravel						
	Totals	Concrete	Coarse			Fine			
	Ft³	8212.71	5420.39			2738.12			
	Yd³	304.17	200.76			101.41			

Outlook quantities

1. Rectangle = 9’ X 18’ x 0.333’ = 53.9 ft^3
2. Semi-circle = ((3.14 x 9’^2) / 2) X 0.333’ = 42.37 ft^3
3. Short wall segments = 2 x 3’ x 2.333’ x 1.333’ = 18.66 ft^3
4. Wall segment = ((3.14 x 10.333’^2) / 2) x 2.333’–((3.14 x 9’^2) / 2) x 2.333’ = 94.44 ft^3

Total = 53.9 + 42.37 + 18.66 + 94.44 = 209.37 ft^3

Cut and Fill Data

Table 16: Reach 1 Cut and Fill

Reach 1 (Law Library Path)													
				Width of Gravel Path			6.00	ft					
				Thickness of Gravel Path			0.50	ft					
				Area of Gravel Path			3.00	ft^2					
Station	Volume From Cross-Sections	Corrected Volume for Gravel Path	Distance	Avg. Area	Volume	Running Total	Station	Volume From Cross-Sections	Corrected Volume for Gravel Path	Distance	Avg. Area	Volume	Running Total
	(ft^2)	ft^2	(ft)	(ft^2)	(ft^3)	(ft^3)		(ft^2)	ft^2	(ft)	(ft^2)	(ft^3)	(ft^3)
103.22	0.10	-2.90	6.78	-2.38	-16.11	-16.11	600	-9.96	-12.96	10	-9.86	-98.56	-688.61
110	1.15	-1.85	10	-1.73	-17.30	-33.41	610	-3.75	-6.75	10	-3.78	-37.76	-726.37
120	1.39	-1.61	10	-1.96	-19.62	-53.03	620	2.20	-0.80	10	1.05	10.51	-715.87
130	0.68	-2.32	10	-2.40	-23.99	-77.02	630	5.90	2.90	10	2.95	29.49	-686.38
140	0.52	-2.48	10	-2.50	-25.01	-102.03	640	5.99	2.99	10	-3.50	-35.03	-721.41
150	0.48	-2.52	10	0.30	3.03	-99.00	650	-7.00	-10.00	10	-7.36	-73.57	-794.97
160	6.13	3.13	10	1.97	19.71	-79.29	660	-1.71	-4.71	10	-7.64	-76.42	-871.40
170	3.82	0.82	10	-0.68	-6.82	-86.11	670	-7.57	-10.57	10	-5.89	-58.85	-930.25
180	0.82	-2.18	10	-1.20	-11.98	-98.09	680	1.80	-1.20	10	-0.46	-4.59	-934.84
190	2.78	-0.22	10	-0.85	-8.54	-106.63	690	3.28	0.28	10	3.51	35.05	-899.79
200	1.51	-1.49	10	1.07	10.69	-95.94	700	9.73	6.73	10	7.07	70.65	-829.14
210	6.63	3.63	10	2.19	21.88	-74.06	710	10.40	7.40	10	7.12	71.15	-757.99
220	3.75	0.75	10	0.44	4.42	-69.64	720	9.83	6.83	10	7.58	75.75	-682.24
230	3.14	0.14	10	1.35	13.48	-56.16	730	11.32	8.32	10	6.71	67.10	-615.14
240	5.56	2.56	10	0.39	3.85	-52.31	740	8.10	5.10	10	7.69	76.85	-538.29
250	1.21	-1.79	10	1.18	11.76	-40.55	750	13.27	10.27	10	6.10	61.00	-477.29
260	7.14	4.14	10	10.29	102.91	62.36	760	4.93	1.93	10	1.01	10.05	-467.24
270	19.44	16.44	10	12.34	123.41	185.77	770	3.08	0.08	10	2.00	20.00	-447.24
280	11.24	8.24	10	8.40	84.05	269.82	780	6.92	3.92	10	1.60	16.00	-431.24
290	11.57	8.57	10	4.20	42.03	311.84	790	2.28	-0.72	10	0.06	0.60	-430.64
300	2.84	-0.16	10	-1.52	-15.19	296.66	800	3.84	0.84	10	1.74	17.35	-413.29
310	0.13	-2.87	10	-2.95	-29.53	267.12	810	5.63	2.63	10	6.64	66.40	-346.89
320	-0.03	-3.03	10	-2.53	-25.25	241.87	820	13.65	10.65	10	11.84	118.40	-228.49
330	0.98	-2.02	10	-2.46	-24.62	217.25	830	16.03	13.03	10	5.56	55.62	-172.87
340	0.09	-2.91	10	2.50	25.01	242.26	840	1.09	-1.91	10	-3.99	-39.94	-212.81
350	10.91	7.91	10	3.45	34.47	276.73	850	-3.08	-6.08	10	-4.87	-48.65	-261.46
360	1.98	-1.02	10	-2.47	-24.75	251.98	860	-0.65	-3.65	10	-6.00	-59.95	-321.41
370	-0.93	-3.93	10	-7.17	-71.72	180.27	870	-5.34	-8.34	10	-12.31	-123.05	-444.46
380	-7.41	-10.41	10	-7.23	-72.34	107.93	880	-13.27	-16.27	10	-13.69	-136.90	-581.36
390	-1.06	-4.06	10	-3.39	-33.94	73.99	890	-8.11	-11.11	10	-12.62	-126.15	-707.51
400	0.27	-2.73	10	-2.76	-27.63	46.36	900	-11.12	-14.12	10	-14.21	-142.05	-849.56
410	0.20	-2.80	10	-1.51	-15.13	31.23	910	-11.29	-14.29	10	-17.00	-170.00	-1019.56
420	2.77	-0.23	10	-3.53	-35.25	-4.02	920	-16.71	-19.71	10	-18.80	-188.00	-1207.56
430	-3.82	-6.82	10	-6.52	-65.22	-69.24	930	-14.89	-17.89	10	-14.81	-148.10	-1355.66
440	-3.23	-6.23	10	-5.44	-54.39	-123.63	940	-8.73	-11.73	10	-15.17	-151.65	-1507.31
450	-1.65	-4.65	10	-5.45	-54.47	-178.10	950	-15.60	-18.60	10	-16.78	-167.75	-1675.06
460	-3.24	-6.24	10	-2.85	-28.50	-206.61	960	-11.95	-14.95	10	-11.91	-119.12	-1794.17
470	3.54	0.54	10	1.42	14.21	-192.40	970	-5.87	-8.87	10	-8.88	-88.77	-1882.94
480	5.30	2.30	10	0.78	7.83	-184.56	980	-5.88	-8.88	10	-5.77	-57.70	-1940.64
490	2.27	-0.73	10	-1.41	-14.08	-198.64	990	0.34	-2.66	10	-1.25	-12.45	-1953.09
500	0.92	-2.08	10	-2.15	-21.50	-220.14	1000	3.17	0.17	10	1.27	12.65	-1940.44
510	0.78	-2.22	10	-1.17	-11.73	-231.87	1010	5.36	2.36	10	-2.69	-26.90	-1967.34
520	2.87	-0.13	10	-0.92	-9.19	-241.06	1020	-4.74	-7.74	10	-8.67	-86.70	-2054.04
530	1.29	-1.71	10	1.89	18.86	-222.20	1030	-6.60	-9.60	10	-5.31	-53.10	-2107.14
540	8.48	5.48	10	5.30	52.99	-169.21	1040	1.98	-1.02	10	17.28	172.75	-1934.39
550	8.12	5.12	10	1.21	12.12	-157.09	1050	38.57	35.57	10	30.79	307.85	-1626.54
560	0.31	-2.69	10	-4.45	-44.46	-201.55	1060	29.00	26.00	10	18.22	182.20	-1444.34
570	-3.20	-6.20	10	-8.91	-89.11	-290.67	1070	13.44	10.44	7.62	7.95	60.54	-1383.80
580	-8.62	-11.62	10	-14.64	-146.36	-437.02	1077.62	8.45	5.45	(-)	(-)	(-)	
590	-14.65	-17.65	10	-15.30	-153.03	-590.06							
								Total	-51.25	(yd^3)			

Table 17: Reach 2 Cut and Fill

Reach 2 (Academic House Dorms)													
				Width of Permeable Path			6.00	ft					
				Thickness of Permeable Path			0.50	ft					
				Area of Gravel Path			3.00	ft^2					
Station	Volume From Cross-Sections	Corrected Volume for Permeable Path	Distance	Avg. Area	Volume	Running Total	Station	Volume From Cross-Sections	Corrected Volume for Permeable Path	Distance	Avg. Area	Volume	Running Total
	(ft^2)	ft^2	(ft)	(ft^2)	(ft^3)	(ft^3)		(ft^2)	ft^2	(ft)	(ft^2)	(ft^3)	(ft^3)
113.86	2.01	-0.99	6.14	-1.88	-11.55	-11.55	360	5.63	2.63	10	2.28	22.75	-177.20
120	0.23	-2.77	10	-2.80	-27.99	-39.54	370	4.92	1.92	10	3.05	30.50	-146.70
130	0.18	-2.82	10	-4.12	-41.18	-80.71	380	7.18	4.18	10	4.61	46.05	-100.65
140	-2.41	-5.41	10	-5.63	-56.28	-136.99	390	8.03	5.03	10	3.97	39.70	-60.95
150	-2.84	-5.84	10	-4.68	-46.80	-183.79	400	5.91	2.91	10	3.88	38.75	-22.20
160	-0.52	-3.52	10	-1.77	-17.72	-201.51	410	7.84	4.84	10	5.06	50.60	28.40
170	2.97	-0.03	10	0.60	6.03	-195.48	420	8.28	5.28	10	1.93	19.30	47.70
180	4.23	1.23	10	0.16	1.57	-193.91	430	1.58	-1.42	10	3.69	36.87	84.57
190	2.08	-0.92	10	2.08	20.80	-173.11	440	11.79	8.79	10	6.89	68.90	153.47
200	8.08	5.08	10	2.87	28.65	-144.46	450	7.98	4.98	10	2.21	22.07	175.54
210	3.65	0.65	10	-0.83	-8.25	-152.71	460	2.43	-0.57	10	-0.91	-9.05	166.49
220	0.70	-2.30	10	-2.05	-20.45	-173.16	470	1.76	-1.24	10	-1.36	-13.55	152.94
230	1.21	-1.79	10	-0.36	-3.55	-176.71	480	1.53	-1.47	10	-2.16	-21.56	131.38
240	4.08	1.08	10	2.35	23.50	-153.21	490	0.16	-2.84	10	-2.90	-29.01	102.38
250	6.62	3.62	10	2.09	20.85	-132.36	500	0.04	-2.96	10	-3.00	-29.96	72.42
260	3.55	0.55	10	0.02	0.25	-132.11	510	-0.03	-3.03	10	-0.90	-8.96	63.46
270	2.50	-0.50	10	-0.02	-0.20	-132.31	520	4.24	1.24	10	2.41	24.05	87.51
280	3.46	0.46	10	-1.35	-13.51	-145.83	530	6.57	3.57	10	1.81	18.10	105.61
290	-0.16	-3.16	10	-2.77	-27.69	-173.52	540	3.05	0.05	10	-1.11	-11.05	94.56
300	0.62	-2.38	10	-1.41	-14.08	-187.60	550	0.74	-2.26	10	-0.85	-8.50	86.06
310	2.56	-0.44	10	-0.38	-3.75	-191.35	560	3.56	0.56	10	0.15	1.45	87.51
320	2.69	-0.31	10	-1.53	-15.30	-206.65	570	2.73	-0.27	10	-1.73	-17.32	70.19
330	0.25	-2.75	10	-2.12	-21.15	-227.80	580	-0.19	-3.19	8.55	-4.39	-37.51	32.68
340	1.52	-1.48	10	0.37	3.65	-224.15	588.55	-2.58	-5.58				
350	5.21	2.21	10	2.42	24.20	-199.95							
									Total	1.21	(yd^3)		

Table 18: Reach 4 Cut and Fill

Reach 4 (Glass Bowl Parking Lot)													
				Width of Permeable Path		6.00	ft						
				Thickness of Permeable Path		0.50	ft						
				Area of Gravel Path		3.00	ft^2						
Station	Volume From Cross-Sections	Corrected Volume for Permeable Path	Distance	Avg. Area	Volume	Running Total	Station	Volume From Cross-Sections	Corrected Volume for Permeable Path	Distance	Avg. Area	Volume	Running Total
	(ft^2)	ft^2	(ft)	(ft^2)	(ft^3)	(ft^3)		(ft^2)	ft^2	(ft)	(ft^2)	(ft^3)	(ft^3)
46.7	0.00	-3.00	3.3	-2.72	-8.97	-8.97	360	21.21	18.21	10	8.59	85.92	120.14
50	0.57	-2.44	10	-2.55	-25.51	-34.48	370	1.97	-1.03	10	-0.96	-9.61	110.53
60	0.33	-2.67	10	-4.81	-48.08	-82.56	380	2.11	-0.89	10	-3.58	-35.75	74.78
70	-3.95	-6.95	10	-7.74	-77.36	-159.91	390	-3.26	-6.26	10	-3.94	-39.42	35.36
80	-5.52	-8.52	10	-10.29	-102.94	-262.86	400	1.38	-1.62	10	1.56	15.63	50.99
90	-9.07	-12.07	10	-8.20	-82.02	-344.87	410	7.75	4.75	10	3.86	38.64	89.63
100	-1.34	-4.34	10	-4.84	-48.41	-393.29	420	5.98	2.98	10	2.30	23.02	112.66
110	-2.34	-5.34	10	-5.89	-58.87	-452.16	430	4.63	1.63	10	2.05	20.50	133.16
120	-3.43	-6.43	10	-4.72	-47.15	-499.31	440	5.47	2.47	10	3.42	34.21	167.37
130	0.00	-3.00	10	-6.52	-65.22	-564.53	450	7.37	4.37	10	4.31	43.15	210.52
140	-7.04	-10.04	10	-7.72	-77.23	-641.76	460	7.26	4.26	10	0.72	7.20	217.71
150	-2.40	-5.40	10	-5.46	-54.61	-696.37	470	0.18	-2.82	10	3.66	36.55	254.26
160	-2.52	-5.52	10	1.32	13.23	-683.14	480	13.13	10.13	10	7.27	72.66	326.92
170	11.16	8.16	10	12.54	125.41	-557.74	490	7.40	4.40	10	2.10	21.00	347.93
180	19.92	16.92	10	23.72	237.25	-320.49	500	2.80	-0.20	10	-1.05	-10.50	337.43
190	33.53	30.53	10	26.41	264.06	-56.43	510	1.10	-1.90	10	0.00	0.01	337.44
200	25.28	22.28	10	23.30	233.00	176.57	520	4.90	1.90	10	6.56	65.60	403.04
210	27.32	24.32	10	13.28	132.80	309.37	530	14.22	11.22	10	12.08	120.84	523.87
220	5.24	2.24	10	-2.47	-24.75	284.62	540	15.95	12.95	10	8.45	84.48	608.35
230	-4.19	-7.19	10	-8.88	-88.80	195.82	550	6.95	3.95	10	5.18	51.78	660.13
240	-7.57	-10.57	10	-7.40	-74.04	121.78	560	9.41	6.41	10	6.71	67.13	727.26
250	-1.24	-4.24	10	-7.89	-78.86	42.92	570	10.02	7.02	10	5.47	54.73	781.99
260	-8.54	-11.54	10	-8.66	-86.57	-43.64	580	6.93	3.93	10	3.77	37.67	819.67
270	-2.78	-5.78	10	-7.58	-75.75	-119.39	590	6.61	3.61	10	6.37	63.72	883.39
280	-6.37	-9.37	10	-7.50	-75.05	-194.44	600	12.14	9.14	10	16.35	163.46	1046.84
290	-2.64	-5.64	10	-3.98	-39.78	-234.22	610	26.55	23.55	10	22.03	220.28	1267.12
300	0.68	-2.32	10	-4.23	-42.31	-276.54	620	23.50	20.50	10	18.18	181.83	1448.95
310	-3.14	-6.14	10	-5.86	-58.63	-335.17	630	18.86	15.86	10	7.81	78.06	1527.01
320	-2.58	-5.58	10	-0.15	-1.54	-336.71	640	2.75	-0.25	10	4.00	40.03	1567.04
330	8.28	5.28	10	6.78	67.84	-268.87	650	11.26	8.26	10	12.91	129.11	1696.15
340	11.29	8.29	10	12.87	128.67	-140.19	660	20.57	17.57	8.07	7.65	61.75	1757.90
350	20.44	17.44	10	17.44	174.42	34.22	668.07	0.74	-2.26				
				Total	65.11	(yd^3)							

Table 19: Reach 5 Cut and Fill

Reach 5 (Savage Arena Parking Lot)													
				Width of Permeable Path			6.00	ft					
				Thickness of Permeable Path			0.50	ft					
				Area of Gravel Path			3.00	ft^2					
Station	Volume From Cross-Sections	Corrected Volume for Permeable Path	Distance	Avg. Area	Volume	Running Total	Station	Volume From Cross-Sections	Corrected Volume for Permeable Path	Distance	Avg. Area	Volume	Running Total
	(ft^2)	ft^2	(ft)	(ft^2)	(ft^3)	(ft^3)		(ft^2)	ft^2	(ft)	(ft^2)	(ft^3)	(ft^3)
102.73	-0.58	-3.58	7.27	7.25	52.74	52.74	420	9.80	6.80	10	7.38	73.85	1649.51
110	21.09	18.09	10	14.50	145.01	197.75	430	10.97	7.97	10	8.03	80.25	1729.76
120	13.92	10.92	10	6.65	66.54	264.29	440	11.08	8.08	10	12.73	127.33	1857.09
130	5.39	2.39	10	10.02	100.22	364.51	450	20.38	17.38	10	27.00	269.98	2127.07
140	20.65	17.65	10	32.46	324.62	689.13	460	39.61	36.61	10	16.55	165.49	2292.56
150	50.27	47.27	10	38.29	382.93	1072.06	470	-0.51	-3.51	10	-9.66	-96.57	2195.99
160	32.32	29.32	10	25.17	251.72	1323.78	480	-12.80	-15.80	10	-14.31	-143.10	2052.89
170	24.03	21.03	10	21.50	215.05	1538.83	490	-9.82	-12.82	10	-9.81	-98.14	1954.75
180	24.98	21.98	10	6.49	64.88	1603.71	500	-3.81	-6.81	10	-6.89	-68.91	1885.84
190	-6.01	-9.01	10	-16.03	-160.29	1443.42	510	-3.97	-6.97	10	-10.67	-106.68	1779.16
200	-20.05	-23.05	10	-21.44	-214.38	1229.04	520	-11.37	-14.37	10	-15.20	-151.96	1627.20
210	-16.82	-19.82	10	-20.53	-205.31	1023.73	530	-13.03	-16.03	10	-9.55	-95.48	1531.72
220	-18.24	-21.24	10	-13.02	-130.21	893.53	540	-0.07	-3.07	10	-4.81	-48.06	1483.66
230	-1.80	-4.80	10	-3.74	-37.40	856.13	550	-3.54	-6.54	10	-9.22	-92.19	1391.48
240	0.32	-2.68	10	3.63	36.28	892.41	560	-8.90	-11.90	10	-13.10	-131.02	1260.45
250	12.93	9.93	10	3.29	32.86	925.27	570	-11.31	-14.31	10	-10.60	-106.05	1154.40
260	-0.36	-3.36	10	-8.59	-85.91	839.36	580	-3.90	-6.90	10	-4.01	-40.14	1114.26
270	-10.82	-13.82	10	-9.51	-95.11	744.24	590	1.87	-1.13	10	0.38	3.84	1118.10
280	-2.20	-5.20	10	3.31	33.13	777.37	600	4.90	1.90	10	1.51	15.13	1133.24
290	14.83	11.83	10	1.63	16.28	793.65	610	4.13	1.13	10	0.92	9.15	1142.39
300	-5.57	-8.57	10	-0.79	-7.93	785.71	620	3.70	0.70	10	0.78	7.82	1150.21
310	9.98	6.98	10	13.58	135.83	921.55	630	3.86	0.86	10	2.46	24.56	1174.76
320	23.18	20.18	10	22.53	225.30	1146.85	640	7.05	4.05	10	-3.40	-33.95	1140.81
330	27.88	24.88	10	2.29	22.87	1169.73	650	-7.84	-10.84	10	-9.64	-96.40	1044.41
340	-17.30	-20.30	10	-25.62	-256.21	913.52	660	-5.44	-8.44	10	-9.84	-98.43	945.99
350	-27.94	-30.94	10	-21.37	-213.73	699.79	670	-8.25	-11.25	10	-9.25	-92.55	853.44
360	-8.81	-11.81	10	-6.00	-60.02	639.78	680	-4.26	-7.26	10	-7.21	-72.07	781.37
370	2.80	-0.20	10	10.75	107.47	747.24	690	-4.15	-7.15	10	-7.46	-74.59	706.78
380	24.69	21.69	10	29.46	294.64	1041.88	700	-4.77	-7.77	10	-9.14	-91.35	615.43
390	40.24	37.24	10	28.63	286.26	1328.15	710	-7.50	-10.50	10	-6.79	-67.89	547.54
400	23.01	20.01	10	15.68	156.79	1484.93	720	-0.08	-3.08	12.7	-3.04	-38.60	508.94
410	14.35	11.35	10	9.07	90.73	1575.66	732.7	0.00	-3.00				
				Total	18.85	(yd^3)							

Runoff Calculations

All Calculations are based off of the Ohio Department of Natural Resources Manual’s Best Management Practice “Chapter 02”

For this project the amount of new surface that will be partially impermeable is divided up into different sections. There are 4 reaches of the river gaining a pathway and 2 outlooks.

Area of the Outlooks: (2 Outlooks (1/2(3.14*9’^2) +18’*6’)) = 470 ft^2

Area of Pathway:

Reach 01: 5844ft^2
Reach 02: 2970ft^2
Reach 04: 3912ft^2
Reach 05: 3792ft^2

Total Pathway and Outlook Areas: 16,988 ft^2 (.39 acres)

Runoff Found by using Water Quality Volume (WQv):

WQv (ac-ft) = C*P*A

C = Volumetric Runoff Coefficient
P = 0.75” Rainfall
A = Drainage area (acres)

Table 20: Runoff Coefficient Value

Material	Runoff Coefficient Value (C)
Concrete	1.0
Pervious Concrete	.89
Gravel	.5

Concrete
WQv (ac-ft) = C*P*A =
(1.0)(0.75”)(0.39 acres) = 0.293 ac-in

= 1062 ft^3 of runoff
= 0.063 ft^3 of runoff/ft^2

Pervious Concrete
WQv (ac-ft) = C*P*A = (0.89)(0.75”)(0.39 acres) = 0.260 ac-in

= 945 ft^3 of runoff
= 0.056 ft^3 of runoff/ft^2

Gravel
WQv (ac-ft) = C*P*A = (0.50)(0.75”)(0.39 acres) = 0.146 ac-in

= 531 ft^3 of runoff
= 0.031 ft^3 of runoff/ft^2

MSE Retaining Wall Calculations

$\phi_{sand} = 30$

$$\phi_f' = \frac{2}{3} Shear\ strength\ of\ soil = \frac{2}{3}(30) = 20$$

$$S_v = \frac{T_{all}}{(\gamma_1 * z * k_a)FS}$$

$T_{all} = 2000\frac{lb}{ft}$

$\gamma_1 = 135\frac{lb}{ft^3}$

$z = 1.5$

$k_a = 0.6$

$$S_v = \frac{2000\frac{lb}{ft}}{\left(135\frac{lb}{ft^3} * 1.5 * 0.6\right)1.5} = 2.74\ ft$$

Use 1 ft since we need a 6 ft wall

$$L = L_r - L_e = \frac{H - z}{\tan\left(45 + \frac{\phi_1'}{2}\right)} + \frac{S_v * k_a * \sigma_o * FS}{2 * \sigma_o * \tan(\phi_f')}$$

Max length at z=0

$$L = \frac{6 - 0}{\tan\left(45 + \frac{30}{2}\right)} + \frac{1 * 0.6 * 1.5}{2 * \tan(20)} = 3.46 + 1.24 = 4.7\ ft$$

$L_r = 3.46\ ft \quad L_e = 1.24\ ft$

Use $L_e = 2.04\ ft$ so the factor of safety against sliding is larger than 1

$L = 5.5\ ft$

$$L_l = \frac{S_v * \sigma_o' * FS}{2 * \sigma_o' * \tan(\phi_f')} = \frac{L_e}{2}$$

$$L_l = \frac{2.04}{2} = 1.02\ ft$$

Factor of Safety Against Overturning

$$FS_{overturning} = \frac{M_R}{M_C}$$

$$M_O = P_a * \eta_{arm\ about\ "C"}$$

$$M_O = (\tfrac{1}{2}\gamma_1 * H^2 * k_a) * \eta_{arm\ about\ "C"}$$

$$M_O = \left(\tfrac{1}{2} * 135 * 6^2 * 0.6\right) * 2 = 1458 * 2 = 2916\ \tfrac{lb\ ft}{ft}$$

$$M_R = w * \eta_{arm\ about\ "C"}$$

$$w = L * H * \gamma_1$$

$$w = 5.5 * 6 * 135 = 4455\,\tfrac{lb}{ft}$$

$$M_R = 4455 * \tfrac{5.5}{2} = 12251.25\ \tfrac{lb\ ft}{ft}$$

$$FS_{overturning} = \frac{M_R}{M_C} = \frac{12251.25}{2916} = 4.2$$

Factor of Safety Against Sliding

$$FS_{sliding} = \frac{w\tan(k * \phi_1')}{P_a}$$

$$K = \tfrac{2}{3}$$

$$FS_{sliding} = \frac{4455\ \tan\left(\frac{2}{3} * 30\right)}{1458} = 1.112$$

Factor of Safety Against Bearing

$$FS_{bearing} = \frac{q_{ult}}{\sigma'_{o(H)}}$$

$$q_{ult} = C'_2 N_C + \frac{1}{2}\gamma_2 L_2{}' N_\gamma$$

For $\phi'_2 = 15$ => Table 3-3 $N_c = 10.98 \quad N_\gamma = 2.65$

$$L'_2 = L_2 - 2\,e$$

$$e = \frac{L_2}{2} - \frac{M_r - M_o}{\Sigma V}$$

$$L_2 = 5.5$$

$$\Sigma V = \gamma * H * L$$

$$\Sigma V = 125 * 6 * 5.5 = 4125\,\frac{lb}{ft}$$

$$e = \frac{5.5}{2} - \frac{12251.25 - 2916}{4125} = 0.487ft$$

$$L'_2 = L_2 - 2\,e = 5.5 - 2(0.487) = 4.526ft$$

$$q_{ult} = C'_2 N_C + \frac{1}{2}\gamma_2 L'_2 N_\gamma \; = 15 * 10.98 + \frac{1}{2} * 125 * 4.526 * 2.65 = 914.32$$

$$\sigma'_{o(H)} = \gamma_1 * H = 130\,(6) = 780\;\frac{lb}{ft^2}$$

$$FS_{bearing} = \frac{q_{ult}}{\sigma'_{o(H)}} = \frac{914.32}{780} = 1.17$$

Appendix B: Alternative Maps

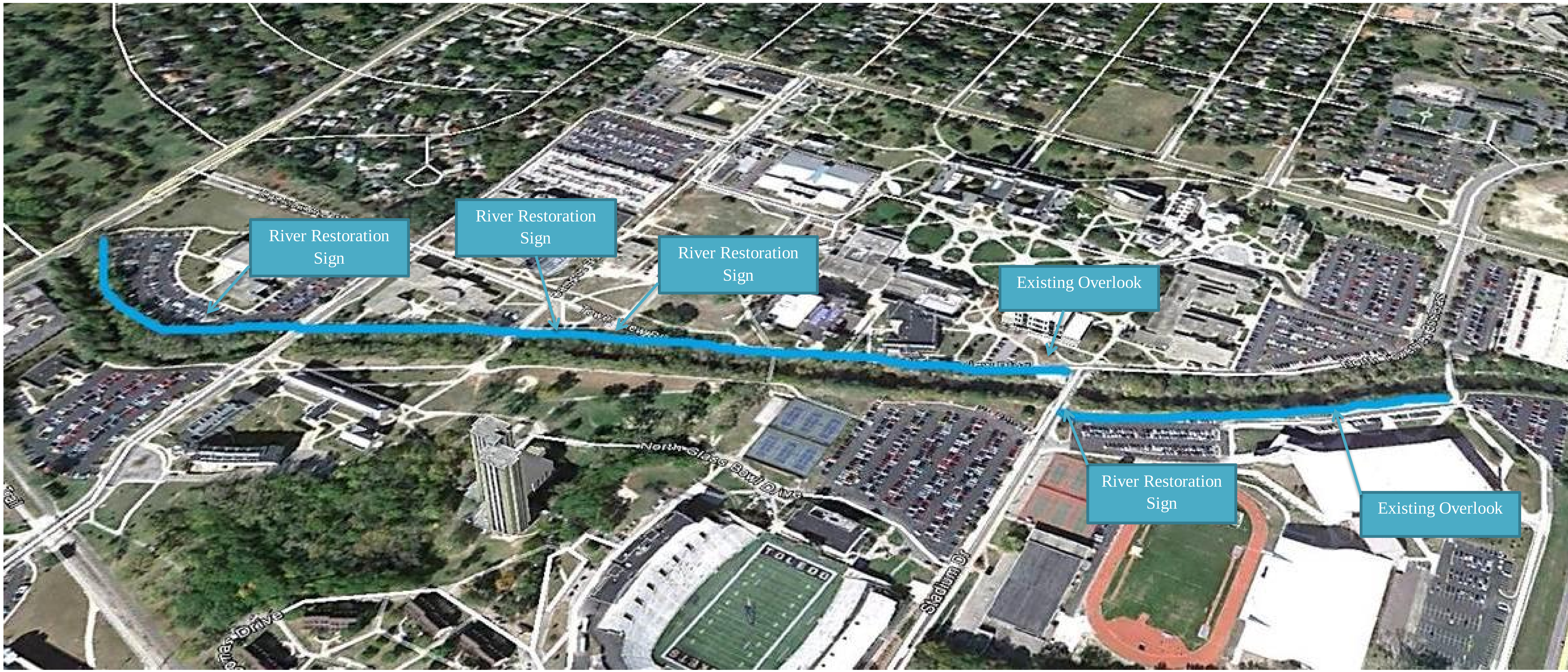

Figure 4: Pathway 1 Traveling from Savage Arena South Side of River to David C. Root Bridge then North Side of River to Secor Road

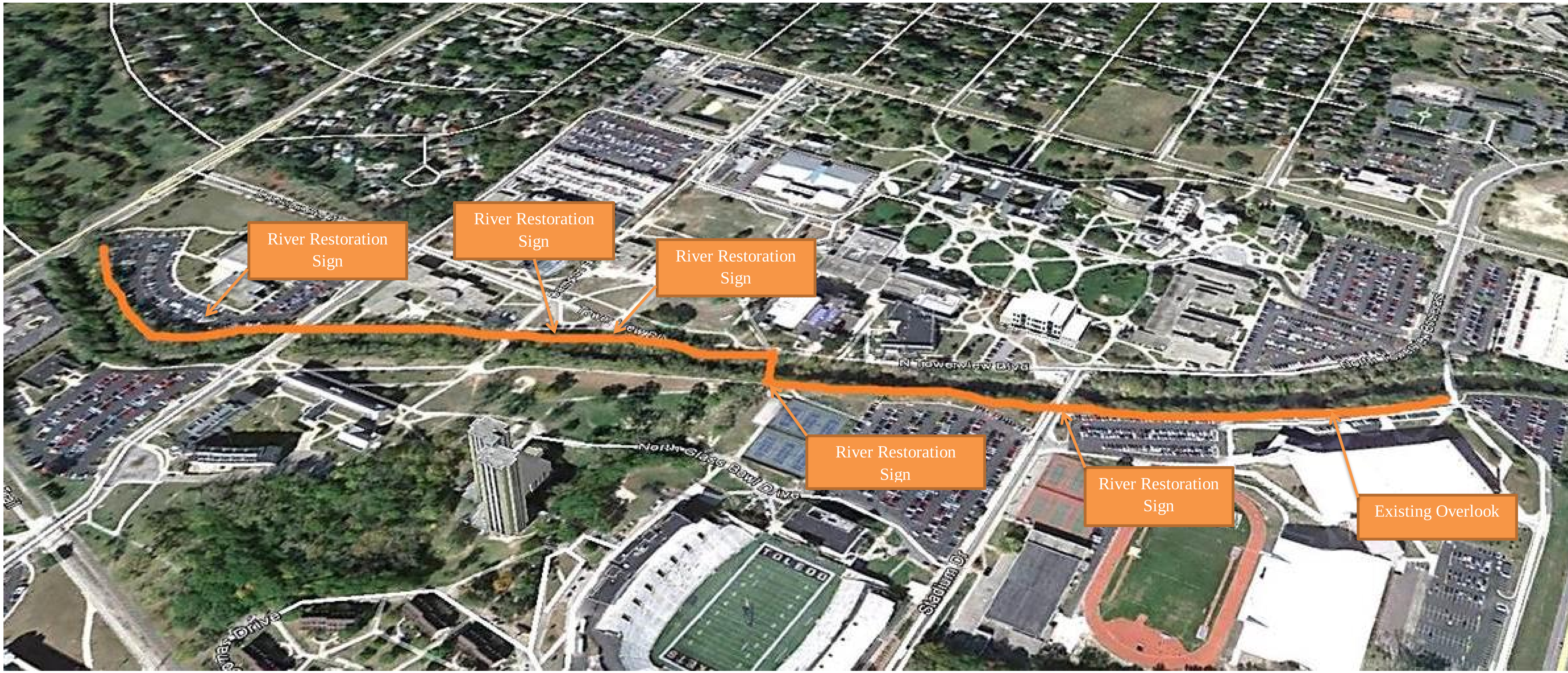

Figure 5: Pathway 2 Traveling from Savage Arena South Side of River to Library Bridge then North Side of River to the Law Building

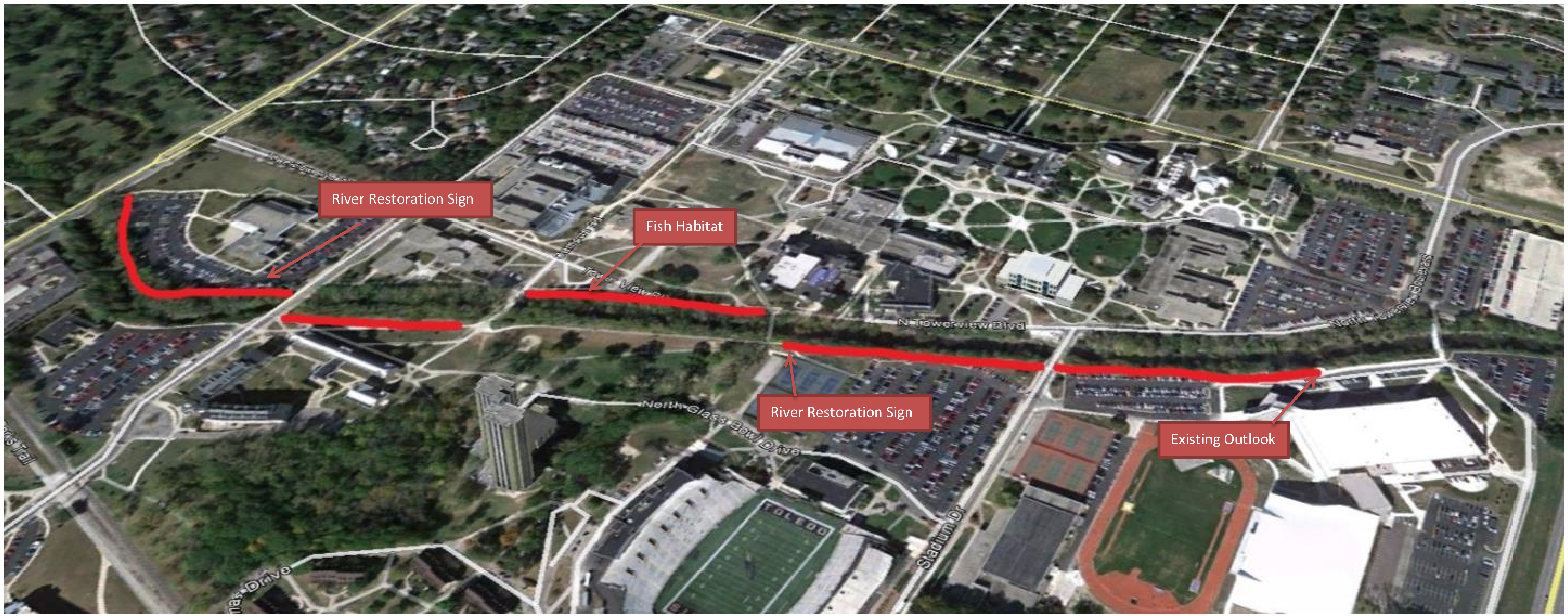

Figure 6: Pathway 3 Traveling from Savage Arena on South Side of River to Library Bridge then on North Side of River to Performance Arts Bridge then South Side to West Rocket Drive then North Side to Secor Road

Figure 7: Rendering 1 of Reach 1

Figure 8: Rendering 2 of Reach 1

Figure 9: Rendering 1 of Reach 5

Figure 10: Rendering 2 of Reach 5

Appendix C: Schematics

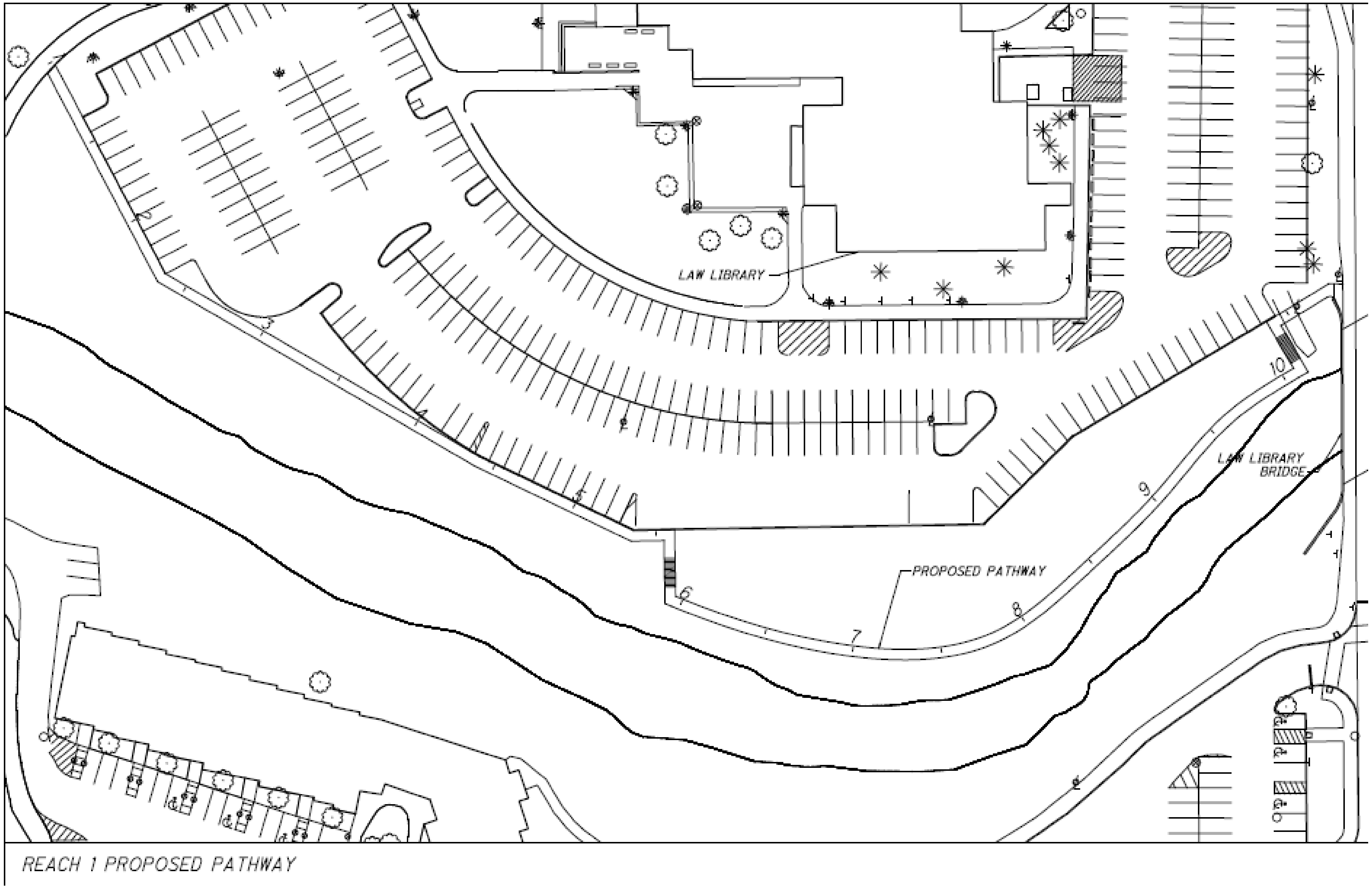

Figure 11: Reach 1 Proposed Pathway Plan View

Figure 12: Reach 1 Proposed Pathway Satellite View

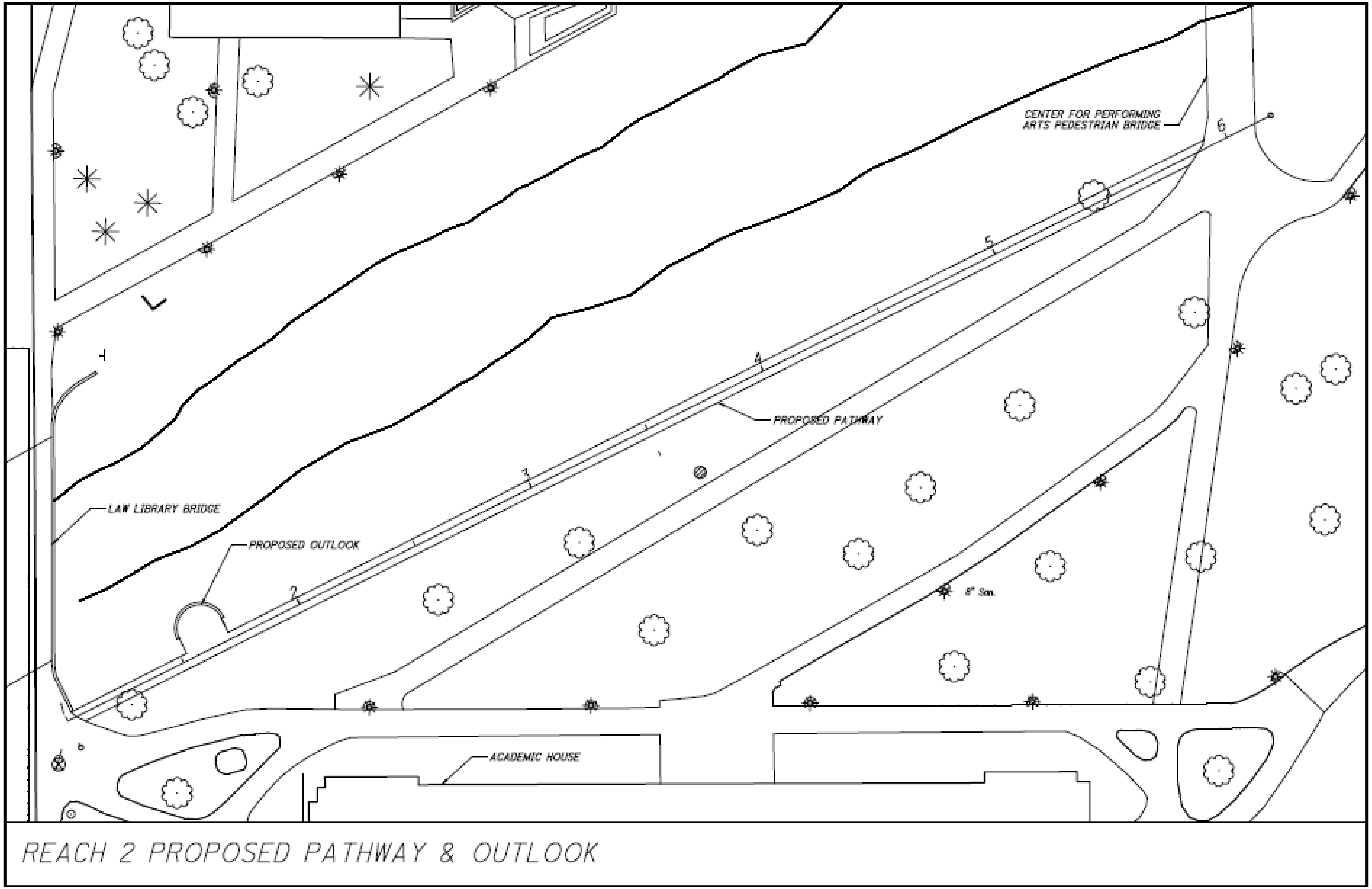

Figure 13: Reach 2 Proposed Pathway & Outlook Plan View

Figure 14: Reach 2 Proposed Pathway & Outlook Satellite View

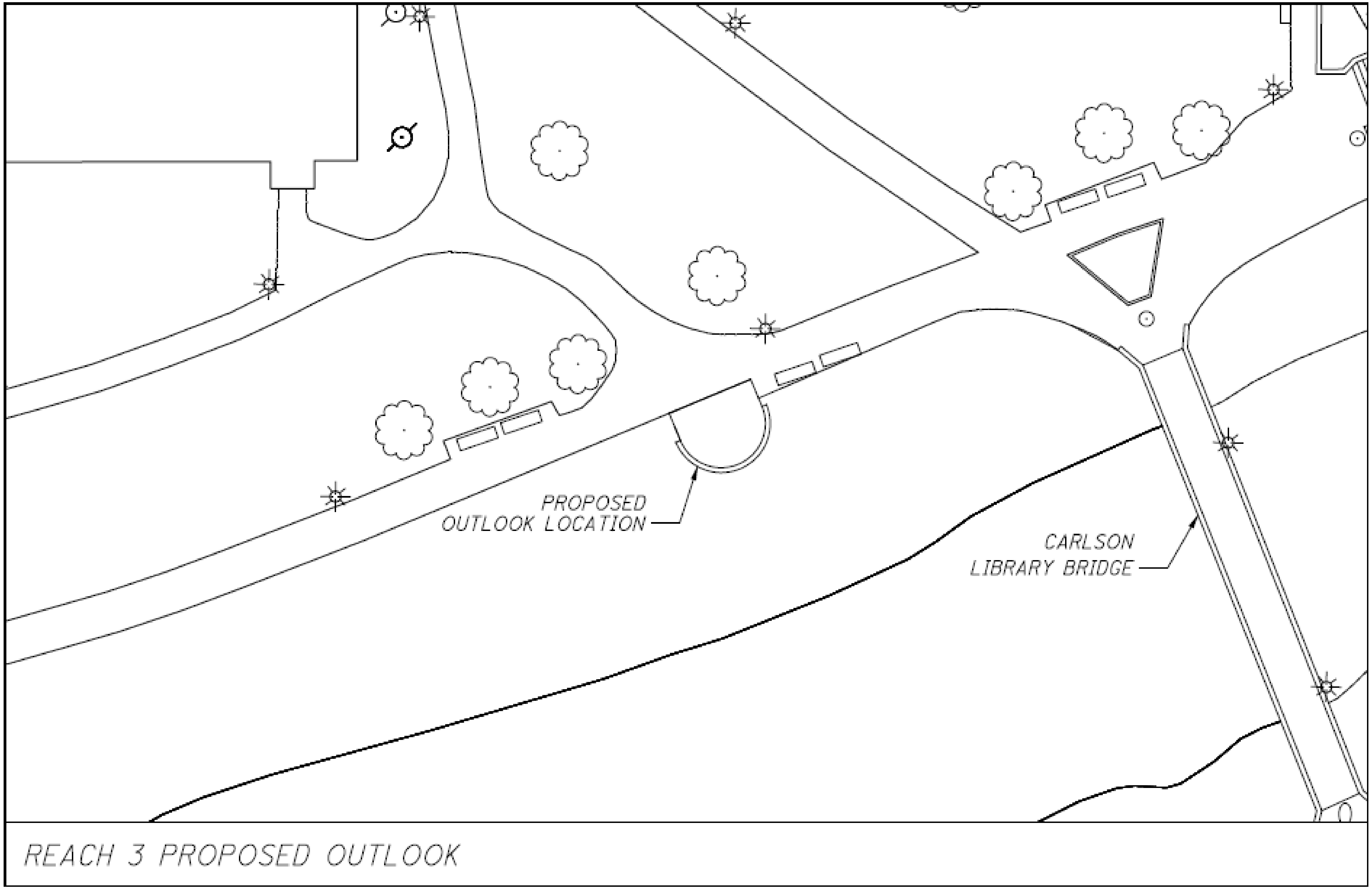

Figure 15: Reach 3 Proposed Outlook Plan View

Figure 16: Reach 3 Proposed Outlook Satellite View

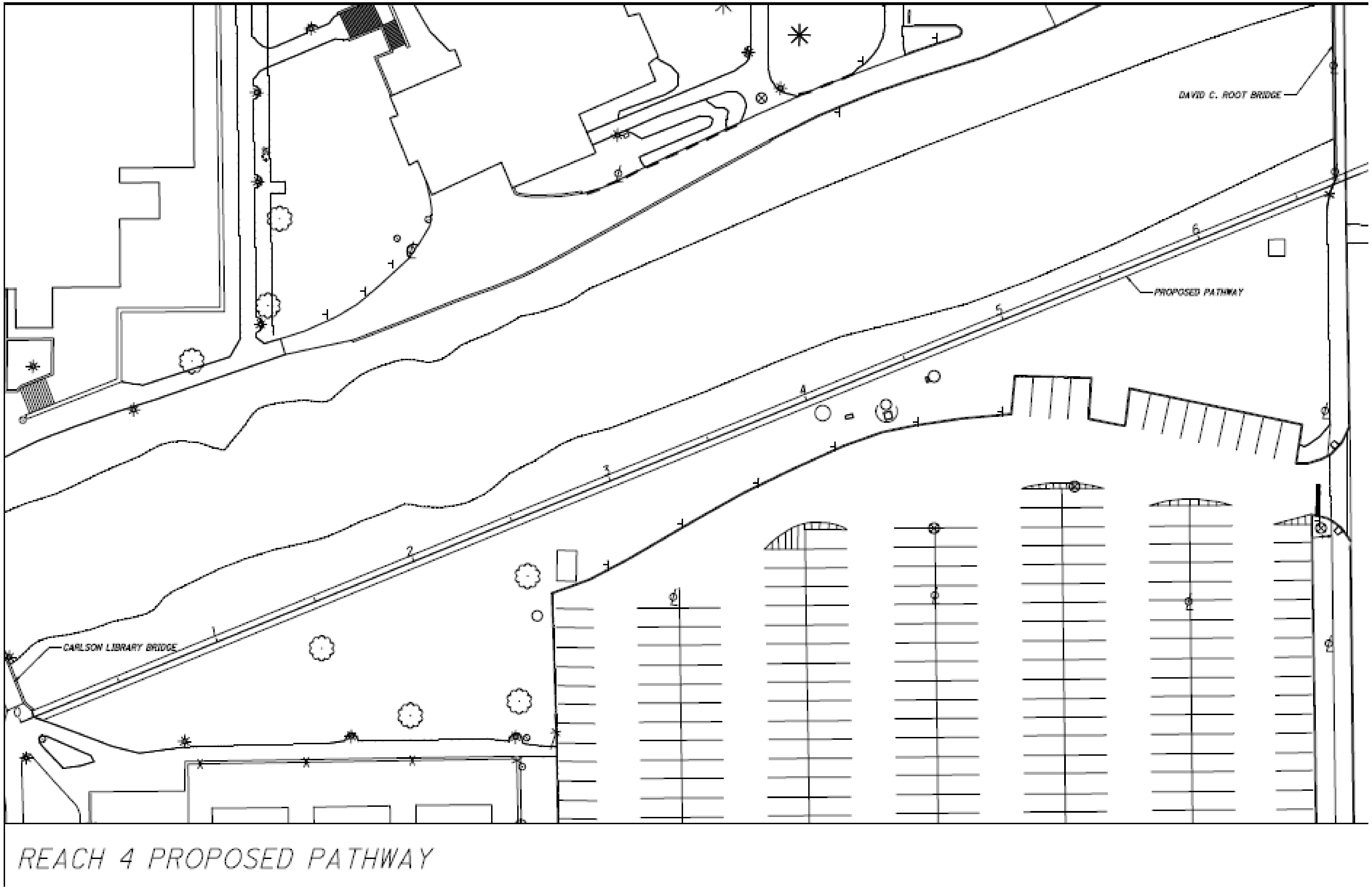

Figure 17: Reach 4 Proposed Pathway Plan View

Figure 18: Reach 4 Proposed Pathway Satellite View

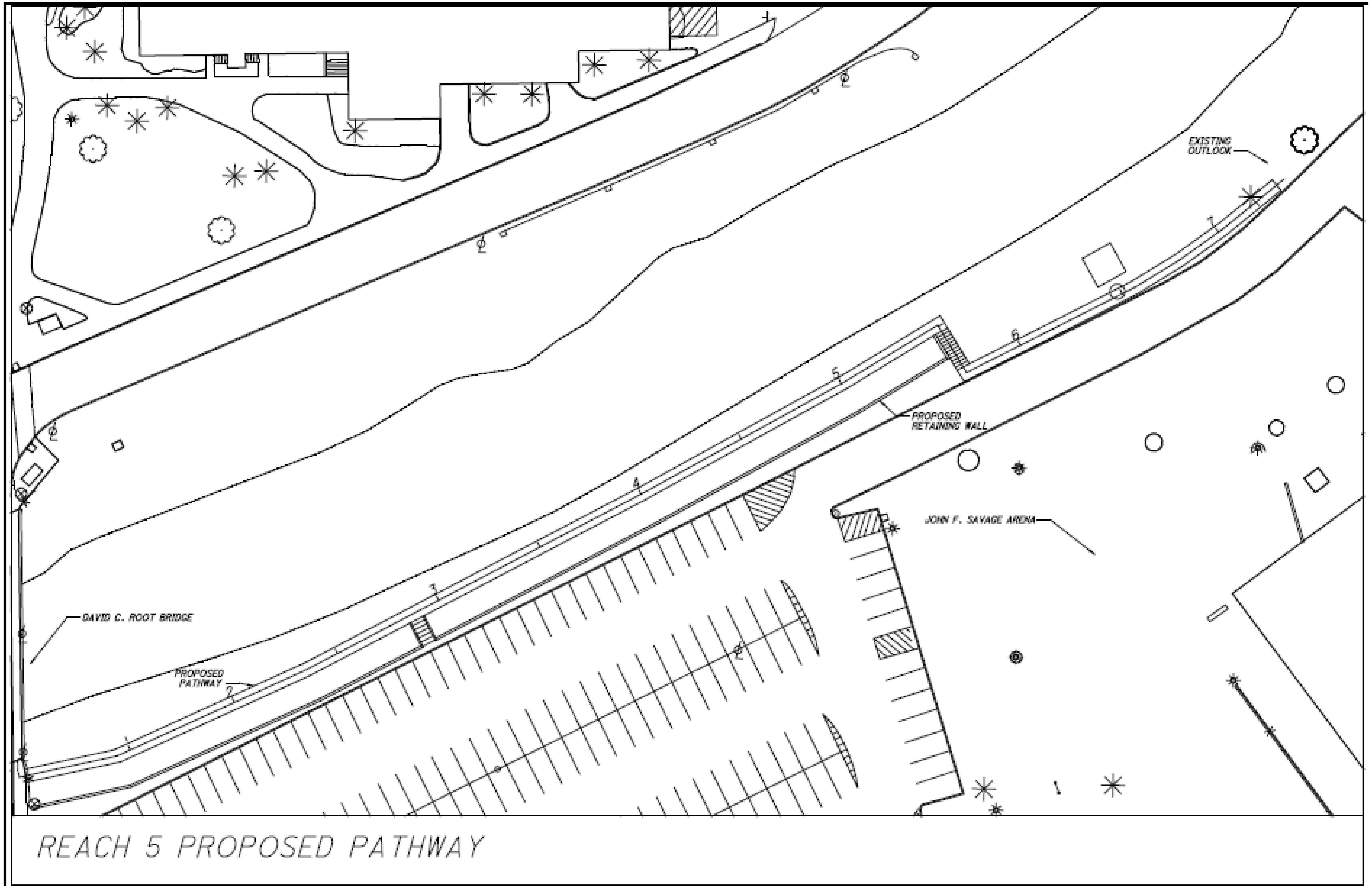

Figure 19: Reach 5 Proposed Pathway Plan View

Figure 20: Reach 5 Proposed Pathway Satellite View

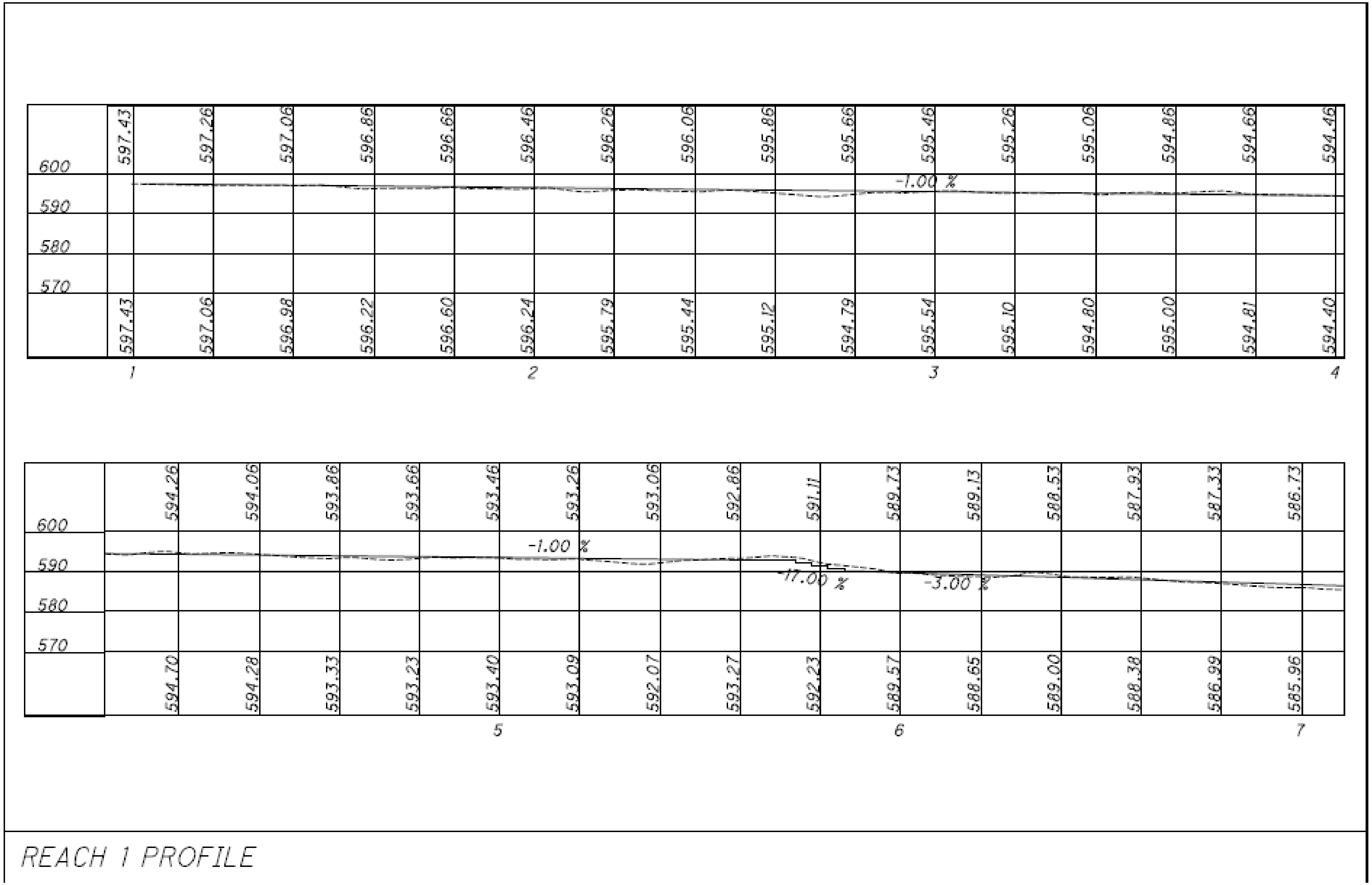

Figure 21: Reach 1 Profile from Secor to Mid-Bench

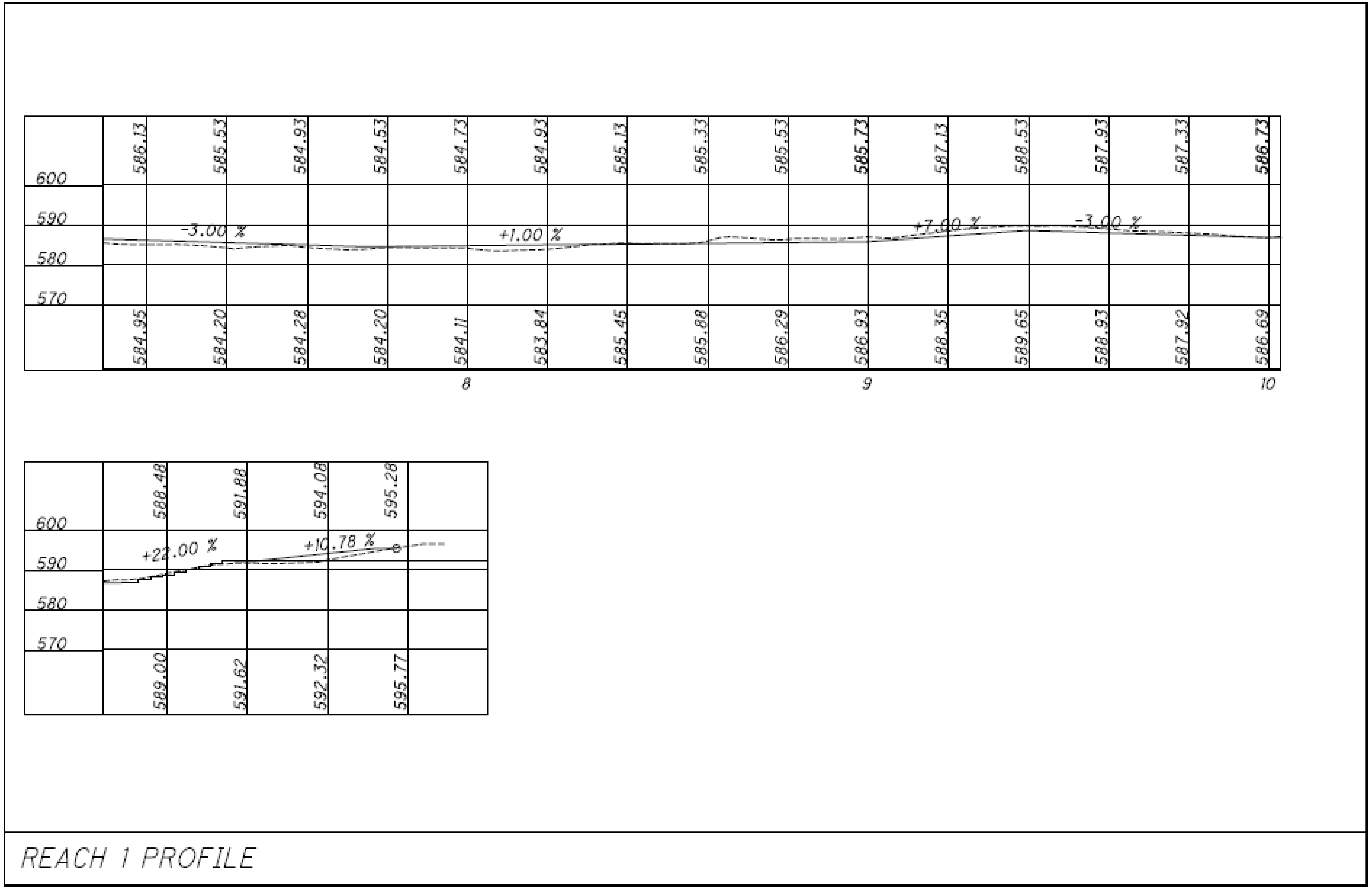

Figure 22: Reach 1 Profile from Mid-Bench to West Rocket Drive Bridge

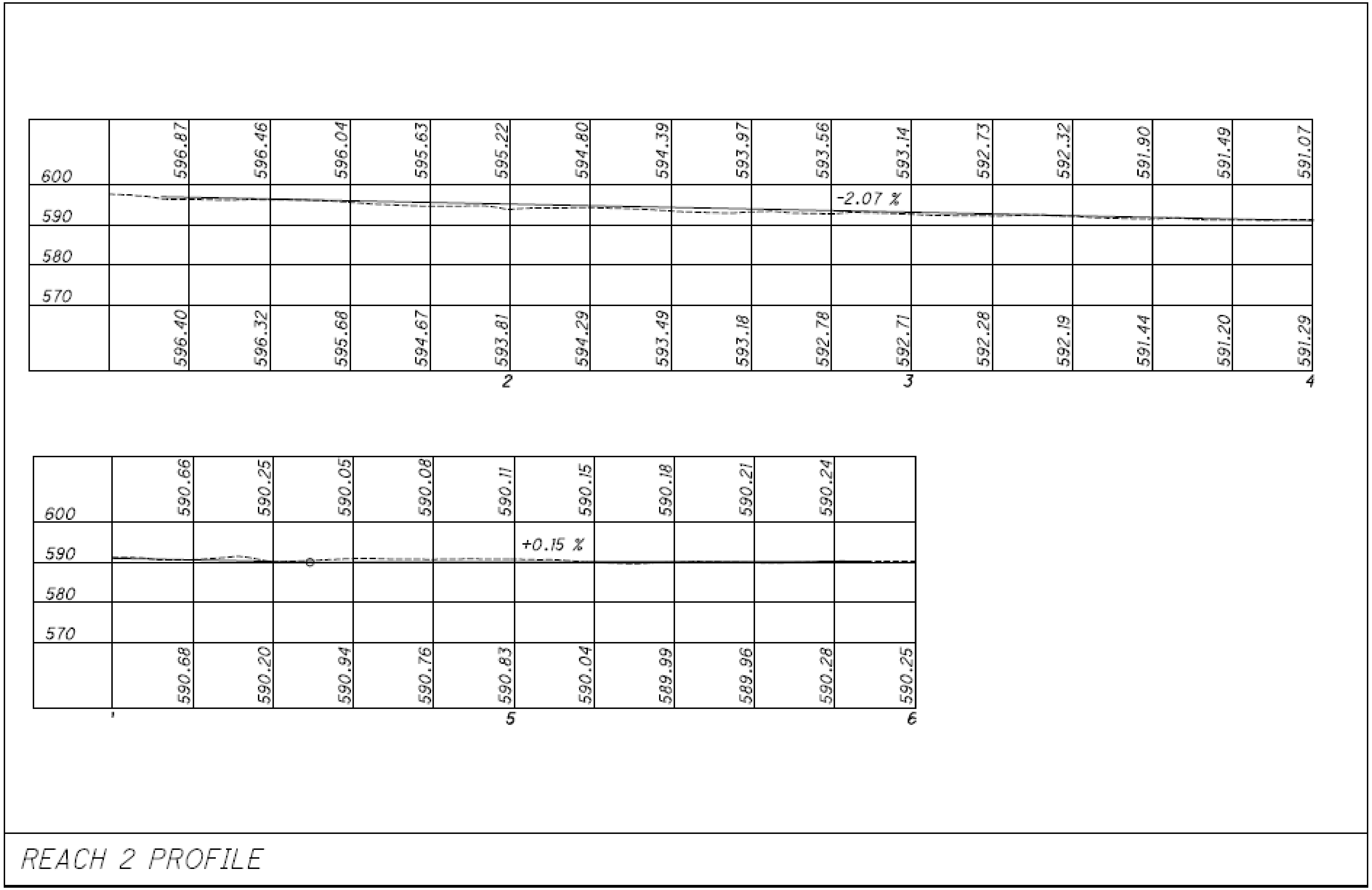

Figure 23: Reach 2 Profile from West Rocket Drive Bridge to Performance Arts Bridge

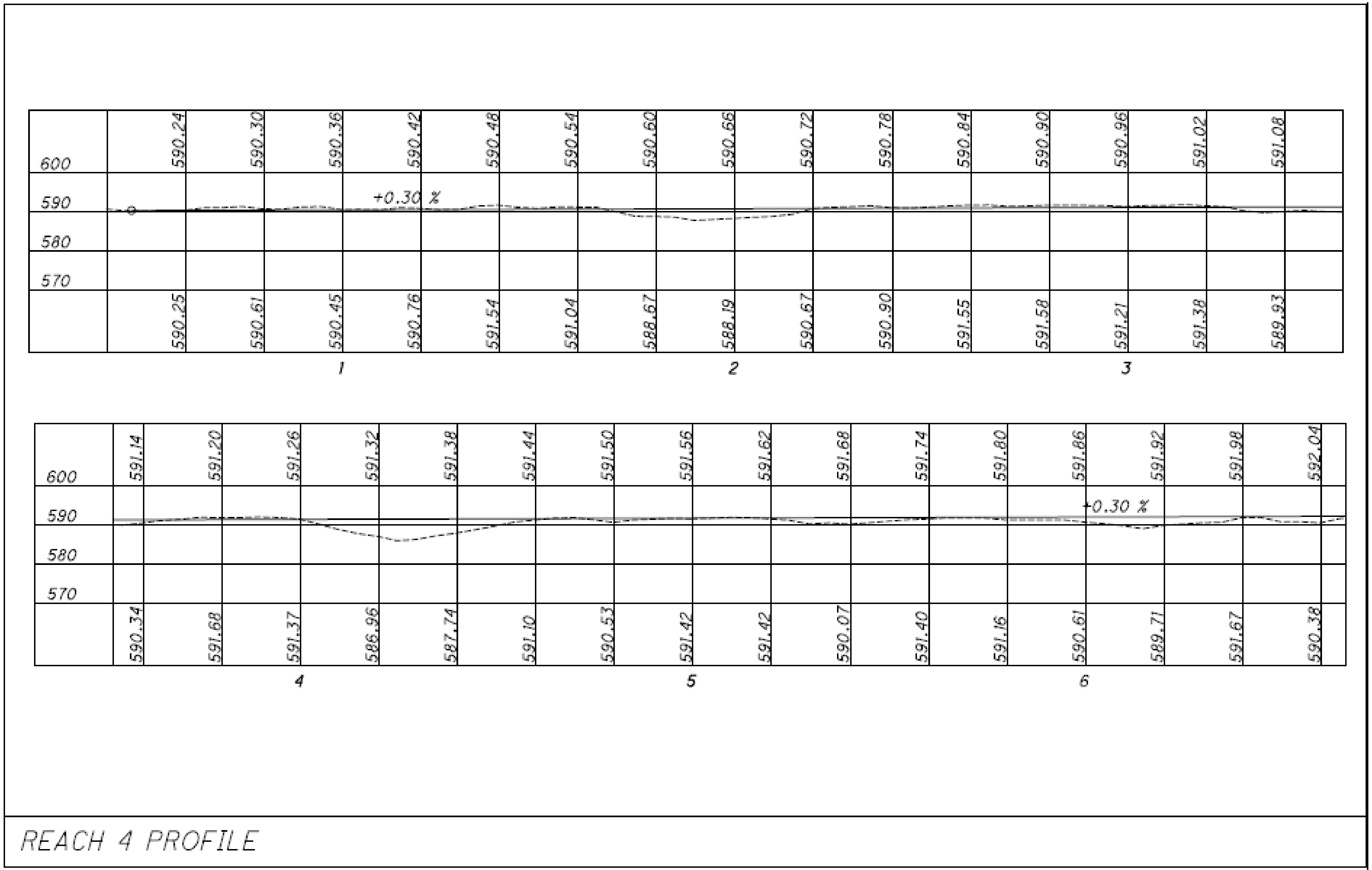

Figure 24: Reach 4 Profile from Carlson Library Bridge to David C. Root Bridge

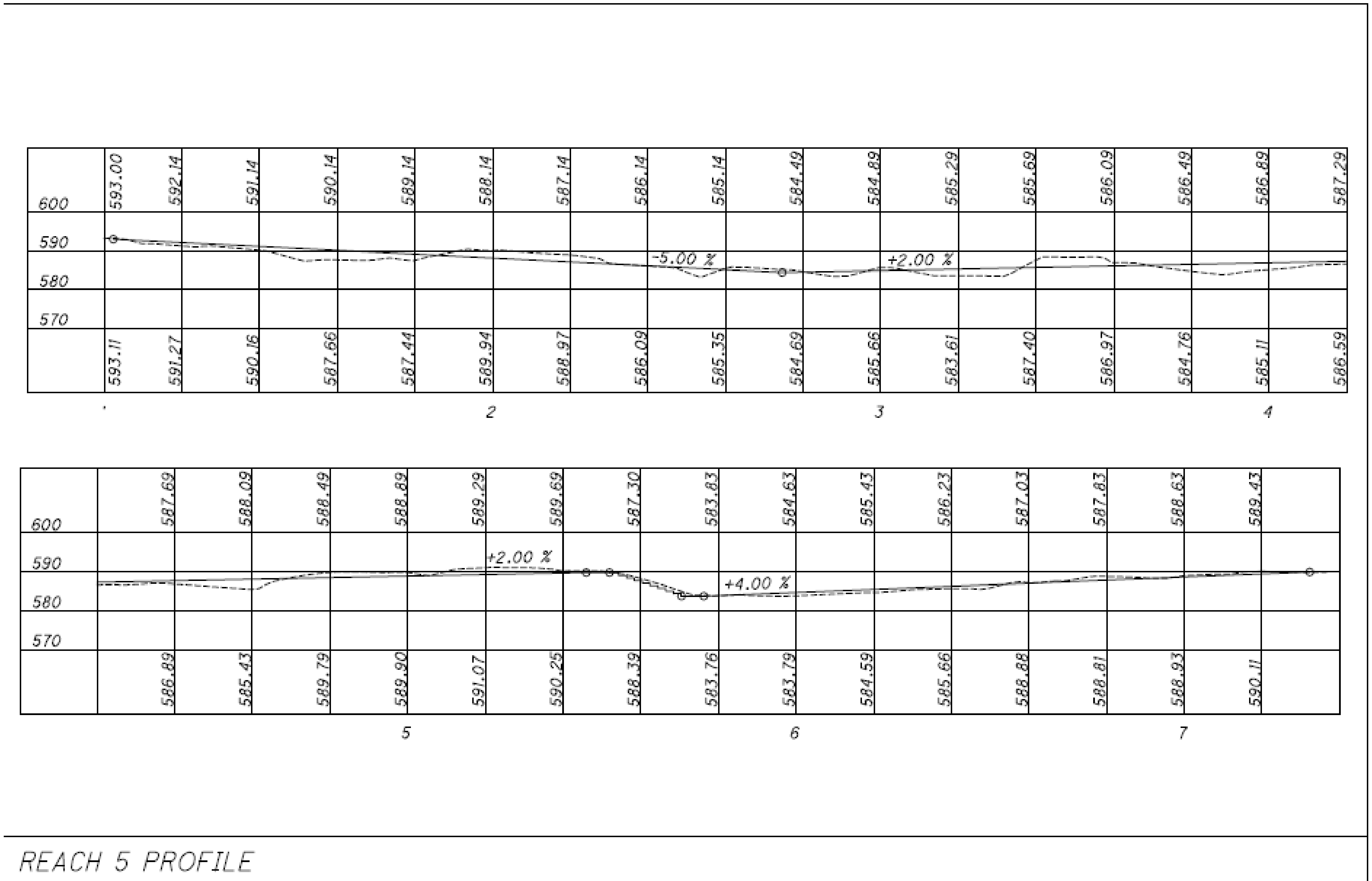

Figure 25: Reach 5 Profile from David C. Root Bridge to Existing Savage Outlook

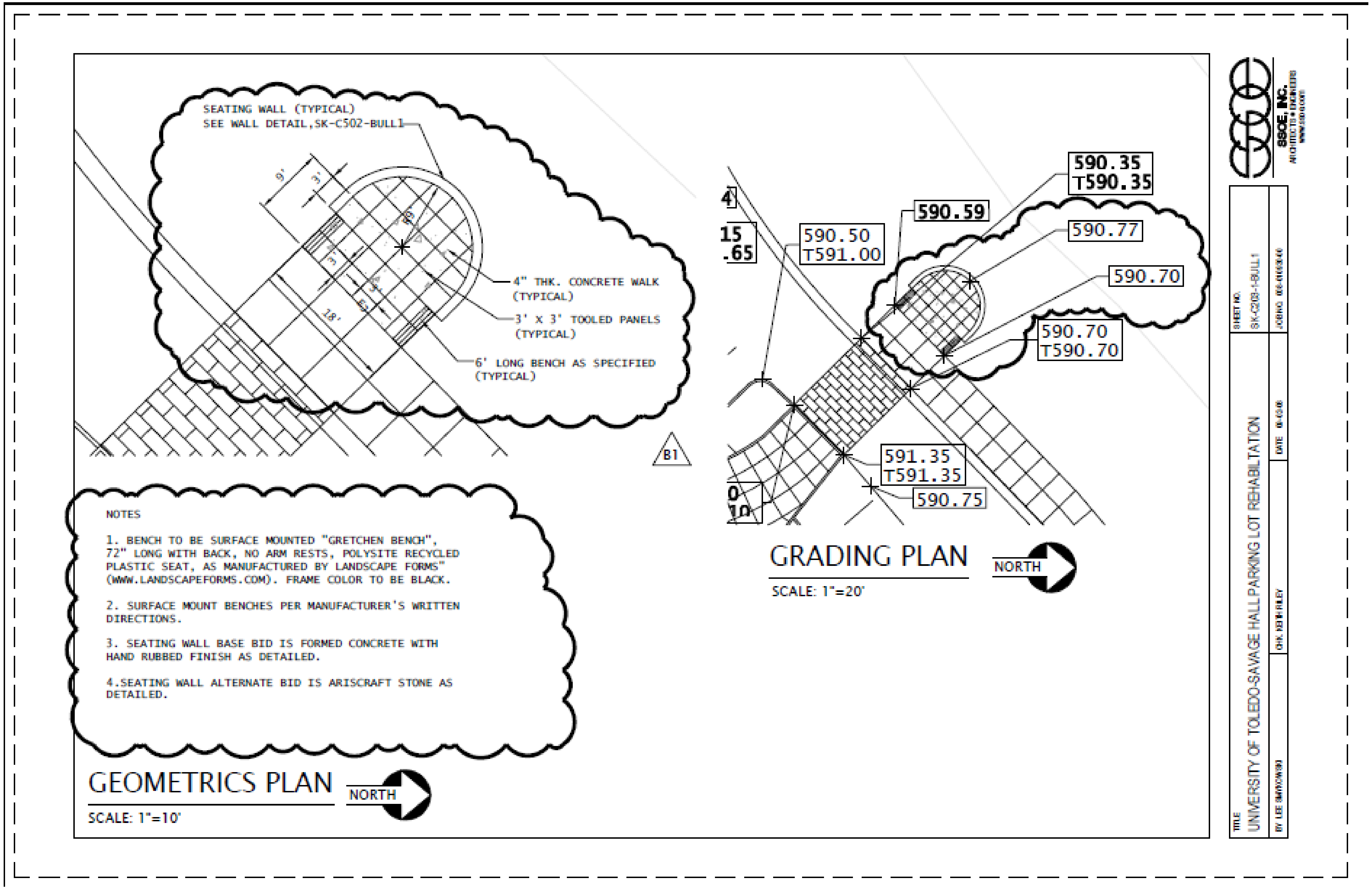

Figure 26: Existing Outlook by Savage Arena Provided by SSOE

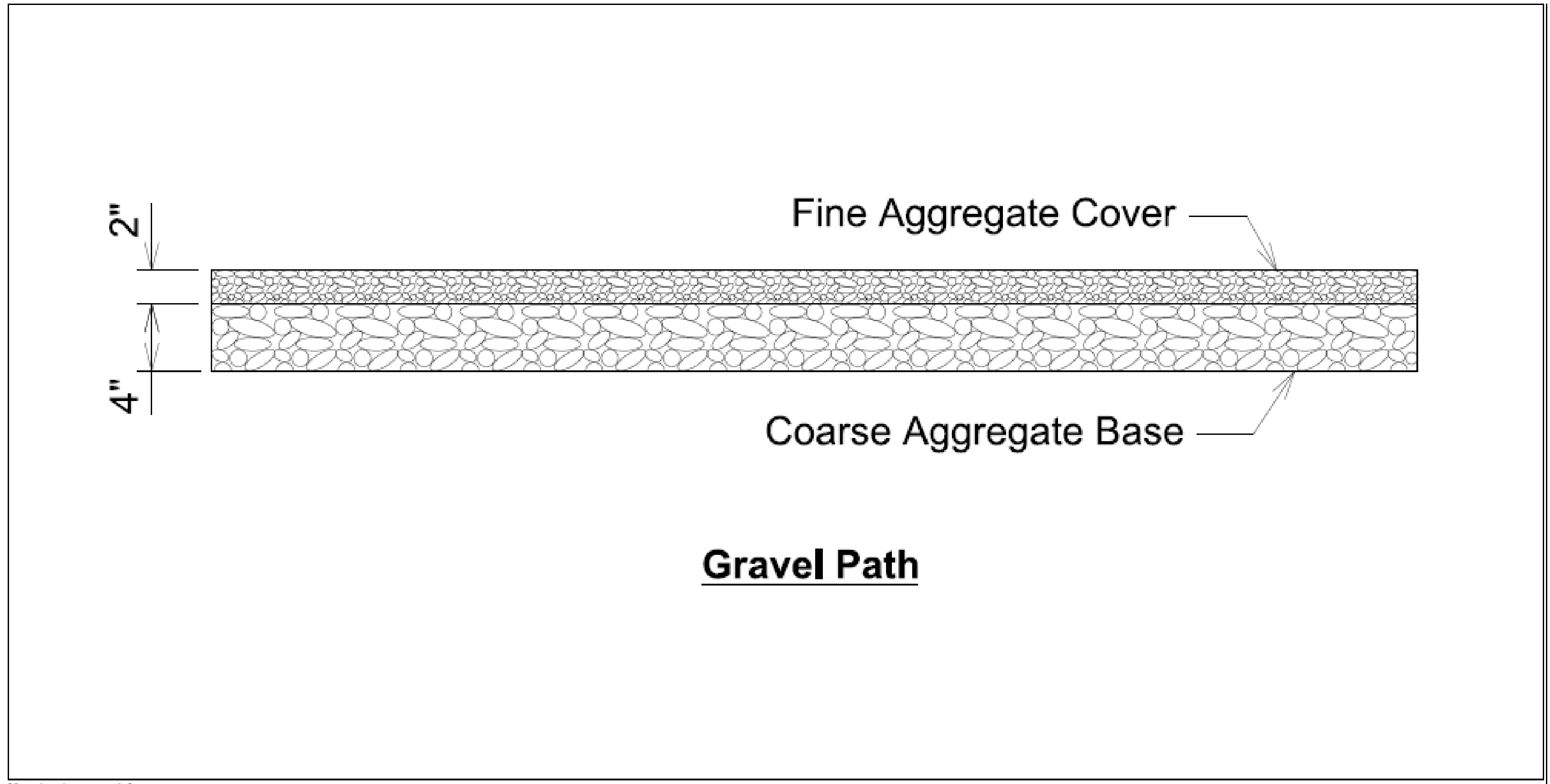

Figure 27: Gravel Path Cross Section Design

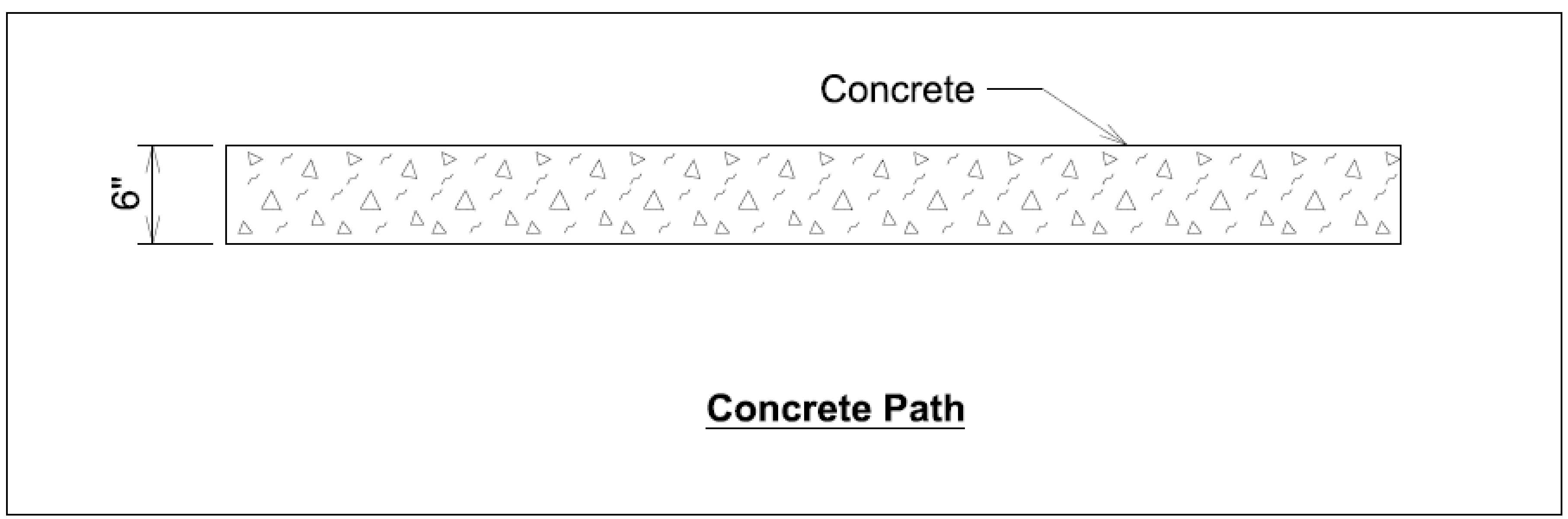

Figure 28: Regular Concrete Path Cross Section Design

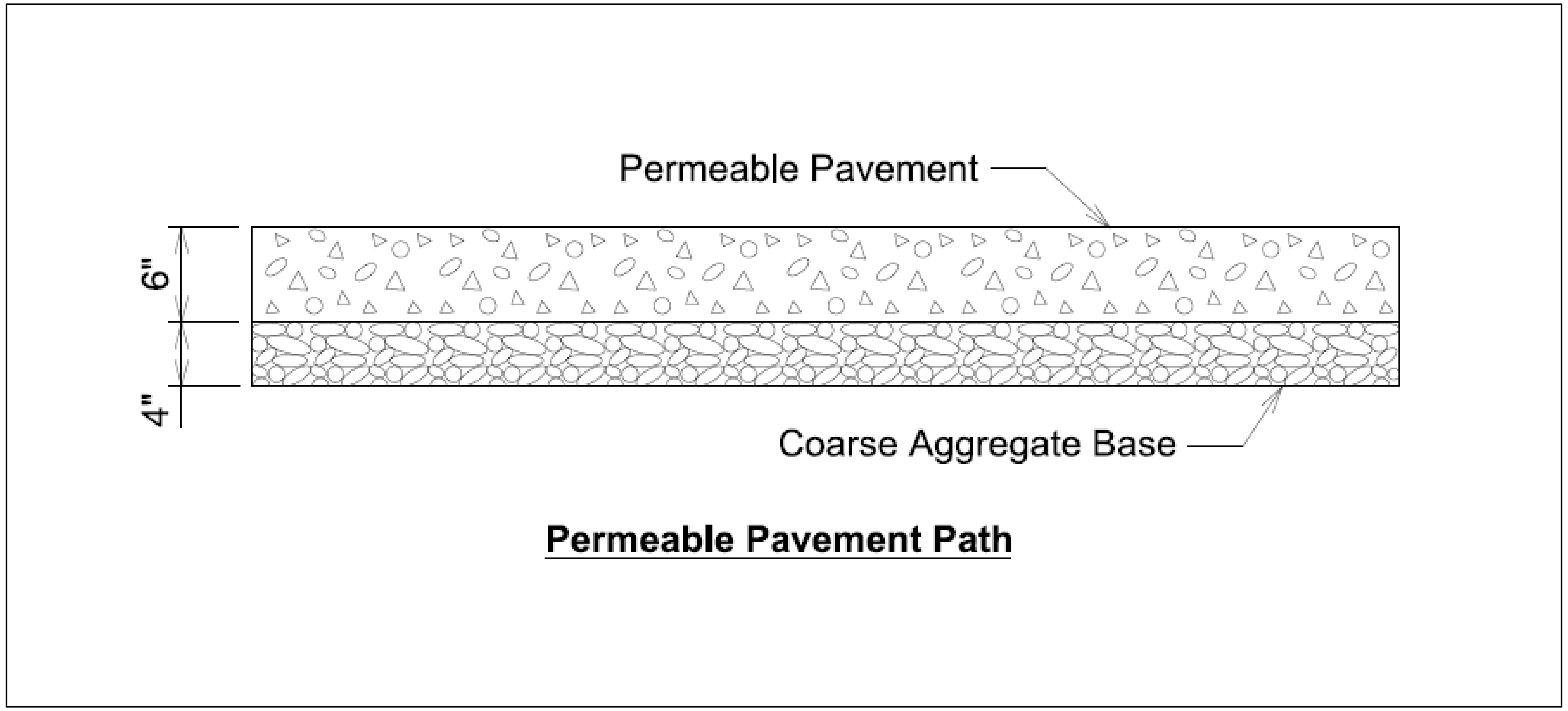

Figure 29: Permeable Concrete Path Cross Section Design

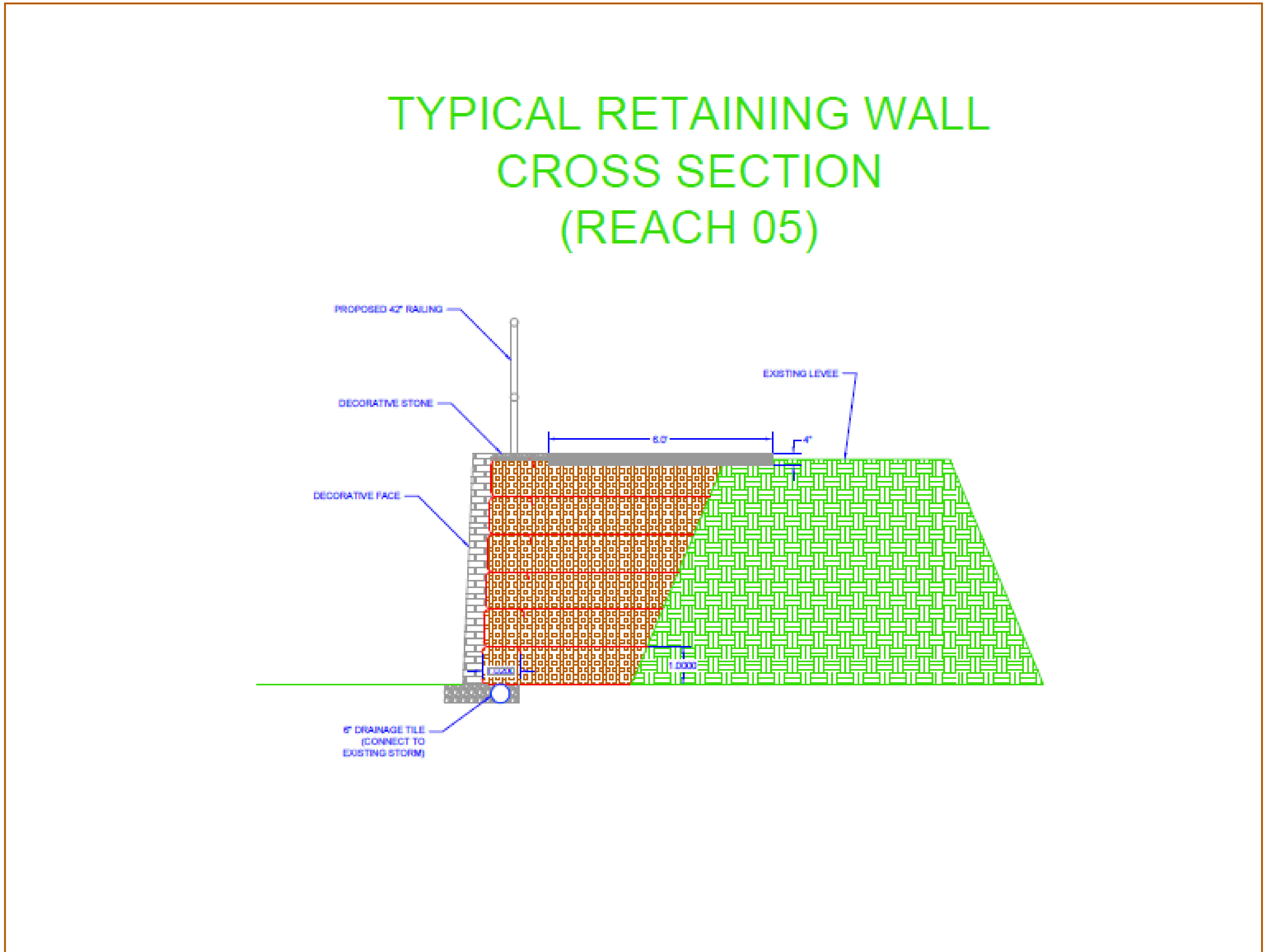

Figure 30: Retaining Wall Cross Section

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