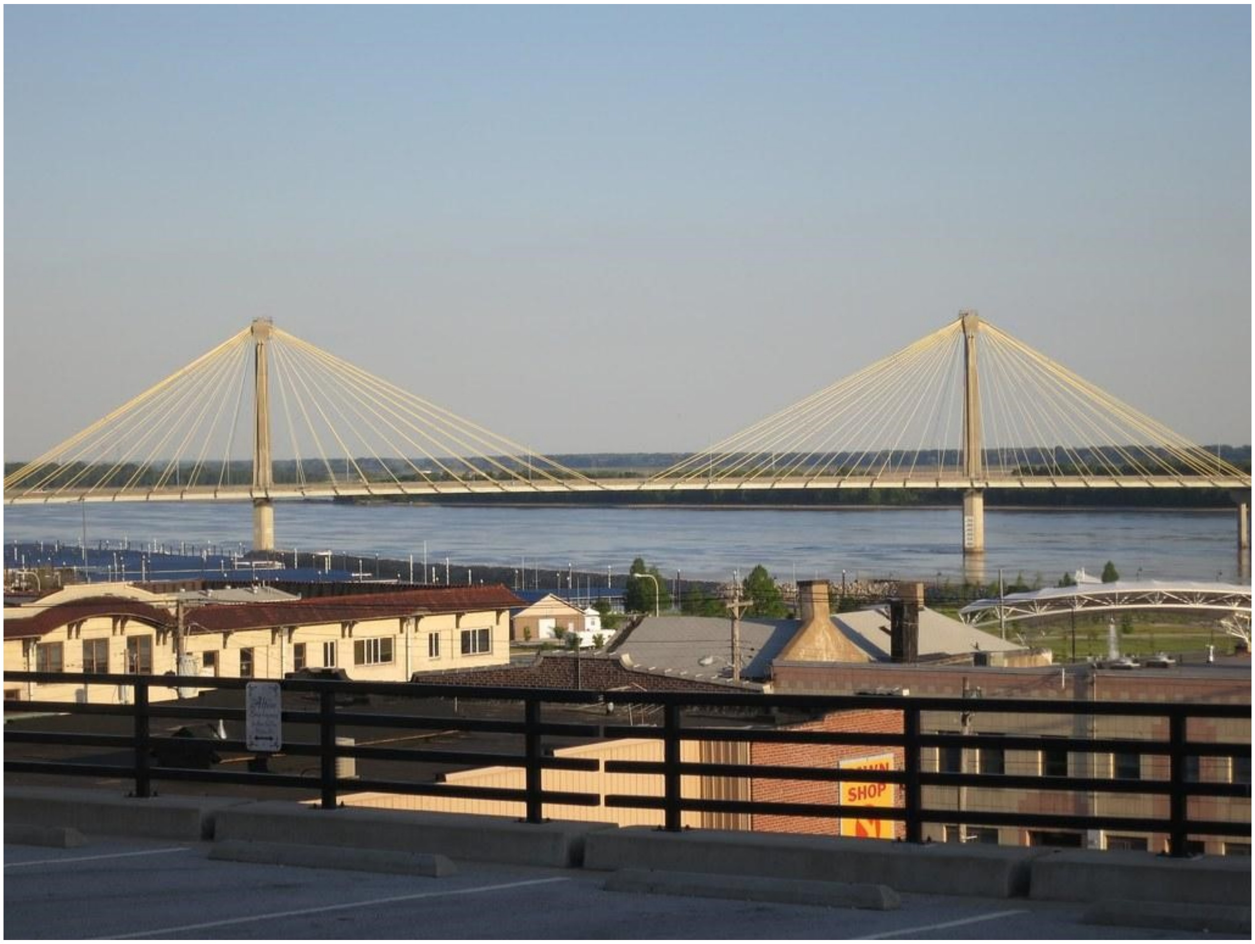
SIUe

Successful Communities Collaborative



Engineering a Safer & More Accessible Alton

Spring 2019●Civil Engineering 493●Civil Engineering Senior Design Class

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School of Engineering/Civil Engineering

SIUE Successful Communities Collaborative Year 2018-2019

In Partnership with

City of Alton, Illinois

www.siue.edu

Acknowledgements

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The team would like to extend a special thank you to Professor Yan Qi and Sheppard, Morgan & Schwaab who provided the opportunity to impact the City of Alton and to gain experience in the design of varied curb ramps. The team would also like to thank Mr. Coey Daniels, P.E., for the topography survey and CAD drawing, as well as his mentorship throughout this design project.

The successful completion of this project would not have been possible without the guidance and hard work of various people. These people include staff members at SMS, SIUE, and the City of Alton. Mr. Cas Sheppard, P.E., the leader of our project, gave us great insight into the scope of the project, and provided us with helpful resources. Mr. Justin Kleinschmidt, P.E., was very helpful with the design of the water basin and the weir structure, as well as the preparation of the plans and cost estimates. Mr. Brendan St. Peters of SMS, sent us many useful files that were used to map out the site and calculate the watershed area and soil types. Mr. Robert Barnhart, Public Works Director for the City of Alton, assisted us in the selection of the location for the basin, and helped give us ideas about maintaining the basin. Mr. Greg Caffey, Development and Housing Director for the City of Alton, provided us with great resources to write our BMP. At SIUE, Professor Rohan Benjankar assisted us in performing water basin calculations. Professor Qi helped to keep our project on track, and made sure that we continued to push forward.

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About SSCC

The SIUE Successful Communities Collaborative (SSCC) is a cross-disciplinary program that supports one-year partnerships between the University and communities in Illinois to advance local resilience and sustainability based on community-identified environmental, social, and economic issues and needs. SSCC seeks to reduce those obstacles by linking existing graduate and undergraduate courses at SIUE to explore innovative solutions to community-identified projects. SSCC selects a single partner community; usually a city or county through a competitive application process. Working with administrative staff and stakeholders in the selected community, the collaborative helps identify projects that will advance local resilience and sustainability based on community-identified needs. Each project is connected with one or more key courses at SIUE that can provide research or technical support and move the project forward.

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About the City of Alton

The City of Alton was founded in 1837 and is located on the Mississippi River in Madison County, Illinois, about 25 miles north of St. Louis, Missouri. It is a part of the Metro-East region of the Greater St. Louis metropolitan area.

Home to about 28,000 residents, Alton is a great place to live, work and raise a family. Alton's 28,000 residents benefit from a cost of living below the national average and the protection of the Alton Police and Fire Departments. The Alton School District and several private and parochial schools provide a wonderful education for area children. Lewis and Clark Community College, Southern Illinois University Edwardsville, and the many colleges and universities in St. Louis region make higher education accessible to residents of Alton. Large employers include the Alton School District, Alton Memorial Hospital, Alton Steel, Inc., American Water Company, Argosy Casino, Global Brass and Copper, Inc., Millers First Insurance Company, Olin Corporation, Riverbend Head Start & Community Services, and Saint Anthony's Health Center. A variety of locally owned small businesses are also located in Alton.

Alton is also the hometown of Jazz musician, Miles Davis, and Robert Wadlow, the tallest known person in history.

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Executive Summary

As a city develops and grows, parts of the infrastructure must be revisited to determine if they are still the best they can be for the residents of that city. The City of Alton is no exception to this. A civil engineering class at SIUE completed three infrastructure projects in Alton that needed to be addressed. The first focused on the ramps on State Street. To be in accordance with the ADA, sidewalks and ramps must be accessible for all people. A team of students worked with a survey group to identify the ramps that needed to be restructured. The team then designed new ramps and curbs to meet state and federal standards. A second project addressed a particularly dangerous intersection. This team also worked with the survey company to design a roundabout that would reduce vehicle accidents as well as vehicle emissions from cars waiting to pass through the intersection. Finally, the third project was to develop a water retention basin as a way to mitigate storm water runoff. By locating the proper funding for these projects and carrying them out, the City of Alton will be able increase the quality of life for its residents. These projects will also help promote a more sustainable way of living in Alton by increasing the safe accessibility to crosswalks and ramps that encourage non-motorized modes of transportation, by reducing time spent idling at intersections, by reducing the risk of accidents, and by minimizing erosion caused by storm waters.

State Street Improvement

Introduction

Many of the ramps at intersections in Alton were built before the Americans with Disabilities Act (ADA) set policies for ramp design to increase accessibility for people with disabilities. Before these standards were put into place, ramps were designed with able-bodied persons in mind and did not require detectable warnings, hard limits on cross- and running-slopes, landing pads for turning, and many other design elements. ADA laws have been in effect since 2010 but have not been strictly enforced until recently (Department of Justice, 2010).

Sheppard, Morgan & Schwaab, Inc. (SMS) has won a contract to do patching, milling and resurfacing along State Street from 200 feet south of Rozier St. north to the city limits, approximately 300 feet north of Delmar Avenue. Since resurfacing is considered an alteration, regulation requires that all of the sidewalk curb ramps meet ADA regulations as per Public Right of Way Accessibility Guidelines (PROWAG) (United States Access Board, 2011) and Illinois Department of Transportation (IDOT) Highway Standards (IDOT, 2019). The student team was tasked by SMS to redesign eight sidewalk ramps and a curb with the objective being to provide convenience, accessibility, and safety to pedestrians traveling along State Street while following standards set by PROWAG, ADAAG, and IDOT.

The group members included Adeshola Adewale, Blake Bergmann, Andrew Cisler, Ryan Gueldener, and Benjamin Jennings. Mentors from SMS included Dave Godar, P.E. and Coey Daniels, P.E., as well as Greg Caffey, Director of Development and Housing for the City of Alton.

To complete this project, the group performed a field survey to note the existing conditions of each intersection. After the group discussed the changes that need to be made for each ramp with SMS, each group member hand-sketched and designed the new ramps in AutoCAD.

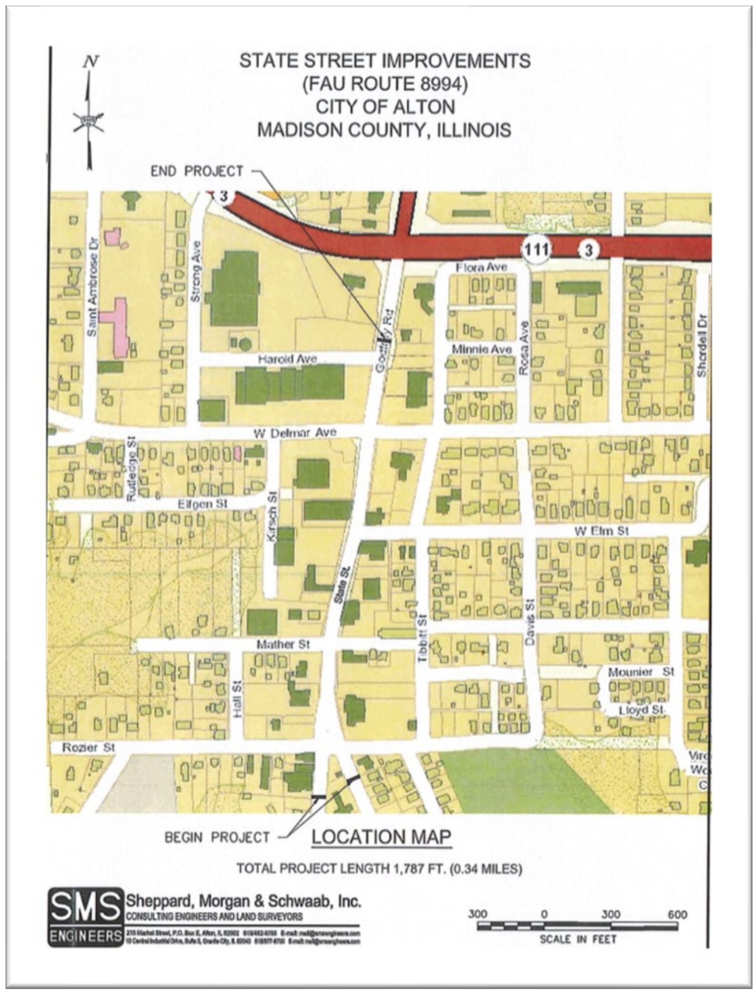


Figure 1: Location Map

Project Tasks Completed

Field Survey

Our first task was to conduct a field survey to confirm the existing conditions of State Street with the plans provided by SMS. The student team took photos of each intersection, measured the heights of curbs and widths of sidewalks with measuring tapes, and measured existing cross- and running-slopes with a smart level. This task was completed on Friday, January 25, 2019.

The group found that multiple sidewalks were not in compliance with ADA regulations, with existing cross-slopes greater than 2.0% and running slopes greater than 8.3%. Tripping hazards were also found at several intersections, with changes in elevation between the edge of pavement and the ramp.

Rough Prototypes

We then created rough prototypes for each street corner, based solely on the geometry of the intersection and existing sidewalks. Exact measurements were not taken into account at this stage, with the focus being on the layout of each ramp. The prototypes were reviewed and revised with Mr. Daniels, who suggested alternative designs for several ramps.

Hand Drawings

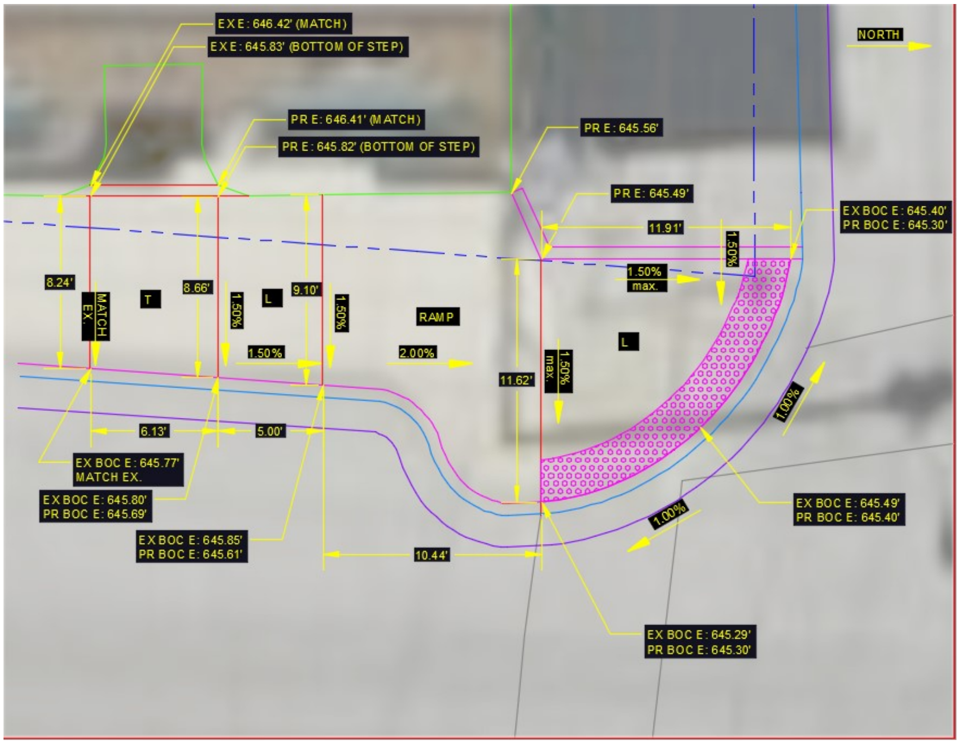
After the rough prototypes were created, we created hand-drawn designs for each ramp. Measurements, elevations, and cross- and running-slopes were considered at this point and the designs were compared against PROWAG, ADAAG, and IDOT Standards to ensure that they were in compliance. Once the hand drawings were completed, they were again reviewed by Mr. Daniels before designing in AutoCAD.

CAD Drawings

Upon approval of hand drawings, members of the group were tasked with recreating the designs in AutoCAD Civil 3D. The designs were completed in a file containing the survey points collected by SMS and an aerial image obtained from the East-West Gateway Council of Governments. The CAD drawings are more precise, with exact measurements of elevations, slopes, and dimensions of ramps to ensure compliance. Additionally, the CAD drawings can be used in the creation of plan sheets to prepare for construction.

Ramp Designs

All eight ramp designs comply with ADAAG, PROWAG, and IDOT Highway Standards. Specifically, the following conditions are met: maximum cross slope of 2%, maximum ramp running slope of 8.33%, maximum sidewalk running slope of 5%, minimum 4 feet wide pedestrian access route within the sidewalk, and a new 2-foot-wide detectable warning. The details of each ramp's design are listed below.



Ramp #1: The existing conditions of this curb ramp contained no detectable warnings and had a 2" high ledge at the edge of pavement. To solve this issue, the final design includes the curb declining with the sidewalk and a detectable warning placed in front of the curb ramp (Figure 2).

Figure 2: Ramp #1

Ramp #2: The detectible warning on this curb ramp has deteriorated and needs to be replaced. The sidewalk curves around an existing sewer inlet. This inlet will be replaced. The new design includes a narrow curb ramp to avoid buying property and a sidewalk placement that incorporates room for a new drainage inlet to the east (Figure 3).

Figure 3: Ramp #2

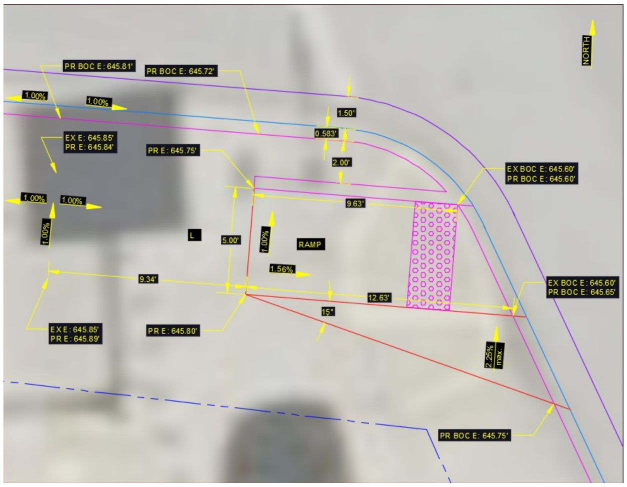


Figure 4: Ramp #3

Ramps #3 and #4: These curb ramps are located on an island in the middle of State and Belle Street (See Figure 4). There are no existing detectable warnings and the edges and large cracks provide a tripping hazard. The design uses triangular panels to remove the edges from the ramp and includes a steady incline to prevent rainwater from puddling (Figure 5).

Figure 5: Ramp #4

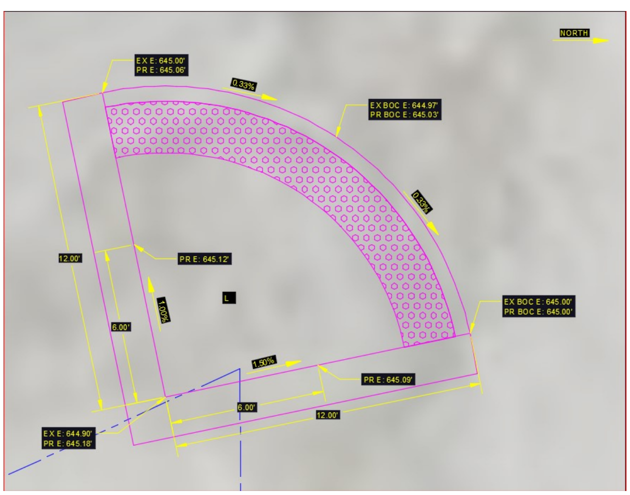
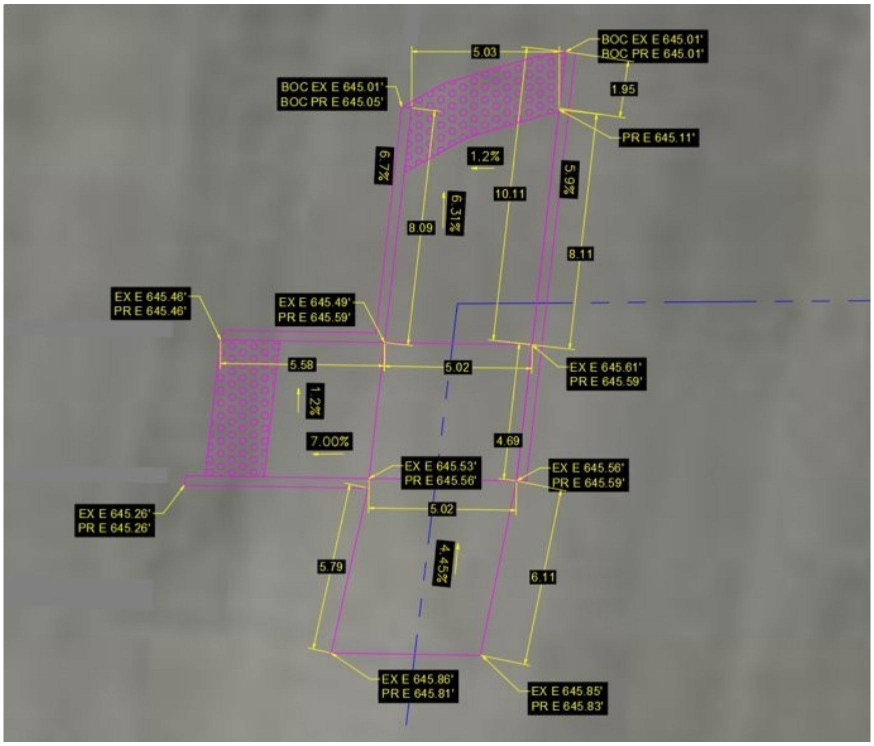


Figure 6: Ramp #5

Ramp #5: There was no existing sidewalk or ramp in this location, but there is a need for a corner island for pedestrians to safely cross Rozier and Belle Streets. The corner island is designed to face the point of intersection between Belle Street and Rozier Street (Figure 6).



Ramp #6: There is no existing ramp at the corner intersection. A depressed corner design that ramps up to both sidewalks leading up to it is used so that the corner is wheelchair accessible (Figure 7).

Figure 7: Ramp #6

Ramp #7: The ramp does not have a lower landing pad for wheelchairs to safely stop before the road. This ramp was redesigned to have a two perpendicular curb ramps for the crosswalks crossing Delmar Avenue and State Street. The storm inlet will be removed, and the crosswalks will be realigned (Figure 8).

Figure 8: Ramp #7

Figure 9: Ramp #8

Ramp #8: The existing ramp design currently does not include a landing pad, which is necessary for wheelchairs to be able to safely change direction and turn a 180° angle. The design of a corner parallel curb ramp is used to allow more room for the 4 feet by 4 feet landing pad. Type B curbing will be used for the backside, opposite side of pavement, of the sidewalk (Figure 9).

Cost Estimate

Once the final AutoCAD drawings were created, the cost analysis of payable items was calculated (Figure 10). The quantities of new sidewalk pavement, curb and gutter, and detectable warnings—as well as the removal of the existing structures—were found by finding the lengths of polylines and drawn areas in the AutoCAD drawings. Using the material unit costs provided by Mr. Daniels, the cost for each ramp was calculated and summarized in Figure 10. The total project cost will be $39,515.80.

	Sidewalk				Curbing						Detectable Warning		Cost Per Ramp
	Removal		New		Removal: Curb and Gutter		New: Curb and Gutter		New: Type B		New		
	Area	Cost	Area	Cost	Length	Cost	Length	Cost	Length	Cost	Area	Cost	
Material Cost	Sq ft	$4 /sq ft	Sq ft	$7 /sq ft	Ft	$25 / ft	Ft	$35 / ft	Ft	$30 / ft	Sq ft	$50 / sq ft	
Ramp 1	330.0	$1,320.00	330.0	$2,310.00	55.1	$1,378.00	55.1	$1,929.20	16.0	$480.00	35	$1,750.00	$9,167.20
Ramp 2	86.0	$344.00	86.0	$602.00	52.8	$1,320.00	52.8	$1,848.00	17.2	$516.00	8	$400.00	$5,030.00
Ramp 3	70.5	$282.00	70.5	$493.50	38.7	$968.50	38.7	$1,355.90	9.6	$288.00	10	$500.00	$3,887.90
Ramp 4	80.9	$323.60	80.9	$566.30	37.0	$925.50	37.0	$1,295.70	9.6	$288.00	10	$500.00	$3,899.10
Ramp 5	0.0	$0.00	69.7	$487.90	0.0	$0.00	0.0	$0.00	43.0	$1,290.00	33	$1,650.00	$3,427.90
Ramp 6	140.5	$562.00	140.5	$983.50	36.8	$919.25	36.8	$1,286.95	0.0	$0.00	15	$750.00	$4,501.70
Ramp 7	145.0	$580.00	145.0	$1,015.00	32.1	$802.50	32.1	$1,123.50	36.6	$1,098.00	21	$1,050.00	$5,669.00
Ramp 8	140.0	$560.00	140.0	$980.00	22.5	$562.50	22.5	$787.50	18.1	$543.00	10	$500.00	$3,933.00
Cost Per Pay Item		$3,971.60		$7,438.20		$6,876.25		$9,626.75		$4,503.00		$7,100.00	
												Total Project Cost	$39,515.80

Figure 10: Cost Estimate

Envision Sustainability Rating System

During the semester, the Senior Design class hosted Michael Buechter as a guest speaker—Mr. Buechter is a former president of the American Society of Civil Engineer's (ASCE) St. Louis Chapter and an advocate for the ASCE's Envision sustainability model.

Envision is a method for measuring sustainability similar to LEED, but is designed to be applicable to a wider variety of projects. Envision models sustainability in three major categories: environmental, economic, and social, and incorporates all three aspects into its rating system.

As part of the assignment for the Senior Design project, the group was tasked with taking the survey to rate the project. As the group has little information about the data collected by SMS or the construction methods for the project, most questions were inapplicable to the group which caused the scores to be much lower than in reality.

The first category of the survey, Quality of Life, had a rating of 65/100 and relates to promoting social sustainability by aiding the community's wellbeing. The second category, Leadership, had a rating of 37/100 and relates to promoting sustainable construction and engineering methods with regard to leadership and delegation. The third category, Resource Allocation, had a rating of 17/100 and relates to promoting renewable or recycled materials and energy. The fourth category, Natural World, had a rating of 54/100 and relates to protecting existing habitats. The fifth and final category, Climate, had a rating of 54/100 and relates to reducing damage and pollution to the atmosphere.

Conclusion

The project started with a basic overview, a field survey, and a briefing of standards, guidelines and ways to complete the project. The design portion was done in three steps. These steps were producing hand drawings to understand the layouts, followed by putting these rough designs into AutoCAD, and then finalizing plans for the ramps by changing slopes to be more user friendly where possible. Half of the ramps were modified from the existing conditions and the other half implemented a depressed curb design. Upon completion of the designs, a cost analysis was run on all the ramps. This cost analysis included the concrete for the sidewalk, the two different types of curbing, and detectable warnings. The total of the cost estimate for all eight ramps came to $39,515.80. This project will affect Alton positively by improving the quality of life of pedestrians. Upon competition of the project, each group member had the chance to experience real-world applications and gain knowledge of design work in the field of Civil Engineering.

Intersection Improvements

Introduction

The Intersection Improvement team was tasked with the analysis and redesign of the State St./ Rozier St./Belle St. intersection in Alton, Illinois. The awkward geometry of the five-leg intersection elicited a poor initial design that resulted in perceived long delays and a high accident rate. As a result, in 2016, the City of Alton hired Dave Godar, P.E., of Sheppard, Morgan & Schwaab, Inc. (SMS) to perform a traffic study on the intersection in an effort to receive federal funding for a possible redesign project. The City of Alton is currently unable to fund the project, so their focus aims at receiving a federal grant for the project. Two potential sources of funding are the Congestion Mitigation and Air Quality Improvement (CMAQ) grant and the Highway Safety Improvement Program (HSIP). CMAQ funding can be obtained if the redesign is shown to reduce the overall driver delay, which will then reduce emissions. HSIP funding can be obtained if the redesign proves to reduce traffic fatalities and serious injuries. Unfortunately, SMS staff was not able to accurately model the existing conditions, which prevented the City of Alton from receiving the CMAQ funding. However, SMS was able to complete a large portion of the initial analysis of the intersection, which can be carried over into the project. With the help of the SIUE faculty, the Intersection Improvement team identified data that was used to model the intersection in order to gather an accurate measure of the Level of Service (LOS) and associated delay in an effort to receive the CMAQ funding. Once this step was completed, the team moved on to the development of an alternative roundabout design.

Project Objectives

The primary objective of the intersection redesign is to improve the experience of drivers on the State St./Belle St./Rozier St. intersection by increasing mobility and reducing overall driver delay, emissions, and crashes.

Approach to Objective/Methodology

Each student worked collaboratively so that all team members learned about each step taken within the design process. The team completed most of the steps to reach the objective. The first step was to meet with Mr. Godar and discuss the initial problem with the intersection and brainstorm solutions. Once a solution was agreed upon, the team completed data analysis about the intersection. This included crash analysis, delay times, and analysis of trend data. To complete the crash analysis, Greg Caffey, Director for Housing and Development for the City of Alton, sent the team crash reports which were analyzed using IDOT standards (BLRS Manual Section 22-2.11(b)(9)). The team then moved on to the delay times of the intersection. After consulting with Professor Yan Qi, the team decided VISSIM software would be needed to analyze the intersection. With the help of Professor Ryan Fries, this was made possible and the intersection was rated at a Level of Service (LOS) of A with an AM peak delay of 7 seconds and a

PM peak delay of 6 seconds. With this information, the team decided that the awkward layout of the intersection was to blame for the amount of crashes and the amount of complaints by drivers about this intersection. At this point the team decided to move ahead with the intersection redesign as a roundabout.

Tasks Completed

Tasks completed by the team include data collection, record research, analyzing crash data, determining the LOS and delay for the existing conditions of the intersection, observing the intersection geometrics, development of striping and signage plan, and construction cost analysis.

Data Collection & Record Research

This task required members of the team to investigate the intersection and to reference the project data given by SMS. The data that needed to be collected were the current Average Daily Traffic (ADT), design year ADT, current design volume, design year's design volume, the functional classification, the current design vehicle, and the design vehicle for the design year. The current ADT was given by SMS from their preliminary research. The design year ADT was obtained by increasing the current ADT by 12% as instructed by SMS. The current design volume was completed by taking 10% of the current ADT. The volume of the design year was completed by taking 10% of the design year's ADT. The functional classification was obtained from SMS's preliminary research. The design vehicle of the current intersection was also obtained from SMS's research. The design vehicle for the roundabout design is the largest vehicle for the current conditions of the intersection. All findings can be found in Table 1.

Table 1: Data Collection of Current Intersection and Roundabout Design

ADT Current (Vehicle)	**Design Volume Current (Vehicles)**	**Functional Classification Current**
State Street (N) = 11,400	State Street (N) = 1,100	State Street = Minor Arterial
State Street (S) = 8,000	State Street (S) = 770	Belle Street = Major Collector
Belle Street = 4,400	Belle Street = 420	Rozier Street = Local Road
Rozier Street (W) = 310	Rozier Street (W) = 31	
Rozier Street (E) = 310	Rozier Street (E) =31	**Design Vehicle Current**
		State Street = WB-65
ADT 2027 (Vehicles)	**Design Volume 2027 (Vehicles)**	Belle Street = WB-55
State Street (N) = 12,300	State Street (N) = 1,230	Rozier Street = WB-50
State Street (S) = 8,600	State Street (S) = 860	
Belle Street = 4,700	Belle Street = 470	**Design Vehicle 2027**
Rozier Street (W) = 350	Rozier Street (W) = 35	Roundabout = WB-65
Rozier Street (E) =350	Rozier Street (E) = 35	

Data Analysis

A MicroStation file was completed by the team to more easily see the locations and causes of the crashes based on data provided by Mr. Caffey. Sixteen crashes were recorded from 2013 - 2018. The crashes are color coordinated by year, with the legend shown in the top-right corner of the sketch. For example, four green conflicts indicate four crashes in 2014 (Figure 11). Each crash site shows the path of each vehicle before the conflict and has its corresponding crash rating and the date it occurred, as shown in the example of the enlarged crash site (Figure 12). The highest crash rates occur in the areas of crossing Rozier St. from Belle St. and State St. and the T-intersection from South State Street that leads to North State Street and South Belle Street. The type of crashes with the highest frequency are T-bone collisions in which one vehicle makes a head-on collision with the side of another vehicle. A pattern can be seen in T-bone crashes as the vehicles on the streets with heavier volume get hit by the vehicles on the streets with lesser volume. There were two instances where a vehicle failed to stop at the Rozier Street intersection going north-bound on State Street. These vehicles collided with objects in the median which resulted in damage to a single vehicle each time.

The City of Alton uses a rating system that varies from Illinois'. The standard ratings in Illinois are as follows: "A" is incapacitating injury, "B" is non-incapacitating injury or apparent injury, and "C" is reported but not evident. The ratings from the City of Alton are as follows: "A" is no injury/drive away, "B" is injury and/or tow due to crash, and "C" is no injury/tow. The rating that differs the most between the two is the crash rating "A". This variation illustrates that different ratings can be used in different parts of the state. The group used the crash rating standards from the crash reports provided by the City of Alton in its analysis.

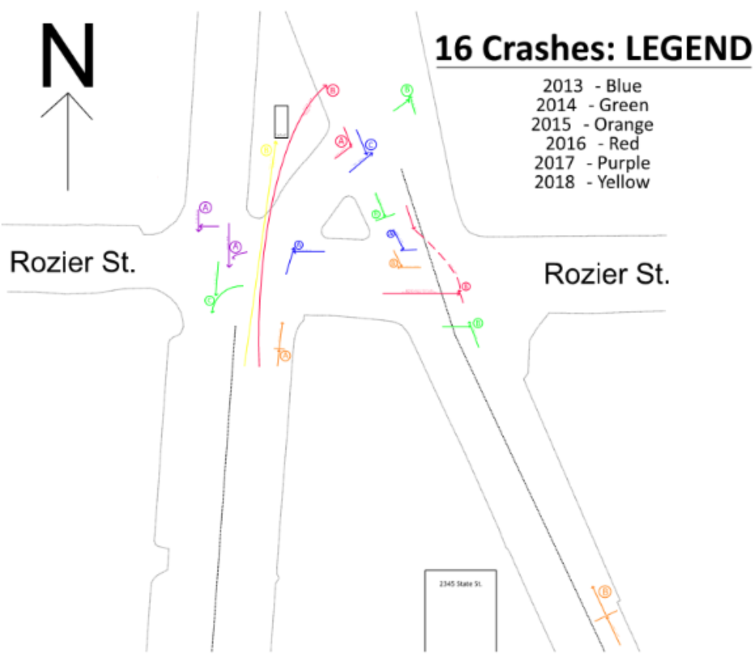


Figure 11: MicroStation Crash Diagram

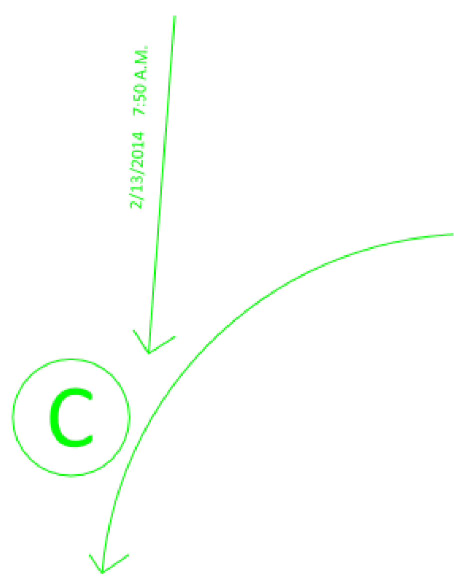


Figure 12: Enlarged Crash Site Example

Determining Level of Service and Delay

Existing Conditions:

The intersection with existing conditions was analyzed using VISSIM software and matrices of the adjusted vehicle flows and with the help of Professor Fries. This was completed and the intersection was rated as a LOS of A. The AM peak delay was 7 seconds and the PM peak delay was 6 seconds. These times can be seen in Table 2 and Table 3 respectively. This was not the result the team expected. The team and the group's host, Mr. Godar, expected and hoped for more delay than what was proved by VISSIM. If the delay had been greater than the result found, it could lead to gaining the funding needed for this intersection improvement.

Table 2: AM Peak for Existing Conditions

SIMRUN	TIMEINT	MOVEMENT	QLEN	QLENMAX	VEHS(ALL)	PERS(ALL)	VEHDELAY(ALL)
2	1800-5400	1	1.134184291	69.05638987	1095	1095	6.24560048
3	1800-5400	1	1.151293719	68.11991056	1103	1103	6.67783539
4	1800-5400	1	0.966364774	63.28088355	1099	1099	6.264689194
5	1800-5400	1	1.271231557	57.14979882	1102	1102	6.999348872
6	1800-5400	1	0.928597732	52.81953689	1092	1092	6.0170054
7	1800-5400	1	1.57181607	69.80356159	1101	1101	7.471059452
8	1800-5400	1	1.603929215	72.36865491	1105	1105	7.718511676
9	1800-5400	1	1.616703415	65.81207348	1097	1097	7.628976231
12	1800-5400	1	0.968425212	69.46540274	1098	1098	6.342309259
14	1800-5400	1	0.879562918	49.46458167	1098	1098	6.256653574
16	1800-5400	1	2.716277584	108.4902894	1096	1096	9.697009787
10	1800-5400	1	1.760042029	81.81101875	1096	1096	7.99542161
11	1800-5400	1	1.488508343	60.60509491	1103	1103	7.349873642
13	1800-5400	1	1.2211783	72.69342752	1095	1095	6.815966938
15	1800-5400	1	1.585537229	79.93681305	1094	1094	7.637716126
AVG	1800-5400	1	1.390910159	69.39182918	1098.266667	1098.266667	7.141198509

Table 3: PM Peak for Existing Conditions

SIMRUN	TIMEINT	MOVEMENT	QLEN	QLENMAX	VEHS(ALL)	PERS(ALL)	VEHDELAY(ALL)
1	1800-5400	1	1.222075249	68.33764945	1185	1185	6.236586657
2	1800-5400	1	1.673744471	85.66700954	1195	1195	7.199871746
3	1800-5400	1	1.570074099	76.56943917	1189	1189	7.125741983
4	1800-5400	1	1.159449766	60.5053851	1183	1183	6.403679848
5	1800-5400	1	1.665941715	81.10740611	1194	1194	7.018452568
6	1800-5400	1	0.902245995	68.64978685	1194	1194	5.573152148
7	1800-5400	1	0.926312053	50.1473521	1194	1194	5.689832859
8	1800-5400	1	0.9965656	56.02796674	1193	1193	6.095349677
9	1800-5400	1	1.76157673	91.46206708	1192	1192	7.137076571
10	1800-5400	1	1.001970828	71.40291418	1189	1189	5.769177316
11	1800-5400	1	1.10849172	80.94334031	1188	1188	6.357057599
13	1800-5400	1	1.75916197	83.04826232	1184	1184	7.377335919
15	1800-5400	1	0.97180077	62.51907152	1198	1198	5.840043711
12	1800-5400	1	1.17129336	57.38296275	1192	1192	6.308462919
14	1800-5400	1	1.116596656	80.78631075	1200	1200	6.130977245
AVG	1800-5400	1	1.267153399	71.63712826	1191.333333	1191.333333	6.417519918

Developing Intersection Geometrics

The design of the roundabout began as a traditional sketch. Specific problems became apparent from the initial design. For example, the traditional roundabout design would require several building demolitions and private property excavations due to its wide parameters. These factors would decrease likelihood of acquiring funding and increase the overall cost of the improvement.

The traditional roundabout was maneuvered to alternate locations, yet it always interfered with existing buildings and private property. In addition, the entrance/exit locations of State St. and Belle St. on the southernmost side of the roundabout were so close in location throughout this movement procedure that their entrance/exit locations molded into one large entrance/exit. This geometric conflict would lead to future issues in traffic flow and safety. With these problems in mind, the geometry of the roundabout was changed to an elliptical shape. This design would allow for the increase in distance between the State St. and Belle St. entrance/exit locations. In addition, the elliptical shape allows for the avoidance of building excavation, decreasing cost of the improvement. The redesigned roundabout requires City acquisition of small portion of a used car lot on the southernmost tip of the roundabout (Figure 13). The car lot can be purchased at a much lower cost than the cost of demolition and excavation of existing buildings and purchase of private property required by a traditional roundabout. The final conceptual design is shown (Figure 13).

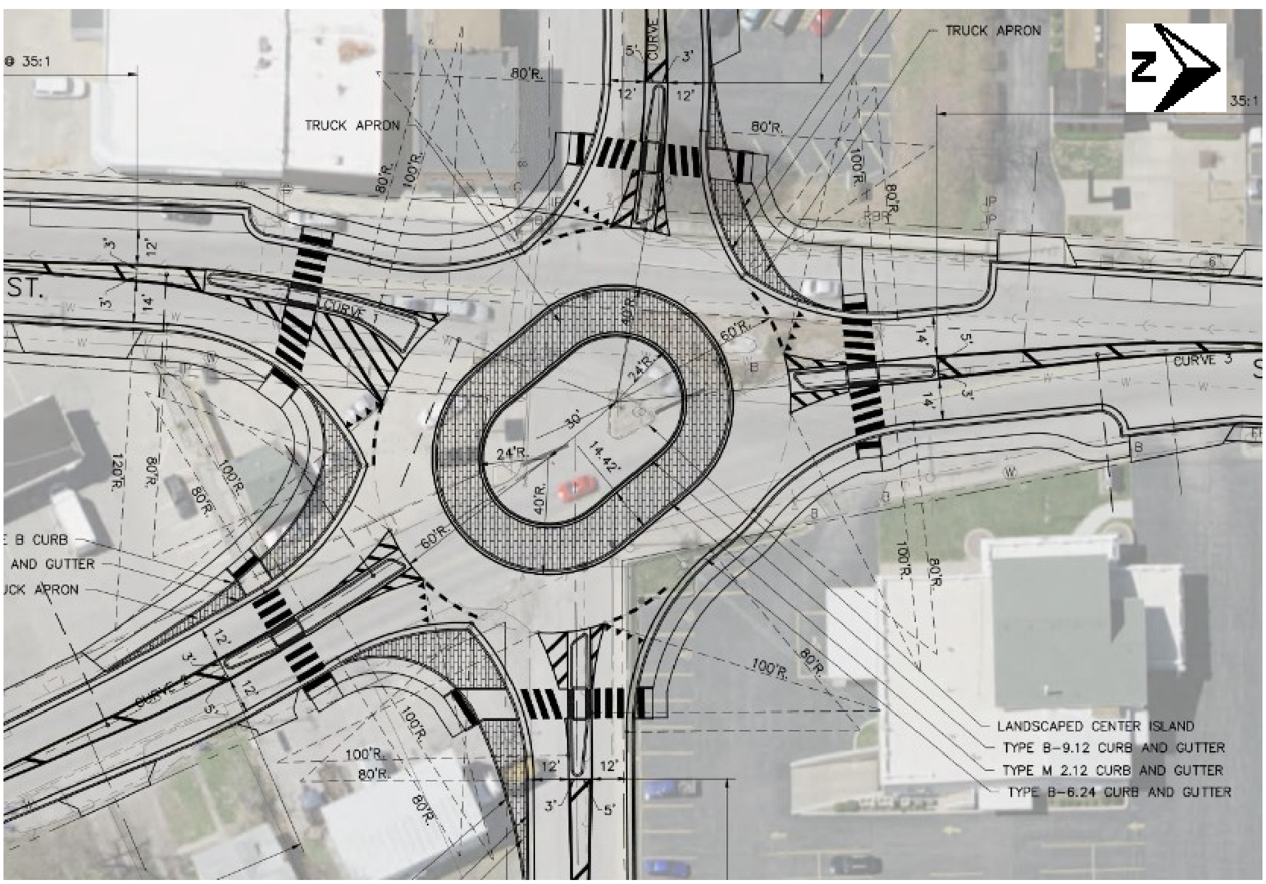


Figure 13: Design Draft of Roundabout

The team also moved the roundabout to the southern direction of the intersection, giving a wider radius for an Interstate Semitrailer (WB-65 design vehicle) to make its turn (Figure 14).

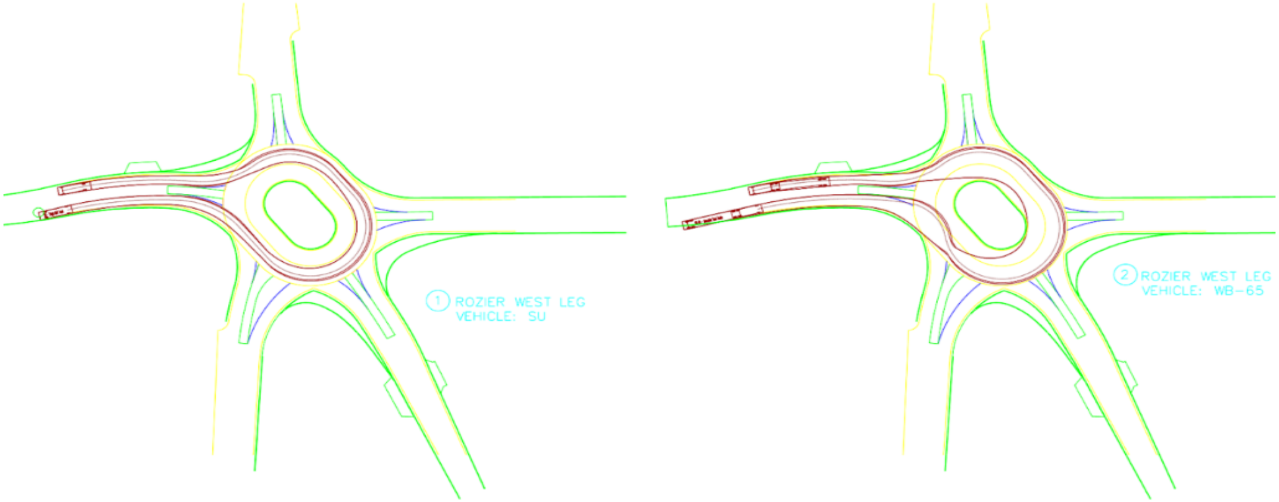


Figure 14: Offtracking of WB-65 Interstate Semitrailer Design Vehicle

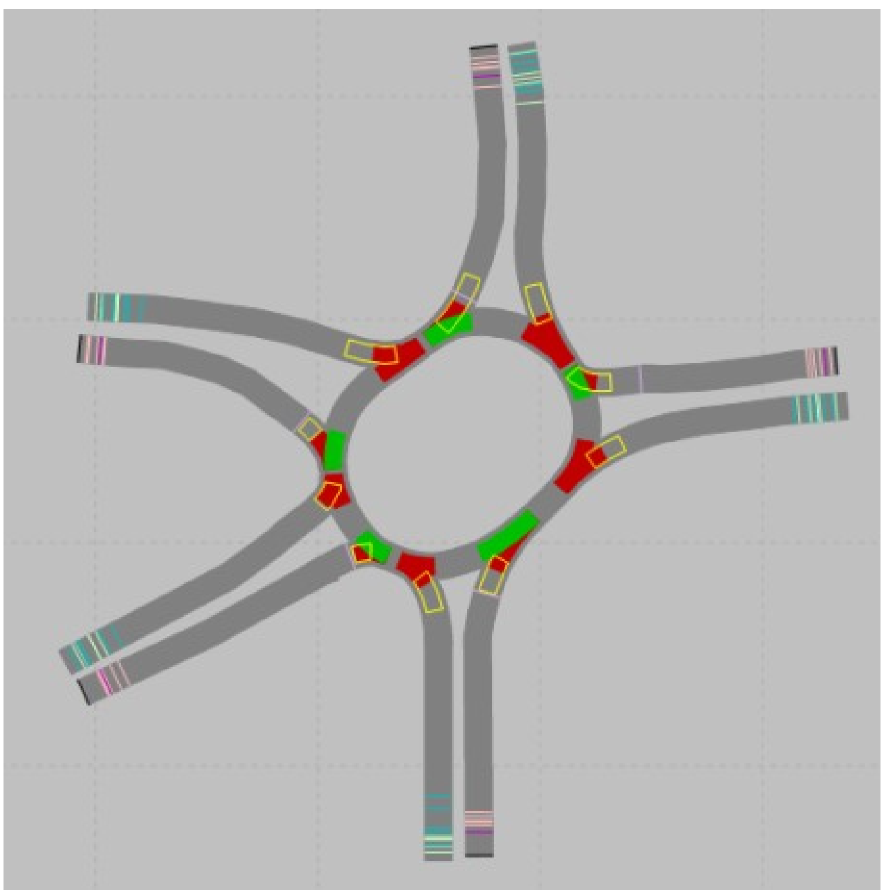


Figure 15: VISSIM Model of Proposed Roundabout

Alternative Design Finalization

Even though funding in the near future is unlikely, the group still carried out the project. The intersection with proposed conditions of the alternative final design was analyzed using VISSIM software (Figure 15). This was completed by the team and once again, a LOS of A was obtained.

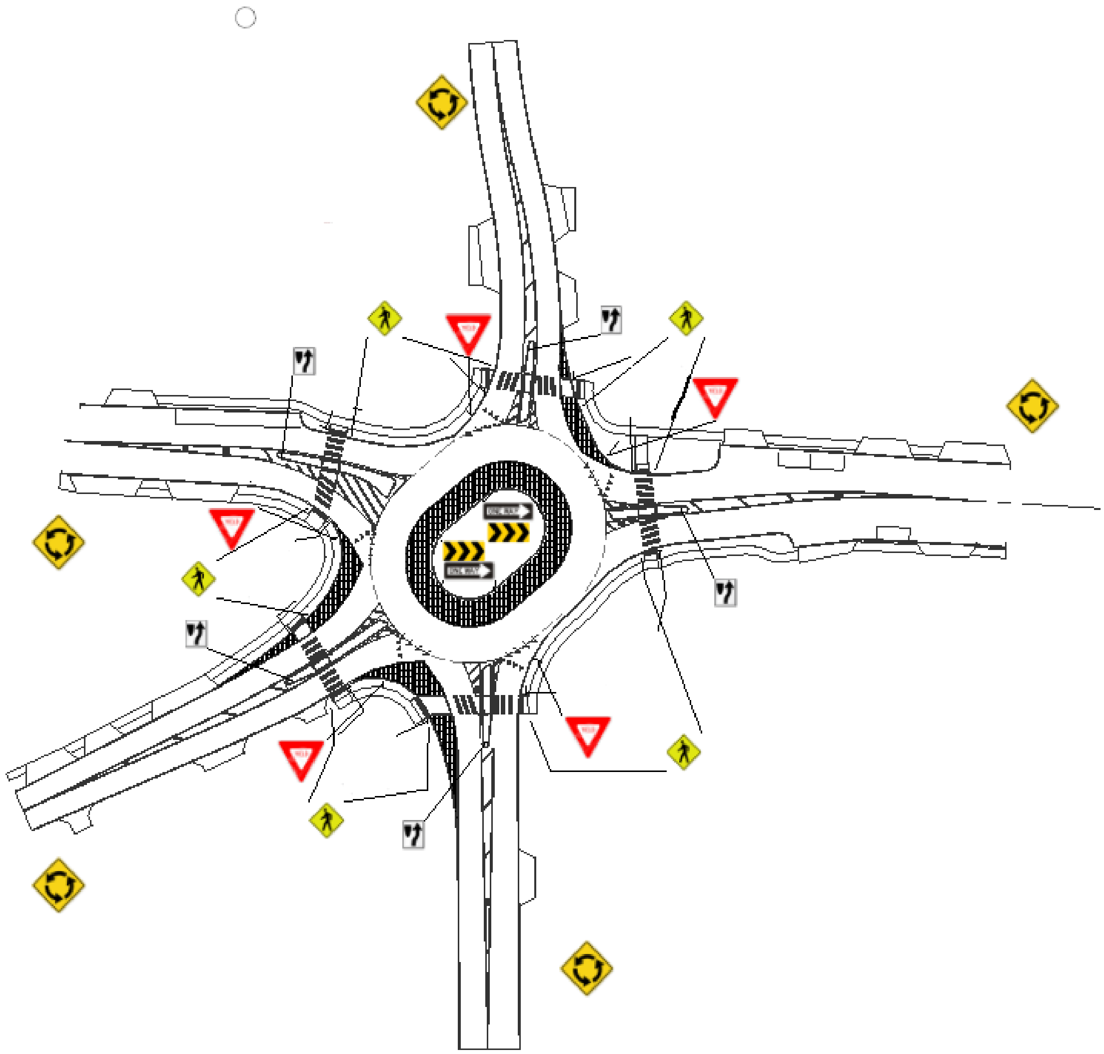


Figure 16: Proposed Striping and Signage Plan

Striping and Signage Plan

Roundabout, yield signs, pedestrian crossing signs, movement regulation signs, one-way signs, and chevrons direct and alert incoming traffic (Figure 16). These signs and the metal posts used to support them are included in the cost estimate in Table 4.

Construction Cost Analysis

The total cost analysis for the project is shown in Table 4. This includes pavement removal, new pavement installation, signage, striping, and detectable warnings to construct the roundabout within the five legs of the intersection. The total cost of the materials used is projected to be $4,075,558. A 25% contingency allows an additional $1,018,889 for any extra additional costs for the project. This contingency is 25% of the total materials cost. These cost estimates are based on past projects and are subject to change.

Table 4: Cost Estimate

5-Legged Roundabout Cost Estimate

CODE NO.	ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL
31100910	SUBBASE GRANULAR MATERIAL, TYPE A 12"	SQ YD	5797	17	98549
42000301	PORTLAND CEMENT CONCRETE PAVEMENT 8"	SQ YD	57967	57	3304119
42300200	PORTLAND CEMENT CONCRETE DRIVEWAY PAVEMENT 6"	SQ YD	5094	50	254700
42400100	PORTLAND CEMENT CONCRETE SIDEWALK 4"	SQ FT	4905	5.5	26977.5
42400800	DETECTABLE WARNINGS	SQ FT	400	45	18000
44000100	PAVEMENT REMOVAL	SQ YD	9039	8	72312
60600605	CONCRETE CURB. TYPE B	FOOT	978	34	33252
60605000	COMBINATION CURB AND GUTTER, TYPE B-6.24	FOOT	1021	18	18378
60605900	COMBINATION CURB AND GUTTER, TYPE B-9.12	FOOT	205	25	5125
60608300	COMBINATION CURB AND GUTTER, TYPE M-2.12	FOOT	305	25	7625
60608521	COMBINATION CURB AND GUTTER, TYPE M-2.24	FOOT	412	25	10300
72000100	SIGN PAN - TYPE 1	SQ FT	155	30	4650
72900200	METAL POST - TYPE B	FOOT	238	20	4760
LR430030	CONCRETE PAVER PAVEMENT	SQ YD	645	62	39990
Z0036200	PAINT CURB	FOOT	2947	60	176820
TOTAL					4075558
TOTAL 25% CONTINGENCY					1018889

Sustainability

The intersection improvement of the proposed roundabout within the State Street, Belle Street, and Rozier Street proves to be very sustainable to the environment. The net quality of life will be improved by the project and the negative impacts will be mitigated. There will be effective leadership and commitment to achieve project sustainability goals. Energy will be conserved by reducing the net embodied energy of project materials over the project life. The present building structures and other sites around will not be touched as this roundabout is placed. Emissions will also be reduced. The quality of life, leadership, resource allocation, natural world, and climate/risk are all at very safe percentages when considering the excel data sheet that the team filled out (Figure 17).

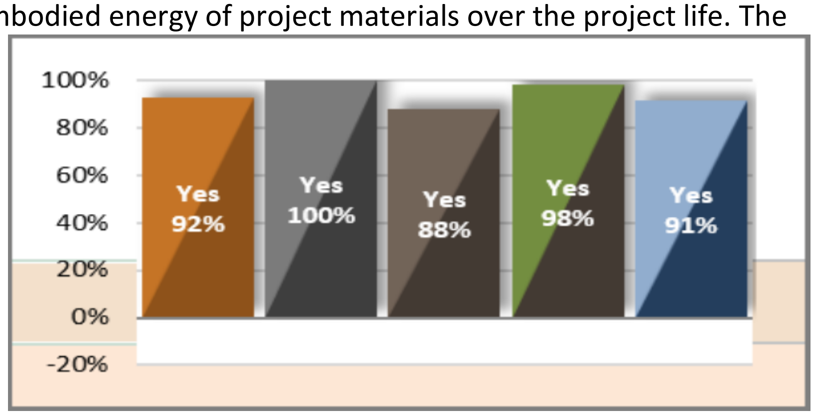


Figure 17: Envision checklist highlighting key engineering principles

Storm Water Management

Introduction

Project Description

The City of Alton currently has ordinances in place to regulate development within the corporate limits, but there are requirements and regulations by other government agencies, such as Madison County and the Illinois Environmental Protection Agency (IEPA), that must be followed when construction projects are undertaken in the City. These development ordinances, together with the Storm Water Control Ordinances, give the regulations for development. There is no document currently adopted that deals with management practices for storm-water runoff. The team worked with the Engineers at Sheppard, Morgan & Schwaab, Inc. (SMS) to develop effective storm-water management plans for the City of Alton. These plans will be referred to as Best Management Practices (BMPs). Another portion of the project is to design a regional storm-water detention basin in Rock Springs Park. The environmental group will be incorporating the developed BMPs into the design.

Design Objective

The primary objective of the storm-water management plan is to provide guidelines for residents, businesses, and other developments in the City of Alton for storm-water runoff management practices. As for the detention basin, the objective is to calculate total rain, runoff, area, and depth values and use that data to prepare the park for possible future developmental changes that would affect how the area handles storm-water.

Methodology

In order to successfully complete the BMPs document, the team first researched ordinances and regulations at the city, county, and state levels. By utilizing resources such as the host engineering firm, base maps, field data, City of Alton archives, and various websites, the group had ample access to the data necessary for this project. Once all the important ordinances, forms, and regulations were found, a list of those deemed necessary was created. The necessary documents, regulations, and preferred wordage was then included in the BMPs document. Supplementary research and information were provided about the three subcategories for which the student team was responsible.

After the necessary forms, ordinances and guidelines were divided into their corresponding subcategories, the group began preparing a rough draft BMPs including these items and additional info that would be beneficial to the target audience (residents, businesses, and developers). Once the team was satisfied with the rough draft, the group met with Mr. Sheppard and Mr. Caffey to get their feedback and guidance. Finally, after revising the document, the group turned it over to the City of Alton for approval. As for the storm-water basin in Rock Springs Park, the student team accomplished the following: analysis of the drainage basin using elevation and Lidar maps, projection of future development in the basin with hypothetical situations, calculation of discharge rates of current and future situations, and preparation of plans including the specifications and cost estimates of basin construction. After the tasks mentioned above were completed, the student team prepared a final report including sustainability considerations for the storm-water basin.

Tasks Completed

Introduction Meeting with Host

The team traveled to Sheppard, Morgan and Schwaab, Inc. in Alton to meet for the first time with Mr. Sheppard and Mr. Caffey. The expectations for the team, the overall scope of the project, and a rough timeline were discussed.

Prepared Base Maps

Separate maps for utilities, Lidar (elevations), and field data were sent to the group from an associate at SMS. With these maps and guidance from Mr. Sheppard, the group was able to link the elevation and area layout maps (Figure 18, 19, & 20) to get more detailed information needed for the basin design. Linking the maps in Civil 3D was accomplished by referencing each map to one another and making sure they were all in the same coordinate system. This then overlaid the individual maps on separate layers and allowed for each one to be turned on or off. In the future, the team will use the combined map file to determine runoff area and area required for desired retention basin (Figure 21 & 22). This will be done by creating a ground surface in Civil 3D and delineating the watershed area (Figure 22 & 23) that pours into the intended basin location. Once the area is delineated, the required catchment volume and area can be calculated.

Figure 18: City of Alton sewer, ground, and property lines

Figure 19: City of Alton elevation, sewer, and property lines

Figure 20: All previous maps combined and coordinates matched

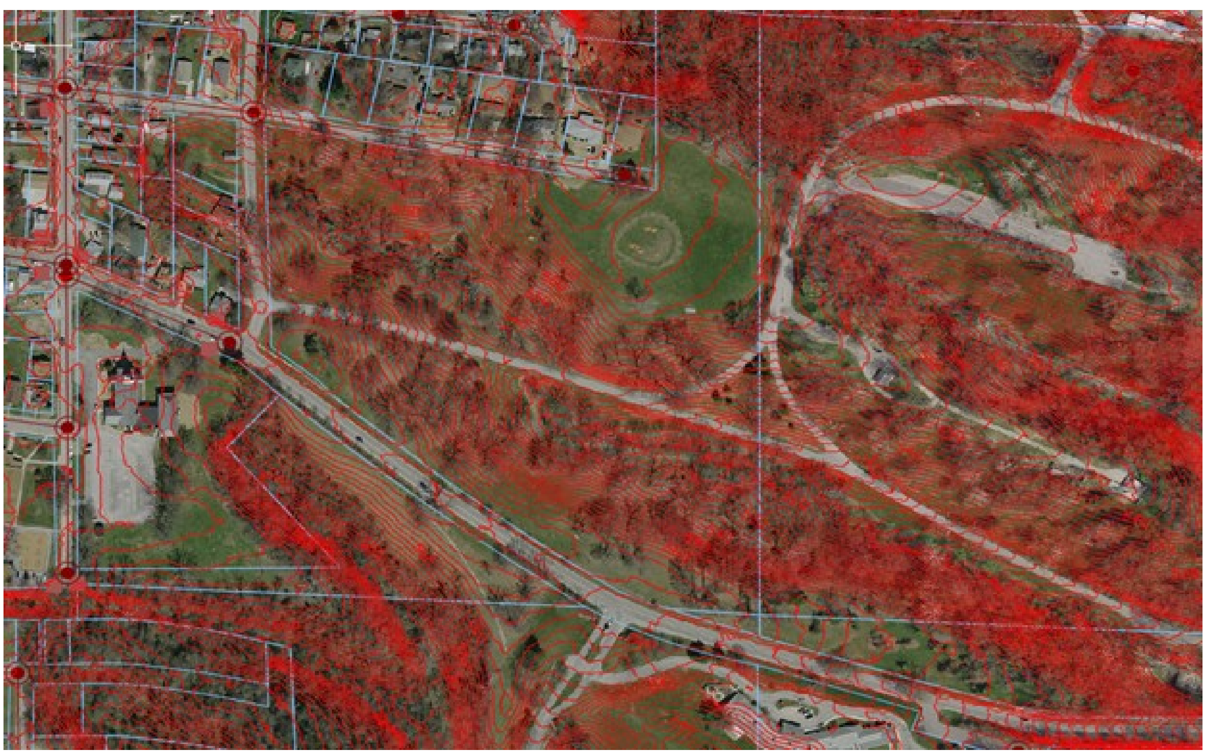


Figure 21: Combined maps zoomed in at basin location

Figure 22: Rough area of watershed and soil map provided by USDA website

Best Management Practice Partial Document

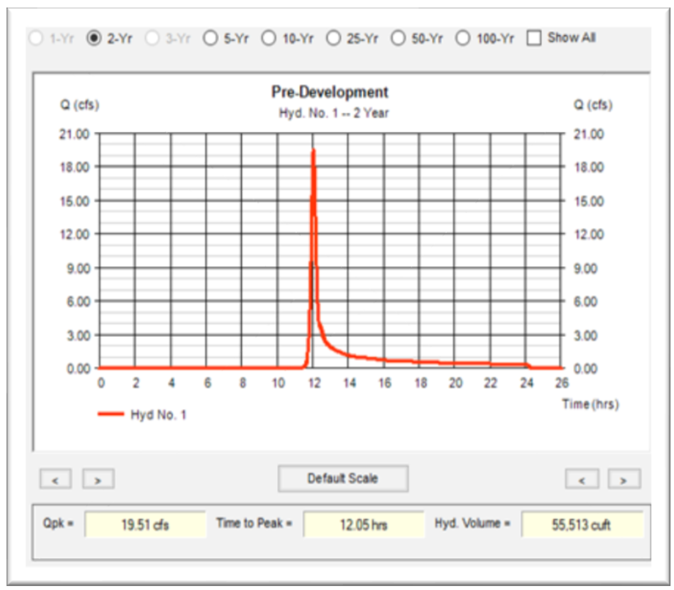


Figure 23: Hydrograph for our pre-development 2-year storm situation.

After discussion with Mr. Sheppard and Professor Qi, all parties decided it was appropriate that the BMPs portion of the project be limited to only three of the six total subcategories. This was acceptable to all parties because the senior design course mainly focused on the analysis and design of real-world engineering projects. Based on the first three categories of the document, the team researched and compiled important ordinances and regulations from the city, county, and state level (Alan 2007; Pitt 2004; Pruitt 2008). Once the group had the list of important articles to reference and knowledgeable information for the target audience, the document was started. A rough draft was completed and revised numerous times until Mr. Sheppard and the team approved. The finished document for the three selected categories is referenced when needed in the design of the detention basin in Rock Springs Park. We also have hydrographs for pre-development 100-year and post-development 2- and 100-year storm events to compare when necessary.

Defined Runoff Areas and Soil Type

Runoff areas were defined by the combined efforts of our group and Justin Kleinschmidt, P.E., from SMS Engineering. In order to perform a pre- and post-analysis for the drainage basin, theoretical structures were added into the surrounding environment to better offset peak hourly flows. Directly to the north of the drainage basin was theoretical placement of commercial property for the post-development analysis. This addition caused more runoff from uphill to be directed and to pass through the basin located at a lower elevation. To the northeast of the commercial property line was a theoretical parking lot located next to a pre-existing baseball diamond commonly used by the public. Additionally, pre-existing residential properties with a small creek running through them, which leads to the proposed basin, are located to the west. These features, in conjunction with a roadway located south of the basin, allowed water to flow down into the wet bottom basin. The elevations and key features helped define runoff areas in order to better assess the volume of rain runoff. The next step was to visit the USDA website and obtain a soils report. This report allowed us to determine the soils type of each area. Determining the soil types was key to finding out the weighted curve number, which we used in determining runoff volume. Figure 22 shows the watershed area and soil sections in relation to the design plans.

Determined Volume of Rain Runoff

In order to determine the volume of rain runoff, the group met with Mr. Kleinschmidt to help define the runoff area and to determine key components in peak hourly flow design. Using a hydrograph software within Civil 3D, the group determined the weighted curve number for both pre- and post-development. These curve numbers, along with the watershed area of 15 acres, were entered into the same software to determine the amount of runoff for both 2- and 100-year storm events. The pre-development peak flow values are important because the dam and weir are built to release the post-development flow at the rates before runoff was theoretically increased. The post-development volume of runoff is important because it allows the team to determine the peak amount of runoff the basin would need to handle in a 100-year storm event after the hard surface structures are in place.

Calculated Needed Area of Basin

Mr. Kleinschmidt provided us with a proposed site and height of the proposed dam. Once the peak volume of runoff was determined for the post-development 100-year storm event, the group calculated the area of individual contour lines relative to the plans for the proposed dam. We determined that 10 contour lines, or 10 feet, of the basin would be needed to handle the amount of water determined earlier. SMS instructed us that the basin would be a wet bottom, or retention, basin. The bottom 5 feet of the dam will hold water, while the top 5 feet of the dam will have a weir structure in place that chokes down the peak flows to prevent flooding downstream.

Designed Weir and Dam

To design the weir, the group once again turned to Civil 3D. It has some amazing software that will model a weir and its characteristics once given sufficient data. The data we provided it included the 2-year up to the 100-year storm events and corresponding volume amounts for each. The next step was to select a weir type. It was settled that a rectangular weir would be a better solution than a culvert for maintenance reasons: a culvert is more likely to get clogged and is harder to unclog because the end will most likely be submerged in water during a storm event, while the weir is always above water or at the highest elevation of the water. After the rectangular weir was decided, we started to experiment with the crest length, or opening width, of the weir. The height was already specified at 5 feet given the total height of dam being 10 feet, since the first 5 feet is for retention purposes. The group settled on 2 feet for our crest length because it was below the target discharges, and it gave us over a foot of freeboard (distance between max water height and top of dam) as instructed by SMS.
The target discharges were determined earlier when computing the basin volume. Figure 23 shows the target discharge for 2-year while Figure 24 shows the discharge and water elevation compared to the corresponding storm year.

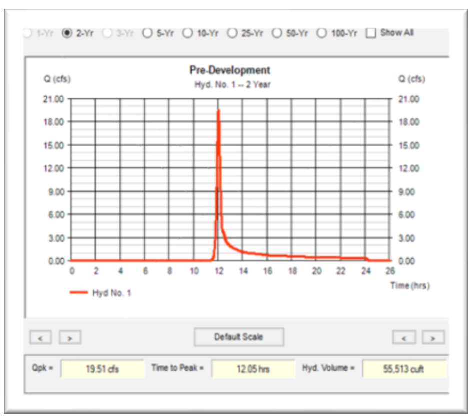


Figure 23: Hydrograph of target discharge for 2-year storm event

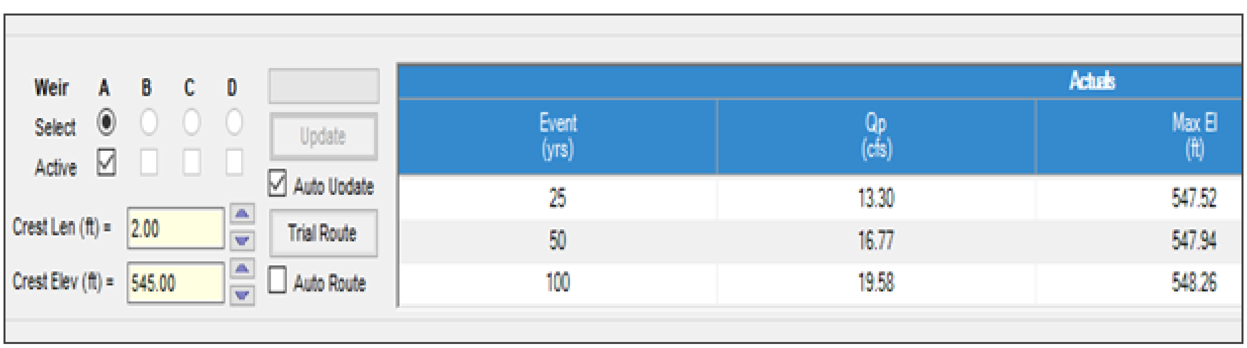


Figure 24: Designing the weir with adjusted the crest length.

Cost Estimates The team created a cost estimates document to inform the members at SMS of what it would potentially cost to implement this water basin. Cost estimate documents consist of a table that represents the types of items, quantity of items, price per item and the total cost of items. These costs are then summed together to give a grand total for the construction of the project. For this project, the items needed included furnished excavation, seeding, temporary ditch checks, stone and rip rap, and concrete structures. The grand total for the completion of this project was estimated to be $43,864.70 (Figure 25).

Pay Item ID	Item	Unit	Quantity	Unit Cost	Total Cost
20400800	FURNISHED EXCAVATION	CU YD	205	$ 62.40	$ 12,792.00
25000305	SEEDING CLASS 3A	ACRE		$ 5,657.31	$ -
28000305	TEMP. DITCH CHECKS	FOOT	95	$ 14.82	$ 1,407.90
28100107	STONE RIPRAP CLASS A4	SQ YD	360	$ 74.43	$ 26,794.80
50300225	CONC. STRUCTURES	CU YD	8.2	$ 350.00	$ 2,870.00
				TOTAL	$ 43,864.70

Figure 25: Breakdown of cost estimates

Prepared Construction Specs and Plan

Once the needed area of the basin was calculated, the team was then able to prepare site plans. Within AutoCAD the team edited existing terrain to show how the new dam would affect the surrounding elevation for the proposed wet bottom basin. Additionally, side and front views of the weir system were drawn using the same software to better illustrate the final look of the design once implemented. While no figures were delegated for this report, key drawings and site plans have been handed over to SMS Engineering for further review.

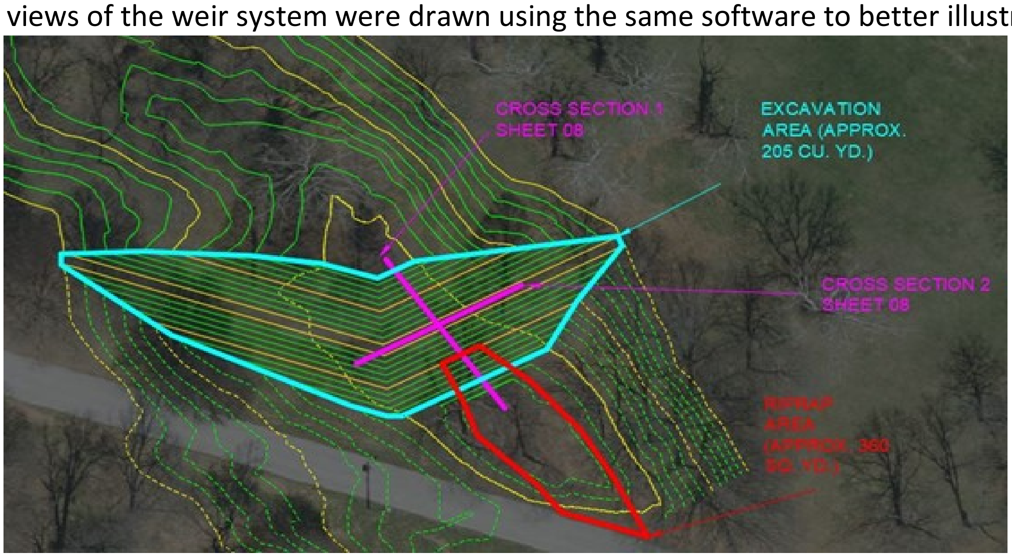


Figure 26: The final engineering decisions and site plan for the basin and dam design

Sustainability

The Envision program proved to be a challenging component of the senior design course. The program categories were: Quality of Life, Leadership, Resource Allocation, Natural World, and Climate & Risk. The team scored the highest in Leadership due to the simple nature of the project, while scoring above average on Quality of Life, Natural World, and Climate & Risk. The lowest score was held by Resource Allocation due to few resources needing allocation. The simplicity of the project also led to many unanswerable responses, which ultimately lowered the team's performance score. Figure 27 illustrates this sentiment.

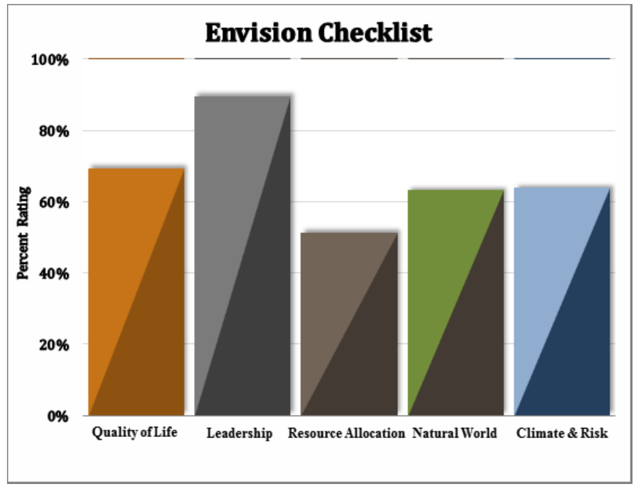


Figure 27: Envision checklist highlighting key engineering principles

Conclusion and Next Steps

The next steps in this project would be to locate the appropriate funding for these projects. Each one of these projects will add quality to living in Alton. It is possible that with safer and better designed ramps, sidewalks, and intersections, that there could be more people visiting the areas along State and Belle Streets. Better management of storm water will be beneficial for not only the people who live in these areas, but also for potential businesses that are looking to open in Alton.

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