The University of Iowa | Office of Outreach and Engagement

FINAL DELIVERABLE

Title	Sidney High School Trail
Completed By	Stefan Kaplarevic, Abbey Teubel, Alex Kraft
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UI Department	Civil and Environmental Engineering
Course Name	Senior Design - CEE:4850:0001
Instructor	Richard Fosse
Community Partners	Sidney Hometown Pride, City of Sidney

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Sidney High School Trail

Sidney, Iowa

Prepared For Terry Graham, Vice President of Sidney Pride
May 3rd, 2019

Submitted by: ASA Engineering

Stefan Kaplarevic, Project Manager
Abbey Teubel
Alex Kraft

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Section I: Executive Summary

ASA Engineering is a student-based engineering firm headquartered in Iowa City, Iowa providing civil and environmental services. ASA staff bring unique skills to each project with skills in fields of utility work, road design and project management in extremely time-sensitive environments.

ASA Engineering was provided the task of designing a cost effective, safe and inclusive trail for the town of Sidney by the Sidney Hometown Pride Group. Currently, there is no existing path or trail from town to high school; the only accessible mode of transportation to school is by vehicle. ASA Engineering looked at three designs for an optimal trail and decided, with the help of Sidney Pride, on the path that starts at Sidney High School, stay in the current Right of Way south of Knox/Foote Rd and crosses at Maple St. The trail will be 10 ft wide and 5ft after the crosswalk. ASA proposes to add a yield sign and implement a zebra stripe crossing to ensure the safety of the pedestrians while keeping traffic flow consistent when no pedestrians are present.

Showing the potential trail leading to the school

ASA Engineering is excited to design a path for students to have the option to walk or ride their bikes to school rather than drive. Active transportation can be cost effective and have positive health impacts on the community. Though the trail is connecting the town to the school, it is designed for all members to use. At 10 ft wide and no more than 5% grade, the trail makes an easy walking path for all ages. All

athletics, clubs and community members will can make this trail part of their daily routine for leisure, exercise, or family outings.

Aerial image of proposed trail

ASA Engineering suggests after building the sidewalk to add benches and lighting to help create a more recreational feel. Per request of the client, ASA designed the trail to blend in with the current landscaping but added floral arrangements near the school. ASA found native plants representing school colors. This leaves an open canvas for school classes to contribute projects, such as bird houses in art class or planting plant species in science classes.

Examples of "school spirit" plants to add around the walkway

The trail plan also carries additional support in updating the town's current sewer, stormwater and water systems to the school. The addition of a sewer line for the high

school to Maple St. will allow for removal of the septic system and leach field behind Sidney High School, allowing an open area for building expansions or recreational facilities. A 6-inch secondary water line from the high school to the connection on Maple St. will allow for a looped system creating more capacity and more reliability for fire safety measures. Finally, a curb and gutter stormwater system will be designed on the South Side of Knox/Foote. Rd. The addition of this drainage system is necessary for the construction of the trail but will have the added benefit of fixing erosion problem near the front of Sidney High School by eliminating the ditch system currently in use. These three new features will create an opportunity for further growth in the town, if wanted. All of the infrastructure will be in place so that houses could be placed along Knox/Foote Rd.

The total project cost is $986,700. This amount includes the trail design along with all utility improvements. The water main and sanitary sewer line could be removed to lower the cost of the project. The water line and sanitary sewer line cost $225,000 and $231,000 respectively. This could bring the project cost down to as little as $393,000. However, it is recommended to include the water and sanitary sewer lines in the initial project. It has the added benefits of future development and added fire protection. Also, it will be more cost effective in the long run to include all utilities in this project. If utilities had to be added later, the new trail would have to be removed and replaced to correctly implement the sanitary sewer line. All updates to this area of Sidney, Iowa will help promote a growing community.

ASA Engineering is very humbled by the opportunity to design and present the Safe Route to School/recreational trail for and to all community members of Sidney, Iowa.

Final Rendering of Sidney High School Trail

Section II: Organization Qualifications and Experience -

Name: ASA Engineering

Project Manager: Stefan Kaplarevic

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ASA Engineering is a student-based design team at the University of Iowa Civil and Environmental Engineering program participating in capstone senior design. The Team consists of:

Stefan Kaplarevic, our project manager, is a 4th-year senior receiving a degree in civil engineering and minor in business administration. Stefan's focuses are in Fluid Mechanics, Principles of Hydraulics and Hydrology and Water Resource Design and will be lead on all hydraulic design for the project. Outside of the classroom, he has interned with HBK Engineering focusing on utility design and surveying on a multitude of jobs ranging from Google Headquarters to I-90 interchange. After graduation he will be working full time with Mortenson as a field engineer.

Abbey Teubel is a senior receiving a degree in civil engineering and an art minor at Iowa. Abbey's focuses are in Transportation Design, ArcGIS, Science and Reinforced Concrete Design and will be lead on all ArcGIS and ADA compliance for the project. She is currently taking sustainable systems to learn more about ENVISION activities and how to help promote building with less waste. Outside of the classroom, she has interned with Linn County Secondary Roads learning out how to survey and all the steps that go into building roads. She has also worked for HDR on their I-80/I-380 interchange project. She will be working full time with HDR after graduation. Her mixture of art classes and engineering have given her a good foundation for seeing a project from all sides.

Alex Kraft is a senior focusing on the management side of civil engineering during his studies at the University of Iowa. Alex will also be lead on Civil 3D and ADA of the Project. This gives Alex a background in civil engineering, along with management styles gained through business courses. He is currently taking Design of Steel Structures to better understand the design software AUTODESK ROBOT. Outside of the classroom, Alex has interned with Walsh Construction working with Project Managers, Project Engineers, and Construction Superintendents. The project was a railroad bridge demolition and reconstruction. He also worked for Rush University Medical Center as a

Construction Management Intern. At Rush, Alex managed a multitude of projects that were ongoing in the hospital system. Alex is experienced in the planning and construction of civil engineering projects.

Section III: Design Services

1. *Project Scope*: The “Safe Route to School” project will connect Sidney High School by trail to Maple St. ASA Engineering presented three options for the client to choose. The route chosen travels south of Knox/Foote Rd. and crosses by crosswalk on the west side of Maple St. The project was designed and drafted using design standards to make the project eligible to be funded through DOT Grants. The trail will be 10 ft wide from the school until crossing Knox Rd. at Maple St. where the sidewalk will continue at 5 ft until completion. ASA created a Master Plan of underground utilities for Sidney High School. Currently, there are no sewer connections from city sewer to the high school. The school uses a leach field making any future expansion plans challenging. The Masterplan proposes to connect sewer line to the school creating a more reliable sewer system and eliminating the leach field located behind the high school. This also creates potential for future housing developments along Knox Rd. Additionally, a secondary water line will be proposed creating a looped system. This will ensure a more reliable water line and significantly improve fire protection. To plan for future development in the area, ASA decided to eliminate the ditch to the south of Knox Rd. and add an urban stormwater curb and gutter system. These will connect into the current culverts. Furthermore, ASA Engineering suggests incorporating aesthetically pleasing features such as lights, benches and natural plants into the trail design. ASA will incorporate green spaces between the road and the trail to ensure clear zone requirements are satisfied. Lastly, ASA engineering will investigate and propose an option on how to fix the erosion at the culvert just east Sidney School’s driveway. ASA infers that much of the erosion will be fixed once the new curb and gutter are implemented into Knox Rd.

2. *Work Plan*: Throughout the project, ASA engineering followed the Gantt Chart found below. ASA Engineering sent an updated chart periodically to the client to keep them in the loop of how the project is performing.

Section IV: Constraints, Challenges, and Impacts

1. *Constraints*: The Safe Route to School project will connect a sidewalk trail system from Sidney High School to Maple Street. The route will be a 10 ft wide trail from Sidney High School along Foote/Knox Rd. to Maple Street, and a 5 ft sidewalk on Maple Street that will connect to the currently existing sidewalk. The trail will meet Iowa Department of Transportation Standards and will be ADA compliant to qualify for Iowa DOT grants. SUDAS codes will be followed in the design process. Finally, construction will be phased to minimally impact the school day at Sidney High School. The construction will be scheduled during the summer when Knox/Foote Rd needs to be closed. If the road can stay open one lane, construction will be able to pursue.

2. *Challenges:* One of the main challenges with creating the trail was the steep elevation change on the south side of Knox Rd. The steep grades made ADA and SUDAS compliance difficult to follow without drastically raising the cost of the project. ASA Engineering suggests moving fill dirt from the farmland directly south to the uneven ground for a cheaper, locally sourced fill turn to create a smoother grade. ASA advises removing the topsoil of the highly elevated farmland, taking fill dirt and then replacing the topsoil back to the farmland and grading the new land at a 2% grade to help with water runoff for the farmer. This will leave the farmland with nutrient soils and an easier terrain to plow/plant.

These changes will also maximize opportunity to develop out the land near Knox/Foote Road if the farmer ever decides to sell.

Another issue brought up by our client was the erosion near the culvert to the northeast of Sidney High Schools exiting drive. Our client stated they have tried several different options to fix the erosion issues in the area but none have worked. ASA will propose filling and seeding the eroded area and adding a curb and gutter system. This will remove a significant amount of runoff and eliminate the need for a ditch. Curb and gutters were designed for water from the elevated sidewalk to drain into them. The culvert will attach into a storm water system. ASA will propose a Master plan to add sewer and water connections to Sidney High School within the schools right of way (ROW). The sewer, trail, and water main will all stay within the current ROW.

The property owner at the corner of Maple St. has quite a few trees in the area of the proposed sidewalk. The owner asked for ASA to design the trail while taking out a minimal number of trees. ASA worked hard to keep as many trees as possible, but in order to create to ADA compliance, many will have to be taken out. ASA estimates that around 15 trees and bushes will be cleared from the owner's land.

ASA Engineering will work to create a recreational trail for broad community use and appeal with characteristics such as aesthetically pleasing features to fit the town of Sidney.

3. *Societal Impacts:* The societal impacts from the project will be mostly positive. The following community elements were evaluated for impacts and factored into the design of the train:

    Population Characteristics: Sidney has a population of 1,001 people with 40 years being the median age. The population has been steadily decreasing since 2000 (-20.62%). Our path design can help both the students get to class and senior citizens have a recreation area to walk. Since 25% of the population is below 18, we can infer that many of them are still in school. Around 20% of the population is over 65. Our client stated that recently the community center was shut down; the trail can lead to more activities. The other 55% of the population can use the trail for recreational purposes, as a bike path, to walk to school events for their children, or to get out and walk around the town.

    Community and institutional structures: Adding the urban curb and gutter and sewer/water pipelines will create an opportunity for growth in the area along the trail. Population in many small, rural towns are declining in population due to a lack of new housing. Adding a new development along the trail can help with increasing the population in the town.

    Individual/Family changes: 50.1% of the community are married, 37.24% are married with kids, which is higher than the national average. Sidney is a family community so adding a trail to education facilities can help families get their students to school. For younger students who still have a parent drive them to school, the trail can help free up time for them to leave earlier for work.

    Personal/Property Rights: Though our project will stay within the current right of way, there will be temporary construction easements. ASA Engineering plans on creating a borrow area from the farmland to the south of Knox Rd. for fill. Cut and fill tables for this borrow area can be found in Appendix C. Finally, topsoil will be stripped, stockpiled, and redistributed to the farmland to ensure the land will remain productive.

    Community Resources: Currently, Sidney Iowa does not have any trails. The implementation of the trail will create an opportunity for the community of Sidney to get out and get active with their family and friends. The trail will host benches and lights so all community member can enjoy walking and relaxing if they need a break. The lights on the trail will help keep the environment safe for all ages.

    Sustainable Practices: Adding a trail from Sidney High School to Maple St. can help promote a sustainable lifestyle in the Sidney Community. Having a trail wide enough for bike usage can help the community travel more efficiently while lowering emissions in the air. The size of Sidney is approximately 1.378 square miles, so travel would not belong. Students choosing to bike or walk the short distance could save on gas, car maintenance and could help promote a healthier

lifestyle in the community. Lastly, the trail will incorporate native plants near the front of the school to help maintain the native environment.

Section V: Alternative Solutions That Were Considered

Three options were considered in the Safe Trail to Sidney High School design. ASA Engineering created concepts for a “Cross at McClure Ave. Design”, a “Cross with a Tunnel Design” and a “Cross at Maple Design”. The “Cross at Maple Design” was chosen by the client to be designed by ASA Engineering. All options are discussed below.

Option one represented the “cross at McClure Ave.” design. An image rendered in ArcGIS of the trail can be found in figure 2.1 below. The trail would have started at the entrance of Sidney High school, travelled east down Knox Rd, crossed north at McClure Ave, and then continued until it reached Maple St. This option highlighted the McClure Ave crossing as a vantage point; cars on both sides of the road would be able to see pedestrians crossing easily. Cons of this design included utilities on the Northside of Knox being in the way of construction and our client shared they would have to purchase a new fence for the owner of the land to the north of Knox.

Figure 5.1 represents the design route crossing at McClure Dr.

Option two represented the “cross with a tunnel” design. An image rendered in ArcGIS can be found in figure 2.2. This option featured the same start at Sidney High School as the first but before McClure Dr., the path would have tunneled under the road. This design would have given the students at Sidney High School potential to make the tunnel their own by creating murals on the walls. The dotted blue line featured

potential for a future fitness loop that connected the high school to the rodeo grounds to downtown helps bring the town of Sidney closer together. This option would erase all concerns with traffic safety issues because the citizens wouldn't be on the road. Cons included everything listed in option one plus the cost of boring the hole, potential for becoming a multi-phase project, and this option needed guardrail over the tunnel area adding an extra cost.

Figure 5.2 represents the design crossing with a tunnel

Our client chose the “cross at Maple St. design” route as the design they wanted to move forward with. A rendering of the design can be found in figure 2.3 below. Ultimately, the final design was chosen after ASA suggested it would be the most cost effective and have the least impact on existing utilities. ASA will add a yield sign at the intersection of Knox Rd. and Maple St leading to safety even though it is not at a vantage point. This will also lead to less queuing during peak hours of traffic flow. The design was a new, fresh take on what the client had previously suggested to ASA. Another major pro for the design selected is the fill from the farmland to the south will not have to be hauled across the road, like the first two designs. A con for this option is the property owner where the trail is being paved would be in charge of maintenance, such as shoveling and deicing. We would recommend for the property owner to form a contract with Sidney High School maintenance for snow removal and deicing in the winter.

Figure 5.3: shows the Maple St. route

Section VI: Final Design Details

Trail

Trail design followed the Iowa DOT Design Manual 12A-2 Standards for Accessibility and Shared Use Path Design 12B-2. Type 2 trail determination was based on the following criteria of a path serving as a transportation route to facilities that fulfill a basic life need, provide access to a program or service, or provide a safe route for non-drivers. ASA design incorporates a 10ft portland cement shared path trail from the Sidney High School to the intersection of Knox/Foote St. Standard sidewalk design was implemented in the design using a target value of 1.5% cross slope and a longitudinal slope within 2% of the current's streets profile (Knox/Foote St.). Curb Ramps at Maple St. and Foote St. intersection are designed within ADA compliance, with cross slopes within the 6.25% and 8.3% longitudinal slope and incorporating detectable warnings to help indicate crossings to person with low vision and location of the back of curb. Turning spaces are exhibited on the top of each curb ramp allowing users to stop, rest, and change direction on the top or bottom of a curb ramp (R304.2.1). Zebra stripe 2ft. detectable warnings are 2 ft across and recommend across entirety of paved surface (R304.1.4). Remaining trail will consist of a 5ft portland cement sidewalk running north on Maple St. The sidewalk will implement previously discussed standard sidewalk design of a 1.5% target value cross slope and longitudinal slope within 2% of current streets profile (Maple St.).

Curb and Gutter

Curb and Gutter design followed Sudas Design Manual 5C-2 Geometric Design Elements. Curb and gutter installation were implemented on the south portion of Knox/Foote St. to the west of Maple St. and Foote St. intersection. The design comprised of a standard 6" Curb and standard 2' curb and gutter section. Existing pavement on Knox/Foote St. was jointed to the designed 2' curb and gutter section using "BT-5" abutting pavement joint. Sections of the proposed curb and gutter design incorporated Intake design and spacing for stormwater management which followed Section 2C-3 of the Sudas Design Manual. ASA design proposes using an open throat 8'x6" curb, SW-508 large box intake and 15" RCP pipe. Placement of open throats and intakes were analyzed based on the existing roads profile and was placed at lowest elevation of the Knox/Foote St. and distances no greater than 400 ft between intakes.

Figure 5.4: shows an aerial shot of the proposed sidewalk

Roadway Modification/Grading

The Grading of the design follows the Iowa SUDAS Design Manual 12A-2E (2) Standards for Accessibility and SUDAS Design Manual Section 2A-1. The elevations of the land area south of Knox Road was filled to match the elevations of Know Road. After a volumetric analysis, in Civil 3D, the Cut/Fill statistics equalled a net of 5368.02 cubic yards of fill. Per 2A-1 (C12), Land grading of the project site should be performed to take advantage of existing contours and minimize soil disturbance. The cross slope the sidewalk is 1.5%. The clear zone between the sidewalk and Knox Road will match the cross slope of the sidewalk at 1.5%. This will ensure adequate drainage to the storm

sewer. The inner and outer boulevard will also be seeded using native grass to match the surroundings. The total area of land that needs seeding is 0.96 acres. The area around the culvert near the east driveway of the school is experiencing erosion. A riprap erosion stone will be used to fix the damaged area. The volume of the eroded area is 267.75 cubic feet. According to Iowa DOT design manual section 1-04, the density of erosion stone is 120 pounds per cubic foot. Converted to tons, the amount of Class 3 Riprap needed for the erosion control will be 16.07 tons.

Crosswalk

The Crosswalk connecting the south and north side of Knox Road follows the Iowa DOT Design Manual sections 3B-1, 3B-2, and 9B-2. Crosswalk lines are solid white lines, not less than 6 inches and not greater than 24 inches in width marking both edges of the crosswalk. The Crosswalk follows the standard road plan PM-110 found within Iowa DOT 3B-2. The crossing is 10 ft wide with 24 inches thick white bars that are spaced 24 inches edge to edge. The Iowa Traffic and safety manual cites the U.S DOT Manual on Uniform Traffic Control Devices for the specifications of Yield Signs. Determination of yield signs was based on keeping same traffic pattern for the intersection and keeping pedestrians safe during times of trail usage. The standard S1-1 yield sign is designed to be 2 foot by 2 foot south and west of the cross walk.

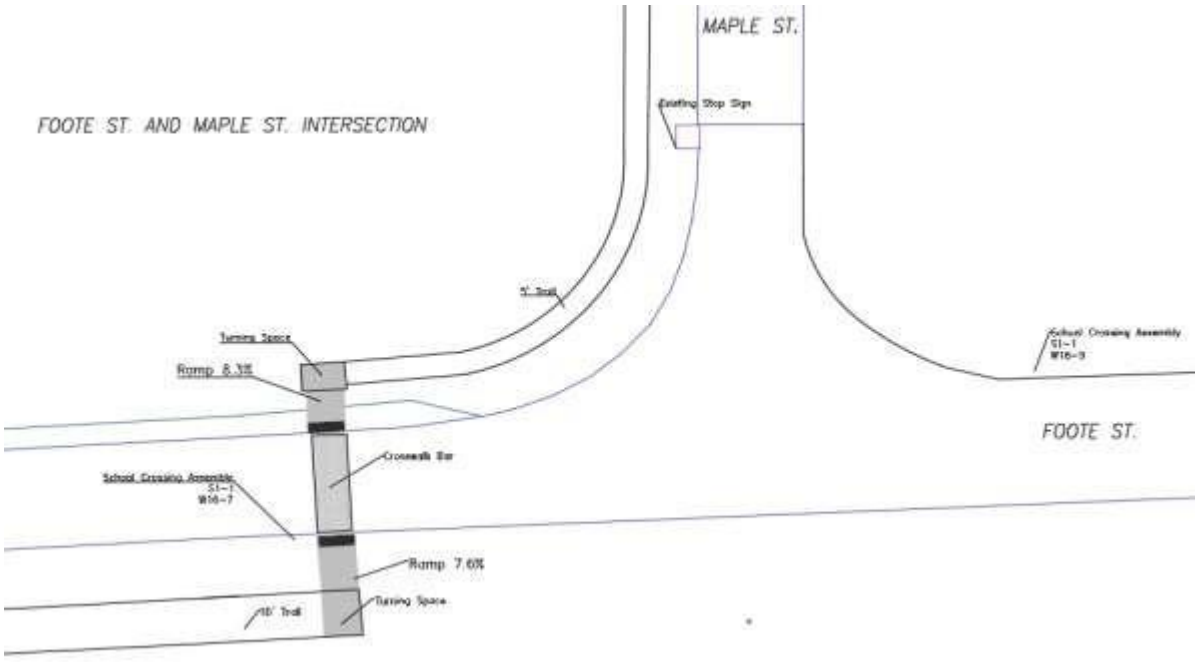

Figure 5.4: Location of Crosswalk

Figure 5.5: Final crosswalk

Sanitary Sewer

Design for Sanitary sewer on the Safe Route to School Project had been designed for future opportunity of development in the area of Knox/Foote Road and Sidney High School. The main objective for city sanitary installation is to remove the current sanitary leach field located directly behind the school. Removal of the leach field allows the school to build on top of the land where the underground structure had existed. The next objective for the sanitary sewer installation is for the opportunity for future development on Knox/Foote Rd. with installation of sanitary and water a new neighborhood would have the necessities for hooking up to city utilities allowing for future development.

Sanitary sewer design follows SUDAS Design Manual 3B-1 Flow Determination and 3C-1 Facility Design. Flow discharge for the average daily flow was calculated using Equation 3B-1.01 found in appendix A to determine daily usage rates for the school and proposed single-family residential community. Diameter calculations are found in appendix A and based on Manning's equation which determined pipe sizes of 10" PVC gravity main and 10" DIP force main are appropriate for the school and future development. The sanitary sewer system is to lay between the back of curb and ROW. 3C-1(G) Crossing and Clearance states horizontal clearances of 5 ft or greater from storm sewer and 10ft horizontal clearance from water main. 3C-1(H) Depth of Sewer should have a minimum depth to the top of pipe of 8 feet unless the sewer can serve

existing basements at a lesser depth. Design shows a depth of 12 ft. to the top of the pipe. 3C-1(L) Circular Sanitary Sewer Manhole design size 48 inches in diameter for the project with connections at end of sewer lines, at all changes in pipe size or grade, at all sewer pipe intersections and at intervals not exceeding 400 ft. for sewers 24 in. or less. Lift station package from Romtec Utilities delivers a sanitary sewer lift station with low flow lift between (5-50 gpm), a duplex pump configuration of 1 hp Goulds Pumps, a 4' diameter wet well, and two 2" discharge pipes. Opportunities for equals will be assessed in final design and cost estimation. Sanitary sewer will connect with the school and current system on north side of Foote St. and West St. at a later date.

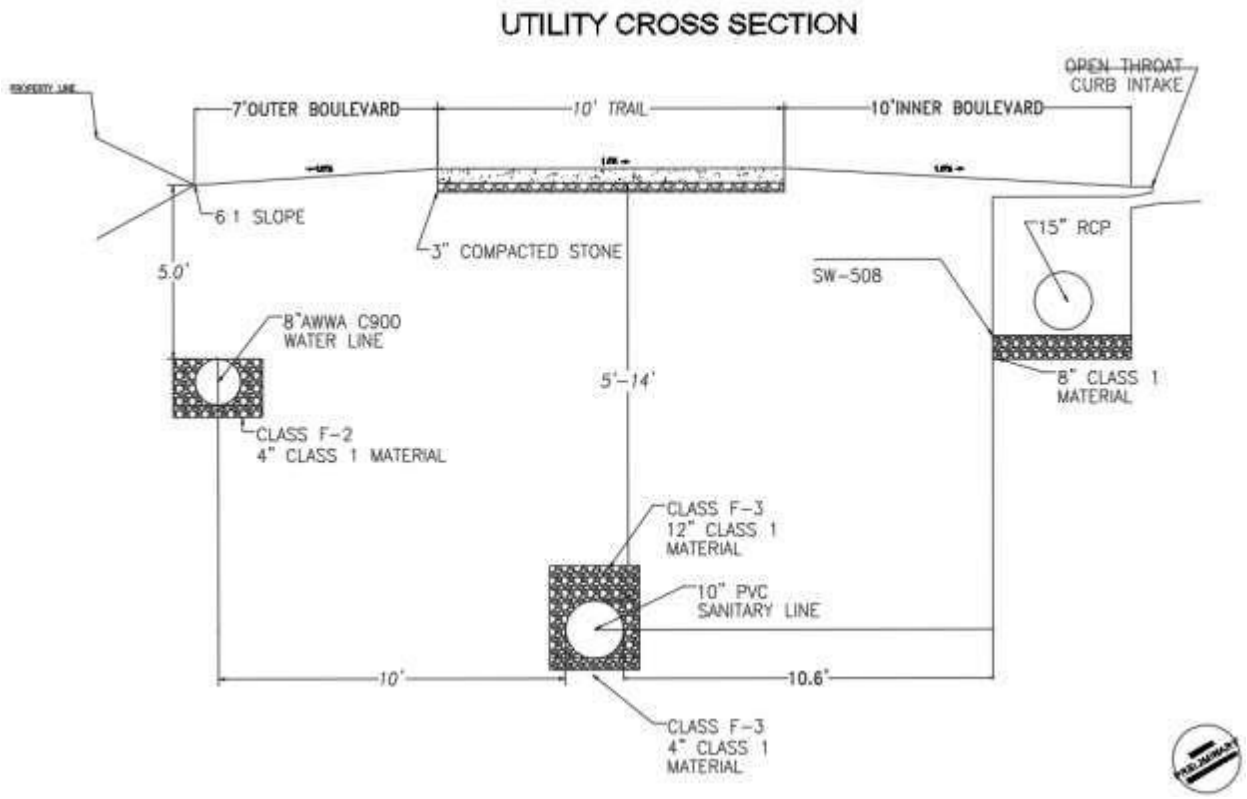

Figure 5.6: Final cross section of water line, sanitary line and curb and gutter

Water Main

A water main was designed for this project to create a closed loop system connecting Sidney High School to downtown. This was done to improve fire protection abilities and create assurance that water will reach the school in the event of a pipe burst/blockage. The water main design follows SUDAS Design Manual 4B-1 Size Determination, SUDAS Design Manual 4C-1 Facility Design, and Appendix B of the International Fire Code from the International Code Council. The town of Sidney, IA

uses an 8 inch PVC AWWA C900 pipe for their existing water mains. The design reflects that. Per 4C-1, fire hydrants connected to the water main should not exceed 400 ft of spacing. Hydrants should also be placed at high and low points. 6 hydrants along Knox Road was implemented to the design. Also per 4C-1, hydrants should not be located within 10 feet of a sanitary sewer line. 6 8 inch Butterfly valves will be added to the water main in the event of necessary shutoffs. The valves will be located at the east and west end of the project scope, where the new mains connect to the existing mains.

Landscaping

Landscaping for the majority of the sidewalk will fit the rural, farm feel of the surrounding area. The client stated they wanted the sidewalk to blend in with the town and did not want to add too much flare. The winding portion of the sidewalk leading up to the school will have a little more curb appeal. ASA Engineering suggests adding the following plants for the area to help enhance the school colors: yellow stargrass, wild flax, black eyed susan and tall dropseed. A complete list of native plants can be found on Plant Iowa Native. To enhance learning near the school, ASA also suggests putting up plaques stating the native plants and information about them. The final suggestion ASA has is adding benches and lighting along the entire trail to help promote a safe and inclusive walkway for the entire community of Sidney, Iowa.

Figure 6.1: Examples of Sidney Landscaping

Construction

ASA Engineering recommends two separate phases for the construction project. Phase one would consist of placing utilities. This would include storm sewer, water main and sanitary sewers. Since no work will be done on the road, this phase can be done

during normal working hours. Placing utilities in a first stage can help with any settling issues in the future

Second phase would consist of creating the sidewalk, curb and gutter and culvert extension. This phase would not be able to disrupt the traffic to the school and we recommend it is done before and after school hours or during the summer. We recommend bidding this phase by March so the contractor can begin grading during the end of the school year and have the summer to work on the road.

Design Drawings

*Refer to drawing sets for design details***********

Section VII: Engineer's Cost Estimate

Below is the cost estimate for the Safe Route to School project. The cost is split up into water, sanitary, storm, concrete and crosswalk.

ITEM	UNITS USED	QUANTITY	$ PER UNIT	TOTAL $
STORM				
Open Throat, Small Box Intake SW-507	EA	6.00	$ 4,637.59	$ 27,825.54
Storm Gravity Main 15"	LF	1225.00	$ 54.27	$ 66,480.75
Culvert CMP 24"	LF	1.00	$ 45.51	$ 45.51
CONCRETE				
Portland cement concrete - Curb/Gutter	CYS	87.86	$ 81.64	$ 7,172.89
Portland cement concrete - Trail	SY	938.40	$ 37.43	$ 35,124.31
EARTHWORK				
Topsoil, spread	CYS	5368.02	$ 25.00	$ 134,200.50
Fine Grading and Seeding	ACRE	0.96	$ 1,181.62	$ 1,134.36
Erosion Control	TON	16.07	$ 38.24	$ 614.33
CROSS WALK				
Stop Line Paint	STA	0.22	$ 10.60	$ 2.33
Cross Walk Paint	STA	1.20	$ 10.60	$ 12.72
Yield Sign Post	EA	2.00	$ 98.12	$ 196.24
Yield Sign	EA	2.00	$ 18.23	$ 36.46
				$ 272,845.94

ITEM	UNITS USED	QUANTITY	$ PER UNIT	TOTAL $
WATER				
Standard Hydrant	EA	6.00	$ 5,293.59	$ 31,761.54
Tee 8" AWWA C900	EA	6.00	$ 350.00	$ 2,100.00
Bend 90 8" AWWA C900	EA	1.00	$ 350.00	$ 350.00
Bend 45 8" AWWA C900	EA	1.00	$ 350.00	$ 350.00
Pipe DR 18 8" AWWA C900	LF	2636.00	$ 52.13	$ 137,414.68
Butterfly Valve	EA	6.00	$ 8,841.67	$ 53,050.02
				$ 225,026.24

ITEM	UNITS USED	QUANTITY	$ PER UNIT	TOTAL $
SANITARY				
Circular SSM 48" SW-301	EA	8.00	$ 6,435.65	$ 51,485.20
SAN Gravity Main 10" PVC	LF	1222.00	$ 53.04	$ 64,814.88
SAN Force Main 2" DIP	LF	364.00	$ 40.00	$ 14,560.00
Romtec 4' Wet Well Lift Station	EA	1.00	$ 100,000.00	$ 100,000.00
				$ 230,860.08

Figure 7.1: Individual Construction Cost

$ 273,000.00	Total Construction Cost
$ 30,000.00	Easements
$ 30,300.00	10% Contingencies
$ 60,600.00	20% Engineering Overhead and Administration
$ 393,900.00	Total Project Cost

Figure 7.2: Least Cost Option

$	729,000.00	Total Construction Cost
$	30,000.00	Easements
$	75,900.00	10% Contingencies
$	151,800.00	20% Engineering Overhead and Administration
$	986,700.00	Total Project Cost

Figure 7.3: Project Cost Including Water and Sewer Utilities

Appendix A: Design Renderings and Models

Figure A.1: The Final Rendering of the Trail Leaving the School

Figure A.2: The Final Rendering of future development

Figure A.3: Aerial image of the sidewalk leading to the entrance of the school.

Appendices B: Sanitary Calculations

A.) Sanitary Sewer Pipe Calculations

Average Daily Flow (Q)

Area x Area Density x Flow Rate = Average Daily Flow (Eq.1)

Low Density (Single Family) Residential

Area = 8.7 Acre Area Density = 10 People/Acre Flow Rate = 100 gcpd

8.7 Acre * 10 People/Acre * 100 gcpd = **8,700 gpd**

Office and Institutional (School)

Area = 4.1 Acre Area Density = 5,000 gpd/Acre

4.1 Acre * 5,000 gpd/Acre = **20,500 gpd**

School (Q)

20,500 gpd converted to **0.032 ft^3/sec**

Residential and School Combined (Q)

29,200 gpd converted to **0.045 ft^3/sec**

B.) Pipe Size Determination

Mannings Equation

D= ((4^5/3 * n * Q)/(1.49 * π * S))^3/8

School Pipe
n=0.013 Q=0.032 ft^3/sec S= 0.40 ft/100ft
D= ((4^5/3 * 0.013 * 0.032)/(1.49 * π * 0.0040))^3/8 = 0.65 ft * 12in/ft = 7.8 in

Size up pipe to **10 inch**

School/Residential Pipe
n=0.013 Q=0.045 ft^3/sec S= 0.28 ft/100ft
D= ((4^5/3 * 0.013 * 0.045)/(1.49 * π * 0.0028))^3/8 = 0.74 ft * 12in/ft = 8.89 in

Size up pipe to **10 inch**

Appendix C: Cut and Fill Report

Cut/Fill Report

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Drawing: \\iowa.uiowa.edu\shared\engineering\home\alkraft\windowsdata\Desktop\\\iowa.uiowa.edu\shared\engineering\home\alkraft\windowsdata\Desktop\Senior Design 1 try 2 (1).dwg

Volume Summary

Name	Type	Cut Factor	Fill Factor	2d Area (Sq. Ft.)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
CF_SCHOOL	full	1.000	1.000	14616.18	10.05	1487.95	1477.90<Fill>
CF_ROAD	full	1.000	1.000	115516.30	1137.06	4998.21	3861.15<Fill>
CF_CURVE	full	1.000	1.000	6578.53	0.85	314.63	313.79<Fill>
CF_MAPLE	full	1.000	1.000	18112.37	345.26	60.43	284.82<Cut>

Totals

	2d Area (Sq. Ft.)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
Total	154823.38	1493.21	6861.23	5368.02<Fill>

* Value adjusted by cut or fill factor other than 1.0

Citation

Office of Design. (n.d.). Retrieved April 12, 2019, from https://iowadot.gov/design/design-manual

Design Manual. (n.d.). Retrieved April 12, 2019, from https://iowasudas.org/manuals/design-manual/

Iowa Traffic Manual. Retrieved April 2019, from www.iowadot.gov/traffic/manuals/pdf/02b-02.pdf.