Floyd River Trail Extension

Hawkeye Engineering Services Inc.

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The University of Iowa
College of Engineering

THE UNIVERSITY OF IOWA
IOWA INITIATIVE
FOR SUSTAINABLE COMMUNITIES

1. Executive Summary

Hawkeye Engineering Services Incorporated (HES Inc.) is a newly formed engineering firm located in Iowa City, Iowa. Five design engineers at HES Inc. have developed a Floyd River Trail extension plan for Sioux City, Iowa. Members of the design team at HES Inc. include Matt Schindel, Ben Ryan, Mike James, Cole Fisher, and Nate Stevenson. All members of the design team currently attend the University of Iowa and have developed design skills through rigorous work in the classroom as well as with multiple engineering firms. The design team at HES Inc. specializes in Civil, Environmental, Sustainability, and Municipal practices.

HES Inc. developed many possible trail routes before selecting the final design location. Our firm believes that the designed route is the best one for Sioux City's needs. The 5,500 foot asphalt trail design required extensive use of the Statewide Urban Design and Specifications (SUDAS) manual, along with the Iowa Department of Transportation and the Americans with Disabilities Act (ADA) specifications. HES Inc. is confident that all aspects of the trail meet the required specifications and will perform as presented. Union Pacific standards were also referenced as to assure all requirements of designing the trail near a railroad were met. The Manual on Uniform Traffic Control Devices (MUTCD) was also referenced in order to design and place all trail signage to specifications.

It was the understanding of HES Inc. that the long term goal for the Floyd River trail is to connect with the Floyd Boulevard and Outer Drive intersection, as well as extend to Le Mars, Iowa. The trail layout in the final design developed by HES Inc. provides optimal trail ending locations that allow safer and easier access to the trail via Floyd Boulevard. Furthermore, the trail ending locations are also designed to accommodate any future extensions that Sioux City may wish to make.

This trail extension design put forth by HES Inc. will provide more recreational space for the residents of Sioux City and the surrounding area. In addition, the design will also provide trail-users a safe and accessible route that will interconnect the existing 12.25 miles of asphalt/concrete trails located within Sioux City to the Floyd River Trail extension. HES Inc. designed the trail with consideration of the environment and the goal to maintain and upgrade the natural beauty of the project corridor. HES Inc. believes this is a trail that will be enjoyed by cyclists and families alike for years to come. The design team at HES Inc. estimates that Sioux City could construct this trail extension at a cost of approximately **$390,000**. The final cost estimate provided includes the cost of materials and labor based off of a location factor for Sioux City provided from RS Means Cost Analysis manuals.

2. Introduction

HES Inc. is an engineering firm qualified to complete various Structural, Sustainability, Transportation, and Municipal engineering services. Each employee of HES Inc. has completed two engineering design courses specific to our areas of engineering practice. Many of the employees at HES Inc. have internship, co-op, or full time experience with other engineering consulting firms. Experience obtained with other firms includes but is not limited to Computer Aided Design, Project Inspection, Concrete Testing, Soil Testing, and Surveying.

HES Inc. has been assigned the task of developing an extension of the Floyd River Trail in the City of Sioux City to connect to existing inner-city trail routes. Problems arose in 2009 when Union Pacific re-routed their local tracks. The tracks blocked off the existing trail from connecting with other city trails located near the surrounding neighborhoods. Many residents of the city have taken to crossing the railroad tracks by foot near the intersection of Jefferson Street and Floyd Boulevard. HES Inc. has designed a Floyd River Trail extension that will eliminate dangerous railroad crossings as well as maintain the goal of adding additional trail length to the existing trail system. We believe that we have designed a trail that the residents of Sioux City will thoroughly enjoy for years to come.

3. Problem Statement

Currently, the users of the Floyd River Trail do not have a proper access point to the trail located near the intersection of Jefferson Street and Floyd Boulevard. Trail users currently park near the railroad tracks and cross the tracks by foot in order to access the existing trail. Since the existing trail ends near the tracks pedestrians using the trail must also cross over the railroad tracks to access Floyd Boulevard and the inner-city trail network. This has raised concerns by trail users, residents and the City of Sioux City regarding the safety of individuals using the existing Floyd River Trail. HES Inc. has been hired to not only extend the existing trail but also eliminate any risks that may associated with accessing the trail.

3.1 Design Objectives

HES Inc. was provided the opportunity to extend the Floyd River Trail from its current ending point near the intersection of Floyd Boulevard and Jefferson Street. HES Inc. understood that the goal of the trail extension project was to connect it to the intersection of Floyd Boulevard and Outer Drive, with an ultimate goal of extending the trail to Le Mars, Iowa in the future. The main problem with connecting the trail to Outer Drive lies in a stretch of railroad owned by Union Pacific running between the existing trail and Floyd Boulevard. It was discovered that Union Pacific's policy on at-grade rail crossings is "the safest crossing is no crossing" and it would be unlikely to obtain a permit to cross at the desired location, the intersection of Floyd Boulevard and Jefferson Street. On top of that, the resident trail users of Sioux City have grown accustomed to crossing the railroad tracks by foot to access the existing section of the Floyd River Trail. This is dangerous and unnecessary, especially without any sort of warning system or proper footing. The trail is to be designed to provide residents of Sioux City more trail length for commuting and recreational use. Another goal of the design was to also incorporate

environmentally sound practices and retain the natural beauty of the surrounding area. HES Inc. also wanted to provide a trail ending point where future trail extensions north towards Le Mars, Iowa would be most feasible.

3.2 Approaches

Sioux City, Iowa follows the Statewide Urban Design and Specifications (SUDAS) design codes, which meant that we had to refer to them while designing the Floyd River Trail extension. In addition, the Iowa Department of Transportation (DOT) and the American Association of State Highway and Transportation Officials (AASHTO) standards were also referred to specifically when dealing with highways, roads, and railroad track crossings. Union Pacific standards were referred to for rail crossings to ensure that all regulations were followed sufficiently. Any plans and design specifications that related to the current trail layout were also taken into consideration while designing the trail extension.

Several permits are required in order to complete this project. The first of which is a permit from Union Pacific for an at-grade crossing at 41st street. A copy of the permit can be found in Appendix A with a list of requirements taken from Union Pacific's website following it. The second permit that will be required is a Temporary Closure of Public Right of Way (ROW) Permit from the City of Sioux City. This will be required during Phase 2 of construction and a copy of the permit can be found in Appendix A.

Before developing a final design, we were required to produce three preliminary design alternatives. These were based off of limited information and resources. The three design alternatives were later presented to Sioux City engineers for further review. Following the review from Sioux City engineers, the preliminary designs were then discussed with our organization. The Sioux City engineers had given our organization input on what they had envisioned for the Floyd River Trail extension. After collaborating with the engineers in Sioux City, it was decided that our third preliminary design, with a few modification, would be most beneficial to the city. Section 3 describes each preliminary design alternative in full detail along with the illustration for each preliminary design layout.

3.3 Constraints

In this section, all of the constraints involved in the extension and improvement of the Floyd River Trail will be listed out and detailed. The first hard constraint of the project was the contract term that started on 2/06/2015 and ended on 5/08/2015. The final design for the trail extension had to be completed before the end date of the contract. In order to ensure that the deadline was met, weekly meetings were held so that any and all progress was to be reported and future tasks were able to be defined. Specific milestones and deadlines were also laid out in a timeline format in order to keep the project on track. In addition to the contract term, the budget was also a hard constraint for the project. A maximum budget of $1.5 million had been set for the trail extension, and therefore, cost estimations for all materials and services related to the project were needed. Costs may include but are not limited to: billable work hours, site visits and travel, land acquisition,

contractors, construction materials and work hours, and overhead. The project will be designed to remain within the scope of the budget. Furthermore, Iowa/ Sioux City design standards for recreational trails (SUDAS) had to be followed, which was also a hard constraint. Any and all design decisions were to be made in accordance with said standards to ensure the safety and legality of the trail extension. Another constraint for the trail extension is the overall land space in which HES Inc. was given to work with. The final design plans agreed upon by HES Inc. and the City of Sioux City were to connect to the existing trail and extend north following the Union Pacific railroad to 41st street. When the trail intersects 41st street, it will run east adjacent to 41st street to Floyd Boulevard where a trail adjacent to Floyd Boulevard will be constructed heading south. This allows the designed trail to connect to the existing inner-city trail system.
Within the boundaries for the project are two stretches of railroad tracks which are owned by Union Pacific. HES Inc. determined the final design would follow north, adjacent to Union Pacific Railroad right of way (ROW). However, constructing a recreational trail that would impede or come near the railroad ROW meant that HES Inc. must comply with the rules and regulations put in place by Union Pacific. This provided problems for HES Inc., because after referring to the UP handbook we were restricted on where we could place a railroad crossing in order to extend the existing trail. Fortunately, the handbook allowed for an at-grade crossing adjacent to 41st street in order to connect the Floyd River Trail to Floyd Boulevard.

A soft constraint that goes along with the proposed project boundaries is land acquisition. Any properties that fall within the design area and are not owned by the City of Sioux City will need to be purchased or acquired through a permanent easement. During the time of the design, HES Inc. also had to coordinate with other engineering firms and planning groups. The meetings served as soft constraints for HES Inc., because the flood mitigation planning in the area only had a minor effect on our overall design. However, since the design trail would follow Floyd Boulevard south, the design had to be coordinated closely with the future planning of reviving Floyd Boulevard. This was another soft constraint HES Inc. had to face since the final design included a section of trail along Floyd Boulevard. Therefore, HES Inc. had to meet with the Urban and Regional Planning group of Sioux City to determine what type of trail complied with the vision Sioux City had for Floyd Boulevard.

3.4 Challenges

Initially, HES Inc. understood that extending and improving the Floyd River Trail would come with a few challenges, the first of which was the residential area that the project site neighbors. The trail was not to intervene with any private property, nor adversely impact the quality of life for any residents in the area. HES Inc. realized another challenge would be to ensure that it did not negatively affect the environment or the natural beauty of the Floyd River area. As mentioned in the constraints section, we understood that the trail extensions could possibly cross two separate railroad tracks which meant that crossings would have to be designed in accordance with SUDAS and the Iowa DOT design standards and codes. HES Inc. believed that the crossings might involve redesigning sections of railroad track or creating new clearance structures, which could prove to be

challenging and expensive. Finally, HES Inc. decided that the trail extension should be aesthetically appealing and match the older asphalt section of the trail so as to remain consistent. HES Inc. also understood that Sioux City would prefer an asphalt trail as well.

HES Inc. came upon many more challenges throughout the preliminary design and research phase that would need to be considered before a final design was complete. One of the main issues that required attention was how to cross the Union Pacific rail line near the trail. Our goal was to connect the existing trail to the Floyd Boulevard and Outer Drive intersection. HES Inc. initially decided to cross the Union Pacific line near the intersection, but after research, we realized that Union Pacific does not allow at-grade crossings for trails. In section 7.1 of the Union Pacific online specifications, it is stated that "The railroad does not allow at-grade rail crossings." This section of Union Pacific specification can be referred to in **Specification D.1**, located in **Appendix D**. The only exception to this rule was at-grade crossings on or adjacent to existing roadways, which must be approved by the railroad before construction. This meant that if we wanted to cross the rail line at our original location, we would have to implement either a bridge or tunnel structure. This would be a very costly decision, and we decided to reroute the trail design to cross both railroads at locations adjacent to 41st Street.

Another challenge HES Inc. faced was that a flood mitigation project was in progress near our location, and that we would need to communicate with that group in order to avoid any possible conflicts between our designs. Early on in the design phase, we met with the corresponding group a few times to make sure that each design could function together and not interfere with any plans. HES Inc. had to adjust our planned trail route and elevations minimally in order to accommodate with the other group's plans. We continued to meet with the group throughout the design phase in order to prevent any project issues in the future.

Physical obstructions also became a challenge for us as we laid out the path of the trail extension. When dealing with the trail section adjacent to 41st Street, we found it easier to cross the road and run the trail along its north side. This was because of utilities, more specifically power poles that were located on the south side of the road. In order to avoid this conflict, we decided to design the trail north of the road. At-grade railroad crossings adjacent to 41st Street were also a physical obstacle we were pressed to find a solution for. Railroad signage and utilities presented an issue for the trail layout and would require some minor relocation. HES Inc. found this to be a necessary evil as it was unavoidable no matter what side of the road we placed the trail.

3.5 Societal Impacts

The Floyd River Trail extension will provide the residents of Sioux City and visitors to the area the opportunity to enjoy the outdoors while promoting physical and mental health. The multi-use trail has several recreational benefits for all individuals regardless of age, race, income, or societal standing. The trail extension encourages individuals to take in the natural beauty of the Floyd River during all seasons. The trail extension will provide several options for users, whether it is for leisure or fitness purposes. Some of the

recreational activities the trail will provide to users are biking, walking, running, and rollerblading. Recreational use of the trail will increase individual health and well-being, which in return will have a positive effect on the local community and the economy. A healthier individual will miss fewer days of work, which will help production for local businesses and increase incomes for families. The trail will introduce community building opportunities as well. Volunteer programs will be put in place to keep the areas along the trail clean. Volunteer programs will also be dedicated to restore the natural beauty along the Floyd Riverfront, which will boost environmental stewardship and provide an aesthetically pleasing experience to those who take advantage of the trail extension. The trail extension will implement several educational components for local residents and those who visit the area. Informative guides will help bridge the environment and the natural history of Sioux City, illustrating how the importance of Floyd River has impacted the history of the city. Trees indigenous to Iowa will be also be planted along the trail to restore the natural environment. The trees planted along the trail will be labeled for easy identification and wildlife placards will be placed along the trail to help identify species native to the area. Ecological education is an important aspect of the trail design because most of the original ecosystems have been destroyed due to development within the area. Raising awareness to the public of how much the riverfront has been transformed throughout the history of the city will create a sense of stewardship amongst users while creating a connection between the citizens of Sioux City and the environment.

The trail extension will also introduce a sustainable option of travel. The trail will serve as a safe alternate route for transportation connecting the existing trail to 41st street and Floyd Boulevard. Extending the trail 41st street and Floyd Boulevard will allow users to easily access bike lanes throughout Sioux City. Regular use of the trail extension will allow residents to interact with neighbors and access basic needs without the dependence of motorized vehicles. Using the trail as an alternative mode of transportation will help users save money as well as help advocate for a healthier environment. The completed trail will draw visitors to the area which in return will benefit the economy of Sioux City and promote future development within the area. The trail extension is the small part of the vision for a statewide trail network that ultimately will connect several counties across the state of Iowa. The trail plan will enrich the local community as well as statewide, allowing users to travel by foot or non-motorized vehicles to any destination within the state. The trail network will help sustain the health of communities across the state while also decreasing greenhouse gases.

4. Preliminary Development of Alternative Solutions

Sioux City, Iowa follows the Statewide Urban Design and Specifications (SUDAS) design codes, which meant that we had to refer to them while designing the Floyd River Trail extension. In addition, the Iowa Department of Transportation (DOT) and the American Association of State Highway and Transportation Officials (AASHTO) standards were also referred to specifically when dealing with highways, roads, and railroad track crossings. Union Pacific standards were also referred to for rail crossings to ensure that all regulations were followed sufficiently. Any

plans and design specifications that relate to the current trail layout were also taken into consideration while designing the trail extension.

Before developing a final design, HES Inc. was required to produce three preliminary design alternatives. These were based off of limited information and resources. The three design alternatives were later presented to Sioux City engineers for further review. The engineers with Sioux City then provided HES Inc. with feedback regarding the preliminary designs, and provided input to our organization on what they had envisioned for the Floyd River Trail extension. After collaborating with the engineers in Sioux City, we were tasked with selecting the best possible preliminary design. The following sections describe each preliminary design alternative in full detail along with the illustration for each preliminary design layout.

Design Alternative #1

Preliminary design alternative one, which is shown in **Figure 1**, is a loop design that connects the Riverside Recreational Trail (shown in red) to a section of recreational trail (shown in white) traveling adjacent to 41st street and Floyd Boulevard. The design layout illustrates a small roundabout located in the southwest portion of the trail that would serve to connect the existing trail with the new riverside extension. From there, the trail would connect to a parking lot near the intersection of Floyd Boulevard and Outer Drive (shown in green) that would also connect to the segment of the trail that follows along Floyd Boulevard. Both trails would extend to the northeast, where they would connect to 46th Street near Highway Route 75.

Figure 1. Preliminary Design Alternative #1

After collaboration with the Sioux City engineers, we realized that the design option was not feasible due to the overall length of the trail. Construction of a trail with this length

would be very costly, and would take too long to construct. We also realized during our site visit that it would be to extremely difficult to run the trail along the river levee. Constructing a trail along the levee would be problematic due to the railroad track and railroad bridge that crosses the levee. In order to construct a trail in this particular area, the trail would have to be constructed on the lower river side of the levee in order to cross underneath the existing railroad bridge instead of crossing over the railroad tracks. This would require extensive permits and funds in order to complete. The length and difficulty of constructing the trail along the levee were the main reasons HES Inc. eliminated this preliminary design from the selection pool.

Design Alternative #2

Preliminary design alternative two, shown in **Figure 2**, is a simplified design that eliminated the Floyd Boulevard segment of the trail completely. Instead of a roundabout in the southwest, the new portion of the trail simply merged with the existing section of the Floyd River Trail. The riverside extension would then follow Floyd River northeast and stop just south of 46th Street. A small loop located at the end of the trail would allow users to turn around on the trail in a natural and convenient manner. The parking lot located at the intersection of Floyd Boulevard and Outer Drive would remain in the same location as the first design alternative. However, a slight alteration to the trail path that connects to it would be made. Preliminary design alternative 2 was a relatively cheaper option than the first design alternative which would allow for the addition of certain amenities to be added such as a park (shown in dark blue).

Figure 2. Preliminary Design Alternative #2

Consequently, HES Inc. has decided that preliminary design option two would not be the best option for Sioux City for reasons similar to why the first design alternative was not selected. However, the length of the trail was not the issue with the design, it was the inability of constructing a recreational path along the levee. Constructing a trail along the levee was going to be difficult and would have similar issues with crossing the railroad and U.S. Route 75.

Design Alternative #3

Design alternative three, shown in **Figure 3**, is a more cost efficient version of the first design alternative. A segment of the trail would still run along Floyd Boulevard, but it would then follow along 41st Street and combine with the riverside trail extension at the east end. Similar to the second design alternative, the roundabout in the southwest would be taken out in favor of simply merging with the existing trail. The parking lot would still exist at the intersection of Floyd Boulevard and Outer Drive, and the money saved with this design could also go towards any added amenities such as a picnic area (shown in light blue).

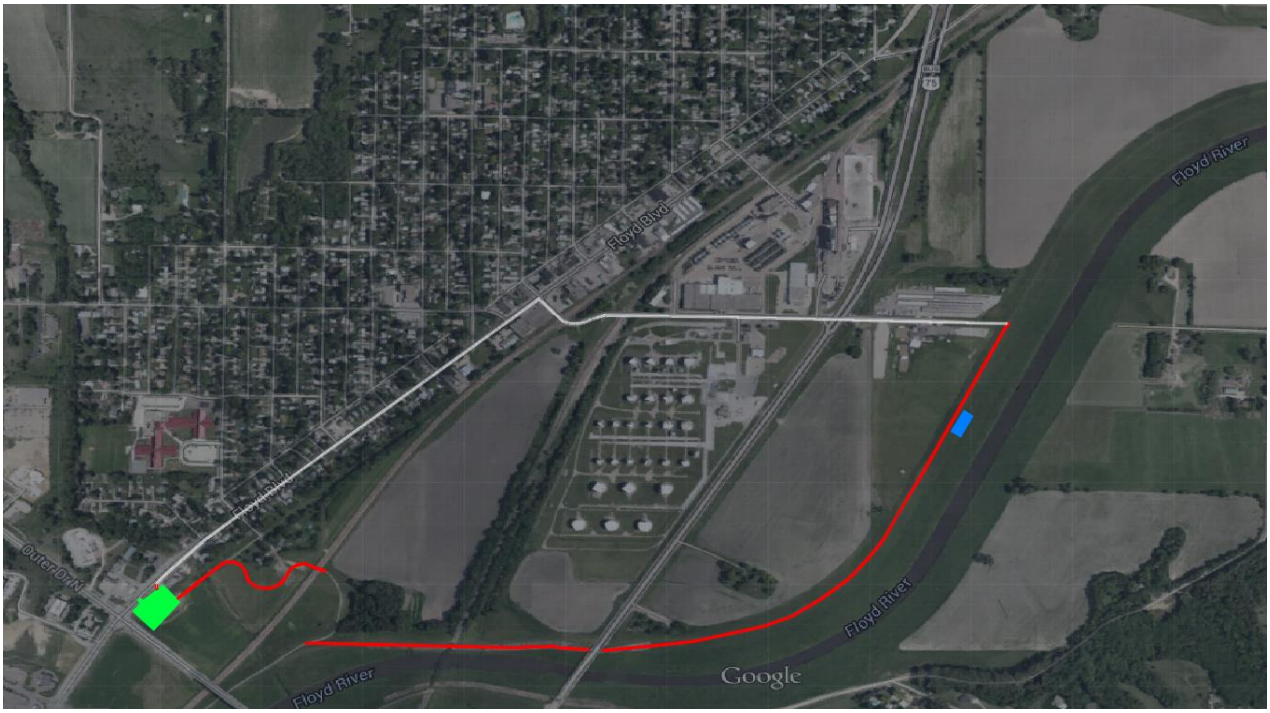

Figure 3. Preliminary Design Alternative #3

The third preliminary design alternative is very similar to what HES Inc. decided to use for the final design. The trail segments adjacent to Floyd Boulevard and 41st Street were kept, as they were appropriate for what Sioux City had envisioned. HES Inc. determined it was beneficial to the final design to remove the trail section along the levee due to the rail and highway crossing issues also observed in the first two preliminary design options.

5. Selection Process

For all three of the preliminary designs, HES Inc. included a parking lot near the Floyd Boulevard and Outer Drive intersection. Our organization also desired an at-grade railroad crossing near the same location. However, both of these concepts were removed from the final design, along with the trail segments connecting the railroad crossing to the parking lot. It was brought to the attention of HES Inc. that the land was of value and plans for commercial development have been discussed in this area. Therefore, the city did not favor the concept of constructing a parking area near this location. HES Inc. also discovered that Union Pacific would not allow an at-grade rail crossing, which was another determining factor for selecting the final design.

It should be noted that the three preliminary designs were not mutually exclusive to begin with. HES Inc. reviewed all of the pros and cons of the three preliminary design options. After reviewing all of the challenges and constraints of the project, we decided to redesign the trail and to implement parts of the preliminary design options. The new design we developed was most similar to the third preliminary design option, with multiple changes.

6. Final Design Details

Information and images are presented throughout this section of the report in order to provide details regarding the final design details. Subsections below are presented to separate certain design aspects of the trail system for clarity purposes.

6.1 Final Design Layout

After overcoming many challenges and constraints of the project area, we were able to develop a final design that we believe is best for Sioux City residents. HES Inc. believes the final design for the trail extension depicted in **Figure 4** is a feasible option for Sioux City.

Figure 4. Final Design Layout

The original plan to connect the trail to the Floyd Boulevard and Outer Drive intersection by crossing the railroad at-grade near the intersection. After some research, we discovered that Union Pacific does not allow at-grade crossings for trails in this scenario. We had to rethink our original design options and were able to develop a solution.

Due to the condition of the current trail near the project location, we decided it would be best to remove some of the existing trail back to the top of the levee. From there, we planned to have the new trail follow the same path of the existing trail. This allowed the flood mitigation group the ability to rely on existing elevation levels for their design. After following most of the original trail layout, we veered the trail towards the railroad in order to follow the tracks toward 41st Street.

HES Inc. decided to have the trail run north towards 41st Street, where it crosses 41st Street. After crossing 41st Street, the trail runs adjacent to the road towards Floyd Boulevard and also towards U.S. 75. We ended one section of the trail at the Floyd Boulevard and 41st Street intersection, as the planning department at the University of Iowa was tasked with researching a trail segment along Floyd Boulevard. Ending here would allow a connection to their trail system, which in turn would provide trail access to the Floyd Boulevard and Outer Drive intersection.

HES Inc. decided to end the trail section running east along 41st Street at the intersection of 41st Street and U.S. 75. We decided this would be an ideal ending point for this project phase, as it would allow for a good starting point for future trail extension towards Le Mars, Iowa. HES Inc. would recommend a future trail extension across U.S. 75 following 41st Street, and then turning north and following the Floyd River towards Le Mars.

6.2 Project Phasing

HES Inc. recommends completing the Floyd River Trail construction in two phases. The first phase of the project recommended by HES Inc. is the segment of trail running south to north along the western set of railroad tracks (Red section of the design layout in

Figure 4). This first phase of trail construction begins at the current ending point located near the intersection of Floyd Boulevard and Outer Drive. HES Inc. believes the best ending point for the first phase of construction is located just north of 41st Street, where the trail comes to a T intersection. It should be noted that this section of trail is 10 feet wide.

The second phase of construction recommended by HES Inc. is the remaining trail segment that runs adjacent to 41st Street (White section of the design layout in **Figure 4**). HES Inc. believes that the second phase of construction may be best suited to begin either on the western or eastern end of this trail segment. This would allow for one directional paving of this segment of the trail. It should be noted that due to physical constraints, this section of the trail was designed to be 8 feet wide. SUDAS specifications allow for an 8-foot-wide trail under certain scenarios. Refer to **Specification D.2** in **Appendix D** for more details.

The blue and green sections of the final design layout in **Figure 4** were not designed by HES Inc., but are recommended as future extensions of the Sioux City trail system. The blue section of trail would run along Floyd Boulevard, allowing a connection of the trail at the Floyd Boulevard and Outer Drive intersection. The green segment of trail would allow for a reasonable path towards the Floyd River, where the trail could turn north and extend towards Le Mars, Iowa.

6.3 Design Speed

After reviewing SUDAS specifications, it was determined that the ideal design speed for the Floyd River Trail be 25 mph. We used the chart located in **Specification D.3** of **Appendix D** for design speed selection. The final trail design has a maximum slope of 5% or under, so 25 mph was selected as the design speed.

6.4 Stopping Sight Distance

The stopping sight distance was calculated for a grade of 5% using **Equation 1** located in **Appendix B**. The calculations completed by HES Inc. resulted in a stopping sight distance of approximately 96 feet for the trail.

6.5 Radius of Curvature

The radius of curvature sample calculation can be referred to in **Appendix B** using **Equation 2**. The radius of curvature calculated by HES Inc. was approximately 146 feet. This calculation was completed assuming 0.035 ft/ft as the rate of superelevation.

6.6 Cross Sections

For the task of designing the trail, HES Inc. had to develop three different cross sections for the project. The cross section depicted in **Figure 5** was designed and developed for the first phase of the project. **Figure 6** depicts the cross section designed for phase two of

the project. For crossing Springfield Street, the pavement thickness had to be increased in order to withstand vehicle traffic. The cross section for the Springfield Street crossing is depicted in **Figure 7**.

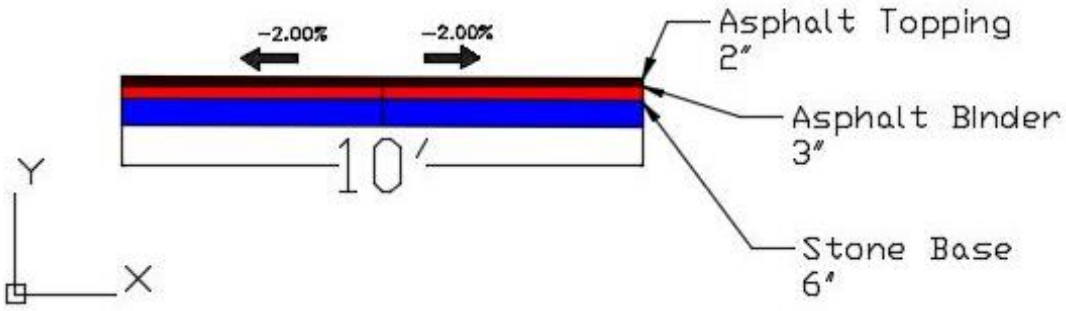

Figure 5. First Phase Cross Section

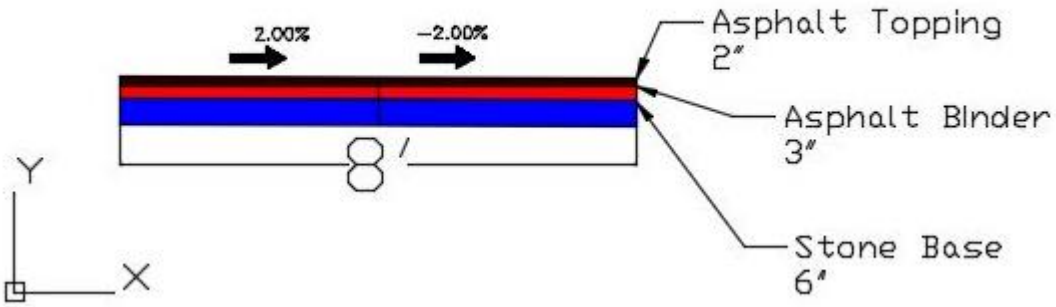

Figure 6. Second Phase Cross Section

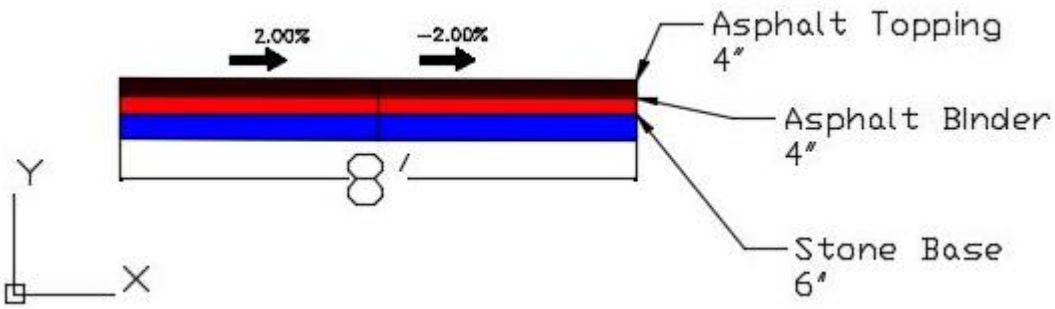

Figure 7. Springfield Street Cross Section

6.7 ADA Requirements

In compliance with the Iowa DOT design manual and SUDAS, detectable warning surfaces are required at all street crossings and at-grade rail crossings. These surfaces consists of a series of domes raised up from the ramp that warn a pedestrian that the trail is ending and street or rail crossings are ahead. The surfaces must extend a minimum of 2 feet away from the street curb and 6 feet from the start of a rail crossing. The surfaces must also extend the full width of the trail or street crossing. The orientation of the domes must be perpendicular as well in order to allow for persons with wheelchair disabilities to navigate through the surface. Examples of different crossings can be found below in **Figure 8** and **Figure 9**.

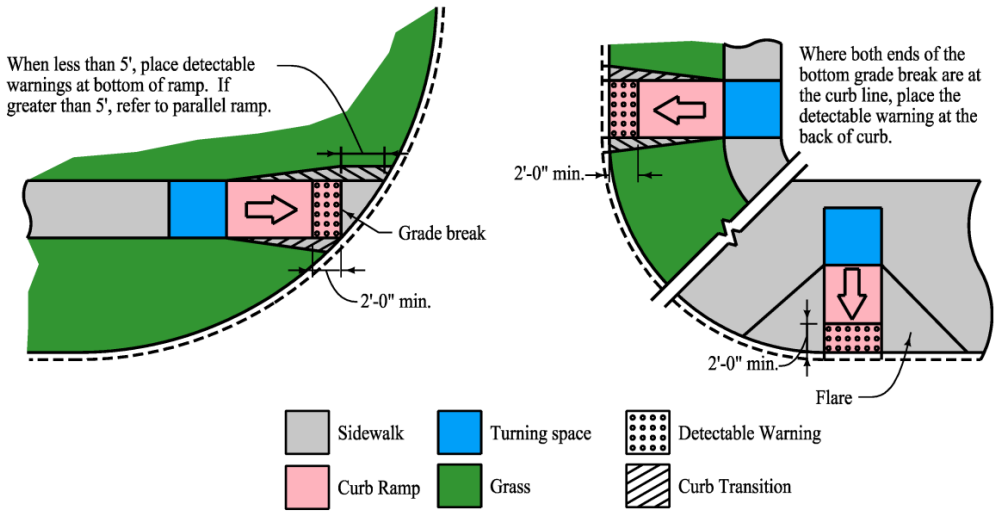

Figure 8. Detectable Warning Layout Examples 1

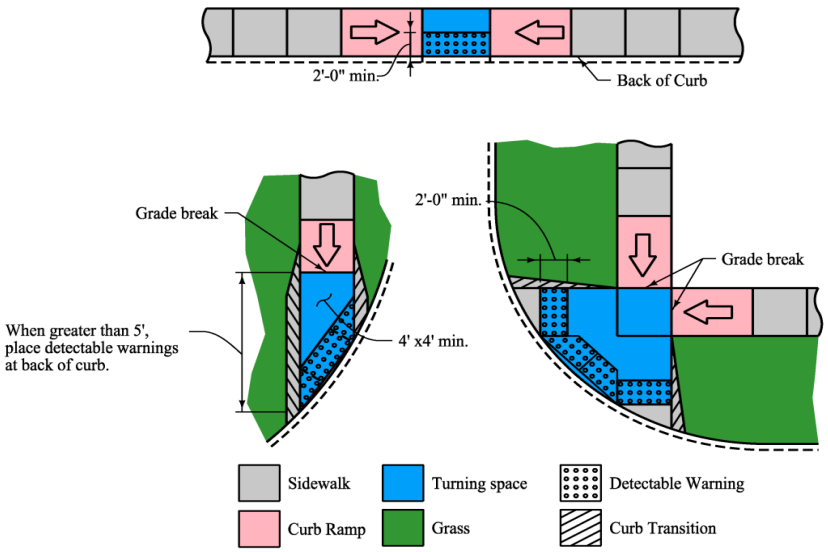

Figure 9. Detectable Warning Layout Examples 2

6.8 Crossing 41st Street

To ensure the safety of pedestrians using the shared-use recreational trail, HES Inc. has referred to the Manual on Uniform Traffic Control Devices (MUTCD). It should be noted that the contractor working on the trail extension should also refer to the MUTCD to ensure that the final project is consistent with the design put forth by HES Inc.

HES Inc. decided to have the trail cross 41st Street between the two railroads near the project site. Crossing 41st Street was a decision made based on utility placement along 41st Street. The southern side of 41st Street had electrical poles that were blocking path design, and it would have been costly to relocate them. We decided that we had a clearer path along the north side of 41st Street, which would allow for easier constructability.

The sign layout for the 41st Street crossing that HES Inc. recommends is similar to an example found on the website for the Iowa DOT. A sign layout of the crossing is depicted in **Figure 10** below. Also, from **Specification D.4** attached in **Appendix D**, signs must be placed no less than 2 feet from the edge of the trail to the edge of the sign.

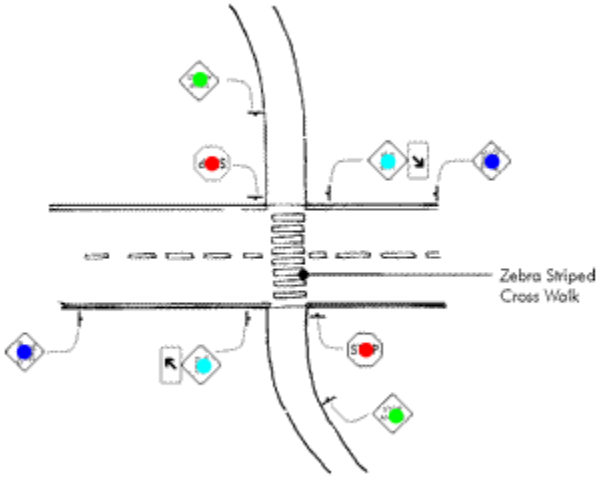

Figure 10. Signage Layout for Crossing at 41st Street

In **Figure 10**, each sign is color coded and depicted below for clarity purposes.

- Trail Crossing Ahead signs: There are some variations of this style of sign, and the one HES Inc. recommends is shown below. This style of sign also warns drivers of the approximate distance they are from the trail crossing. HES Inc. recommends placing two of these signs along 41st Street, one on the east side and one on the west side of the crossing location. HES Inc. recommends placing the western sign at a distance of 200 feet before the crossing location. This is due to the road distance available before the crossing location is reached. HES Inc. recommends placing the eastern sign at a distance of 300 feet before the crossing location.

- Trail Crossing Sign (W11-15): The Trail Crossing sign is similar to the Trail Crossing Ahead sign and is depicted below. This sign warns drivers at the location of the trail crossing. A Trail Crossing sign tells drivers to yield to pedestrians crossing the road at a marked crosswalk. The sign shown below is what HES Inc. recommends in this location.

- Stop Ahead Sign: The Stop Ahead sign is used to warn cyclists and pedestrians of a stop sign ahead. The sign HES Inc. recommends using is shown below. HES Inc. also recommends placing this sign approximately 100 feet before pedestrians reach the trail stop sign.

- Stop Sign (R1-1): This sign functions exactly how a stop sign does for vehicle traffic. This forces pedestrians to stop before crossing the street at a marked crosswalk. However, the typical stop sign for trails is much smaller than one for vehicle traffic. A typical stop sign for pedestrian and bicycle trails is shown below.

There is another sign HES Inc. would like to add to the intersection that is not marked in **Figure 10**. The sign that is recommended is a No Motor Vehicles (R5-3) sign. This sign would be placed adjacent to the trail stop signs and on the opposite side of the trail. This

sign would face 41st Street in order to prevent motorists from using the trail. A typical No Motor Vehicle sign is shown below. No Motor Vehicle signs will also be placed throughout the project corridor at any point where vehicle access is possible.

The final addition HES. Inc. recommends for the trail intersection with 41st Street is Zebra Striped crosswalk markings. These markings are depicted in **Figure 10**, and are shown below for reference. These striped markings are placed in order to show drivers the crossing location for trail users.

6.9 Crossing Springfield Street

Crossing Springfield Street will not be as difficult as crossing 41st Street. The T-intersection of Springfield Street and 41st Street is already controlled by a stop sign. Traffic on Springfield Street must stop and yield to traffic on 41st Street. HES Inc. recommends placing a stop sign along the trail on each side of its intersection with Springfield Street. This would provide traffic on 41st Street with the right of way. Trail traffic and Springfield Street traffic would yield to traffic on 41st Street. After yielding to traffic on 41st Street, traffic on the trail and on Springfield Street would treat their intersection as if it were a 3-way stop.

It should be noted that Springfield Street is a gravel roadway, which means that additional pavement must be added to each side of the trail. This is required to prevent gravel from being spread across the trail path due to vehicle traffic. The required additional pavement must extend to 20 feet from both trail edges. More information regarding gravel roadway crossings is shown in **Specification D.5** located in **Appendix D**.

The additional signage required for this intersection layout consists of two stop ahead signs, and two stop signs. One of each sign mentioned would be placed along the trail west and east of Springfield Street. A Zebra Striped Crosswalk should also be painted directly onto the trail segment crossing Springfield Street. For sign and crosswalk placement details, please refer to **Section 5.3.**

6.10 Crossing the Railroads along 41st Street

In order to connect the trail along 41st street to Floyd Boulevard, the trail must cross two sets of railroad tracks. Therefore, an at-grade crossing was designed along 41st street in these two areas with proper signage to ensure pedestrian safety when approaching and crossing the railroad as shown in **Figure 11** below. When approaching the railroad from the east or west, a yellow railroad crossing sign (W10-1) should be placed 112 feet from the railroad tracks to warn pedestrians of the railroad tracks ahead. The signs are a warning to pedestrians, and they should proceed with caution in case a train may be entering the intersection as the pedestrian is approaching or crossing the railroad tracks. Railroad markings should also be painted on the trail surface as another warning to pedestrians that they are approaching tracks. The painted railroad crossing sign on the trail surface should be painted within the 12 - 112 foot span before approaching the railroad tracks. Additional signs, such as a stop sign (R1-1) with a railroad crossing sign (R15-8) and a look sign (R15-8), should also be placed at a 12 foot minimum from the tracks as an additional safety measure to pedestrians crossing the railroad tracks. A solid white line should also be painted on the trail surface a minimum of 12 feet from the physical railroad crossing. The solid white line represents a safe stopping point for pedestrians to ensure that a train is not approaching the intersection as the pedestrian is about to cross.

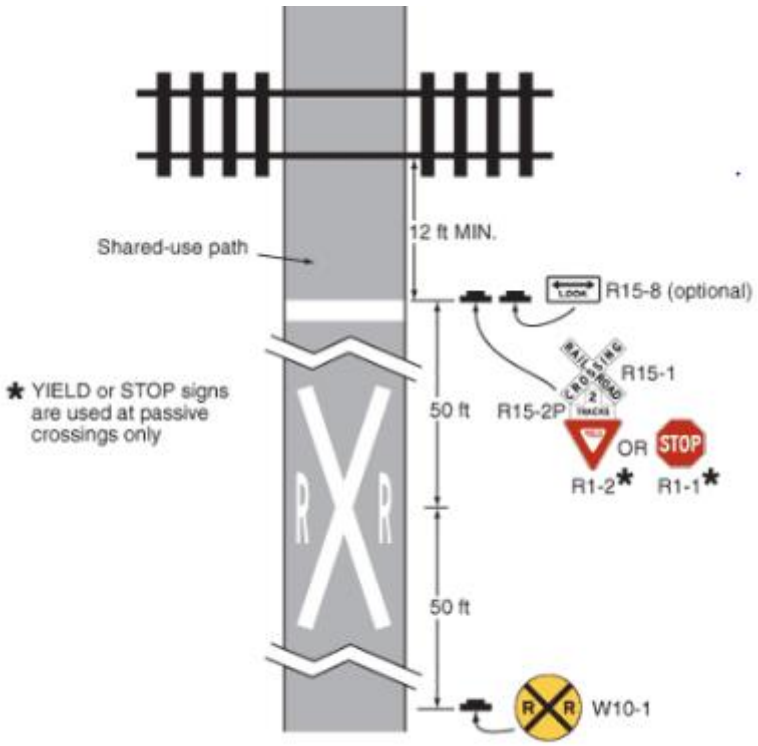

Figure 11. Sign Layout for Rail Crossings

The approach area located on each side of the track should also be raised to the level of the railroad track. The approach slopes should also have a minimum grade of 2% and should be flat for a distance of 5 feet on both sides of the railroad track. This is important because surfaces that are not flush can pose as a tripping hazard to pedestrians using the trail. Also, a textured rubber railroad crossing pad should be used on the surface of the landing approaching the railroad tracks as shown below in **Figure 12**. The rubberized pad is recommended by HES Inc. because it will not buckle, expand, or contract with changing weather conditions.

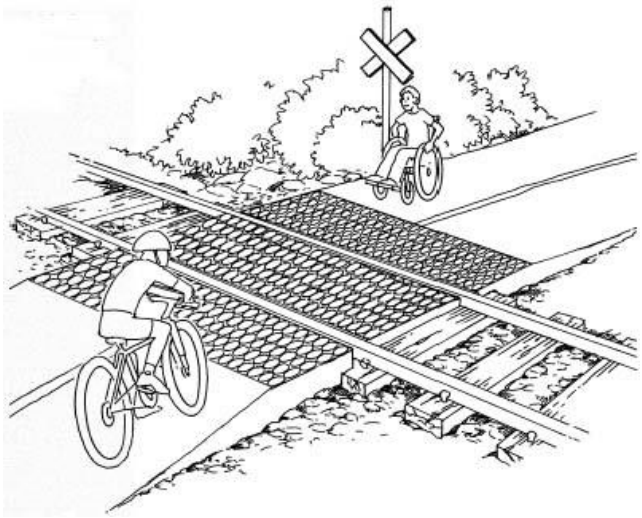

Figure 12. Railroad Approach with Rubberized Pads

Crossing the actual railroad track can also pose a potential threat to pedestrians, especially those who use wheel based equipment. Therefore, additional safety measures were put in place by HES Inc., such as placing a rubber flange filler in the gap located between the trail surface and the railroad track as shown below in **Figure 13**. The flange filler will not only eliminate the risk of getting a tire caught within the gap but also provide a smooth transition between both trail surfaces located on each side of the track. The rubber material also allows the flange to deflect down as a train travels along the tracks, then returns to its normal state after the train has passed through.

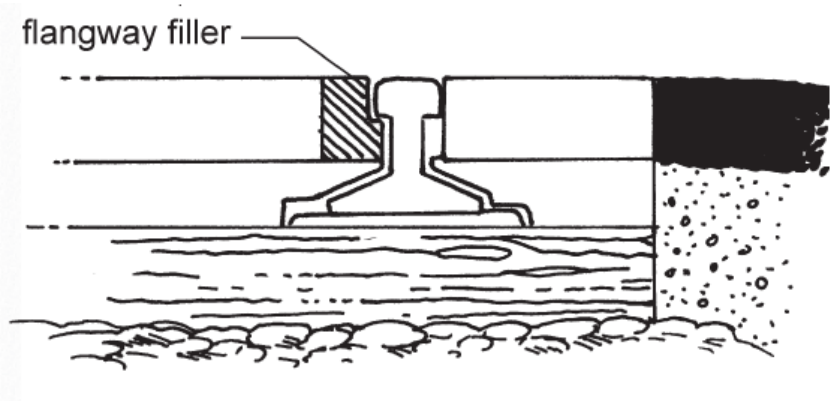

Figure 13. Flange Filler

6.11 Fencing

In order to maintain safety and discourage trail users from crossing the railroad tracks, the Union Pacific Guidelines for Railroad Grade Separation Projects Section 4.6 requires fencing along the right-of-way of the railroad. Although the southern off-road section of the trail is placed well outside of the railroad right-of-way, an 8-foot-tall vinyl-covered chain link fence may need to be placed at a 15 foot offset from the trail on the west side in order to better promote safety for trail users. This fence type was chosen because it

conforms to the details laid out on Plan No. 711000, sheet 1 of the Union Pacific Guidelines. Whether or not the fence will be necessary is up to the discretion of Union Pacific. A copy of Plan No. 711000, sheet 1is provided in **Specification D.6** in **Appendix D**. A guardrail was also considered for separating 41st street from the trail section adjacent to it, but **Specification D.7** in **Appendix D** states that a barrier is not required as long as the edge of the trail is offset by at least 5 feet from the edge of the traveled way.

6.12 Object Relocation/Removal and Trail Horizontal Clearance Requirements

SUDAS specifies certain horizontal clearance requirements and they will be followed for the trail design. SUDAS requires a 2 foot minimum clearance from the edge of the trail and the edge of signs. The same 2 foot clearance is also required from the edge of the trail and trees, light poles, electrical poles, and similar objects.

To maintain horizontal separation requirements specified by SUDAS, some objects may need to be removed or relocated to ensure safety of trail occupants. HES Inc. believes that four electrical poles near the west end of the 41st Street trail segment may require relocation. Three of the four poles are between the two sets of railroad tracks, with the fourth pole being located just east of the easternmost railroad tracks. These electrical poles are all on the north side of 41st Street.

Railroad warning signs for drivers may require relocation along 41st Street. These signs shall be located at or more than 2 feet from the trail edge. Because of the significance of railroad warning signs, relocation of any railroad infrastructure must be coordinated with Union Pacific.

HES Inc. also foresees the possibility of needing to relocate road signs along 41st Street. If road signs must be relocated, they shall maintain the SUDAS specified 2 foot minimum horizontal clearance from the trail. For road signs that must be relocated, HES Inc. recommends placing them 2 feet from the edge of 41st Street, which would provide 3 feet of clearance from the trail.

If trees or shrubs are within 2 feet of the trail, they are to be removed. Some trees and shrubs will also need to be removed for grading and working space requirements. The contractor must coordinate tree removals with the client for any trees located outside of the 2 foot horizontal clearance space.

6.13 Land Purchase/Permanent Easement Required

There are two parcels of land not owned by the city that will be required for the trail. These parcels are both on the north side of 41st Street and are the first two parcels just west of U.S. 75. The trail will only require a few feet of land on these parcels to function properly and meet all specifications. HES Inc. believes Sioux City should discuss this with these parcel owners, in order to reach an agreement on land use. This means the city may have to purchase sections of these parcels, or work out an agreement for a permanent easement with the owners of the parcels.

6.14 Future Additions

The following subsections refer to different possibilities of extending the Floyd River Trail in the future. HES Inc. has not completely designed any of the future extension plans. These possible trail extension ideas are for Sioux City's review, in order to help them mesh the current trail design with future plans.

6.14.1 Crossing U.S. 75 at the 41st Street Intersection

In order to extend the Floyd River Trail to Le Mars, HES Inc. recommends that the trail extension cross U.S. 75 along 41st Street. Additional signage would be required to ensure the safety of the pedestrians using the trail. Although HES Inc. did not design a complete trail crossing for U.S. 75 along 41st Street, recommendations have been made for appropriate road crossing signals and structures. HES Inc. believes these are the best options to ensure the safety of the trail users. The options include placing Prepare to Stop When Flashing (PTSWF) signs along U.S. 75. or constructing a structure above ground that does not impede with the flow of traffic on U.S. 75.

When entering Dubuque, Iowa on U.S. 20 from the west, there is a PTSWF sign system in place. However, this location does not include a pedestrian crosswalk. Dubuque's PTSWF system in this location is effective in slowing down and stopping traffic on a high speed roadway, which is what would be required for this section of U.S. 75. This is why HES Inc. believes a PTSWF sign system would be effective in stopping traffic safely for pedestrians to cross U.S. 75. Some sample PTSWF signs are depicted in **Figure 14** below.

Figure 14. Sample PTSWF Signs

With this implementation, a new set of stoplights along U.S. 75 at the intersection with 41st Street would be required as well. The PTSWF sign would allow drivers on U.S. 75 enough warning of a possible red light at the intersection. With this scenario, it is recommended to run the PTSWF beacons and the stoplight through a push button setup for pedestrians. Additional signage would be required for traffic on 41st Street as well. This additional signage would likely include a yield to pedestrians sign along with a stop sign, and they would be placed along 41st Street on both sides of U.S. 75. The PTSWF sign placement distance was calculated with **Equation 3** and the provided variable assumptions listed in **Appendix B**. Based on the calculations, the PTSWF signs should be placed along U.S. 75 roughly 450 feet before the proposed stoplights.

A possible concern with this design would be traffic congestion. With stoplights added to U.S. 75, traffic capacity may possibly decrease. It is unknown how much this solution would affect traffic, and further traffic analysis would need to be completed to understand how an additional set of stoplights would affect traffic flow in the area.

An alternative to the PTSWF setup that HES Inc. recommends is a bridge structure across U.S. 75 along 41st Street. This type of structure could implement spiral ramps on either side of the road, so that it would be easily accessible to all possible means of pedestrian traffic. The bridge structure would likely be more costly than the PTSWF and traffic light system mentioned above. However, a bridge structure would not affect traffic flow in the area. This would also allow pedestrians using the trail to cross the road without delay, and would guarantee their safety from traffic.

6.14.2 Trail Bridge Adjacent to Outer Drive Bridge

Another possible future addition to the Floyd River Trail includes a pedestrian bridge structure near the Outer Drive bridge that would merge with the existing trail. The pedestrian bridge structure would serve as a safety measure for pedestrians to cross over the railroad tracks while also serving as another access point to the trail for pedestrians. The pedestrian ramp is an expensive option that will have to be discussed further by the city because additional funding may be required for design and construction. It is possible that the pedestrian bridge structure could be constructed as an addition to the Outer Drive bridge. Additional testing and inspection would be required to verify that the Outer Drive bridge would be structurally sound with an addition of this magnitude.

6.14.3 Floyd Boulevard Trail Segment

In order to connect the trail to the Floyd Boulevard and Outer Drive intersection, HES Inc. proposed a trail section adjacent to Floyd Boulevard. However, plans are currently being developed by the University of Iowa's Urban and Regional Planning department for the renovation of Floyd Boulevard. It should be noted that the plans of HES Inc. have coincided with the plans of the urban and regional planning organization in order to create a recreational route that will promote activity along Floyd Boulevard. After communicating with the Urban and Regional Planning organization, it was determined that a feasible point for connecting the trail to Floyd Boulevard was at the 41st Street

intersection. The intentions of future trail development along Floyd Boulevard allowed HES Inc. to design a trail segment adjacent to 41st street to the intersection of Floyd Boulevard in order to connect with the planned trail design put forth by the Urban and Regional Planning Organization. It should be noted that HES Inc. did not design the trail segment along Floyd Boulevard and any questions regarding that area should be directed to the Urban and Regional Planning group.

7. Cost and Construction Estimates

In order to determine the overall construction cost which includes labor, overhead and profit (O&P) for the design, HES Inc. has referred to the 2015 RS Means cost estimation guides. The RS Means guides referred to by HES Inc. include the Residential and Landscape guide along with the Commercial Renovation Cost Data guide. The cost of paving and subbase, shrubs, trees, benches, fencing costs and dirt work were found within the Residential and Landscaping Guide. Whereas, the costs for the signs were found within the Commercial Renovation guide. The cost for each item was identified as a general construction and labor cost for the United States, so HES Inc. had to multiply each cost by the appropriate location factor for Sioux City, Iowa. The location factor was important when developing a cost analysis because it depicts the different costs for construction and labor depending on the state and city in which the construction takes place. The location factor varied in each guide so HES Inc. took this into consideration when determining the overall cost of the project. For example, the factor for Residential and Landscaping was 0.86, while the factor for Commercial Renovation was 0.879.

It should also be noted that the RS Means guides did not list each item implemented into the design, so HES Inc. has allocated an amount of the budget for other items listed in the cost estimates. These costs were based off of multiple sources, as HES Inc. wanted as accurate of an estimate as possible. The items not included in the RS Means manuals that HES Inc. allocated budget for include constructing the trail over both railroad crossings along 41st street, cast-in-place concrete, waste receptacles to be placed along the trail, and ADA ramps (includes cost of concrete for setting truncated domes).

HES Inc. estimated the total cost of the Asphalt trail to be approximately **$390,000**. If Sioux City would rather use concrete, HES Inc. estimates that the total cost of the project would increase to approximately **$500,000**. A complete breakdown of cost estimates can be referred to in **Table C.1** located in **Appendix C**.

In regards to cost comparison between Asphalt and Concrete, HES Inc. has assumed that the concrete trail would last approximately 20 years without requiring repair. HES Inc. has also made the assumption that an Asphalt trail would last approximately 10 years before requiring repairs. Based off the cost of each trail, HES Inc. has developed an annual cost value comparison to compare both trail surfaces. This comparison is based off costs to construct the trail paths only and disregards other project costs that will not require repair. HES Inc. has estimated the annual cost of the Asphalt trail to be approximately **$16,500**, and the annual cost of the concrete trail to be approximately **$13,700**. Refer to **Appendix C** for the annual cost breakdown of Asphalt in **Table C.2**, and the annual cost breakdown of Concrete in **Table C.3**. It should be noted that neither of the calculated annual costs accounts for repair costs at the end of the pavement life.

8. Conclusions

The Floyd River Trail extension will provide residents of Sioux City and visitors to the area the opportunity to enjoy the natural beauty of Sioux City. In addition, the trail will serve as a safe alternate route for transportation connecting the southern existing 4.2 miles of trail to the northern part of Sioux City. Extending the trail to the northern parts of Sioux City will encourage healthy outdoor recreation while supporting economic development to businesses located along Floyd Boulevard. The trail extension will also promote sustainable travel, employment, education, conservation and community development opportunities to an area desperately in need of restructuring. The carefully thought out design is a suitable alternative for all trail-users, whether it is for walking, running, rollerblading or cycling, that ultimately follows the vision of the statewide trail plan which will connect Sioux City to Le Mars in the future phases of development.

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Appendices

Appendix A. Required Permit Forms

Permit A. Union Pacific Railroad Crossing Permit

Road Crossing Application Form

SECTION 1: TO BE COMPLETED FOR ALL CROSSINGS

Name _____

Address _____

City _____ State_____ Zip Code_____

Contact Person _____

Phone _____ Fax _____

( ) Individual ( ) Partnership ( ) Proprietorship ( ) Corporation: _____ State Incorporated

Names of Officers, Partners or Proprietor _____

Billing Address if different than above _____

Type of Road Crossing:

____Private Farm Crossing ____Private Commercial Crossing ____Contractor's Crossing

____Pedestrian Overpass ____Pedestrian Underpass ____Other _____

____Existing Crossing ____New Installation ____Relocation

____Permanent Use ____Temporary Use for _____ Mos. ____Reconstruction

Crossing will be used to access _____

Type of Vehicles To Be Driven Over Crossing:

____Passenger Cars ____Recreational Vehicles ____Pickups

____Farm Equipment ____Heavy Construction Equipment ____Other _____

Approximate number of daily one way trips over the crossing _____

Name of Owner of Property to be served by crossing _____

Address if different than above _____

Crossing is Located in the:

_____ Section _____, Township _____, Range _____

(Example: SE 1/4 of NW 1/4 Section 15, Township 39N, Range 12E)

In / Near the City of _____, _____ County/Parish, State of _____

Attach a Legal Description of Your Property to be served by the crossing and a Property or County Map showing the Location of the Crossing.
INDICATE on the map the distance measured along the track between the crossing and fixed objects in the vicinity (i.e. bridge, culvert, railroad mile marker, public road)

SECTION 2: TO BE COMPLETED FOR EXISTING CROSSINGS ONLY

Name(s) of previous users of crossing _____

Crossing is currently covered by license agreement number _____

Dated _____ with _____

SECTION 3: TO BE COMPLETED FOR INSTALLATION OF NEW CROSSINGS ONLY

How is property currently accessed?_____

Why was access to property not obtained from previous owner_____

_____

Desired crossing will be _____ feet ( ) north ( ) south ( ) east ( ) west

of nearest _____ ( ) public ( ) private road crossing.

Track is in _____-ft cut/fill Number tracks crossed_____ Track is on: ( ) curve ( ) straight

Signed _____ Date _____

FOR RAILROAD USE ONLY

RAILROAD MILEPOST_____ RAILROAD SUBDIVISION_____ AARDOT NUMBER_____

MGR IND & PUBLIC PROJECTS _____ MGR TRACK MAINTENANCE _____ MGR SIGNAL MAINTENANCE _____

TELEPHONE:_____ TELEPHONE:_____ TELEPHONE:_____

SUPERINTENDENT TRANSP SVCS APPROVAL RECEIVED:

WIDTH OF CROSSING_____ WIDTH OF RR RIGHT-OF-WAY____ CROSSING SURFACE _____

FLAGGING PROTECTION REQUIRED? _____ LOCKED GATES REQUIRED AT RIGHT-OF-WAY LINES?_____

SPECIAL PROVISIONS: ESTIMATED COST (ATTACH MATERIAL AND FORCE ACCOUNT ESTIMATE)

WORK TO BE PERFORMED BY RAILROAD:

ANNUAL LICENSE FEE _____ ANNUAL SIGNAL MAINTENANCE FEE _____

SUBMITTED BY _____ DATE _____

TITLE: _____

Requirements for railroad crossing permit taken from Union Pacific's website for at-grade crossings:

. All construction work for new crossings from end of tie to end of tie within the track area must be performed by Union Pacific employees or contractors at applicant's sole expense.

. All grading and drainage work on roadway approaches, including maintenance, will be the responsibility of applicant at applicant's sole expense.

. All relocation of utilities due to construction of a new crossing (if any) is at applicant's sole expense.

. Any maintenance work performed by Union Pacific forces will be at applicant's sole expense.

. Any current or future warning devices required for the crossing (passive or active) will be installed and maintained by Union Pacific employees or contractors at applicant's sole expense.

. All liability for accidents or injuries which arise as a result of the construction, maintenance and use of the crossing is assumed by applicant.

. A current certificate evidencing insurance coverage in the following amounts is required:

. New individual and residential private crossings and encroachments: General Public Liability providing $1,000,000 for each occurrence and general aggregate limit of $1,000,000; Automobile Public Liability providing $500,000 for each occurrence.

. Commercial and industrial crossings and encroachments and contractors' private crossings and encroachments: General Public Liability providing $5 million for each occurrence and general aggregate limit of $10 million; Automobile Public Liability providing $2 million for each occurrence; Worker's Compensation covering the statutory liability determined by state law. Railroad Protective Liability providing $2 million for each occurrence and aggregate limit of $6 million.

. Before any construction begins on a new crossing, applicant must enter into written agreement with Union Pacific and make payment to Union Pacific for the estimated cost of construction work.

. Applicant will pay Union Pacific all required engineering review fees and license fees.

. Before performing any work on Union Pacific property, applicant will telephone Union Pacific at 1-800-336-9193 (a 24-hour number) for fiber optic cable information, and will notify Union Pacific's manager of track maintenance ten (10) working days prior to start of construction.

. The **Application** must be printed and completed in its entirety. (The Application document in this section is a PDF [Portable Document Format] file, which requires the Adobe Acrobat Reader for viewing.) Completed applications and a nonrefundable payment of $500.00 (made payable to **Union Pacific Railroad Company**, Federal Taxpayer Identification No. 94-6001323) for preliminary engineering review of new crossings are to be forwarded to the appropriate manager for the area in which your crossing will be located, as identified on the map titled **Managers of Industry and Public Projects**. Failure to complete the application in full may delay processing. Please allow a minimum of 30 days for processing existing crossing requests and a minimum of 180 days for new crossing requests.

. Depending on the scope of the work and proximity to our tracks we may require that Railroad Protective Liability Insurance be obtained, in addition to general liability insurance. We have acquired a blanket Railroad Protective Liability Insurance policy which may allow inclusion of

your project under our coverage for an additional charge. We've found that in many instances it may be cheaper for the contractor do this than to obtain their own coverage. However, we do encourage you to shop around, as you may find a more favorable rate. An application form and additional information on **Railroad Protective Liability Insurance** through UPRR can be found in this section.

. In the event there is a need to revise an established Private Road Crossing Agreement, any changes will need to be reviewed and approved by the Manager of Industry & Public Projects (MIPP). This would include any changes to the scope or location of the project as defined in the Basic Agreement and must be specific to that project. If the local MIPP approves of the revisions, he will forward to the Real Estate Department and the Contract Manager will draft and send a Supplemental Agreement or appropriate document for execution. There would be an administrative fee of $500.00 assessed for this process. This will eliminate the need for a completely new application and agreement which will result in time and costs savings for all involved. It is Railroad policy that we do not assign road crossing Agreements and any new user(s) should make application for a new license agreement.

Permit B. Sioux City Right-of-Way Permit

SIOUX CITY

Right-of-Way Obstruction or Excavation Application | 2015

	Name	Address	Phone	Email
Applicant:				
Facility Owner:				
Contractor				

Work in: (Street) _____ ☐ Paved ☐ Unpaved ☐ Parkway

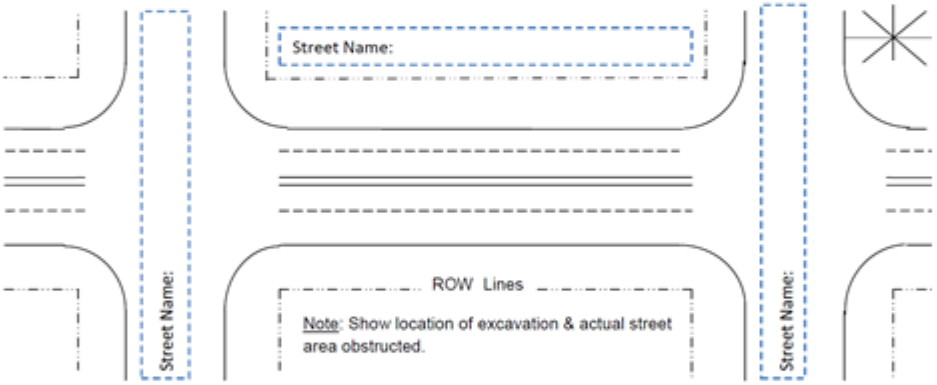
From: (Street) _____ To: (Street) _____

Address Served: (If Applicable) _____

Start Date: _____ Completion Date: _____

Project Description: _____

Type of Work: _____



Excavation Area		Obstruction Street/Sidewalk Area	
Street (sf):		Number of Lanes:	
Sidewalk (sf):		Street Length (lf):	
Parkway (sf):		Sidewalk Length (lf):	

By signing the permit below, the Permitee agrees to defend, indemnify, and hold harmless the City, its employees, and agents from all suits, actions, damages, or claims to which the City may be subject to, of any kind or nature whatsoever, resulting from, caused by, or arising out of the Permitee's use or occupancy of the public right-of-way authorized by this permit.

Applicant Signature Date	Jade Dundas Date
Permit holders acknowledgement of rules, regulations & City Code	Assistant City Manager of Public Works City of Sioux City, Iowa

PUBLIC WORKS DEPARTMENT 405 6th Street · P.O. Box 447 · Sioux City, IA 51102 WEB www.sioux-city.org

ADMINISTRATION PH 712-279-6222 FAX 712-279-6950 | WATER TREATMENT PH 712-279-6126 FAX 712-279-6179 | WASTE WATER TREATMENT PH 712-279-6916 FAX 712-279-6191 | ENVIRONMENTAL SERVICES PH 712-279-6369 FAX 712-279-6950 | ENGINEERING PH 712-279-6224 FAX 712-279-6369 | FIELD SERVICES PH 712-279-6999 FAX 712-279-6410 | RECREATION SERVICES PH 712-279-6139 FAX 712-279-6194

Appendix B. Equations and Calculations

Equation 1. Stopping Sight Distance (From SUDAS Section 12B-2)

$$S = \frac{V^2}{30(f \pm G)} + 3.67V$$

where:

S = Stopping sight distance (ft)
V = Velocity (mph)
f = Coefficient of friction (use 0.16 for a typical bicycle)
G = Grade (ft/ft) (rise/run)

Using Equation 1 with the corresponding values and assumed values, HES Inc. calculated the stopping sight distance required for cyclists. The calculation is completed below, for a maximum grade of 5%.

S = ((25 mph)^2/ 30*(0.16 +- 5)) + 3.67*(25 mph)
S = 625/154.8 + 91.75

S = 95.8 feet ~ 96 feet

Equation 2. Radius of Curvature (From SUDAS Section 8-2)

$$R = \frac{V^2}{15\,(e+f)}$$

where:

R = Minimum radius of curvature (ft).
V = Design Speed (mph). (see Table 2.1)
e = Rate of superelevation (0.02 ft./ft. min. to 0.05 ft./ft. max.)
f = Coefficient of friction. (use 0.25 for paved surfaces, 0.125 for non-paved surfaces)

Assuming an average superelevation of 0.035 ft./ft.
R = (25 mph)^2/15*(0.035 + 0.25)
R = 625/4.275

R = 146.2 feet ~ 146 feet

Equation 3. (From WSDOT PTSWF Systems)

$$D = 1.47Vt + \frac{V^2}{30\left[\left(\frac{a}{32.2}\right) \pm \frac{G}{100}\right]}$$

Where:

$D = Sign\ placement\ distance$

$V = Posted\ speed\ (mph)$

$t = Perception\ /\ reaction\ time\ (1.5\ s)$

$a = Deceleration\ rate\ (10\ ft/\sec^2)$

$G = Grade\ (\%)$

Using **Equation 3** and the variable assumptions, the sign placement distance (D) was calculated for the U.S. 75 PTSWF signs as follows:

V = Posted Speed (U.S. 75) = 55 mph, Assume G = 0%

D = 1.47(55mph)(1.5s) + (55mph)^2/(30((10/32.2)+-(0/100)))

D = 122 +- 325 = 447 feet ~ 450 feet

D = 450 feet

Appendix C. Tables and Figures

Table C.1. Project Cost Estimation

Reference #	Item	Description	Crew Type	Daily Output	Labor Hours	Units	Total Cost Per Unit	Total O & P Cost Per Unit	Location Factor	Quantity	Project Total
32 12 16.14 0030	5" Thick Asphalt Pavement	6" Stone Base, 3" Binder Course, 2" Topping	B-25C	9000	0.005	S.F.	$3.20	$3.61	0.879	49,260	$156,311
32 12 16.14 0055	8" Thick Asphalt Pavement (Asphalt Trail)	6" Stone Base, 4" Binder Course, 2" Topping	B-25C	9000	0.005	S.F.	$4.45	$4.99	0.879	2,060	$9,036
32 12 16.14 0055	8" Thick Asphalt Pavement (Concrete Trail)	6" Stone Base, 4" Binder Course, 2" Topping	B-25C	9000	0.005	S.F.	$4.45	$4.99	0.879	1,430	$6,272
32 06 10.10 0300	5" Thick Concrete Pavement	Concrete, 3000 psi, CIP, 6x6-W1.4xW1.4 mesh, 5" thick	B-24	545	0.044	S.F.	$4.16	$5.40	0.879	49,260	$233,818
NA	8" Thick Concrete Pavement	Concrete, Cast in Place, 4000 psi	NA	NA	NA	C.Y.	$86.80	$97.50	0.879	16	$1,371
03 21 11.60 2410	Reinforcing Steel	Dowels, 2 Feet Long, Deformed, #4	2 RODM	480	0.033	Ea.	$2.46	$3.52	0.879	42	$130
32 11 23.23 0100	Base Course - Concrete	Crushed 3/4" stone base, compacted, 6 " deep	B-36C	5000	0.008	S.Y.	$5.82	$6.55	0.879	5,474	$31,516
32 31 13.20 0920	8' Fence	8'H, 6 ga. wire, 2-12" line post, galv. steel, in concrete	B-80C	180	0.133	L.F.	$37.51	$43.50	0.879	2600	$99,415
32 93 43.20 0100	Ash Tree	Ash, 2" Caliper	B-17	8	4	Ea.	$258.00	$340.00	0.86	15	$4,386
32 93 43.20 0800	Elm Tree	Elm, 8'-10'	B-17	20	1.6	Ea.	$190.50	$232.00	0.86	15	$2,993
32 93 43.20 1600	Red Maple Tree	Red Maple, 8'-10', 1"-1 1/2" Caliper	B-17	10	3.2	Ea.	$398.00	$485.00	0.86	15	$6,257
32 93 43.20 1800	Oak Tree	Oak, 2 1/2" - 3" Caliper	B-17	6	5.33	Ea.	$553.00	$680.00	0.86	15	$8,772
32 93 43.20 2300	Poplar Tree	Poplar, 9'-11', 1 1/4" Caliper	B-17	10	3.2	Ea.	$238.00	$305.00	0.86	15	$3,935
G1010 120 0980	Clearing & Grubbing	NA	NA	NA	NA	Acre	$6,900.00	NA	0.879	2	$12,130
G1010 122 1400	Strip Topsoil	200' haul 1101-4000 S.Y., by Dozer	NA	NA	NA	S.Y.	$0.59	NA	0.879	5366	$2,783

32 92 19.14 0900	Seeding	Bluegrass, Tractor Spreader	B-66	52	0.154	M.S.F.	$25.35	$31.00	0.879	34.5	$940
10 14 53.20 1300	Traffic Signs	24" x 24" high intensity stock sign	B-80	70	0.457	Ea.	$91.15	$110.00	0.879	25	$2,417
10 14 53.20 1500	Sign Post	10'-0" bolted galvanized steel	B-80	200	0.16	Ea.	$42.70	$50.50	0.879	25	$1,110
32 33 43.13 0100	Site Seating	Park bench, precast conc., w/ wood back rail 8' long	NA	4	4	Ea.	$1,105.00	$1,275.00	0.86	3	$3,290
31 05 13.10 0200	Cut and Fill	Spread 200 H.P. Dozer, No Compaction, 2 mi. Haul, Common Borrow	B-15	600	0.047	C.Y.	$19.01	$22.00	0.879	203	$3,926
NA	Garbage/Pet Waste Recepticles	NA	NA	NA	NA	Ea.	$100.00	$100.00	NA	3	$300
32 17 23.13 0020	Paint Markings	Acrylic waterborne, white or yellow, 4" wide, less than 3000 L.F.	B-78	20000	0.002	L.F.	$0.27	$0.34	0.879	750	$224
NA	ADA Detectable Warnings and Installation	NA	NA	NA	NA	Ea.	$500.00	$500.00	NA	8	$4,000
NA	Railroad Crossings	Railroad Work	NA	NA	NA	Ea.	$15,000.00	$15,000	1	2	$30,000
NA	Mobilization/ Traffic Control	NA	NA	NA	NA	L.S.	$35,222	NA	NA	1	$35,222
										Project Total Asphalt =	$387,445
										Project Total Concrete =	$495,206

Table C.2. Annual Cost of Asphalt (10 Year Life)

Asphalt Costs											
Reference #	Item	Description	Crew Type	Daily Output	Labor Hours	Units	Total Cost Per Unit	Total O & P Cost Per Unit	Location Factor	Quantity	Project Total
32 12 16.14 0030	5" Thick Asphalt Pavement	6" Stone Base, 3" Binder Course, 2" Topping	B-25C	9000	0.005	S.F.	$ 3.20	$ 3.61	0.879	49260	$ 156,311.00
32 12 16.14 0055	8" Thick Asphalt Pavement (Asphalt Trail)	6" Stone Base, 4" Binder Course, 2" Topping	B-25C	9000	0.005	S.F.	$ 4.45	$ 4.99	0.879	2060	$ 9,036.00
											$ 165,347.00
										Yearly Cost (10 Years) =	$ 16,534.70

Table C.3. Annual Cost of Concrete (20 Year Life)

Concrete Costs											
Reference #	Item	Description	Crew Type	Daily Output	Labor Hours	Units	Total Cost Per Unit	Total O & P Cost Per Unit	Location Factor	Quantity	Project Total
32 12 16.14 0055	8" Thick Asphalt Pavement (Concrete Trail)	6" Stone Base, 4" Binder Course, 2" Topping	B-25C	9000	0.005	S.F.	$ 4.45	$ 4.99	0.879	1430	$ 6,272.00
32 06 10.10 0300	5" Thick Concrete Pavement	Concrete, 3000 psi, CIP, 6x6-W1.4xW1.4 mesh, 5" thick	B-24	545	0.044	S.F.	$ 4.16	$ 5.40	0.879	49260	$ 233,818.00
NA	8" Thick Concrete Pavement	Concrete, Cast in Place, 4000psi	NA	NA	NA	C.Y.	$ 86.80	$ 97.50	0.879	16	$ 1,371.00
03 21 11.60 2410	Reinforcing Steel	Dowels, 2 Feet Long, Deformed, #4	2 RODM	480	0.033	Ea.	$ 2.46	$ 3.52	0.879	42	$ 130.00
32 11 23.23 0100	Base Course - Concrete	Crushed 3/4" stone base, compacted, 6" deep	B-36C	5000	0.008	S.Y.	$ 5.82	$ 6.55	0.879	5474	$ 31,516.00
											$ 273,107.00
										Yearly Cost (20 Years) =	$ 13,655.35

Appendix D. Specifications

Specification D.1. At-Grade Rail Crossings (Union Pacific Section 7.1)

7.1 At Grade Crossing

The Railroad does not allow at grade Trail crossings. Alternative plans should be considered to avoid crossing Railroad tracks at grade. At grade crossings immediately adjacent to an existing public roadway crossing with existing Highway Railroad warning devices may be considered. However, all costs associated with the installation of the new crossing surface and crossing warning device changes or relocation will be borne by the Applicant. Scope of proposed crossing work will be determined at a joint diagnostic meeting between the Railroad and Applicant. The Trail must conform to Railroad and MUTCD requirements.

Specification D.2. Trail Width (From SUDAS Section 12B-2)

C. Shared Use Path Design Elements

The following considerations should be used as a guide when designing shared use paths.

1. **Width:** A bicyclist requires a minimum of 4 feet and a preferred 5 feet of essential operating space based upon their profile. The typical path width is 10 feet to accommodate two-way traffic. Consider wider paths (11 to 14 feet) when at minimum one of the following is anticipated:
   - User volume exceeding 300 users within the peak hour.
   - Curves where more operating space should be provided.
   - Large maintenance vehicles.
   - There is a need for a bicyclist to pass another path user while maintaining sufficient space for another user approaching from the opposing direction. 11 feet is the minimum width for three lanes of traffic.

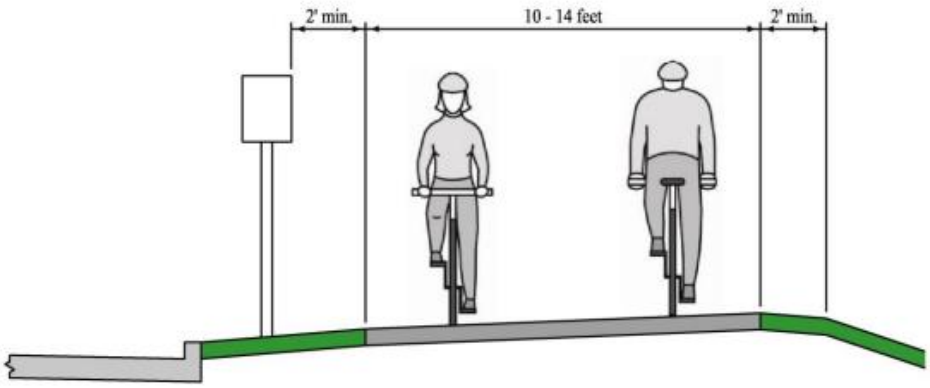
   Path width can be reduced to 8 feet where the following conditions prevail:
   - Bicycle traffic is expected to be low.
   - Pedestrian use is generally not expected.
   - Horizontal and vertical alignments provide well-designed passing and resting opportunities.
   - The path will not be regularly subjected to maintenance vehicle loading conditions.
   - A physical constraint exists for a short duration such as a utility structure, fence, etc.

   Path widths between 8 and 5 feet should be avoided; paths less than 5 feet do not meet ADA requirements.

Specification D.3. Design Speed Selection (From SUDAS Section 12B-2)

Terrain	Design Speed (mph)
Grades less than 2%	18
Grades less than or equal to 5%	25
Grades 6% and more	30

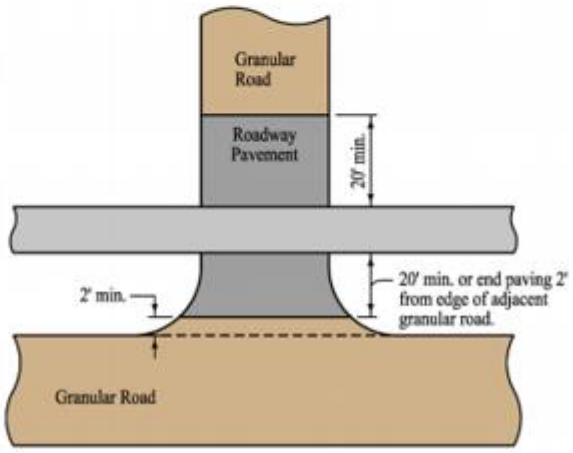
Specification D.4. Horizontal Clearance (From SUDAS Section 12B-2)



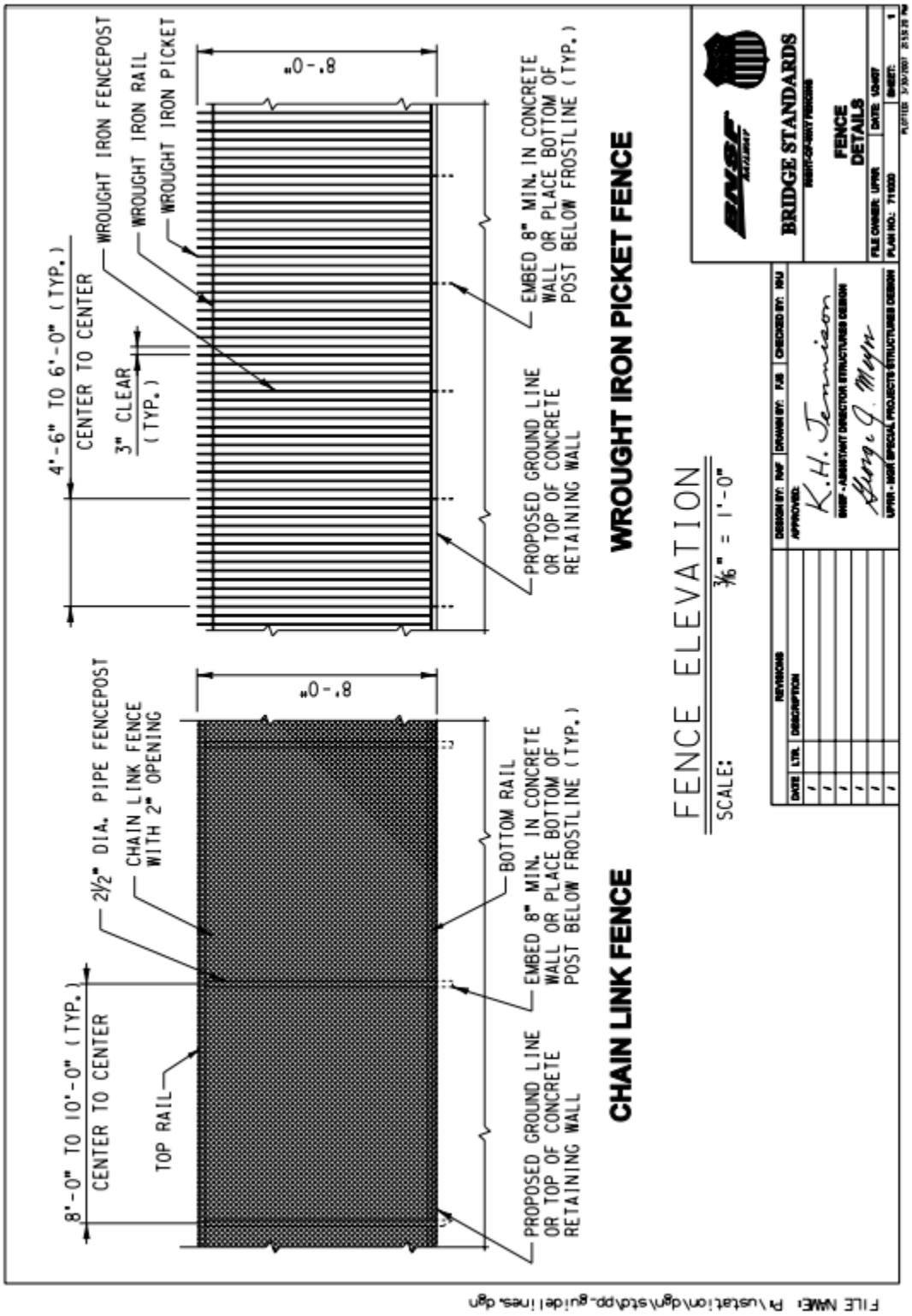
Specification D.5. Unpaved Surface Crossing (From SUDAS Section 12B-2)

F. Crossings at Unpaved Surfaces

When crossing an unpaved roadway, alley, or driveway, a minimum of 20 feet in addition to the path width should be paved on each side of the path to reduce the amount of gravel tracked onto the path. If edge of parallel unpaved roadway is less than 20 feet from the closest edge of the path, only pave to within 2 foot of edge of the parallel unpaved roadway. The thickness of the path and adjacent roadway paving should be designed to accommodate vehicular traffic and meet the requirements of the agency responsible for the roadway.



Specification D.6. Fencing (From Union Pacific Section 7.5)



Specification D.7. Separation of Roadway and Path (From SUDAS Section 12B-2)

Separation of Roadway and Path: A separation should be provided between a two-way shared use path and the adjacent roadway to demonstrate to both the bicyclist and the vehicle driver that each facility is independent of the other. This is particularly important at night. If the separation from the face of the curb or the edge of the traveled way to the near edge of the path is less than 5 feet, a barrier or railing is recommended. The barriers or railings need not be of the size and strength to redirect errant motorists unless a crashworthy barrier is needed due to high speeds and clear zone requirements. Barriers at other locations serving only as a separation should be the height of standard guardrail.

If needed, barriers and railings should be used, but since they can create considerable concerns in urban areas due to aesthetics, visibility, and maintenance problems, it may be necessary to initiate the documenting exceptions process (Section 12B-2, A, 2). The separation between the face of the curb and the path should be maximized, but with the presence of the curb, some landscaping area, and street lighting, the overall objectives of the separation can be satisfied.