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USI Cross Country Trail Design

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ACKNOWLEDGEMENTS

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Coach Mike Hillyard – Cross Country Coach

Coach Austin Nolan – Assistant Cross Country Coach

Joe Gratz – Assistant Director of Intramurals

Dr. Jason Hill – USI Professor

Dr. Adam Tennant – USI Professor

ABSTRACT

The project's purpose was to create a new and improved cross-country trail that can be used by local high schools and grade schools, and a practice course for the university. The current cross-country trail consists of drainage issues, rough terrain, too many choke points, and landcover with gravel spread throughout, which is not allowed for a trail.

The project started with multiple meetings with the group between the two cross country coaches in Coach Hillyard and Coach Nolan, the university's safety manager in Brian Morrison, and the university's director of intramurals in Joe Gratz. The team then had some clearing down around the trail to create an easier surveying method. Once the clearing was done, the team surveyed the entire trail and surrounding grass fields that could be used. The survey will help create an alignment of the trail, data for culvert sizing, and measurements of other important factors throughout the project. As mentioned above, a culvert analysis was completed for three separate areas that either had an existing ditch or needed a ditch to control flooding. Finally, an estimate was completed for the entire project and a plan set was created that consists of the alignment, culvert analysis, clearing and grubbing, and cut and fill areas.

The design produced many results from the plan set, culvert analysis, and bid estimate. The plan set came out to a total of seven sheets and displays all the important factors the project consists of. The culvert analysis produced pipes with sizes of six and eight inches that will all be twenty-five feet in length. The bid estimate was $45,346, and hopefully the university will use this as a budget when they decide to complete this project. The ability to create multiple meetings, complete the surveying, create the plan set, analyze the drainage problems, and produce an estimate were all great experiences.

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TRAIL DESIGN AND IMPLEMENTATION

1 INTRODUCTION

The University of Southern Indiana owns a dilapidated trail on the south side of campus. This location is in the same location as their disc golf course and runs through it as well as the forest behind it. The project idea came from a local contracting company in the area, which the team heard about and wanted to use as a senior design project. The project is creating a course for USI cross-country's team to practice on and opportunities for local high schools in the area. Once the team examined the trail, it was clear it maintained groundwork and drainage issues.

2 PROJECT SCOPE

This project's scope covers various aspects of pre-design work, trail design, culvert analysis, and cost estimate. To address each area of the project, the trail design was led by Darek Reuter, while the culvert design and cost estimate was led by Dalton Folz. Clearly, the aspects involved multiple processes and teamwork in these areas, therefore both partners are familiar with each area.

The first step of the project was to develop meetings between the people involved. During the fall semester, that was the team's goal. Brian Morrison, Joe Gratz, Coach Hillyard, and Coach Nolan were all key meetings for the team in understanding what the university wanted to achieve, but also what attributes the cross-country coaches desired to see on their trail. This was a major step in the project because it is where the team developed the idea of the trail and helped the team figure out exactly what needs to be produced from this design.

For the trail design, it was obvious the team needed a lot of data from the trail. Therefore, surveying was completed at the beginning of the fall semester to create an alignment of the trail and point out important features in the trail.

For the culvert analysis, three areas were examined for an addition of one culvert in each. Many resources were used to find the data needed in the step of the project. The rational method was used to find the flow rate and Manning's equation was used to size the pipe.

For the cost estimate, HeavyBid was used to create the entire estimate using labor, material, and equipment. A master crew was developed within the team and a bid schedule was put together. The estimate was developed on field experience and material costs from suppliers.

The design completed meets all the coaches' criteria, along with the university's wishes. Therefore, with the design completed, the team will again reach out to Brian Morrison and University of Southern Indiana to provide them with the complete design, along with the cost estimate, and see if they would like to move forward with the design created.

3 TRAIL BACKGROUND

3.1 PRELIMINARY DISCUSSIONS/MEETINGS

Before starting a design for the USI Cross Country trail, meetings were held to plan for the main goals desired by the university for the project. To get a list of parameters for the trail, the team reached out to Bryan Morrison and Mike Hillyard who work for USI. Bryan Morrison is the Environmental Health and Safety manager for USI and works with USI on budgets for any project that deals with ground crews and athletic expansions. Bryan was the team's initial contact for the course and discussed USI's desire and need to pursue the project. Mike Hillyard is the USI division 1 cross country coach and the team spoke with him to find out what the needs of the cross-country team were to be for the trail.

The first meeting with Bryan was in October of 2023 where he took the team on a walk through the area that USI was considering for the course and mentioned the importance and need of revitalization for this area. Through this discussion, the team found out that the current place, Angel Mounds, that the USI cross country team currently runs will no longer allow anyone to run there starting in 2025. Bryan explained the running team would need a new place by 2025 and explained that he was eager to see what ideas the design team could come up with to make a functional running area at USI in a cost-effective way. He gave the group his contact information to easily get questions answered when it came to any parameters the University had in terms of design expectations and budget. Bryan also gave the group a USI property boundary map to see how large of an area USI had for the team to work with for the course. He then directed the team to reach out the Mike Hillyard to discuss what needs the cross-country team at USI would have for the area.

The team met with Coach Hillyard in November of 2023 with Bryan present for the meeting. The Coach explained that the Cross-Country team would mainly use the trail at USI as a practice area or for very small meets as USI does not have a possible running area that would be large enough to sustain the rules of big cross country meets. The team then discussed with the coach about what the USI trail will need to be up to his standards and meet the guidelines for the small meets his team could possibly host. The last preliminary meeting was held in December 2023 to discuss any follow-up questions about the goals and parameters of the projects that the team had for Bryan and the Coach.

3.2 GEOGRAPHIC LOCATION

The geographic location of the trail is within the University's campus as shown in the image below. Part of the trail will overlap the USI disc golf course to create an ease of access to runners and the public. It will also have public parking access through USI Lot F for runners to park.

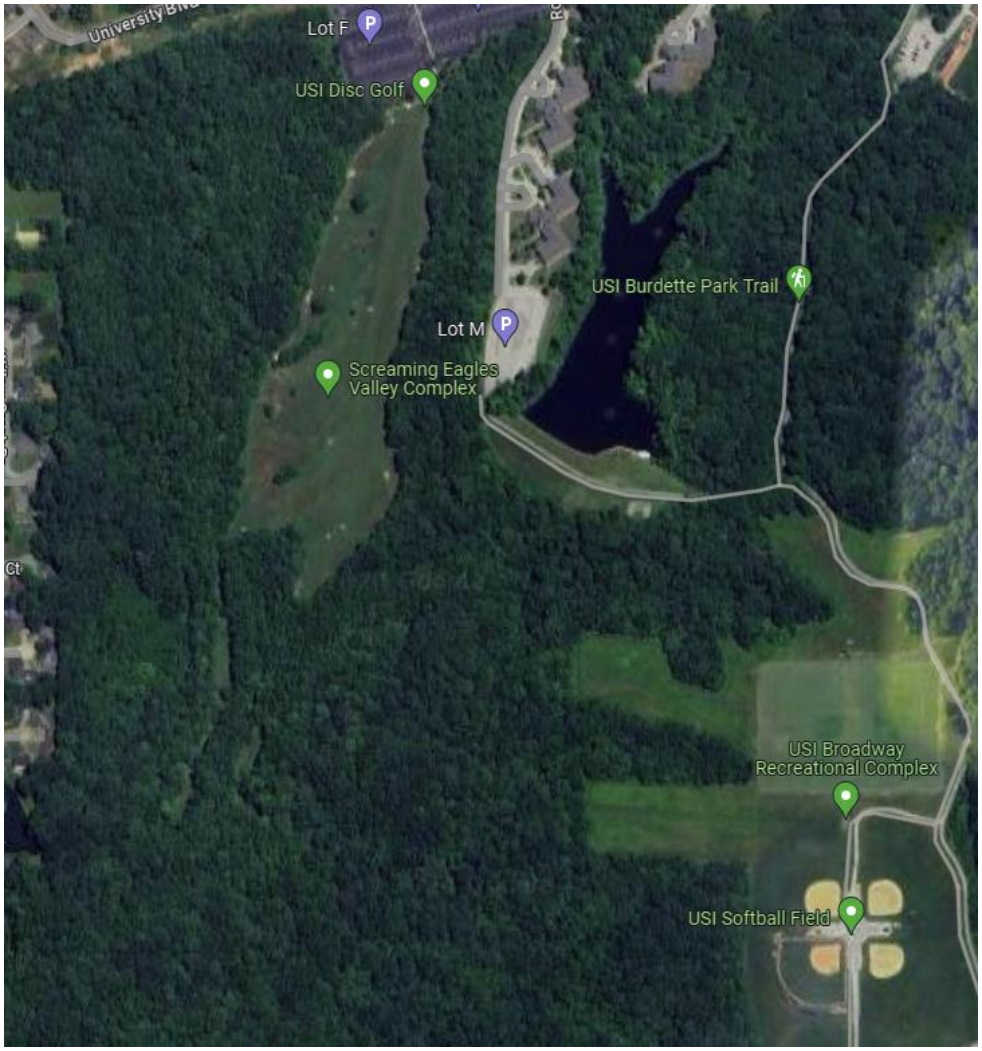

Figure 1: Geographic Location of Trail

The reason this part of USI was selected for the trail is due to the existence of a past Cross Country Trail here over a decade prior. The old trail was not maintained, causing new plans to make these areas usable. The lack of maintenance caused overgrowth, drainage issues, and groundwork needs seen through the initial walk throughs of the site and become key parts to address in the trail's design.

3.2.1 Cross Country Standards

When meeting with Coach Hillyard, standards for the cross-country trail were discussed. Coach Hillyard explained that standards are different depending on what the trail is used for such as small or large meets, men's or women's running, and for different age groups. The standards the coach wanted the team to follow when designing the trail was to keep a minimum width of fifteen feet and to use fine limestone on any area that needs to be covered. He also explained the desire for multiple distance possibilities when using the trail. These varieties of distances could be altered using ribboning and temporary posts. Also, temporary matting could be used in any needed area that needs to be covered such as disc golf slabs. The main goal of the design for him was to maintain the fifteen-foot minimum width throughout the trail. The coach explained that a larger width is even better, if possible, in areas where runners would be more likely to be close together such as in the beginning of the trail. This reflects the need to prevent any sharp turns or choke points in the beginning area of the trail. He also mentioned the largest running distance he would need is 5 miles so that became a goal of the project.

3.2.2 USI Design Expectations

The USI cross country trail design expectations were set from meetings with Bryan. The expectations set by USI were to present a design that was cost effective while still making the Trail usable for the cross-country team. Bryan Morrison also wanted the team to use as much of the older trail areas as possible without the removal of very large or mature trees. Bryan wanted to preserve as much of the natural look of the USI forested area as possible. The design also needed to be manageable for USI to finish before the University could no longer use Angel Mounds in 2025. Another stipulation USI added was that maintenance for the trail in the future would need to be subcontracted due to lack of grounds staff currently at the University. This makes sure that the trail will be maintained without the need for USI to add on more permanent staff.

Another goal the team had for the design after discussions with Bryan was to make this design usable for the public and younger cross-country runners. A new entranceway is something that the group agreed would help advertise the new trail and bring more people to see the campus which could result in more future enrollment. Bryan agreed that USI would allow for other

schools and younger students to have use of the trail in the future. Other school's cross-country runners and the public will be able to run on this trail.

3.3 PROJECT SCHEDULE

The project schedule was broken up into seven different phases: Brainstorming, Planning, Surveying, Designing, Culvert Analysis, Cost Estimate, and the Deliverables. These seven phases are important because they kept the project on track and helped the team stay organized while designing the cross-country trail.

Project Timeline

Activity	Start	End	Notes
Brainstorming	8/30/2023	10/25/2023	Research Contacts, Visit Site, Develop Scope and Parameters, Project Overview
Planning	11/1/2023	1/29/2024	Meetings, List of Equipment, Finalize Schedule
Surveying	9/14/2023	12/17/2023	Property Boundaries, Equipment Limitations, Survey Trail and Drainage Data, Examine Data
Designing	1/10/2024	4/1/2024	Trail Alignement, Expansion Areas, Clearing Areas, Groundwork Areas, Seeding/Strawing Areas
Culvert Analysis	1/15/2024	3/15/2024	Watershed Area, Flow Rate, Design Culverts, Assign Material
Cost Estimate	1/10/2024	4/1/2024	Equipment, Labor, Material, Subcontractors
Deliverables	4/1/2024	4/30/2024	Total Budget, Archway Design, Plan Set Sheet

Table 1: Project Timeline

The project started with tracking down the contacts needed at the University and any other outside help the team would need. The team then developed the scope of the project to convey to these contacts once they were needed. After this brainstorming, the planning started to take place. The team then made a list of everything needed to complete the project; from equipment to restrictions to other responsibilities that might come up.

The team officially started working on the project in the surveying phase. The team dedicated one full weekend to survey the entire trail and process the data into AutoCAD Civil3D. Once all the data was processed, multiple phases could be started at once. One team member would start working on the design aspects of the trail, while the other team member would

design the culverts. The survey data was essential in both phases, resulting in productive work throughout the rest of the project. Once these two phases were completed, the cost estimate was created giving a master crew for the entire construction and a list of materials needed to finish the trail. The cost estimate relied on the complete design for quantities, therefore it was one of the last phases of the project. Finally, the last phase of the project was to create the deliverables. These deliverables consist of the plan set created for the University of Southern Indiana and address any questions the university had about the team's design and the process the team took to create it.

4 CROSS COUNTRY TRAIL DESIGN

4.1 SURVEYING

The first step the team took within the project was to conduct a survey. The team chose to conduct a GNSS or global navigation satellite system survey due to the number of points planned to be taken for the layout of the trail. Trimble equipment provided by the University was used to complete this survey. A receiver and tablet were used to document all the points. An eight-hour day was taken by the team to survey over 300 points on the trail and identify any areas of interest or landmarks. About 150 points were taken along the left side of the trail and 150 points were taken along the right side of the trail so that a border of each side could be made when the survey was completed.

Figure 2:Using the GNSS Receiver to Document Survey Point

4.1.1 Surveying Data

The Trimble equipment used for the GNSS survey allowed raw data points to easily be accessed through an excel file on the tablet. This file contained the northing, easting, elevation, and description of each point taken. The excel file raw point data was converted to a csv file to allow for it to be inserted into the AutoCAD CIVIL 3D Program.

Figure 3: Raw Survey Data

4.1.2 Follow Up Meetings and Disc Golf Obstacles

After surveying was completed by the team, a follow-up meeting was had with Bryan to talk about the flow of the trail and some questions for what areas could be used and how to avoid some obstacles such as the Burdette trail, disc gold foundations, and the intramural fields. The team presented the ideas to move a sign that belongs to the disc golf field to allow the trail to flow properly as well as conduct some clearing around the other obstacles. Bryan invited the team to meet with Joe Gratz who oversees the frisbee golf and intramural fields to get permission

for the trail ideas. Joe agreed with the team's proposals and was okay with moving to sign but asked the team not to move any of the disc golf holes. This allowed the team to move forward with the design and decide what areas needed to be cleared to work with the flow that Bryan had agreed with the team on.

4.2 CIVIL 3D

Using Civil 3D, the raw point data file was used to create a trail layout that reflected the parts of the trail and expansive field areas that allowed varying distances as the coach asked. This also allowed the team to make sure no choke points were near the start of the trail for the runners. CIVIL 3D was able to know the location of the trail using the Indiana West Planes datum which was also used when the survey was conducted with the Trimble equipment. The trail layout created using the datum was used to measure any distances and areas needed for the project. Civil 3D was also used to annotate any needed parts on the trail and reflect important information such as the start, finish, and parking areas.

Figure 4: Trail Layout in Civil 3D

4.2.1 Clearing

Using the trail layout, areas where clearing were needed could be more easily noted compared to the previous knowledge when walking the trail. CIVIL 3D helped to confirm the key areas of needed clearing so this information could be communicated back to USI so that they could clear the areas needed to avoid the obstacles discussed in the prior meeting. Along with the tree clearing, that disc golf sign would need to be moved as well as a dog sanitation station on the Burdette Trail. Clearing was needed to avoid two-disc golf holes, the intramural field, and the Burdette trail. Along with these obstacles, more clearing was needed to push the forest line back to give runners even more room as well as to clear out any existing dead trees and limbs that could potentially be a safety hazard for runners.

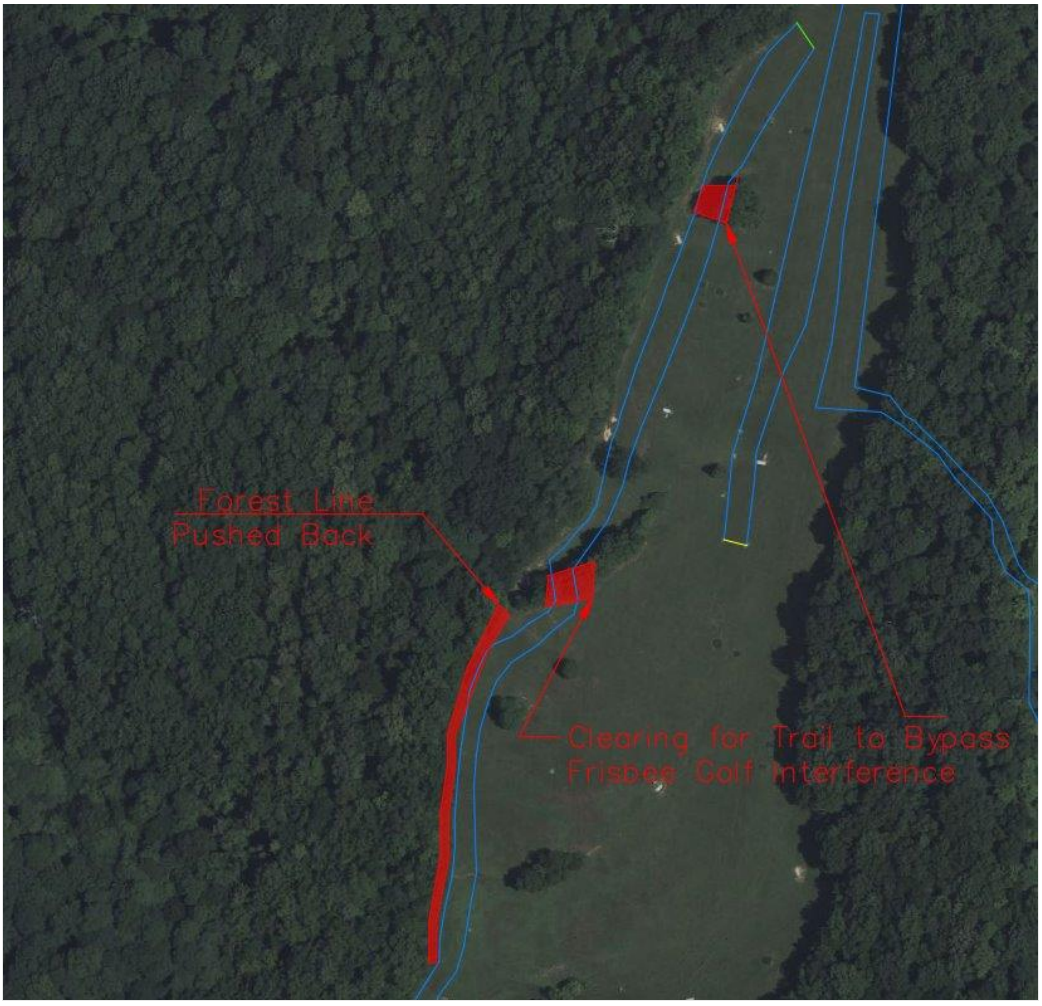

Figure 5: Clearing Area for Disc Golf Holes

Figure 6: Clearing Area for Dead Trees and Intramural Field

Figure 7: Clearing Area for Burdette Trail

4.2.2 Distances

To find the trail's distance, CIVIL 3D was used to get the distance of the left and right side to average, meaning the distances found would be a runner running the trail down the middle.

Table 2: Trail Lengths and Areas

Length and Areas	
	Length (Miles)
Trail Part 1	0.62
Trail Part 2	0.89
	Area (Acres)
Expansion Area 1	2.86
Expansion Area 2	1.27

Due to Coach Hillyard asking for the distances to be variable depending on whose running, the field areas reflected in the Trail layout can be used in different ways to expand or lessen the trail.

Figure 8: Minimum Travel Expansion Area 1

Figure 9: Maximum Travel Expansion Area 1

Figure 10: Minimum Travel Expansion Area 2

Figure 11: Maximum Travel Expansion Area 2

These expandable running areas in the usable fields of the trail can be added when running using ribbon and posts as a temporary boundary for runners to conduct their laps which allows them to meet the distance requirements of the category they're running in. The table below reflects the distances in miles between running the minimum in these areas versus the maximum in these areas.

Table 3: Lengths for Expansion Areas

Possible Length for Areas	
	Length (Miles)
Minimum Travel Expansion Area 1	0.104
Maximum Travel Expansion Area 1	0.620
Minimum Travel Expansion Area 2	0.153
Maximum Travel Expansion Area 2	0.295

The other possibility when running the trail when needing longer distances, is to run it twice. Using CIVIL 3D, it was found that a runback distance from the finish line to the start was

about .17 miles which would need to be added to the total distance when ran twice. Using all these expansion techniques to add variability to the trail, it allowed for multiple distance possibilities for the trail.

Table 4: Distance Possibilities

Total Lengths (Miles)	
Total Milage with Minimum Field Use	1.77
Total Mileage with Maximum Field Use	2.43

Runback Length for Running Twice	0.17
Run Twice with Max	5.02

This table of possible distances reflect that the max use of fields while also running the course twice results in an average distance of 5.02 miles which met the requirement set by Coach Hillyard of a maximum of five miles being needed as a possibility for the trail. Coach Hillyard claimed that this is a main distance that a Men's Cross-country team would need to practice, so this makes the use of the trail as a practice course more appropriate. By reaching five miles, this also means that the trail would be suitable for any length under five miles by using minimum running distances or running it once depending on the category of runner.

4.3 DRAINAGE ANALYSIS

The cross-country trail developed three major areas of concern for drainage issues. These areas were split up into different sections and called out as areas A, B, and C. To give a good idea of where these areas are located, the team has an aerial view of trail calling all three of these areas out and have these areas shown up close below. The analysis started out with an inspection of the drainage issues, a watershed delineation of the areas of concern, and then a sizing of the culverts needed.

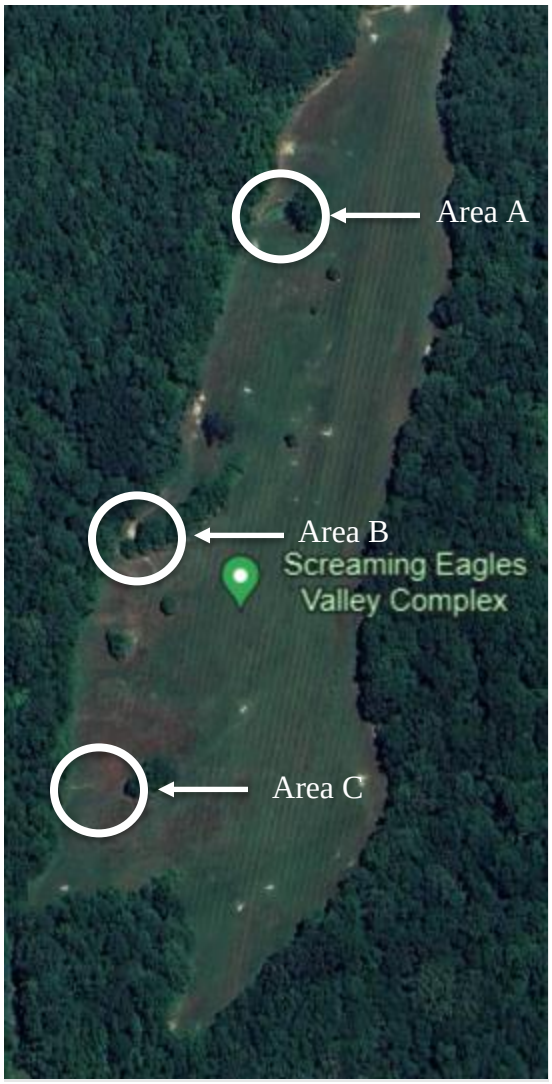

Figure 12: Drainage Concern Areas

4.3.1 Watershed Delineation

The watershed delineation was found by looking at the elevation of the surrounding areas and using these elevations to show what all the water in these specific areas are flowing to. Due to these estimations, the total area was calculated in AutoCAD Civil3D for values of 0.372 acres in Area A, 0.470 acres in Area B, and 0.561 acres in Area C. All three of these areas are pictured below, and as shown in each, there is a need for a culvert addition and the surrounding elevation in the area. In Figure 13 and Figure 14, the areas start at the top of the hill and run down into the ditches before they reach the culvert location. This is why sheet flow is considered at the start of the runoff path and then switches to shallow concentrated flow after one-hundred feet. In Figure 15, the area is a little different since the ditch created was from erosion and wasn't man-made,

therefore causing rough terrain across the whole area. The type of flow was also sheet and shallow concentrated flow here, due to the wide-open pasture of grass before the culvert would be inserted. Once these watersheds were developed, a culvert analysis would need to be done to size all three culverts.

Figure 13: Drainage Area A

Figure 14: Drainage Area B

Figure 15: Drainage Area C

4.3.2 Culvert Sizing

The sizing of culverts was necessary in this project due to the ditches that run through the trail in Areas A and B, and the excess flooding in Area C. The first step to sizing the culverts was by finding the time of concentration for each area.

$$Tc = \frac{0.007(nL)^{0.8}}{i^{0.5}S^{0.4}}$$

Equation 1: Sheet Flow Time of Concentration

$$Tc = \frac{length}{velocity}$$

Equation 2: Shallow Concentrated Flow Time of Concentration

Then, the total of these two times for each area is the final time of concentration. Also, the terrain was considered a pasture with sheet flow for the first one hundred feet for all three areas and then shallow concentrated flow the rest of the way. Sheet flow is the result of water running over a surface as a thin, even layer, and can only last for one hundred feet until it turns into shallow concentrated flow. Shallow concentrated flow occurs in a concentrated flow path for the water.

For Equation 1, Manning's roughness coefficient was found using the Indiana Local Technical Assistance Program (LTAP) manual, considering a short grass pasture with clay as the soil material. The soil material was found using the Web Soil Survey from the United States Department of Agriculture. As mentioned earlier, the one hundred feet length was used because sheet flow maxes out at this length. The intensity is found using the Intensity-Duration-Frequency (IDF) curve data, which came from the National Oceanic and Atmospheric Administration Weather Service. The slope was found using data from Google Earth.

For Equation 2, the velocity is found using the slope and Figure 4 below; where again, the slope was found using data from Google Earth. The length of the shallow concentrated flow in the equation is found by taking the longest length of the watershed area and subtracting one hundred feet from it. This subtraction is due to one hundred feet of sheet flow used in a different calculation, leaving the rest of it for the shallow concentrated flow calculation.

Finally, the concentration time came out to 5.11 minutes for Area A, 6.46 minutes for Area B, and 5.81 minutes for Area C. These values will now be used in the next step in the process, the rational method.

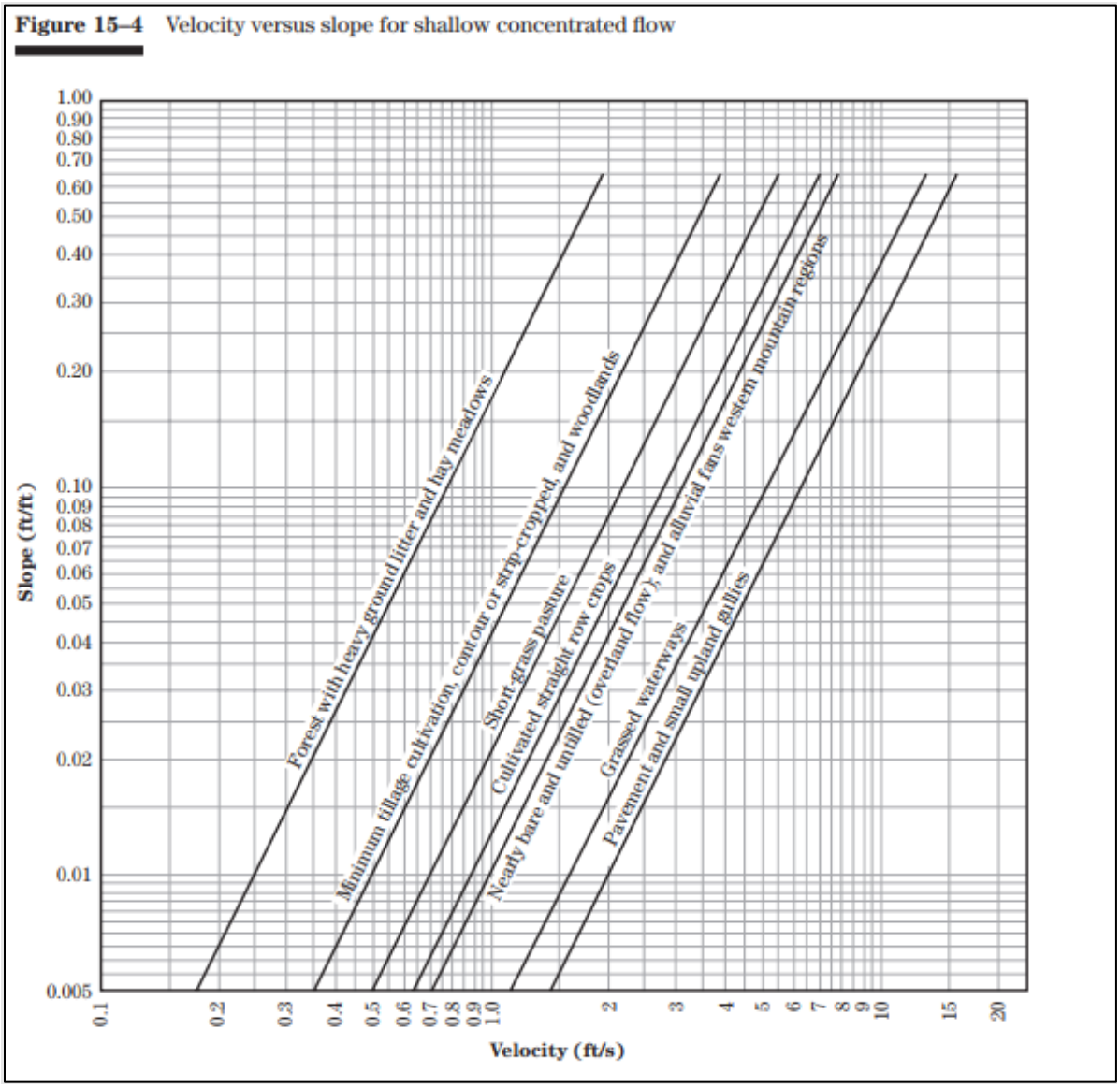

Figure 16: Velocity (ft/s) vs Slope (ft/ft)

Once the time of concentration is found, the rational method can be used to find the flow rate using Equation 3.

$$Q = CiA.$$

Equation 3: Rational Formula

Where C, the runoff coefficient, is found using the LTAP manual. Again, the Web Soil Survey was used to find the soil texture as clay and the terrain is a rolling pasture, which then gives the runoff coefficient a value of 0.55. The rainfall intensity, i, was found by using the time of concentration to interpolate from the data given in the IDF curve from the 5-year flood data from the National Weather Service. The 5-year flood duration was used because this project is a walking trail, knowing that even if the culvert does overflow in a massive rainfall, nothing will be harmed and will not do any damage to the trail. These values came out to be 7.22 inches per hour for Area A, 6.79 inches per hour for Area B, and 6.99 inches per hour for Area C. Finally, the drainage area, A, was found using the size of the watershed delineation areas. These values were 0.372 acres, 0.470 acres, and 0.561 acres for all three areas. Once all these values were plugged into the equation, the flow rate values were 1.48 cubic feet per second for Area A, 1.76 cubic feet per second for Area B, and 2.16 cubic feet per second for Area C.

Since the team now knows the flow rate, the last step of sizing the culverts came when Manning's equation was used to solve the diameter of each pipe.

$$Q = (\frac{1.49}{n})AR^{\frac{2}{3}}\sqrt{S}$$

Equation 4: Manning's Equation

Where the area, A, and the hydraulic radius, R, can both be expressed in forms that use the diameter.

$$A = \frac{\pi d^2}{4}$$

Equation 5: Area Equation

$$R = \frac{A}{P}$$

Equation 6: Hydraulic Radius Equation

$$P = 2\pi\frac{d}{2}$$

Equation 7: Wetted Perimeter Equation

Manning's roughness coefficient was known due to the material of pipe being used, 0.02 for High Density Polyethylene (HDPE) corrugated pipe. The slope, S, of the pipe was found using the change in elevation from the top of where the pipe would start and the bottom where the pipe ends. The team would then take this value and divide it by twenty-five feet, which is the length of every pipe used. Lastly, the goal seek function in Microsoft Excel was used to solve the diameter, which was possible since all the data the team needed could be used in Manning's equation. The pipe diameters came out as 7.01 inches for Area A, 5.24 inches for Area B, and 7.79 inches for Area C. Therefore, the pipe sizes that are needed to complete the project are two eight-inch pipes for Area's A and C, and one six-inch pipe for Area B.

As shown above, the culvert additions were necessary, but just a minor step in the project. These culvert designs will be enforced in the construction of the trail and create an ethical way of controlling the water flow and create an appealing trail with the right care. The addition of these culverts will help control the water flow across the field, but also help keep the smooth terrain through part one of the trail and help maintain the erosion.

4.4 GROUNDWORK

When approaching the project at the start, groundwork was seen as a major problem in multiple areas of the trail. The terrain was rough in some areas, leftover gravel from past projects existed, and some eroded areas needed to be addressed. These are all problems that need fixed before the trail can be run on for safety and maintenance reasons.

4.4.1 Cut/Fill Typical Cross Section

For areas with only rough terrain, the team plans to just use a roller and any seeding necessary to clean these areas, but for the eroded areas and areas with the leftover gravel, more extreme measures needed to be taken. A typical cross section was made for the two main areas with issues which are the straightway and the hill part of the project as shown in the image below.

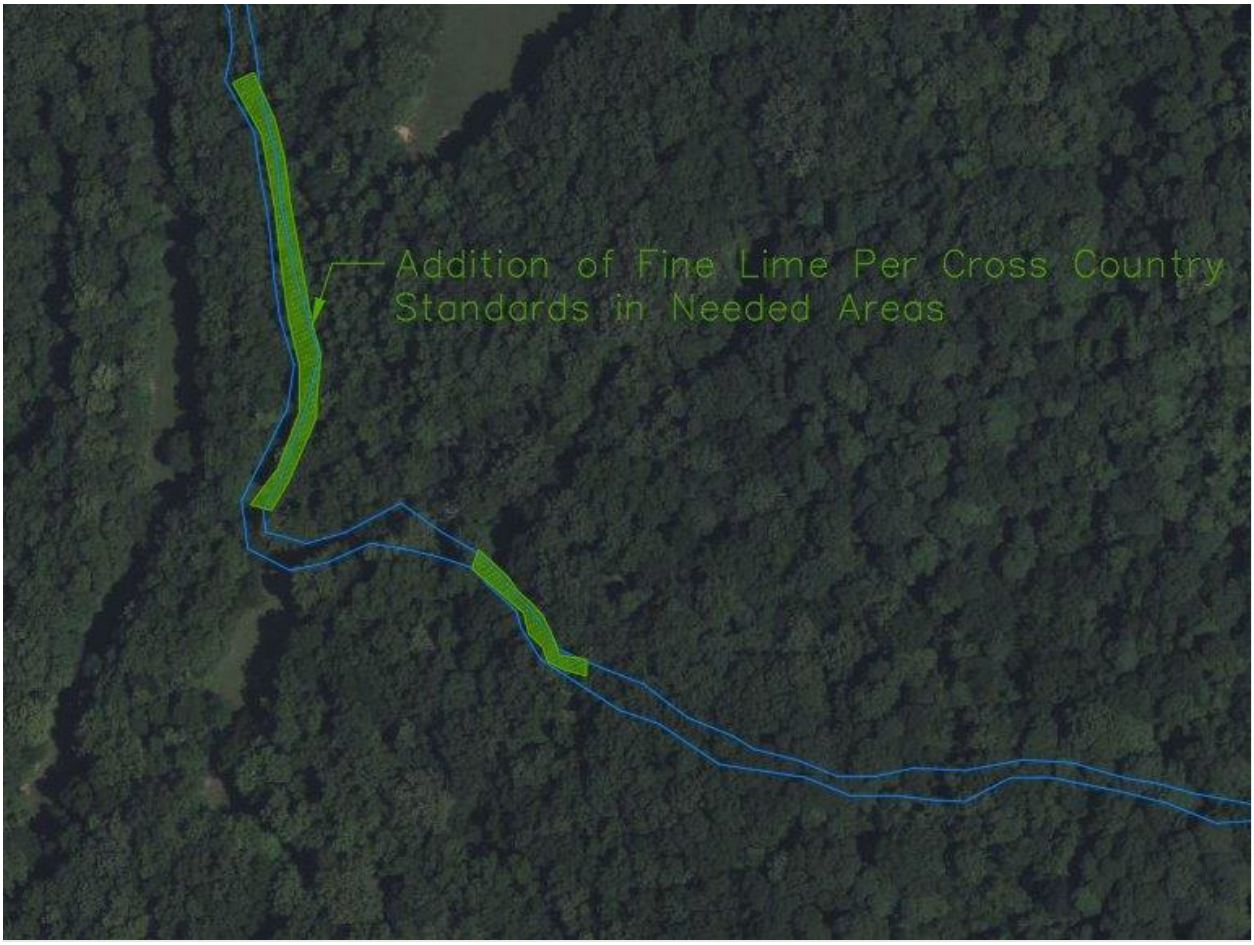

Figure 17: Straightway and Hill Fine Limestone Additions

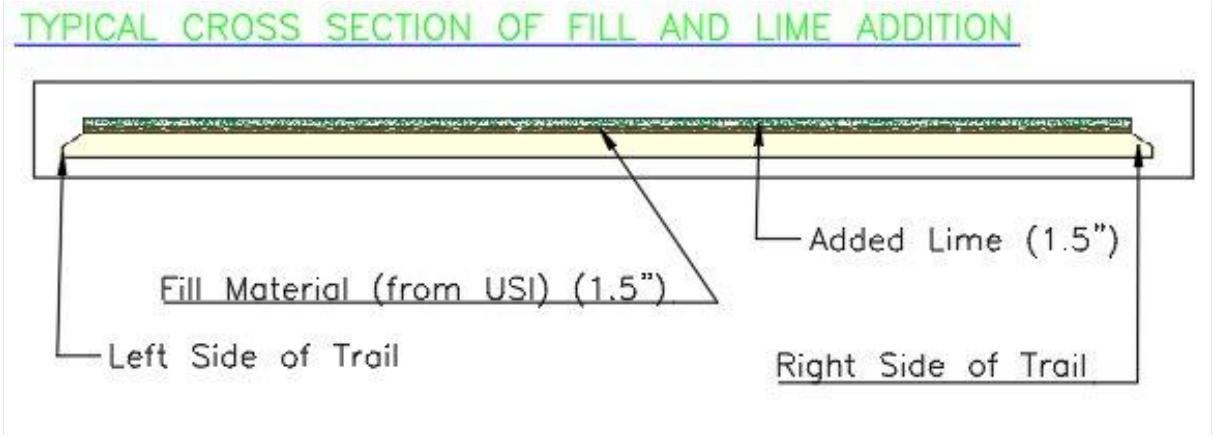

Figure 18: Cross Section of the Trail With Limestone Addition

The typical cross section reflects the team's plans to add 1.5 inches of fill and 1.5 inches of fine limestone on time of these areas with major groundwork needs due to the erosion and leftover gravel. The fill material can be given by USI from a site where they store extra fill material from campus construction projects. CIVIL 3D was used to calculate the needed fill quantities using the areas of the hill and straightway as well as the known needed depth of 1.5 inches. This was then converted into cubic yards.

Table 5: Fill Quantities

Fill Quantities		
Area	Length (ft)	Volume (cyds)
Straightway	467.36	43.27
Hill	169	11.74
Total		55.01

4.4.2 Fine Limestone

Within the trail, any area where the team would want to put gravel instead used fine limestone. These were in those areas on top of the fill material and eroded areas. The reason fine limestone was used is due to cross country standards explained by the coach. Cross Country runners can only run on grass or very fine limestone so there is no pavement or larger aggregates due to safety reasons with the types of shoes the runners where as well as set rules with the University practicing in division one college level.

4.4.3 Seeding

For the areas where clearing was conducted and areas where the ground needed new grass due to rolling the ground to make it flatter for the runners, seeding is needed so that new grass can grow. These areas where the seeding and strawing are needing conducted were made using the CIVIL 3D layout because it will be needed anywhere the clearing was also needed.

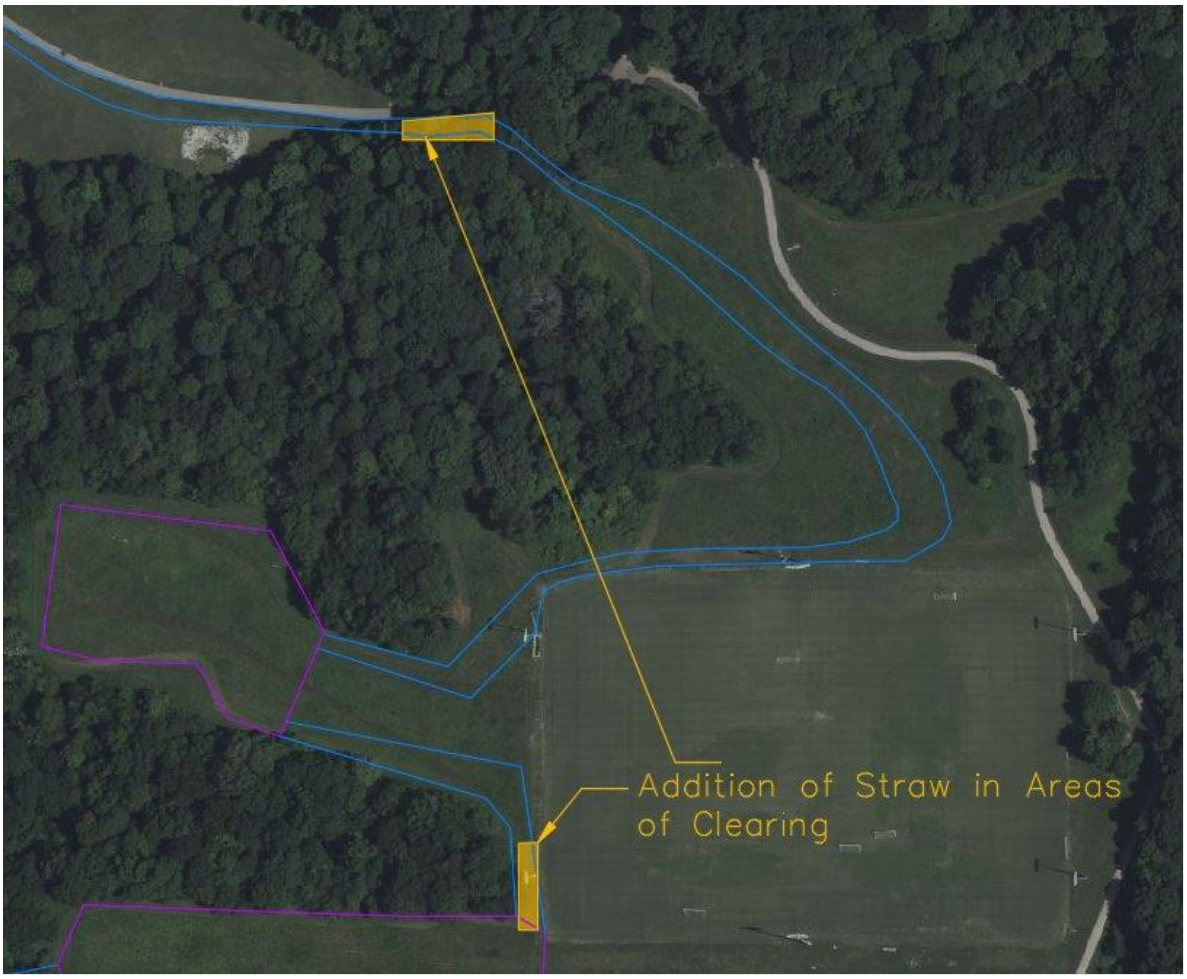

Figure 19: Seeding 1

Figure 20: Seeding 2

4.4.4 Ornamental Bush Additions

One addition Bryan had asked to be added to the trail during the meetings was some form of a permanent marker along the trail in areas where it is possible for the public to know where to run. This would mainly be in the disc golf area. The team decided on the addition of ornamental bushes due to costs and maintenance. They are not costly and do not need much maintenance and are easily seen by anyone who is running the trail.

Figure 21: Ornamental Grass

4.4.5 Matting Establishments

The matting establishment will be done before any cross-country meet is conducted. Coach Hillyard claimed that the team would identify any places where a mat is needed to cover any obstacle such as a disc golf platform or tree root to make sure the runners have a smooth surface. This makes it to where the trail is runnable even if it is not completely perfect. Coach Hillyard claims this is common practice in cross country on any trail that needs it and will not be against any rules of cross country meets.

4.5 ARCHWAY

When meeting with Bryan, he asked the team to figure out an idea for an entrance way for the Trail that would draw attention from the public and provide a marker so people know where they can find the trail. When brainstorming, the team came up with an archway design as it provides aesthetic and meets the guidelines set by Bryan. Using CIVIL 3D, a mockup of an archway that would be an entrance to the field with the trail and disc golf area was designed. It was chosen to be made from brick columns and a metal arch with the needed information Bryan asked for. The design allows for plaques or posters to be added on the brick area if the university chooses as well as adaptable to any size USI decides on for the entrance.

Figure 22: Archway Entrance Mock-Up

5 DESIGN CONSIDERATIONS

5.1 SUSTAINABLE DESIGN

When approaching the project, the team kept a perspective of sustainability in mind. One permanent material that will be sourced for the project is the addiction of fine limestone aggregate. Limestone is found locally which makes it easier to keep maintained and is positive from a sustainability view. From a recovery sustainability view, the project can make use of as many existing structural supports such as the retaining timber on the hills and the existing culverts. From a disposal view, the removed trees can be replaced throughout the property, whether it's through replanting new trees or moving the smaller trees to a new location. The ideas of sourcing, production, use, recovery, and disposal are the main factors the team focused on throughout the project. All these factors will make the project more sustainable and help keep the cross-country trail up to standards.

5.2 PUBLIC HEALTH, SAFETY, AND WELFARE

The cross-country trail design will greatly impact the public health, safety, and welfare due to it constantly being open for public use and the public having the ability to exercise on this trail. Public health will be impacted by letting the runners, walkers, and joggers use this trail as an easy and accessible way to exercise on the trail. Public safety will be impacted due to the secure trail on campus, leaving the trail users the ability to use the trail without danger or a harmful object. The trail will have a smooth ground foundation, with the university providing a ground crew to remove obstacles such as fallen trees and any other debris in the trail. The university also provides public safety throughout the campus, giving protection to anyone on the campus or anyone in need of help. Public welfare will also be affected by the trail because it is a free aspect of the university that the public can use instead of paying for a membership to the gym.

5.3 SOCIAL/LOCAL IMPACT

The trail will have a positive social impact locally as it will add a new place where people can meet to exercise or socialize with others. With USI being a public university and the plan for the trail to also be public, this will cause positive local impact as people of all age groups can use the trail to meet for a healthy activity as well as see the university while using the trail. The trail

also has a wooded and more natural section which can help local people experience nature while using the trail. Overall, the trail should have a beneficial effect on the local community through the addiction of healthy activity in the area.

5.4 ENVIRONMENTAL

The cross-country trail design will also greatly impact the environmental aspects of the areas surrounding it due to the clearing and grubbing areas, groundwork repairing areas, cut/fill and fine limestone addition areas, and seeding and strawing areas. The clearing and grubbing areas affect the vegetation surrounding the trail. Removing trees, bushes, and other shrubs affect erosion and runoff in the area, even if it is just on a small scale. However, the seeding and strawing have a positive impact on the environment due to it being able to grow vegetation where the areas were cleared or other areas that were bare. The groundwork repair areas, cut/fill areas, and fine limestone addition areas all are changing the shape and material of the ground that was once there previously before. However, this will create a positive impact on the environment. With the newly added cut, fill, and fine limestone quantities, drainage will be increasingly better over the area with water flowing down the hills in the ditches on each side and not standing in puddles as it was previously. The fill quantities will also help with the erosion of the trail, giving it a denser material that won't runoff as easily as the previous soil.

5.5 ECONOMIC

The cross-country trail will also provide an economic impact to the University of Southern Indiana. The initial economic impact will be of negative value for the university, considering the budget for the project and all of the materials. However, once the trail was complete and the team could start running on it, the public could start using it, and high schools could have meets on it; the university should see a rise in activity in the area and hopefully a rise in enrollment. This was a major thought from the university when meeting with them about the project; a goal of creating a trail great enough to draw attraction to the university from local schools around the area.

5.6 ETHICAL AND PROFESSIONAL

Throughout the project, the team had a variety of meetings that were conducted in a formal and professional way. The team reached out to the contacts relating to the project for any major

decision made to clear any ideas with them and get their opinions on the matters. When needed, follow-up meetings were conducted. To maintain ethics throughout the project, proper sourcing was used for any important information regarding the project as well as many emails to the contacts asking important questions to prevent assumptions for what the university would want regarding the trail. Professionalism and good manners were a major importance to the team when conducting any meeting or asking any question to contacts or advisors throughout the project.

6 BID ESTIMATE

HEAVYBID

HeavyBid was used as the main resource in creating the cost estimate. HeavyBid is a construction estimating software that can build and review an estimate, as well as manage sub and supplier quotes, material costs and provide important quantities from the entire estimate. The three main aspects in creating an accurate bid are labor, materials, and equipment.

LABOR

The labor used throughout the cost estimate varied between each bid item. However, a master crew was still created to be used for the important bid items during construction. This crew contained labor of a labor foreman, two general laborers, and two operators for the equipment on site. Also, some of the bid items have a modified master crew to complete the construction process.

Figure 23: Labor Crew Example

The labor used throughout the project are in the processes clearing and grubbing process, small and large culverts addition, cut/fill dirt and limestone groundwork, disc golf signs and dog sanitation station replacement, seed and strawing installation, ornamental grasses installation, and the decorative archway installation. The productivity used throughout the estimate was created based on previous field knowledge the team has picked up throughout many summers interning on construction sites. For the clearing and grubbing process, the labor on site would be a foreman, a laborer, and an operator for the

dozer. Using this crew, it was estimated that this bid item would take one full day, which is ten crew hours. The productivity was also based on the quantity cleared and found using AutoCAD Civil3D to measure the takeoff quantity of 0.46 acres. For the culverts being added into the trail design, both bid items used the same crew that consisted of a foreman, four laborers, and an operator for the excavator. The small culverts were estimated to take a full day to complete, while the large culvert replacement was estimated to take a day and a half for the removal and installation process. The cut/fill and fine limestone groundwork bid items both use the master crew to complete the work. Using this crew, the team estimated the cut/fill bid item to take one full day to move and grade the 65.19 cubic yards of dirt on site. The team also estimated the fine limestone bid item to take two full days to get the material onsite down to the correct locations and spread on grade.

Also, the golf sign and bench repositioning, dog sanitation removal, seeding and strawing, and ornamental grasses processes all use the same crew, a foreman and a laborer. The disc golf signs, and bench repositioning has an estimated time of one hour to each object. This time may seem a bit long, however, the team considered that each sign that would be removed had parts, such as the hole description on it, that needed to be saved and used for the refurbished sign. The dog sanitation removal/reinstallation was also estimated to take one hour of work due to the same considerations from before. The seeding and strawing of areas were estimated to be completed in half a day. The time constraint was estimated based on the total area that will maintain grass seed and straw, which was about 0.58 acres. These measured areas were based on what will be torn up from the culvert inserts and clearing, and a couple other areas that already need repair. The ornamental grasses were estimated to take two days to fully complete, based on the assumptions that no equipment would be used, and the crew would use small tools to plant all fifty of these bushes.

Finally, the last bid item to use labor is the archway design. This construction process is a little different than the rest because it will contain one activity that will form up the concrete and place the steel rods, while another activity will be the construction of the brick laying, which will be done by a subcontractor. Therefore, the only labor needed for this item is the concrete and steel work, which was estimated to take a full day. However, the concrete and steel work will not be done at the same time; this is a cumulative bid item, and the full day considers the time for the concrete and the time of the steel installation, which could happen even a day later.

The labor in the project is very consistent with what is already on site and who all will be needed in each construction bid item. The total man hours on the project were 315 manhours, which is the total time of all the work being performed by the crews over the entirety of the project. As the team mentioned before, the labor is just one part of the estimate but is one of the largest factors the estimate relies on.

MATERIALS

The material used in the cost estimate is the next major part of the cost estimate. There are different materials used on the project however, which are construction materials and permanent materials. Construction materials are the materials needed to complete the project, but not stay on the site when the project is completed. However, permanent materials will remain on the construction site even after the construction is completed.

Figure 24: Fine Limestone Material

The bid items that use permanent materials are the small and large culvert additions, the fine limestone, the disc golf and dog sanitation signs, the seeding and strawing, the ornamental grasses, the archway, and the temporary matting establishments. The small culverts used are HDPE culvert pipes at 8-inch and 6-inch diameters. These are all sold in twenty-foot sections, meaning the project would need three sticks of the 8-inch pipe and two sticks of 6-inch pipe, fulfilling the design specification of a twenty-five-foot trail width. The total price of these materials came out to $119.99 a piece for the 8-inch and $79.99 a piece for the 6-inch pipe. The large, corrugated metal pipe came out at a price of $149.00 per linear foot for a 48-inch diameter. This was the only material that the team needed to reach out via email to a different company for. Contech Solutions gave the team this quote and will fabricate the metal pipe to the project's needs. A corrugated metal pipe was used because it needs to be strong enough to hold up the load of runners and the overhead load of dirt. The load the pipe can carry is 550 pounds per inch of the pipe circumference. Also, a corrugated metal pipe is the most reasonable material with that size of diameter.

The fine limestone material will be spread in two different areas of the trail, coming out to 12.02 tons. The estimated cost came to a value of thirty-five dollars per ton. Limestone is used because any material put on a cross-country trail must be a very fine material due to the college cross-country limitations. The disc golf and dog sanitation bid items both have an estimated cost of one-hundred dollars each for construction materials such as small tools and any lumber needed in pouring the concrete. The disc golf signs also have a small cost of thirty dollars for lumber needed if any of the signs are damaged in the repositioning process. The dog sanitation post also has a small concrete cost of five dollars because one bag will be needed when pouring the post. The next bid item that uses permanent materials is the seeding and strawing. The total area was measured so the team could get a rough estimate of how many straw bales, bags of seed, and fertilizer to use, which came to totals of three bags of fifty-pound grass seed, six bags of twenty-pound fertilizer, and sixty-five straw bales. The grass seed material cost came at $37.77 a bag, the fertilizer cost came at $16.97 a bag, and the straw bales cost came at $6.00 a bale. The ornamental grasses are an aesthetical material that the university wanted added along the trail. The grasses were estimated to be about fifty needed throughout the trail at one every fifty feet on each side. The total cost of these grasses is ten dollars apiece. The temporary mattings used are for the disc golf concrete slabs that interfere with the trail. There will only be three of these mats needed for temporary use, coming at a cost of $34.29.

Finally, the last bid item that uses material is the archway. The archway uses bricks, brick mortar, concrete, steel rods, and steel letters. However, the brick laying materials will be laid by a subcontractor. The concrete used was four bags at $4.50 apiece. This concrete will be poured as a base for both brick posts. The steel letters used will spell out “University of Southern Indiana Cross Country and Disc Golf.” Using a steel fabrication shop, these letters will come out to a total cost of $4393.81 for the entire phrase. The steel rods these letters will be welded to are measured at ten-foot lengths and cost $310.23 for nine pieces. The steel rods will span across the two brick posts in a half-circle like shape, as shown in the design picture.

The material used throughout the cost estimate came from multiple different sources, as shown in the citations of the report. HeavyBid’s ability to total all these material costs, along with the amount of each material product, makes it easy to create an estimate with just an entry of all the data. Besides having to search and ask for quotes, the material costs are one of the simplest parts of the estimate.

EQUIPMENT

Figure 25: Dozer and Excavator

The equipment used in the cost estimate was very consistent throughout each bid item, whenever equipment was needed. The reason behind this is due to the extra cost behind bringing in different pieces of equipment for each bid item, it would just be unreasonable. Therefore, the main pieces of equipment on site are provided in the master crew as a CAT D6 Dozer and a CAT 205 Long Carriage (LC) Excavator. However, even though these are the two in the master crew, there are also other pieces of equipment that will be on site during this project's construction.

The bid items that use equipment are the clearing and grubbing, small and large culvert additions, cut/fill and fine limestone groundwork, golf signs relocation, and seed and strawing. The clearing and grubbing bid item uses the excavator from the master crew, a dump truck, and pickup truck. This equipment was based off the crew that HeavyBid provided for a medium sized clearing crew. The small and large culvert additions crew was taken from a crew provided by HeavyBid and was modified with the correct equipment, which was the excavator that will always be on site. The excavator was also checked to make sure it was strong enough to lift the corrugated metal pipe for the large culvert removal and addition. The excavator's lifting capacity was 9000 pounds, while the culvert only weighs 2300 pounds. Also, the cut/fill and fine limestone groundwork bid items both use the same equipment because they both use the master crew to complete the process. The master crew was chosen due to the ability for the excavator and dozer to move dirt and stone efficiently but also grade the stone to what the design constraints call for. Finally, the last bid item that uses equipment is the seeding and strawing of the trail. The only piece of equipment on this item is a pickup truck with the ability to pull a trailer throughout the trail to make it easier for the crew to spread grass seed, fertilizer, and straw.

HeavyBid was a great resource in estimating all of the equipment on the project and the cost of all of it. All this equipment pricing came from HeavyBid's resources provided in the system, as did some of the crews. The team also estimated the mobilization for each piece of

equipment from a local contracting company's main office. These calculations all required the distance from the project site to the office, the drive time, and the number of trips/equipment needed.

SUBCONTRACTORS

The final part in creating the cost estimate was the addition of subcontractors. The construction survey and staking were used as a subcontract, even though the design team completed this process, and the archway brick posts labor and material were used as subcontracts. The construction survey and staking were totaled as a subcontractor because it was a feasible way to sum up the cost of the work completed by the team in the field. The quote came in at $5,100. The archway brick posts were also subbed out because brick laying is a technique that the team has never experienced, therefore the team would not be able to estimate this cost. The ability to subcontract this work out will make it easier for the crew on site, but also give the university a fair price on what the activity would cost. The quote came in at $9,600, with a unit price of $30 per square foot.

Annual Maintenance Expense

The final bid item created was the trail annual maintenance. This money would be used for future expenses or care that is needed for the trail. This bid item was created due to the limited resources The University of Southern Indiana has on their groundkeeper's crew. The estimated cost will cover anything that happens to the trail or any resources that need to be added for the year. The final cost is estimated to be about five thousand dollars. The cost was estimated using the total cost of the fine lime aggregate used because this is the only material that could possibly wash away due to erosion overtime. However, this was an overestimation due to the idea that the culverts would need to be checked yearly for any blocks or unwanted material that could find its way in them. Another maintenance cost would be the removal of fallen trees, shrubs, or any other ways that nature can block the trail and make it unsafe or not usable in the future.

TOTAL ESTIMATE

The estimate's total cost came out to $45,345.20. As shown in the table below, the total cost of each bid item can be seen as well as the quantities used for each item. The quantities were developed through measurements taken from AutoCAD Civil 3D, a total amount needed for each

item, or the bid item was made a lump sum due to all the different activities in these items. Also, the total man hours required for the job was estimated out to 315 hours (about 2 weeks). These are the combined hours from every bid item that required the use of labor. Finally, the last aspect of the construction processes the team wants to cover is the permanent material added to the site. These materials consist of the fine lime aggregate, the three small culverts, the ornamental grasses, and the archway/decorative gate.

Item Numbers	Description	Pay Unit	Quantity	Amount
100	MOBILIZATION	LS	1	$ 2,765.56
110	CONSTRUCTION SURVEY AND STAKING	LS	1	$ 3,200.00
120	CLEARING AND GRUBBING, DISPOSAL METHOD (a)	ACRE	0.46	$ 1,816.74
130	SMALL CULVERT ADDITION	LS	1	$ 2,826.18
140	LARGE CULVERT REPLACEMENT	EA	1	$ 6,400.65
150	GROUNDWORK, CUT/FILL	CYDS	55.01	$ 1,966.61
160	GROUNDWORK, FINE LIME ADDITION	TON	12.01	$ 3,370.09
170	REMOVING/REPLACING DISC GOLF SIGNS	EA	2	$ 361.14
180	MOVING DOG SANITATION STATION	EA	1	$ 154.80
190	SEEDING AND STRAWING	ACRE	0.58	$ 897.74
200	PERMANENT ORNAMENTAL GRASS	EA	50	$ 1,505.50
210	DECORATIVE GATE	LS	1	$ 14,980.32
220	MATTING ESTABLISHMENT (TEMPORARY)	EA	3	$ 99.87
230	TRAIL ANNUAL MAINTENANCE	LS	1	$ 5,000.00
	Total, Base Bid Items:			$ 45,345.20

Table 6: Bid Schedule

7 SHEET SET

The main deliverable discussed within the meetings conducted with the USI contacts was a sheet set. The team decided early in the project to create a sheet set that would summarize all the key parts of the project in an organized and understandable way. This idea was to make it easy to follow the design process and see the solutions to problems within the trail that the team made within the project. All the main ideas for the project could be seen with the use of the CIVIL 3D program in a professional way. This sheet set ended up with a total of seven sheets.

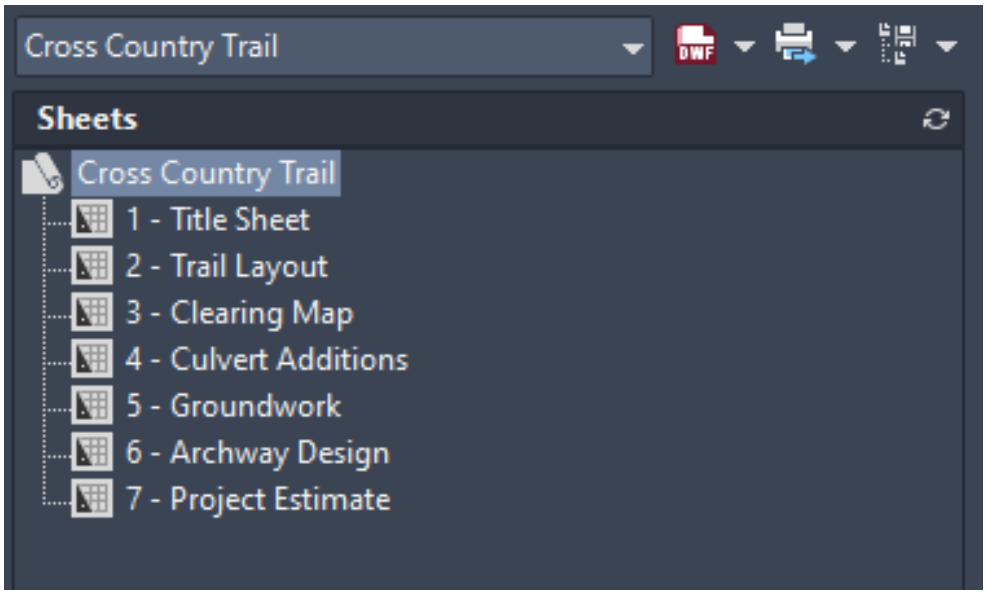

Figure 26: Sheet List

The sheet set as shown above covers the main points of the project being a title sheet, trail layout, clearing map, culvert additions, groundwork, archway design, and the project estimate. These topics have all been covered in depth through this design report, but the team chose to create this sheet set so that it could be looked through quickly by anyone interested in the project and they could understand the key ideas the team came up with. It also is common practice for design projects involving Civil 3D work like this trail to have a sheet set that can present all the Civil 3D drawings in a professional capacity. For this project, the team made a sheet template incorporating the USI branding as shown in the sheet example below.

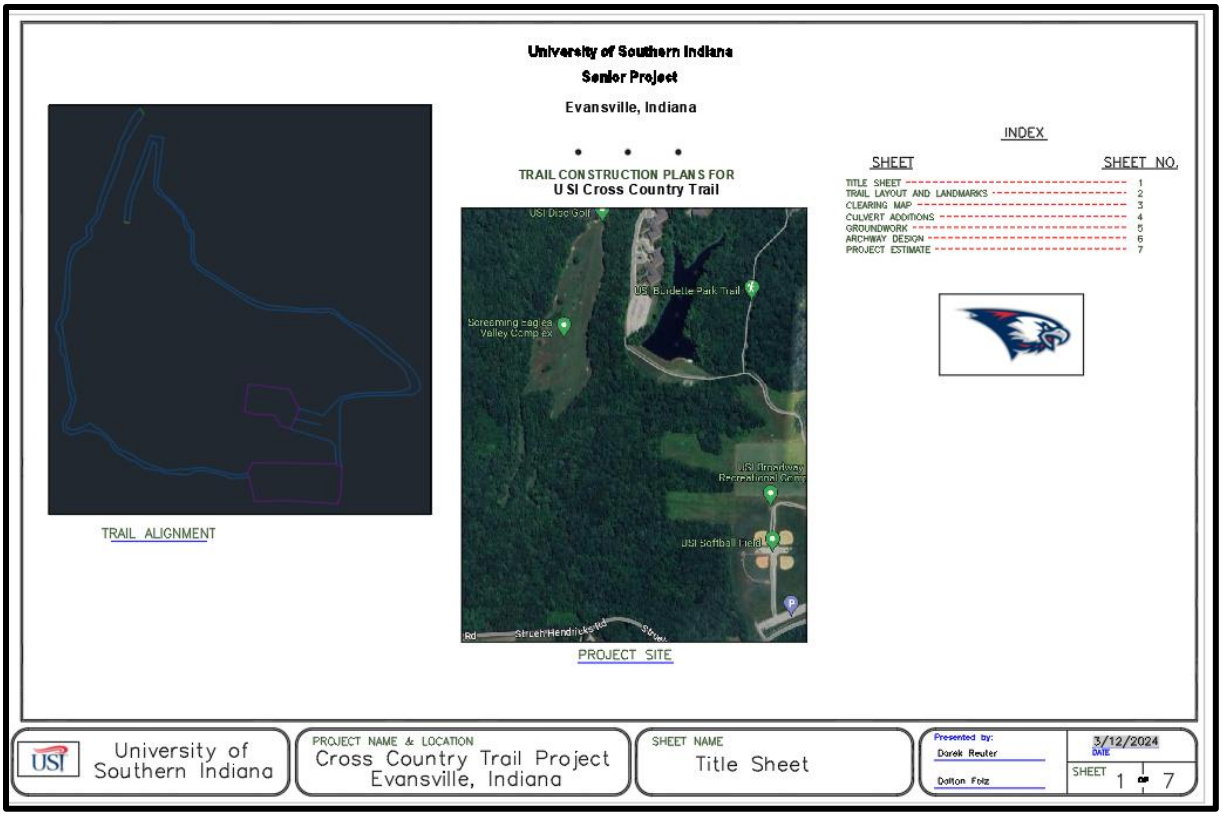

Figure 27: Sheet Example

7.1 SHEET SET DELIVERY

As mentioned, the sheet set covers all the major project ideas more summarized and compact than the report. The main point for making this set is so the team can deliver it to Bryan Morrison, the main USI contact throughout the project, so that he can look through the team's ideas quickly. He can then show any of these sheets or ideas to USI when they are deciding on final designs or what to do for the Cross Country Trail. By giving an organized and summarized sheet set, the chances that USI may use some of the design ideas that the team worked on throughout the project are increased.

8 CONCLUSION AND EXPERIENCE

The cross-country trail project resulted in a great running trail for the University of Southern Indiana and an aspect of the university the public and highschoolers can use. Brian Morrison and Coach Hillyard were both very important people in developing the scope of the project and figuring out the cross-country restraints. Dr. Adam Tennant and Dr. Jason Hill were also very important resources in designing the entire trail. Hopefully, the trail will serve as a great resource for the University of Southern Indiana and any others who will be utilizing the trail.

The trail was also a great experience for the team when designing the trail and receiving experience in surveying, designing, and cost estimating. The surveying aspect was field experience that the team has completed together before, however, it was an activity that neither of the team does very often. The designing aspect was the experience that imitates a real-life designing job from using Civil 3D, analyzing the drainage issues throughout the trail and developing a solution, and choosing the correct material for all the culverts. Finally, the cost estimating aspect was the experience that also imitates real-life office work in the project management world. This experience is very valuable due to both team members going into the construction industry once the team graduates. Some other aspects of the project such as pre-design and the post-design meetings are also great experience for dealing with different people throughout the project. The final step of the project was to deliver the estimate, plan sheet set, and archway design to USI; and then return to the project location and experience the completed trail design once construction is complete.

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APPENDIX

Appendix A: Culvert Data

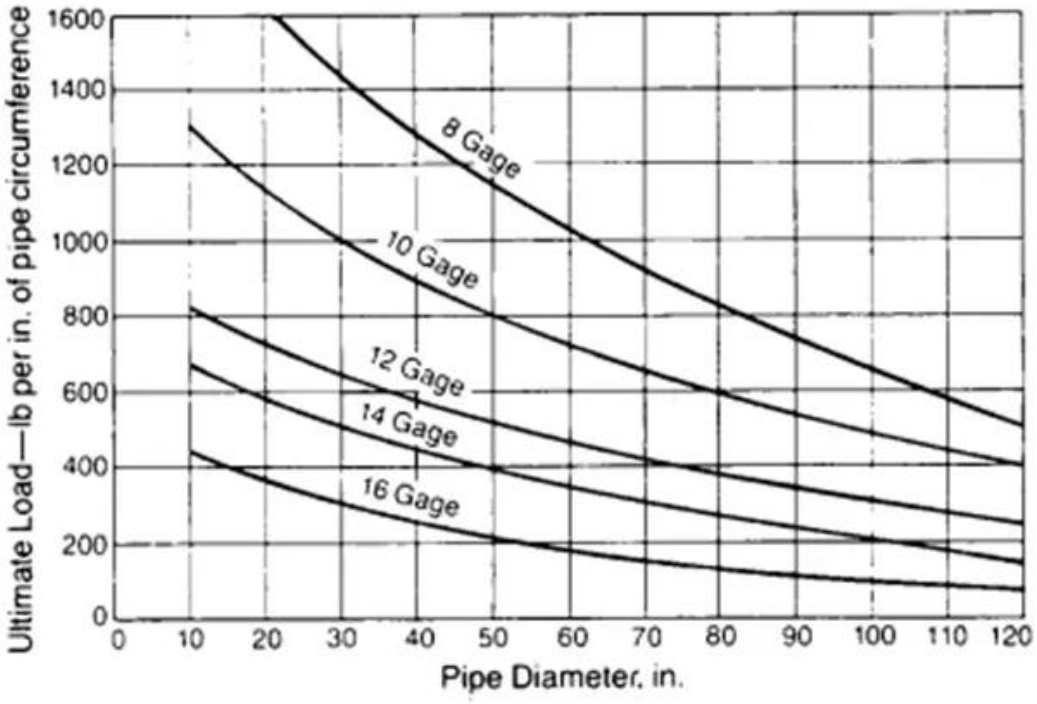
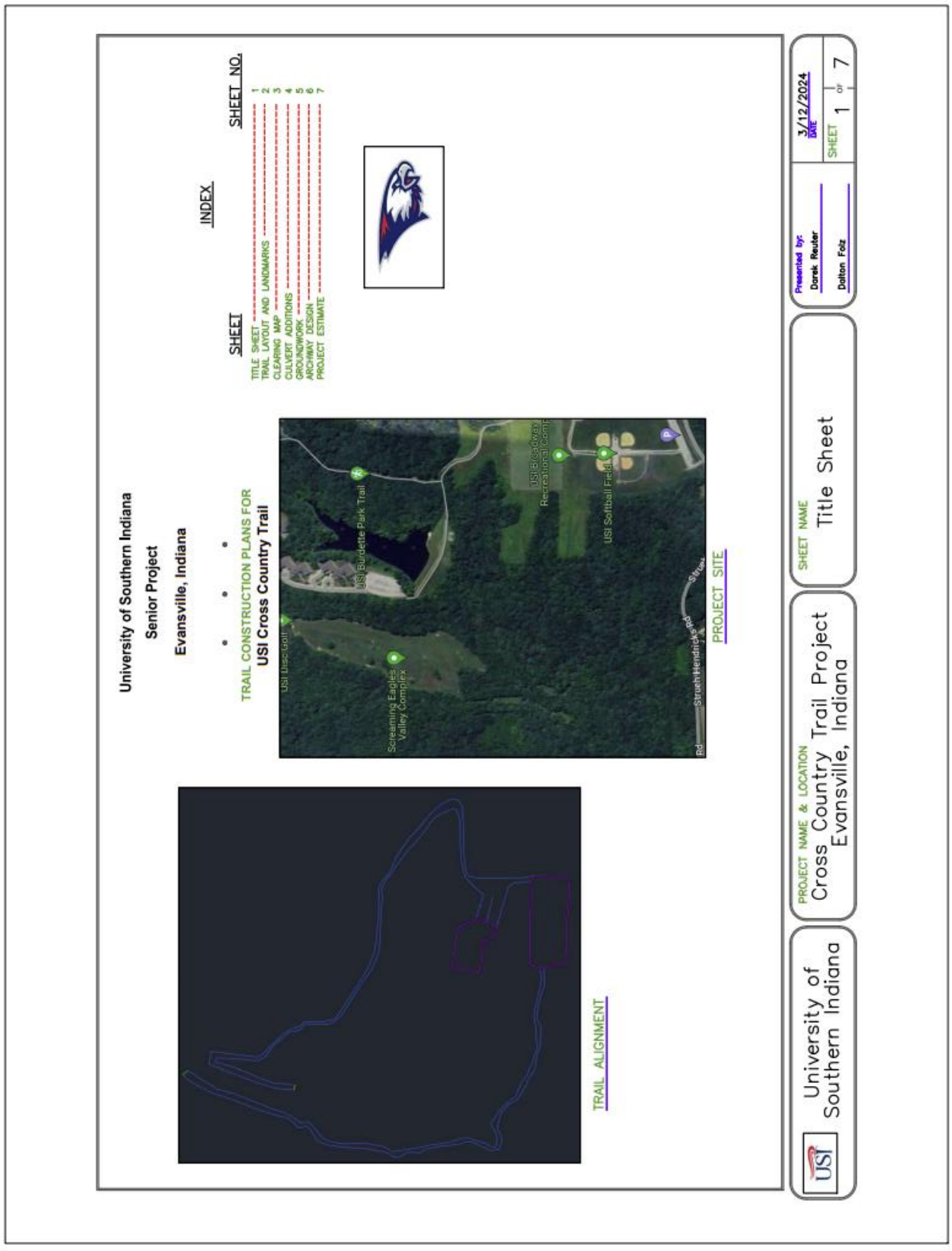


Figure 28: Maximum Load of CMP based on diameter and gauge

CORRUGATED METAL PIPE DETAIL SHEET									
EQUIV-ROUND SIZE (INCHES)	END AREA IN SQ. FT.	AVAILABLE CORRUGATIONS WITH SPAN X RISE			WEIGHTS PER FOOT (LBS)* FOR AVAILABLE GAUGES AND THICKNESS				
		2 2/3" X 1/2"	3" X 1"	5" X 1"	16 .064"	14 .079"	12 .109"	10 .138"	8 .168"
15"	1.1	17" X 13"			12	15			
18"	1.6	21" X 15"			15	18			
21"	2.2	24" X 18"			17	21			
24"	2.9	28" X 20"			19	24	33		
30"	4.5	35" X 24"			24	30	41		
36"	6.5	42" X 29"				36	49		
	7		40" X 31"			41	56		
42"	8.9	49" X 33"				42	57	72	
	9.4		46" X 36"			47	65		
	9.4			46" X 36"			43	58	
48"	11.6	57" X 38"				48	65	82	
	12.3		53" X 41"			54	74		
	12.3			53" X 41"			67	85	102
54"	14.7	64" X 43"					73	92	112
	15.6		60" X 46"			61	83	106	129
	15.6			60" X 46"			75	95	102
60"	18.1	71" X 47"					81	103	124
	19.3		66" X 51"			67	92	118	143
	19.3			66" X 51"			83	106	127
66"	21.9	77" X 52"					89	113	137
	23.2		73" X 55"			74	101	129	157
	23.2			73" X 55"			91	116	140
72"	26	83" X 57"						123	149
	27.4		81" X 59"			81	110	140	171
	27.4			81" X 59"			99	126	153
78"	32.1		87" X 63"			87	119	152	185
				87" X 63"			107	137	165
84"	37		95" X 67"			94	128	164	199
				95" X 67"			115	148	178
90"	42.4		103" X 71"			100	137	175	213
				103" X 71"			123	158	190
96"	48		112" X 75"			107	147	188	228
				112" X 75"			132	169	205
102"	54.2		117" X 79"				155	198	241
				117" X 79"			140	178	215
108"	60.5		128" X 83"				165	211	256
				128" X 83"			149	190	230
114"	67.4		137" X 87"				174	222	271
				137" X 87"			157	200	244
120"	74.5		142" X 91"					234	284
				142" X 91"				211	256
126"	82.2		149" X 98"					247	300
				149" X 98"				222	269
132"	89.5		155" X 104"					260	314
				155" X 104"				232	283
138"	98.3		162" X 108"					273	329
				162" X 108"					295
144"	106.8		168" X 112"					286	343
				168" X 112"					310

Figure 29: Maximum Load per Foot For CMP Pipe

Appendix B: Sheet Set



Trail Layout with Landmarks

Trail Area and Length Quantities

Length and Areas	
	Length (Miles)
Trail Part 1	0.62
Trail Part 2	0.89
	Area (Acres)
Area 1	2.86
Area 2	1.27

Possible Length for Areas	
	Length (Miles)
Minimum Travel Area 1	0.104
Maximum Travel Area 1	0.620
Minimum Travel Area 2	0.153
Maximum Travel Area 2	0.295

Total Lengths (Miles)	
Total Milage with Minimum Field Use	1.77
Total Mileage with Maximum Field Use	2.43

Runback Length For Running Twice	0.17

Area 1 Minimum Travel

Area 1 Maximum Travel

Area 2 Minimum Travel

Area 2 Maximum Travel

University of Southern Indiana	PROJECT NAME & LOCATION: Cross Country Trail Project Evansville, Indiana	SHEET NAME: Trail Layout and Landmarks	Presented by: Darek Reuter, Dalton Folz; DATE: 3/12/2024; SHEET 2 OF 7

Major Areas of Tree and Brush Clearing for the Trail:

Note: General Clearing of Brush and Dead Tree Along Trail was Also Conducted

Trail Part 1 Clearing

Trail Part 1 and Field Clearing

Trail Part 2 Clearing

University of Southern Indiana	PROJECT NAME & LOCATION: Cross Country Trail Project, Evansville, Indiana	SHEET NAME: Clearing Map	Presented by: Darek Reuter, Dalton Folz	3/12/2024 (DATE); SHEET 3 of 7

Trail Culvert Addition Areas

Area A

Area B

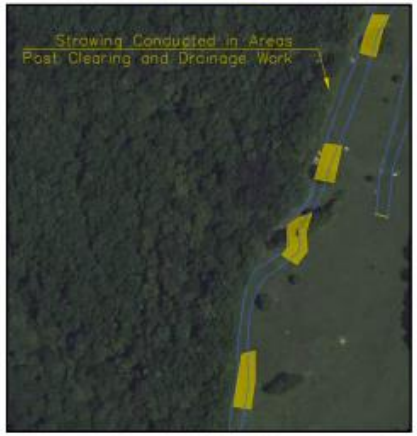
Area C

Watersheds for Areas

Culvert Sizing	
	Diameter (in)
Culvert A	8
Culvert B	6
Culvert C	8

University of Southern Indiana	PROJECT NAME & LOCATION: Cross Country Trail Project, Evansville, Indiana	SHEET NAME: Small Culvert Additions	Presented by: Darek Reuter, Dalton Folz; DATE: 3/12/2024; SHEET 4 OF 7

Strawing

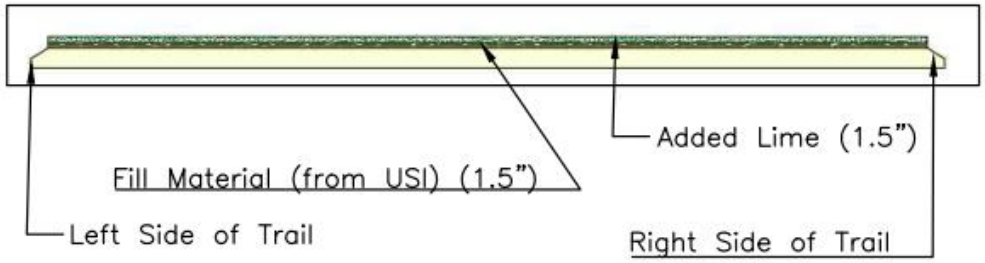


Addition of Fine Lime

Location of Typical Cross section

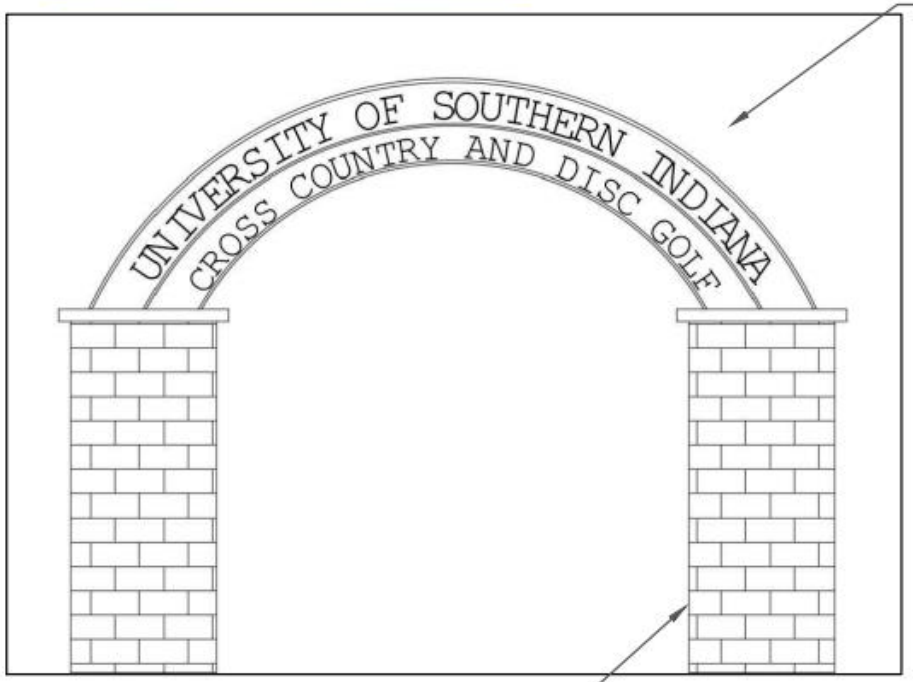
Fill Quanities		
Area	Length (ft)	Volume (cyds)
Straightway	467.36	43.27
Hill	169	11.74
Total		55.01

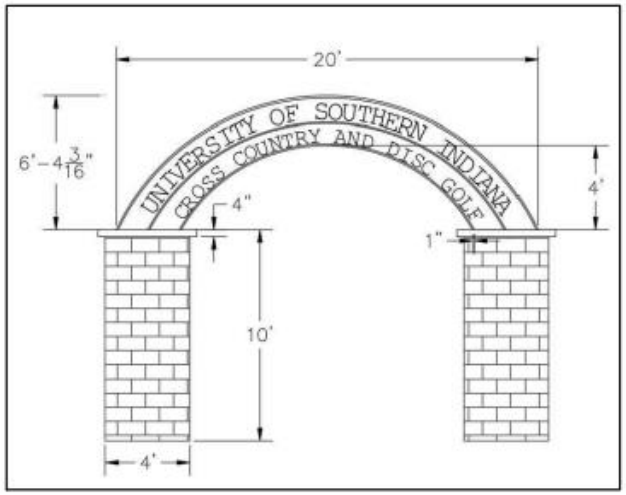
TYPICAL CROSS SECTION OF FILL AND LIME ADDITION



University of Southern Indiana	PROJECT NAME & LOCATION: Cross Country Trail Project, Evansville, Indiana	SHEET NAME: Groundwork	Presented by: Darek Reuter, Dalton Folz; DATE: 3/12/2024; SHEET 5 OF 7

GENERAL ARCH DESIGN





ARCHWAY DIMENSIONS

University of Southern Indiana	PROJECT NAME & LOCATION: Cross Country Trail Project, Evansville, Indiana	SHEET NAME: Archway Design	Presented by: Darek Reuter, Dalton Folz; DATE: 3/12/2024; SHEET 6 of 7

Bid Item Schedule

Item Numbers	Description	Pay Unit	Quantity	Amount
100	MOBILIZATION	LS	1	$ 2,765.56
110	CONSTRUCTION SURVEY AND STAKING	LS	1	$ 3,200.00
120	CLEARING AND GRUBBING, DISPOSAL METHOD (a)	ACRE	0.46	$ 1,816.74
130	SMALL CULVERT ADDITION	LS	1	$ 2,826.18
140	LARGE CULVERT REPLACEMENT	EA	1	$ 6,400.65
150	GROUNDWORK, CUT/FILL	CYDS	55.01	$ 1,966.61
160	GROUNDWORK, FINE LIME ADDITION	TON	12.01	$ 3,370.09
170	REMOVING/REPLACING DISC GOLF SIGNS	EA	2	$ 361.14
180	MOVING DOG SANITATION STATION	EA	1	$ 154.80
190	SEEDING AND STRAWING	ACRE	0.58	$ 897.74
200	PERMANENT ORNAMENTAL GRASS	EA	50	$ 1,505.50
210	DECORATIVE GATE	LS	1	$ 14,980.32
220	MATTING ESTABLISHMENT (TEMPORARY)	EA	3	$ 99.87
230	TRAIL ANNUAL MAINTENANCE	LS	1	$ 5,000.00
	Total, Base Bid Items:			$ 45,345.20

Master Crew
1 CAT D6 Dozer
1 CAT 205LC Excavator
1 Labor Foreman
2 General Labor
1 Operator - Dozer
1 Operator - Excavator

Cost Estimate

Total: $45,345.20

315 Manhours

University of Southern Indiana

PROJECT NAME & LOCATION
Cross Country Trail Project
Evansville, Indiana

SHEET NAME
Project Estimate

Presented by:
Darek Reuter
Dalton Folz

DATE
3/12/2024

SHEET 7 OF 7

Appendix N: ABET Outcome 2, Design Factor Considerations

ABET Outcome 2 states "*An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health safety, and welfare, as well as global, cultural, social, environmental, and economic factors.*"

ABET also requires that design projects reference appropriate professional standards, such as IEEE, ATSM, etc.

For each of the factors in Table N.1, indicate the page number(s) of your report where the item is addressed, or provide a statement regarding why the factor is not applicable for this project.

Table N.1, Design Factors Considered

Design Factor	Page number, or reason not applicable
Public health safety, and welfare	Page 30
Global	The project has no global impact due to the local scope and parameters it retains.
Cultural	The project has no cultural impact due to the project having no correlation to previous beliefs, values, or traditions.
Social	Page 30
Environmental	Page 31
Economic	Page 31
Ethical & Professional	Page 31

Reference for Standards	Indiana LTAP Manual