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Columbus, Nebraska: Southern Housing Development Design Proposal

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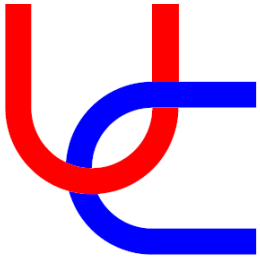

UNCIVIL ENGINEERING

An Undergraduate Honors Thesis Submitted in Partial fulfillment of University Honors Program Requirements, University of Nebraska-Lincoln

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May 15th, 2023

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Disclaimer:

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Abstract

The following paper proposes the design and creation of a new housing development in the city of Columbus, Nebraska in a lot to the south of the city and directly north of the Columbus wastewater treatment plant. The goal of this proposal is to provide readers with confidence that our company is the most qualified to complete the project and will create the safest, most comfortable, most efficient, and most cost-effective final design. This proposal seeks to offer a solution to the lack of affordable housing for the growing workforce in Columbus. In order to arrive at this solution, each subdiscipline of civil engineering (geotechnical, structural, water resources, environmental, and transportation) is utilized to research the existing conditions of the area and to then design the infrastructure of the housing development. Watershed delineation, soil analysis, environmental impact studies, and current traffic studies are types of research done to understand the existing conditions. Site cut and fill, storm and sanitary sewer network design, roadway layout and geometrics, and steel beam and column loading and connections are then created to produce a final design for the new neighborhood. This final design will include around 40 lots, slopes and roadway superelevation to drive sewer flow, a wide set of streets to provide high mobility and accessibility in the development, and a steel park structure for entertainment. The total surveying, design, and construction of this development is estimated to take around 36 weeks and cost $2.5 million.

Key Words: housing development, proposal, civil engineering, Columbus, Nebraska, geotechnical, structural, water resources, environmental, transportation

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Introduction

This proposal has been written in response to the City of Columbus's RFP regarding the desire for a new housing development on the south side of the city, in the 22-acre southern portion of the field bordered by the Columbus Transfer Station and Columbus Wastewater Treatment on the west and south respectively. With population increasing in Columbus, namely in younger or less financially stable groups, the need for more affordable multi-unit housing has arisen and this proposed development, along with the development currently being constructed on the northern half of the field, could be a large step in remedying this issue.

Although the cost of living in this new development being relatively inexpensive is a main goal, it is strongly desired to make the space well-functioning, comfortable, safe, and visually appealing to avoid making the development feel like "workforce housing". This is made more complicated by the proximity of the transfer station and wastewater treatment plant mentioned above, as well as the location of the proposed development site in the flood plain of the Loup River. However, Uncivil Engineering is proposing the design and construction of a development that will meet all the desired requirements and properly mitigate the negative effects of the transfer station, treatment plant, and river, while still maintaining a manageable budget for the City of Columbus. The following sections in this proposal will outline and explain why Uncivil Engineering is qualified to complete this project, what design elements will be used to allow the project to be completed in a successful manner, and how much time and money this project will cost the City of Columbus.

Qualifications

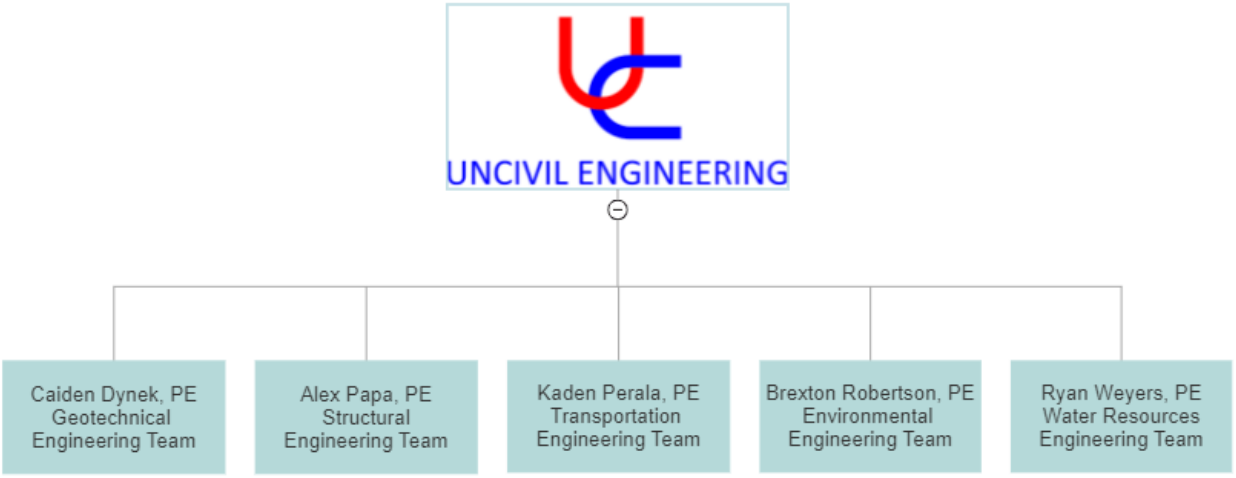

Figure 1. Uncivil Engineering Organization Chart

Established in 2018, Uncivil Engineering is recognized throughout Eastern Nebraska as a premiere general engineering contracting firm that offers a wide range of engineering and construction services. Uncivil Engineering is esteemed for our design expertise in earthwork, hydrologic assessments, water balance, supply and pump systems, floodplain management, drainage, PG grading, roadway and highway systems, public transport systems, construction waste reduction, limit states and serviceability checks on structural systems, and environmental sustainability.

Uncivil Engineering has successfully completed high profile projects that are both highly "visible" and "unseen" in Eastern Nebraska. Some recent projects include, but are not limited to, downtown Lincoln developments, a few Omaha projects, and an urban development outside of Kearney, NE. We currently provide a wide selection of design services and have the necessary skill sets to take on any type of project in the Mid-western area.

The primary engineers presently on the staff payroll all graduated from an ABET-accredited engineering program. Each department head has received his EIT certificate in the state of Nebraska while a few department heads have their EIT certificates in surrounding states as well. We believe the best way to please businesses, nonprofit organizations, government entities and individuals is with our honorable and diligent work ethic.

Ryan Weyers, PE, the lead water resources engineer and secondary transportation engineer on this project, graduated from the University of Nebraska-Lincoln in 2014 with a degree in Civil Engineering with a dual focus in the aforementioned subdisciplines. While in college, he interned one year each at the Schemmer Associates Inc. and Lincoln Transportation and Utilities. During his time with these two organizations, Mr. Weyers worked in transportation and traffic engineering, gaining familiarity and proficiency in pavement marking and signing standards, traffic signal wiring, temporary traffic control, and roundabout design, as well as completing less technical tasks such as different traffic counts and field measurements. Upon

graduation, Mr. Weyers took a job as an entry-level water resources engineer with JEO Consulting Group in their Lincoln office. Here, he had a hand in a number of floodplain, suburban development, and park projects in Nebraska, Iowa, and Kansas and obtained his PE licensure in 2018. Shortly after this, he left JEO to help found Uncivil Engineering, where he has continued to gain experience in both water resources and transportation engineering. Mr. Weyers is trained and experienced in MicroStation and HEC-RAS, along with a strong background in Microsoft Office and some additional familiarity with AutoCAD. Besides these more technical proficiencies, he also possesses well-developed problem solving, written communication, and organization skills that are greatly beneficial when working through any type of civil engineering project.

Caiden Dynek, PE, is the head of the Geotechnical department at Uncivil Engineering. He graduated from University of Nebraska-Lincoln with a degree in Civil Engineering and a minor in Mathematics in 2013. While in school Mr. Dynek was an intern for the NRCS Soil Mechanics lab. After graduation he continued there as an engineer in training while working under the head geotechnical engineers. While there he got to work all over the country and help out with many projects such as dams, bridges, foundations of buildings and identification of soil for best crop yield. Mr. Dynek is trained and experienced in AutoCAD along with other software for dam flows and runoff. While working under the head geotechnical engineers at NRCS, Mr. Dynek completed his PE in 2017. Only one year later did Mr. Dynek help found Uncivil Engineers where he has continued to gain experience in the field of geotechnical engineering.

Alex Papa, PE, is the head of the structural department at Uncivil Engineering. He graduated from the University of Nebraska-Lincoln with a Bachelor of Science in Civil Engineering in 2013. Mr. Papa began his engineering career at Olsson, where he was hired as an intern on the rail track team. During his first few years, he helped to design multiple large rail yards for the Union Pacific Railroad. After graduating, Mr. Papa transitioned to Olsson's structural team, and was involved in dozens of projects across Nebraska and Kansas. Mr. Papa was instrumental in redesigning Kauffman Stadium for the Kansas City Royals and played a key role in the redesign of the Mutual of Omaha Corporate Complex. While working at Olsson, Mr. Papa continued his education, and earned his master's in structural engineering from the University of Nebraska-Lincoln in 2015. Alex continued to work on Olsson's structural team for the next three years, and in the process, earned his PE license in 2018. In late 2018, Mr. Papa left Olsson to help establish Uncivil Engineering, where he has been leading the structural department and assisting on rail transportation projects, including overseeing the streetcar project for the City of Omaha.

Brexton Robertson, PE, is head of the environmental department at Uncivil Engineering. He graduated from the University of Nebraska-Lincoln in 2012 with a Bachelor of Science in Civil Engineering. Furthering his education in this area, he then earned a Master of Science in Environmental Engineering at UNL. Growing up on a family farm, he was greatly passionate about studying the impacts of cattle on the pasture environment in his graduate studies. During his undergraduate years, he could intern at NDOT, where he could work on many projects assessing the environmental impact of transportation designs on its surroundings. After graduation, he took on a full-time job at Kirkham Michael Consulting as an Environmental

Engineer. There he was able to work on projects that included studying the environmental impact of infrastructures, pollution in rivers, and reusing building waste in construction. By 2018, Robertson became one of the founders of Uncivil Engineering, where he continues to help build safer communities for society and the environment, including Nebraska, Kansas, Missouri, and South Dakota.

Kaden Perala, PE, is head of the Transportation department at Uncivil Engineering. He graduated from the University of Nebraska-Lincoln in 2014 with a Bachelor of Science in Civil Engineering. Starting out as a survey Engineer for a local company Adams & Clark in Spokane, WA, he worked his way into the central office as an Entry level Transportation Engineer after a year. Projects he worked on at Adams & Clark include Public Park renovations, cell towers, community neighborhoods, retirement homes, and public/local roadway developments. He moved back to Nebraska in 2017 and began working at NDOT in Lincoln for their Traffic Engineering Division. Before co-finding the company Uncivil Engineers in late 2018, he received his PE license while working at NDOT. Projects he worked on at NDOT include general Crash Reports and Traffic Impact Studies/Analysis, Lincoln South Beltway, and other local developments.

Background

Columbus, Nebraska is quickly becoming a major hub for engineering. Over the last year, Columbus has seen an annual population growth rate of 0.414% (Columbus, NE). This growing population is almost certainly due to the growing workforce and the exploding field of engineering within the city. The goal of the project is to add housing to the rapidly growing workforce in the city of Columbus, Nebraska. The objectives of this project are as follows: obtain survey of the existing ground, regrade the existing site, construct the sewer system and storm water piping, build roads, sidewalks, and other concrete structures, construct the multi-purpose park facility, and finally, landscape along the walking paths and greenspace. Once the roads have been built, an architectural firm will come in and build the housing. During the housing construction, our firm will continue to work on the greenspace and build the multi-purpose park structure. Once all houses have been built, we will return to plant vegetation and address remaining landscaping issues.

This large project comes with a few constraints that must be taken into consideration. Currently, the site is split between a northern and southern site shown in Figure 1. Development on the northern site has already begun construction, so communication will be imperative between the two teams. The southern development will be constructed in conjunction with the northern development. Therefore, construction for this project will begin on the south side to allow for the northern development to use the north side of the property for storage of their vehicles and materials. By the time construction moves to the northern side, the vehicles and materials for the northern development will need to be relocated. Further communication and scheduling between the northern team and our team will continue throughout the design and construction process. Nebraska is also home to variable weather conditions. Therefore, construction will only be feasible between the months of April and November. Once the design has been finalized, construction will begin. Through conversations with the client, it was decided that the final design of the site will be completed and agreed upon by May 12, 2023. Construction will begin soon thereafter on June 1, and will continue, weather permitting, following the schedule outlined below.

Throughout our meetings with the client, we have identified several stakeholders. These include the city of Columbus, surrounding businesses, and current and future residents. The stakeholders' interest will be considered at every step of the design and construction process.

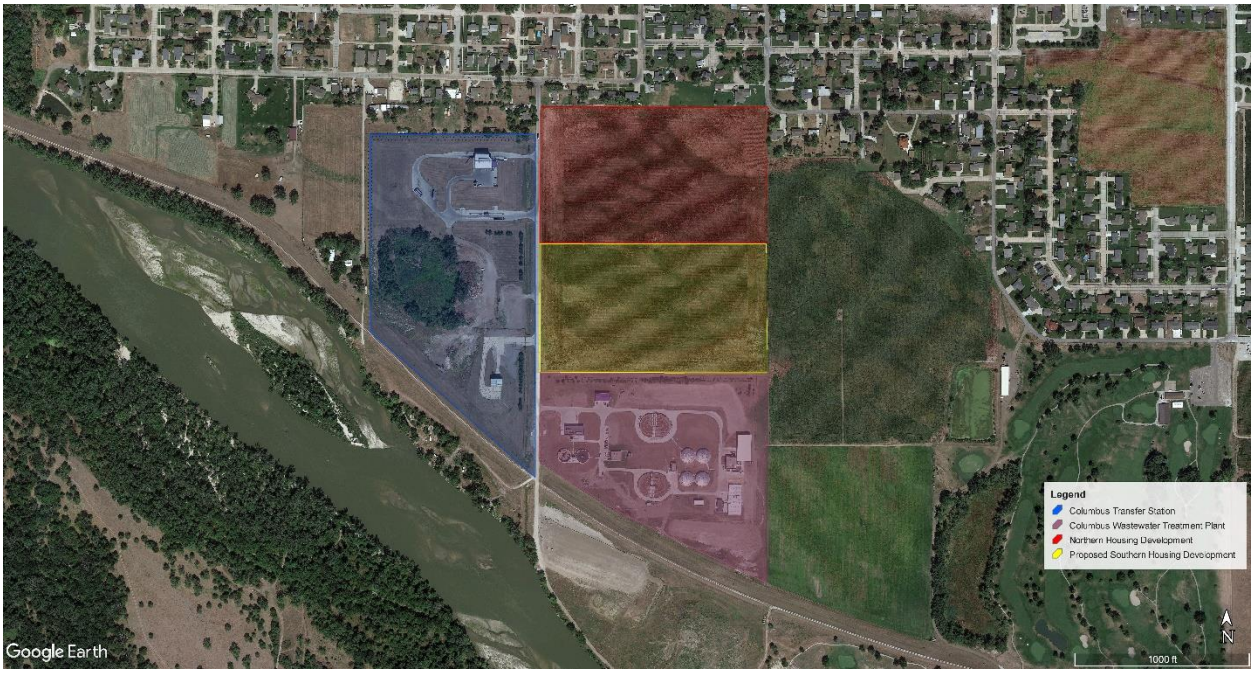

Figure 2. Proposed Housing Development Site in Columbus, Nebraska

Impacts

When this project is finalized, there will be some noticeable social, cultural, and environmental changes. In the new neighborhood there will be a park for the residents to use at their digression. The park will be a good place to gather and connect to others in a shared environment, helping to promote neighborliness while still offering security and protection. With the security and protection given by the neighborhood, children and people of any age will be safe. Some of the benefits of having a new neighborhood is that it invites new people to live in the area that might have different cultures. We understand that we are taking land that was used for crops. To help promote vegetation in the area we plan to plant many native species of trees, grass and bushes. This vegetation will help with runoff, along with cleaner air and help to block the odor from the water treatment plant. To help with runoff there will be a mound that the trees will go on to help direct water. The trees will also help with blocking the view of the water treatment plant from the residences on the south side of the neighborhood.

While the design of the neighborhood is made to draw people in, some may find its location displeasing due to the water treatment plant being nearby. With the neighborhood having many duplexes and triplexes there may be some unrest if people feel like they don't have their own space. While it is good to bring people of other cultures to the area, there may be some issues that arise when two different cultures clash. Some other impacts of having a neighborhood where farmland used to be is that there will be less room for native species to roam along with more cars on the road causing more traffic in the surrounding areas. One of the bigger impacts that neighborhoods have is that there will be more runoff due to there being more concrete in the area.

Scope

Uncivil Engineering will be responsible for coordinating and completing all surveying, measurements, and sampling of the proposed development site and surrounding area. Analysis of the data obtained from these tasks, as well as research into other databases, will be done by Uncivil Engineering, although the City of Columbus may aid in providing additional data or research that could be useful to the analysis. The firm will use this analysis to establish soil properties, existing elevations, pre-construction runoff and watershed delineation analyses, and create an environmental assessment and SWPPP. Obtaining necessary permits at the local, state, and federal levels for proper construction on the site shall be done by Uncivil Engineering in conjunction with the City of Columbus. The vast majority of design work will also be the responsibility of Uncivil Engineering, including, but not limited to, site grading; base and sub-base materials; trunk storm and sanitary sewer system; roadway geometry, signing, and pavement markings; park canopy structure, and some landscaping. The firm typically contracts its own construction company, but if Columbus or the developer wants input into this decision, this is permissible. Planning and scheduling of construction will be a joint effort between Uncivil Engineering, the City of Columbus, and the chosen contractor. Construction will be done by the chosen contractor, with regular check-ins and a final inspection done by the Uncivil Engineering project manager. Post-construction runoff analysis and environmental reports will also be done by an engineer at Uncivil Engineering.

Proposal Statement

The objective of the project is to add housing to a plot of land located in Columbus, Nebraska to account for the growing workforce of the area. This will be achieved by adding several duplex and triplex style housing units while also providing safe roads and recreational areas. Several precautions will be taken into account to try to mitigate poor surrounding conditions including the wastewater treatment plant and landfill transfer station being just south of the lot.

Unfortunately, as of the time of this proposal, we have not received a response on the exact number of residents. Therefore, we have assumed that all units will be duplexes. This is a conservative assumption, given that the units will be a mix of singles, duplexes, and triplexes. We have also assumed that a typical plot size is 1/3 acres. With a park approximately 3 acres in footing, and setting aside space for streets and parking, we will design the housing development for approximately 42 lots. The number of lots is subject to change once additional information is provided.

Figure 3. Proposed Site Layout

Geotechnical

Two files were given to Uncivil Engineering for review on the Columbus, NE. These two documents were soil maps produced by the USDA along with boring logs produced by Olsson. The data given from the boring logs were obtained from three drill holes in Columbus, Nebraska.

The Columbus area is relatively flat with at most 3% slopes in the area. The land used to be farmland and is neighboring a water treatment plant along with a disposal site. There are possible instances of flooding being an issue with the river right by the project site. Along with the possible flooding is erosion issues. The mound that will be put in on the south end and will have slope protection in the form of vegetation.

Based upon the data given the from the Borehole reports the soil is clayey sand (SC), poorly graded sand (SP), sandy lean clay (CL), silty sand (SM), and poorly graded sand with silt (SP-SM). This data was obtained from a hollow stem auger that would use the Shelby tube for the first sample and then a split spoon for the rest of the samples from a given site. The split spoon method does disturb the sample more than the Shelby tube, but with the depth of the sample it doesn't affect the data as much as shallower samples would. One of the data that was given was the percent passing the #200 sieve. In the report it states that the deeper you go the less of the sample passes that #200 indicating that the sample has more rocks and or sand that is larger than the sieve size. From the data given from the report it is clear that the water depth is about 5-6ft deep. The blow counts for these samples show that the water table is high by having the blow counts on the 12 to 18in being added and compared to one another. There is a clear drop in the blow count where that water table is. Moisture values for the sample also peaked at the water table depth.

Figure 4. Site Soil Map

Data from the USDA soil map shows us that there are only two map symbols in the project's location. 2100 is a Boel fine sandy loam with 0-2 percent slopes and is rarely flooded. The mean annual precipitation is 26 to 30 inches, and this sample is somewhat poorly drained. Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr) and the water table depth is about 10-30 inches. Sample 2100 is ~90% Boel and similar soils, ~5% Inavale, ~3% Gibbon, ~2% Loup. Sample 2327 is a Inavale fine sandy loam with 0-3 percent slopes and is occasionally flooded. The mean annual precipitation is 26 to 30 inches, and this sample is excessively drained. The capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr) and the water table depth is more than 80 inches. Sample 2327 is composed of a parent material of sandy alluvium, ~4% Boel, ~3% Ord, and ~3% Barney.

Along the southern side of the property there will be a berm. The berm will stretch the whole southern side roughly 1,300 ft. in length. The berm will have a height of 5 ft., a 2:1 slope on the sides, and a max base of 27 ft. In total there will be 110,500 ft^3 or 4,092.59 cubic yards of dirt being moved to the site for the berm.

The data was reviewed for the purpose of the proposal. Any further testing or analysis for this project should be done by Uncivil Engineering.

Structural

We have been contacted by the City of Columbus Chamber of Commerce for the design of the proposed canopy structure in the neighborhood park. The canopy will measure 40 ft. by 30 ft. with a square footage of 1200 square feet in footprint. The canopy is intended to provide a recreational space for public use in the neighborhood park. The roof of the canopy will be inclined and will be comprised of asphalt shingles. The roof will be supported by a series of steel joists spaced every 2'-0" on center and (2) steel girders. The roof joists and girders will be supported by (4) steel posts which will be hollow tube steel sections. Below the canopy will be a slab on grade that will be designed to withstand the loads of the structure along with the specified soil bearing capacity provided by the geotechnical engineer. The concrete slab will measure 50 ft. by 40 ft. with a square footage of 2000 square feet in footprint. Our firm shall also provide site grading analysis and water analysis to ensure that the structure can efficiently shed water in the event of a storm.

Preliminary pricing has been calculated using both conservative sizing for various members and conservative prices for steel, concrete, and asphalt. Values for steel, concrete and asphalt shingles were taken from unarcorack.com (Steel Pricing Weekly Average), concretenetwork.com (Concrete Network), and ajreliable.com (A & J Reliable, Inc) respectfully. The total price for the final design is subject to change and will be updated once awarded the project.

Gravity and wind loads shall be obtained per the 2018 IBC, ASCE 7-16 and ASCE 7-10. Given that the project will be constructed in Columbus, Nebraska, where there is very little chance of a seismic event, seismic loads will not be considered.

*The design of this structure shall be in accordance with the 2018 International Building Code (IBC) which is adopted by the City of Columbus.

Scope of work:

- Provide structural drawings and supporting calculations for the proposed canopy structure for city review in the City of Columbus
- Coordination with contractors and architects

Water Resources

The steps that Mr. Weyers in the water resources engineering division will need to account for and complete in order for runoff and other water resources objectives to be met will be discussed in this paragraph. Elevation data and soil information obtained from surveying crews, the City of Columbus, and online databases will be utilized to understand the pre-construction runoff and water storage of the site. Additional research will be done to determine the frequency and severity of flooding in this area. With this initial data, Mr. Weyers and Mr. Dynek will work together to complete a grading plan for the site in Civil 3D, that will include the construction of a berm on the southern edge of the development that will force additional runoff towards the development but will provide enhanced flood protection and other benefits to the property. Any existing stormwater and sanitary sewer systems under the site will need to be located by field crews and City of Columbus as-built plans, which will then allow for new lines to be built and tied into these existing lines, with new trunk sanitary and stormwater sewers needing to be designed to handle the population increase in the area. Mr. Perala will work in conjunction with Mr. Weyers to ensure that road and sidewalk cross-section superelevations and profiles, as well as inlet locations, promote proper flow off of these concrete surfaces to avoid pooling. Existing downstream culverts will be evaluated to determine if their size fits the water flow needs of the development post-construction. Tree and plant choice for the development will also be completed with water absorption kept in mind.

As can be seen in the contour map in Figure 5 and the slope map in Figure 6, the site of the proposed development has very little elevation change in its pre-construction state, but does have a natural runoff direction, moving from north-northwest to the southeast across the site, as seen in Figure 7. While the Loup River and Platte River run south of the site and the city of Columbus, the path of the water flow and the presence of levees means that these larger water bodies should not influence the proposed project site in a significant way; the watershed for the site is more northeast, so runoff from the site is more likely to eventually run into these rivers, as seen in Figure 8.

The more clayey nature of the surface soil means that there may not be high infiltration of moisture through the top layer, but with lower layers consisting largely of poorly graded sand, the potential for additional storage and subsurface flow is heightened. As the site currently falls under the category of flat (0-2% slope) cultivated land, its runoff coefficients for 2-, 10-, and 50-year return periods are 0.31, 0.36, and 0.43 respectively, which are relatively small and reflect overall good infiltration. However, these coefficients need to be compared with the above soil data and will increase with the beginning of construction removing vegetation from the site and increase further with the laying of pavement and the construction of houses.

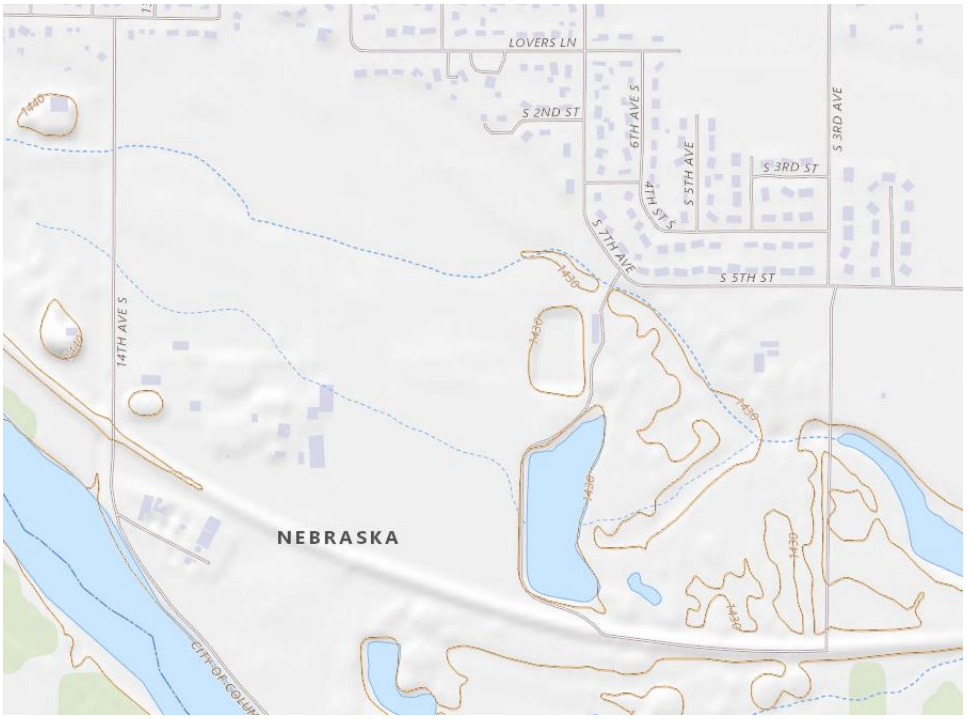

Figure 5. Site Contour Map

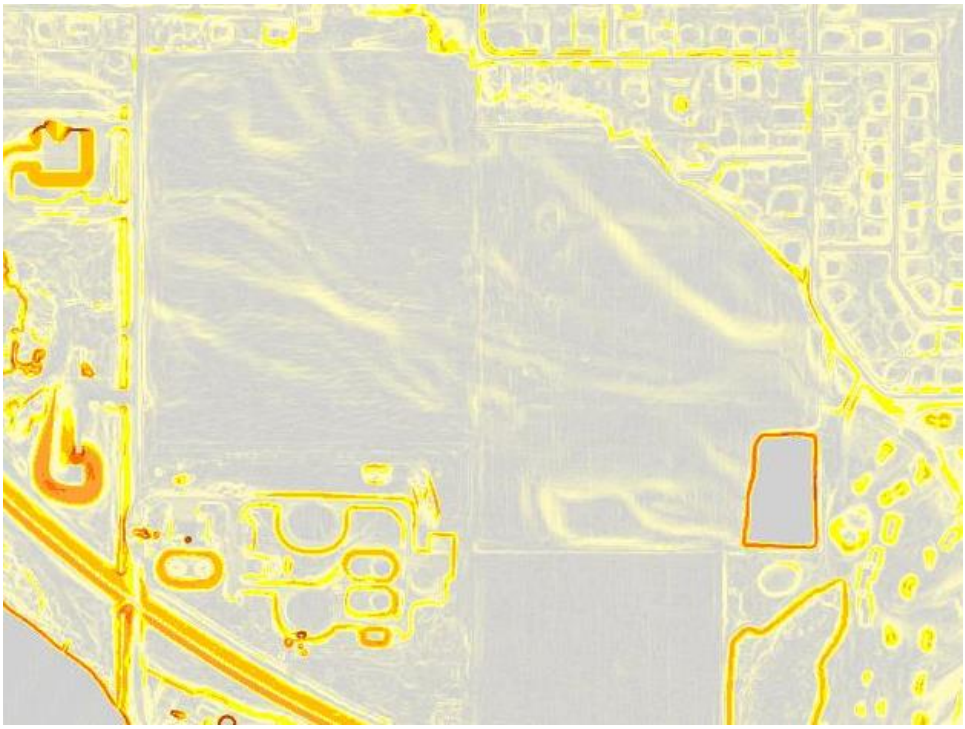

Figure 6. Site Slope Map

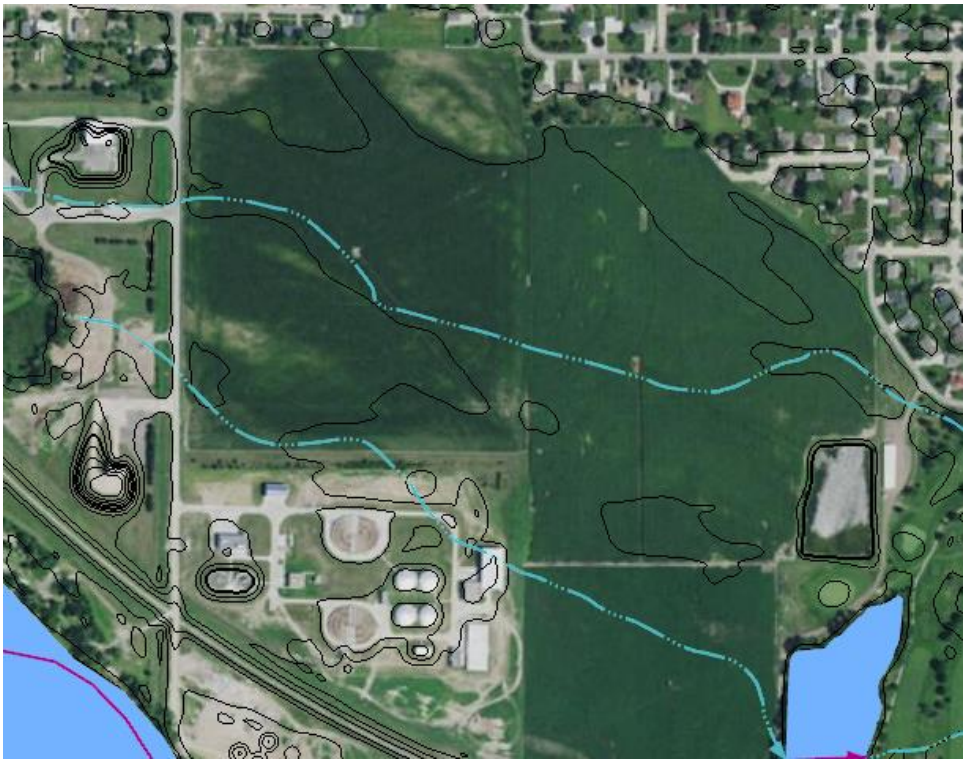

Figure 7. Small Site Watershed and Runoff Map

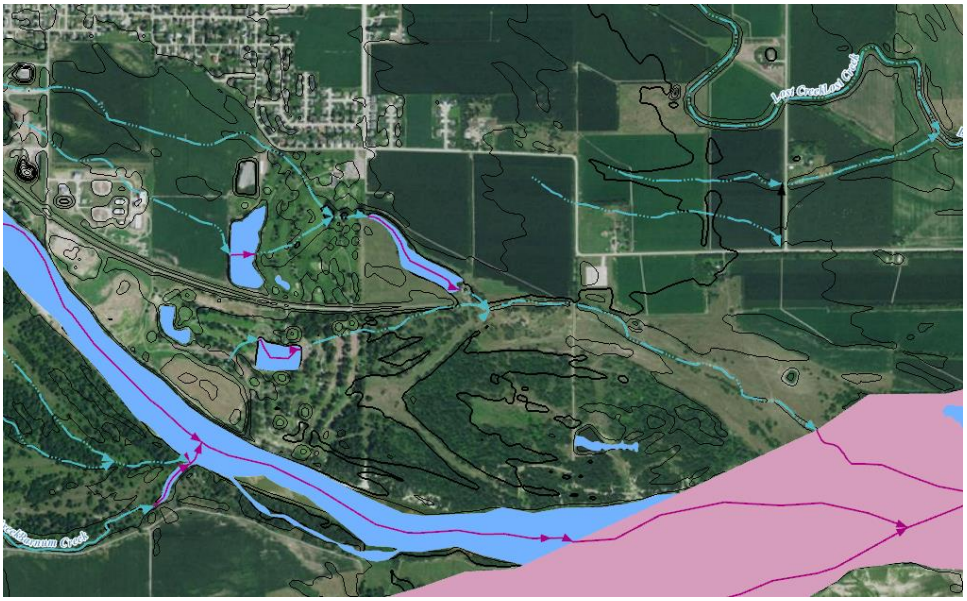

Figure 8. Large Site Watershed and Runoff Map

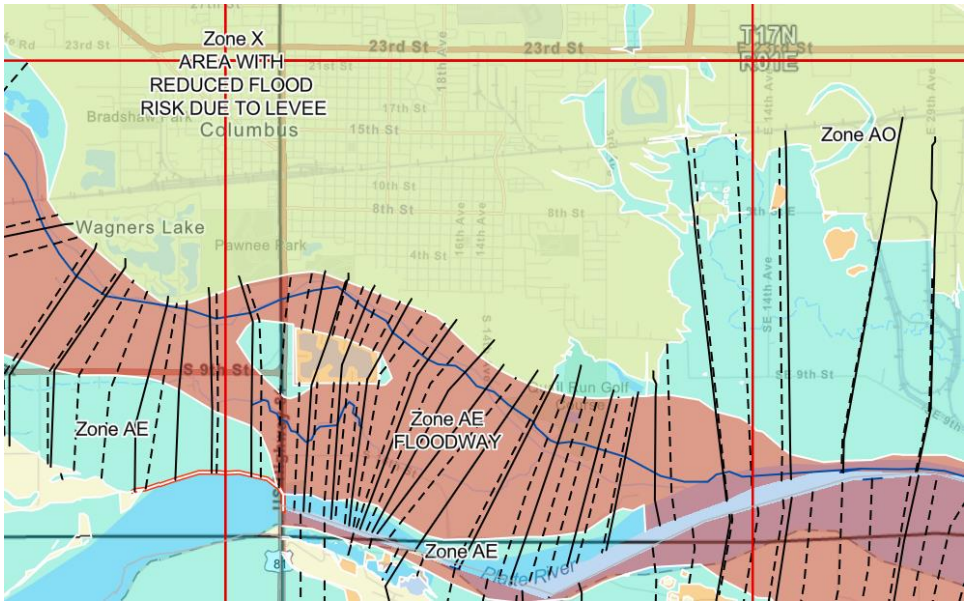

Figure 9. Flood Map

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.365 (0.292-0.470)	0.430 (0.344-0.554)	0.543 (0.432-0.700)	0.642 (0.508-0.831)	0.787 (0.603-1.06)	0.905 (0.674-1.23)	1.03 (0.738-1.43)	1.16 (0.795-1.65)	1.35 (0.882-1.96)	1.49 (0.947-2.19)
10-min	0.535 (0.428-0.688)	0.630 (0.503-0.811)	0.795 (0.633-1.02)	0.940 (0.744-1.22)	1.15 (0.882-1.55)	1.33 (0.987-1.80)	1.51 (1.08-2.09)	1.70 (1.16-2.42)	1.97 (1.29-2.87)	2.18 (1.39-3.21)
15-min	0.652 (0.522-0.839)	0.768 (0.614-0.989)	0.969 (0.772-1.25)	1.15 (0.907-1.49)	1.41 (1.08-1.89)	1.62 (1.20-2.20)	1.84 (1.32-2.55)	2.07 (1.42-2.95)	2.40 (1.57-3.50)	2.66 (1.69-3.92)
30-min	0.930 (0.744-1.20)	1.10 (0.875-1.41)	1.38 (1.10-1.78)	1.64 (1.30-2.12)	2.01 (1.54-2.71)	2.32 (1.73-3.16)	2.65 (1.90-3.69)	3.00 (2.05-4.27)	3.49 (2.29-5.09)	3.88 (2.46-5.70)
60-min	1.21 (0.967-1.55)	1.43 (1.14-1.83)	1.81 (1.44-2.33)	2.15 (1.70-2.79)	2.67 (2.05-3.60)	3.10 (2.31-4.22)	3.55 (2.55-4.95)	4.04 (2.77-5.76)	4.74 (3.11-6.92)	5.29 (3.36-7.79)
2-hr	1.49 (1.20-1.88)	1.75 (1.42-2.23)	2.23 (1.80-2.84)	2.67 (2.13-3.40)	3.32 (2.58-4.43)	3.87 (2.92-5.20)	4.45 (3.23-6.12)	5.09 (3.52-7.16)	5.98 (3.97-8.63)	6.71 (4.30-9.73)
3-hr	1.65 (1.35-2.07)	1.95 (1.59-2.45)	2.48 (2.01-3.13)	2.97 (2.40-3.76)	3.72 (2.91-4.92)	4.34 (3.30-5.80)	5.02 (3.67-6.85)	5.75 (4.01-8.03)	6.79 (4.53-9.72)	7.63 (4.93-11.0)
6-hr	1.92 (1.59-2.38)	2.26 (1.87-2.80)	2.88 (2.37-3.58)	3.46 (2.82-4.31)	4.33 (3.44-5.66)	5.07 (3.91-6.68)	5.87 (4.35-7.91)	6.75 (4.76-9.31)	8.00 (5.40-11.3)	9.01 (5.88-12.8)
12-hr	2.20 (1.84-2.68)	2.57 (2.15-3.13)	3.25 (2.70-3.97)	3.87 (3.20-4.75)	4.83 (3.89-6.22)	5.65 (4.40-7.33)	6.53 (4.89-8.66)	7.49 (5.35-10.2)	8.87 (6.05-12.3)	9.99 (6.58-14.0)
24-hr	2.50 (2.12-3.00)	2.89 (2.45-3.47)	3.61 (3.04-4.34)	4.26 (3.57-5.15)	5.27 (4.29-6.68)	6.13 (4.84-7.84)	7.06 (5.35-9.23)	8.07 (5.83-10.8)	9.52 (6.57-13.1)	10.7 (7.13-14.8)
2-day	2.86 (2.46-3.38)	3.28 (2.81-3.87)	4.03 (3.44-4.78)	4.72 (4.01-5.62)	5.78 (4.75-7.18)	6.66 (5.32-8.37)	7.62 (5.84-9.79)	8.66 (6.32-11.4)	10.1 (7.07-13.7)	11.3 (7.63-15.4)
3-day	3.10 (2.68-3.62)	3.56 (3.07-4.16)	4.37 (3.76-5.13)	5.10 (4.36-6.01)	6.19 (5.12-7.60)	7.09 (5.70-8.81)	8.05 (6.21-10.2)	9.09 (6.67-11.8)	10.5 (7.39-14.1)	11.7 (7.93-15.8)
4-day	3.30 (2.87-3.83)	3.80 (3.30-4.41)	4.66 (4.03-5.43)	5.42 (4.66-6.34)	6.54 (5.43-7.96)	7.46 (6.01-9.18)	8.42 (6.52-10.6)	9.45 (6.96-12.2)	10.9 (7.66-14.4)	12.0 (8.18-16.1)
7-day	3.87 (3.40-4.43)	4.43 (3.89-5.08)	5.38 (4.70-6.18)	6.20 (5.39-7.16)	7.39 (6.19-8.84)	8.35 (6.79-10.1)	9.34 (7.29-11.6)	10.4 (7.71-13.2)	11.8 (8.38-15.5)	12.9 (8.89-17.2)
10-day	4.41 (3.90-5.00)	5.01 (4.43-5.70)	6.04 (5.31-6.88)	6.91 (6.04-7.91)	8.16 (6.87-9.66)	9.16 (7.49-11.0)	10.2 (7.99-12.5)	11.3 (8.40-14.2)	12.7 (9.06-16.5)	13.8 (9.56-18.2)
20-day	5.99 (5.37-6.69)	6.75 (6.05-7.54)	8.00 (7.14-8.97)	9.05 (8.02-10.2)	10.5 (8.92-12.2)	11.6 (9.60-13.7)	12.7 (10.1-15.3)	13.9 (10.5-17.2)	15.4 (11.1-19.6)	16.6 (11.6-21.4)
30-day	7.31 (6.61-8.08)	8.22 (7.43-9.10)	9.69 (8.72-10.8)	10.9 (9.72-12.1)	12.5 (10.7-14.3)	13.7 (11.4-15.9)	14.9 (11.9-17.8)	16.1 (12.2-19.7)	17.6 (12.8-22.2)	18.8 (13.2-24.1)
45-day	8.99 (8.19-9.84)	10.1 (9.20-11.1)	11.9 (10.8-13.0)	13.3 (11.9-14.6)	15.1 (13.0-17.0)	16.4 (13.8-18.8)	17.7 (14.2-20.8)	18.9 (14.4-22.9)	20.4 (14.9-25.4)	21.5 (15.2-27.3)
60-day	10.4 (9.55-11.3)	11.7 (10.7-12.7)	13.7 (12.5-15.0)	15.3 (13.9-16.8)	17.3 (14.9-19.3)	18.7 (15.8-21.3)	20.1 (16.2-23.4)	21.3 (16.3-25.5)	22.8 (16.6-28.1)	23.7 (16.9-30.0)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Figure 10. Columbus Rainfall Data

Environmental

In order to achieve the desired outcome of building a functional community while also adhering to safe environmental guidelines, the history of the land must first be reviewed. This would include observations of the native soil, plants, and animals of the area. Mr. Robertson and the environmental department will work closely with project managers to review the necessary permits needed to design an environmentally friendly project. This would include creating a stormwater pollution prevention plan where it will outline the best possible solution to reduce the spread of pollutants in stormwater from the construction site. While closely working with the project manager, a public involvement plan will also be necessary to introduce public ideas into the plan. Some state and federal databases may be needed to acquire needed information. A 404 permit application will be needed to ensure that several things are looked at. This would include looking at local water channel impacts which would involve the river that runs near the worksite. Preventing harm to endangered species habitats is also an essential task. It would also be ensured that other species would not be significantly impacted. Several sources will be used to evaluate the plan including using USGS topography maps, soils maps, and floodplain maps. Impaired water maps will also be essential as we do have several sources of possible contamination. As said before, there are several concerns regarding the landfill transfer station being just to the west of the lot and the wastewater treatment plant being just south. Surrounding farmland could also be a point of concern as it is common to use pesticides for crops. It should also be noted that native plants and trees should be considered when planting new landscape around the property. Wellhead protection and sizing of the sanitary sewers will also be considered while working with the water resources department. After construction is done, water quality runoff should be analyzed to reassure that new development does not cause any future damage to the surrounding environment.

Transportation

A new residential community was requested in the southern part of Columbus, NE. The site will be connected to 14th Avenue just north of the Columbus Wastewater Treatment plant as shown in Figure 11 below. The local roads in this community will have a width of 36 ft (10ft lane widths, 2 ft shoulder widths, 6 ft for on street parking), outside lane turn widths of 48 ft, inside turn lane widths of 28 ft, a superelevation rate of 3%, a radius of curve of 160 ft, and a speed of 25 mph. For parking along the park, each stall will be angled 30 degrees, have a width of 8 ft and a length of 16 ft. The local park parking will be encroaching the park area by a depth of 12 ft. Our roadways will be constructed using a PG Grade 64-22. There will be a sidewalk surrounding the lot area that will have a width of 4 ft. The total square footage of roadway in this neighborhood will be roughly 121,800 ft^3 or 4,511.11 yd^3. The surface course (seal coat) will have a one-inch thickness, the binder course (asphalt thickness) will have a thickness of three in, the base course will have a thickness of 1 ft, and the sub course will be the natural reported soils listed in the Geotechnical section of this proposal. There will be three speed signs, three dead end signs, two caution signs for children, and two street signs. A fast-drying paint will be used for the pavement markings on the neighborhood roads. This development is projected to produce less than 400 Average Daily Traffic and the only traffic coming to the development will be the residents themselves, visitors, or delivery persons.

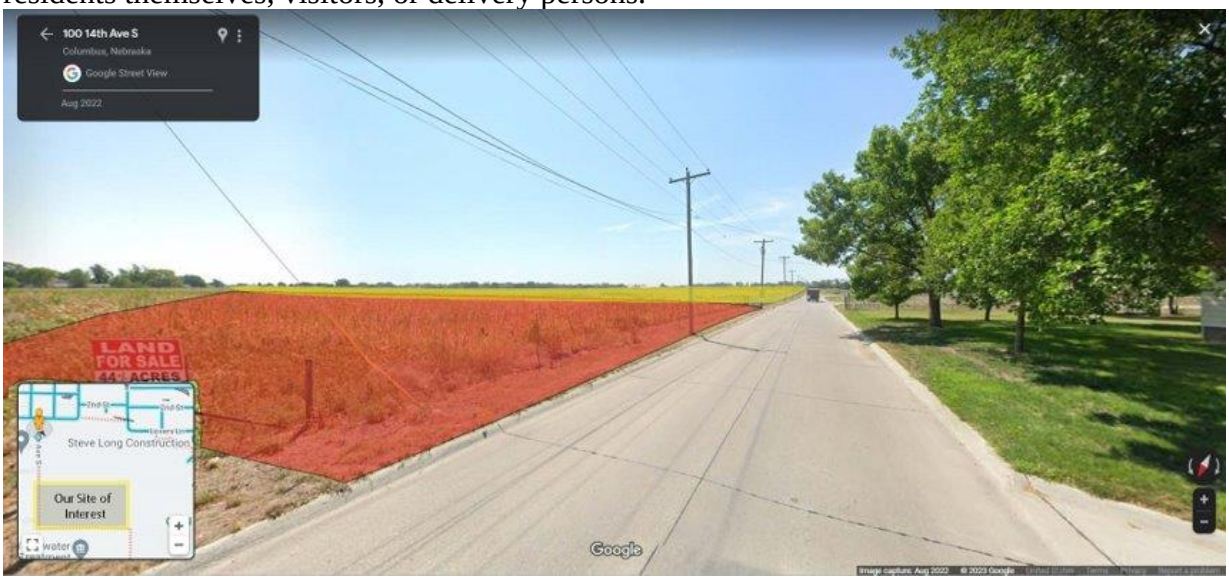

Figure 11. Projected Job Site before Construction

Work Schedule

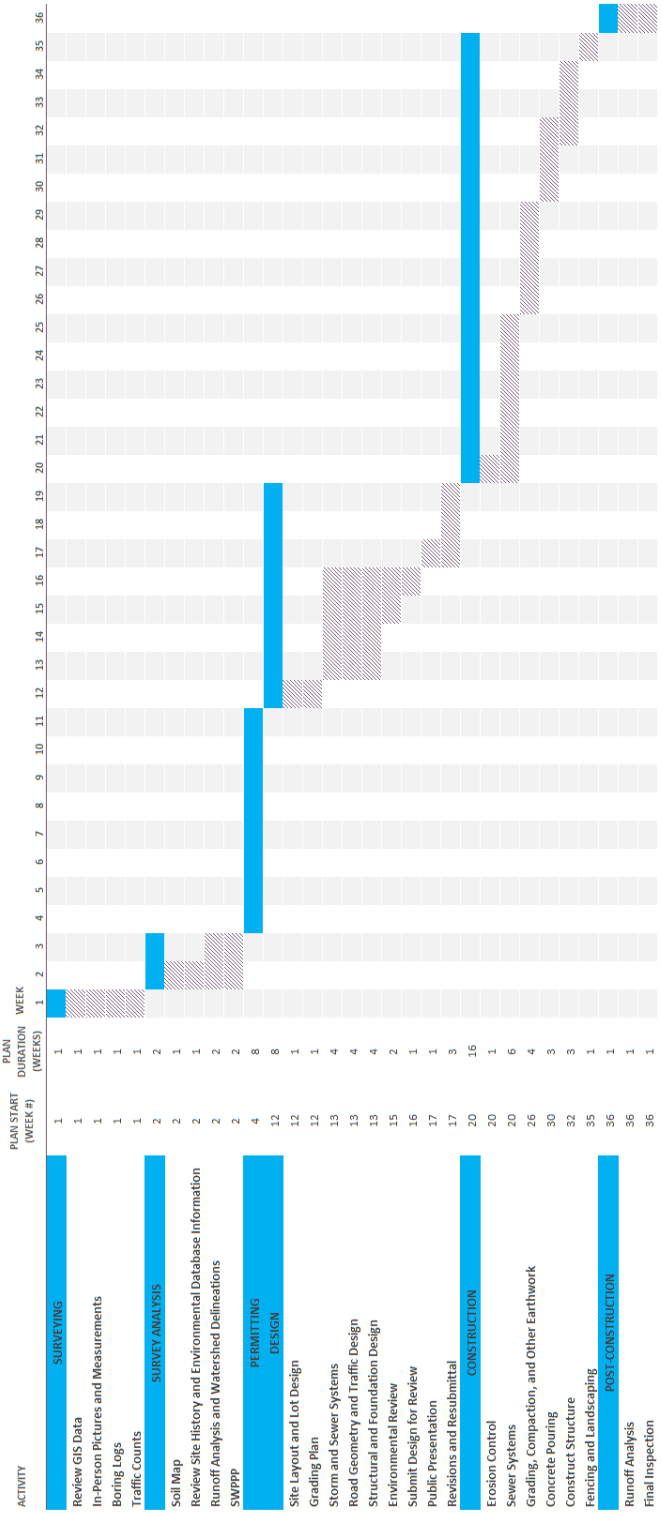

Figure 1212. Proposed Work Schedule

Costs

The cost of labor is split into 2 categories for this project: Design and Field labor. The design cost accounts for one project manager with an hourly rate of $80.00, and four professional engineers with an hourly rate of $70.00. It was assumed that the project manager and each professional engineer would work 40 hours per week for 10 weeks. The field labor cost accounts for all labor, after the design phase and during the construction phase. On average, there will be 10 workers at a time, working 40 hours a week, for 18 weeks, at an average hourly rate of $40.00.

There are additional charges that have been detailed below:

- There will be one public meeting scheduled for Columbus residents to attend and comment.
- We will need to perform two site visits. We will charge $0.625 per mile traveled. Our office is currently in downtown Lincoln, so we estimate an average of 160 miles for each round trip.
- To move dirt to the site, it will cost approximately $25 per cubic yard.

Structure				
Design				
AutoCAD License	3	EA	235.00	705.00
Engineering Paper	2	EA	23.99	47.98
Construction				
Steel	157.76	Cwt	50.19	7917.97
Concrete	75	cu. yd	137.00	10275.00
Asphalt shingle	1200	sq. ft	1.50	1800.00
			Subtotal	20745.95
Geotech				
Earthwork	4093	cu. yd	25.00	102325.00
			Subtotal	102325.00
Water				
Storm Sewer	3000	LF	125.00	375000.00
Sanitary Sewer	3000	LF	100.00	300000.00
Inlets	6	EA	6000.00	36000.00
			Subtotal	711000.00
Environmental				
Environmental Site Assessment	1	EA	6000.00	6000.00
Trees	100	EA	150.00	15000.00

Silt fence (place and remove)	2000	EA	4.06	8120.00
			Subtotal	29120.00
Transportation				
Asphalt	50750	cu. ft	10	507500.00
Base Material	4511.111111	cu. yd	25.00	112777.78
Signage	10	EA	30.00	300.00
Pavement Markings	3350	LF	0.035	117.25
			Subtotal	620695.0278
Transportation	320	mi	0.625	200.00
Public Meeting	1	EA	200.00	200.00
			Design Labor	144000.00
			Field Labor	288000.00
			Total	1916285.98
			30% Contingency	574885.79
			Final Costs	2491171.78
This is a preliminary cost estimate and is subject to change				

Table 1. Preliminary Cost Analysis

Results

This proposal contains details regarding the design process and construction plans for the new housing development in Columbus, Nebraska. Once the final design is completed, it will be sent to the client for final approval by May 12, 2023. Construction on the housing development will begin, soon thereafter, on June 1st and extend into the summer, following the schedule outlined above. This new housing development will have a significant positive impact on the City of Columbus. The job market is exploding within the city, and a new, beautiful neighborhood will be a draw for new families. We would anticipate an increase in population, resulting in significant economic benefits to the City of Columbus.

Conclusions

Thank you for taking the time to evaluate and consider our proposal for the new housing development in Columbus, Nebraska. Our firm truly believes that our outstanding qualifications and experienced engineers are the best in the Midwest. Our mission is to provide our client with excellence customer service and the highest quality end product. We respect and value the opinions of the client at every step of the process, and if changes are necessary, our engineers will act quickly to find a solution. We would love the opportunity to work for the City of Columbus Chamber of Commerce and deliver the housing development that will encourage families to settle down in this wonderful city. We look forward to hearing back from you regarding the project. Please feel free to contact our senior engineers via email or phone:

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Environmental:

Brexton Robertson: brobertson7@huskers.unl.edu, (308) 778-6751

Transportation:

Kaden Perala: kperala@huskers.unl.edu, (509) 218-4506

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