BARR

Lynmar Basin
Stormwater Retrofit Feasibility Study

Concept Rendering

Prepared for
Nine Mile Creek Watershed District

9 MILE CREEK WATERSHED DISTRICT February 2022

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Lynmar Basin Stormwater Retrofit Feasibility Study
February 2022

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Acronyms

AACE	Association for the Advancement of Cost Engineering
MIDS	Minimal Impact Design Standards
MPCA	Minnesota Pollution Control Agency
NMCWD	Nine Mile Creek Watershed District
UAA	Use Attainability Analysis
USGS	United States Geological Survey

1 Introduction and Project Background

1.1 Introduction

This report summarizes the results of the feasibility study for the stormwater retrofit of Lynmar Basin in Edina. Building off the work conducted as part of the conceptual design, this study further evaluated the feasibility of increasing infiltration in this location and considered options to refine and optimize the design to maximize the project benefits. The feasibility study included technical analysis and associated cost and benefit considerations for the following:

- Evaluation of the infiltration capacity of site soils based on soil borings
- Evaluation of potential impacts of increased infiltration on local groundwater levels through a groundwater mounding analysis
- Evaluation of directing additional runoff to the Lynmar Basin, including analysis of water quality benefits, storm sewer modifications necessary to convey the additional runoff to Lynmar Basin, and associated costs.

1.2 Project Background

The Lynmar Basin is a low-lying, open space area between Lynmar Lane and Bristol Boulevard that receives stormwater from a 20-acre residential watershed (see Figure 1-1). The Lynmar Basin, located in the Lake Edina watershed, currently serves as a dry pond, providing flood detention but minimal water quality benefits. This location was identified as a potential site to implement stormwater best management practices in the *Nine Mile Creek Watershed District Lake Cornelia and Lake Edina Water Quality Improvement Project, Feasibility Study/Preliminary Engineering Report* (Barr, 2020) to reduce stormwater volume and pollutants to downstream Lake Edina.

The primary objectives of the project are to retrofit the site to enhance stormwater volume reduction and water quality treatment within the park through increased infiltration and reduce flood risk for nearby properties. Other project objectives include enhancing natural resources and wildlife habitat, enhancing active and passive recreation opportunities within the park, and providing educational opportunities for park users.

The first step of this project was to develop a preferred conceptual design for the stormwater retrofit, which was completed in September 2021 in consultation with City of Edina staff and interested residents. This feasibility study includes additional analyses to evaluate various technical aspects of the proposed project.

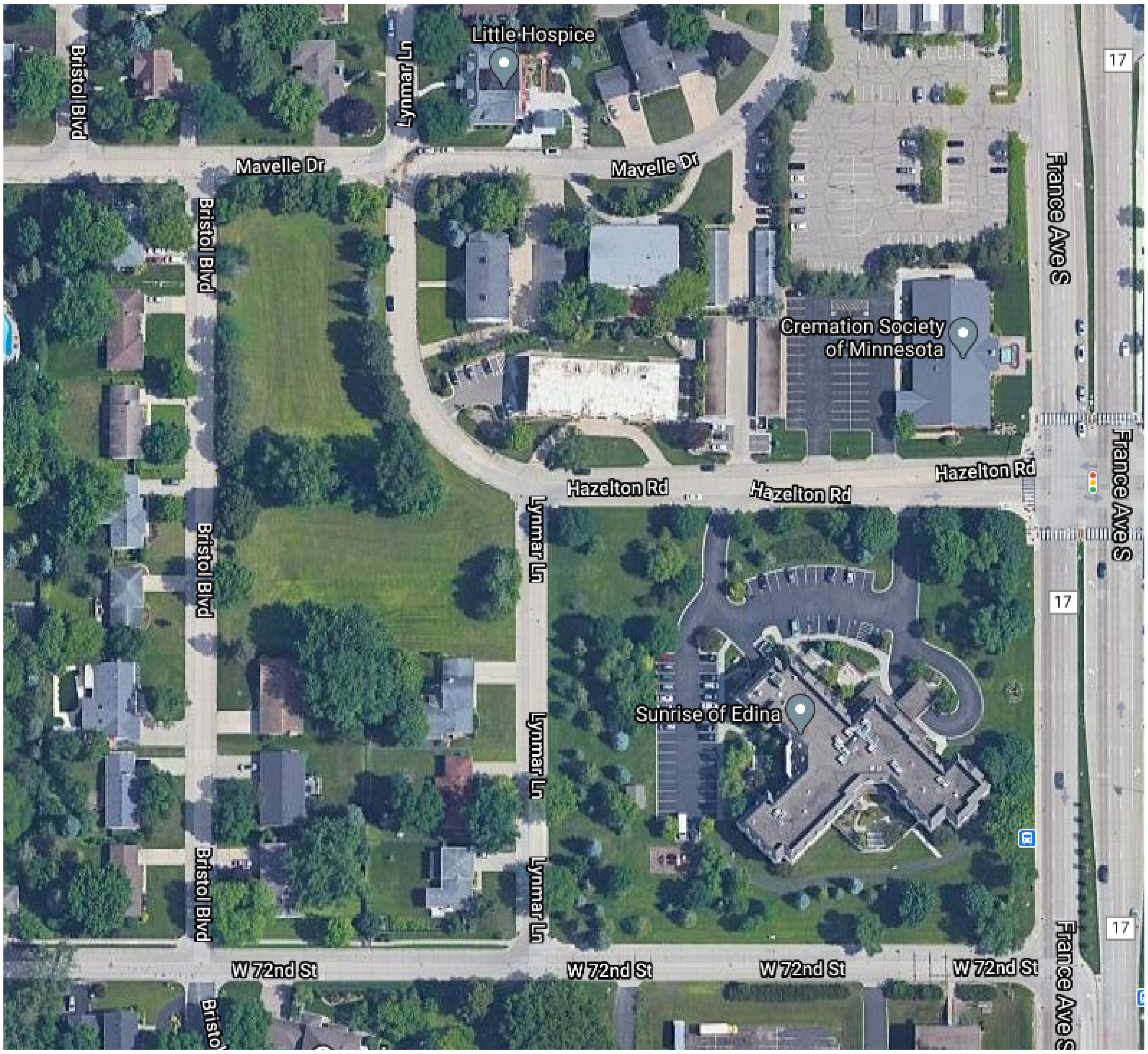


Figure 1-1 Project location. Lynmar Basin is a low-lying, turfed/natural area just south of Mavelle Drive, between Bristol Boulevard and Lynmar Lane.

2 Conceptual Design

2.1 Public Engagement Process

Community outreach and engagement was initiated as part of the Concept Design phase of work in spring of 2021. The engagement process was developed to help the design team better understand existing conditions, public issues and needs, and to help inform conceptual design plans for consideration. This process was detailed in the *Nine Mile Creek Watershed District Lynmar Basin Stormwater Retrofit Concept Plan*, with a brief summary provided here (Barr, 2021).

The City of Edina developed a project website and engagement hub for this project to provide interested individuals access to project information and updates. The site, part of the city's Better Together Edina public engagement platform, also provided a method to receive feedback from interested public. A survey was developed in conjunction with NMCWD, to better understand current park use and values and perceptions regarding the existing park space.

Several community events were held in-person at Lynmar Basin to solicit feedback and answer questions from interested residents and property owners. An initial open house meeting was held on April 20, 2021 in which NMCWD, City of Edina, and Barr staff heard from local residents regarding their thoughts on how the park is used and concerns and questions about the potential retrofit project. Information gathered during this event was used to develop two initial design concepts. The two initial design concepts were shared at a second open house meeting held on July 13, 2021. Feedback received from residents was generally positive and was used to inform the final design concept which is depicted in Figure 2-1. This concept was used as a design basis to evaluate project feasibility and cost effectiveness.

2.2 Summary of Conceptual Design

The stormwater retrofit design concept consists of grading and excavating portions of the basin, including lowering the bottom of the existing basin by approximately one foot, to promote stormwater infiltration and increase flood storage. The proposed design concept will alter the character of the existing park space, so receiving feedback from neighboring residents and park users was especially important. Feedback obtained from residents prior to developing initial design concepts included the following requests:

- Minimize tree removal, especially the trees along the park perimeter that serve as screening from the France Avenue commercial district
- Maintain a portion of the existing park space for passive park recreation, such as picnicking, sledding, and unorganized field play (e.g., playing catch or frisbee)
- Be mindful of neighborhood safety considerations, with a goal to minimize potential for loitering
- Avoid increasing the risk of flooding, including basement flooding

The final concept design is shown in Figure 2-1.

Figure 2-1. Graphical representation of Lynmar Basin Stormwater Retrofit Conceptual Design

3 Feasibility Analysis

This study focused on further evaluation of the feasibility of increasing infiltration in this location, including the following technical analyses, which are described further in this section:

- Evaluation of the infiltration capacity of site soils based on a site soil investigation
- Evaluation of potential impacts of increased infiltration on local groundwater levels through a groundwater mounding analysis
- Evaluation of directing additional runoff to the Lynmar Basin, including analysis of water quality benefits, storm sewer modifications necessary to convey the additional runoff to Lynmar Basin, and associated costs.

3.1 Infiltration capacity of existing soils

Under existing conditions, a storm sewer pipe conveys stormwater from the basin to the trunk storm sewer system at the intersection of Lynmar Lane and Hazelton Road. The invert of the existing outlet pipe is at the bottom of the existing basin, thereby draining all the stormwater that enters the basin directly into the trunk storm sewer.

The stormwater retrofit design concept includes excavating and grading most of the basin to lower the bottom by approximately one foot below the existing storm sewer outlet pipe. This will trap stormwater in the basin, allowing it to infiltrate instead of flowing downstream. (This volume of trapped water is often referred to as "dead storage".) Infiltration will prevent most contaminants in the stormwater from flowing downstream and reduce the total volume of stormwater flowing downstream to Lake Edina.

In order for this concept to work, the soils in the basin need to be able to infiltrate the trapped stormwater within 24 to 48 hours. Certain soils infiltrate stormwater better than others and shallow groundwater can also slow the rate of infiltration. It was therefore necessary to further evaluate the feasibility of infiltration capacity of the soil in the basin and assess distance to groundwater. Four soil borings from the Lynmar Basin site were collected and analyzed to characterize the underlying soils and determine the distance to groundwater. Figure 3-1 shows the locations of the soil borings. A summary of the soil boring analyses and soil boring logs are included as Appendix A.

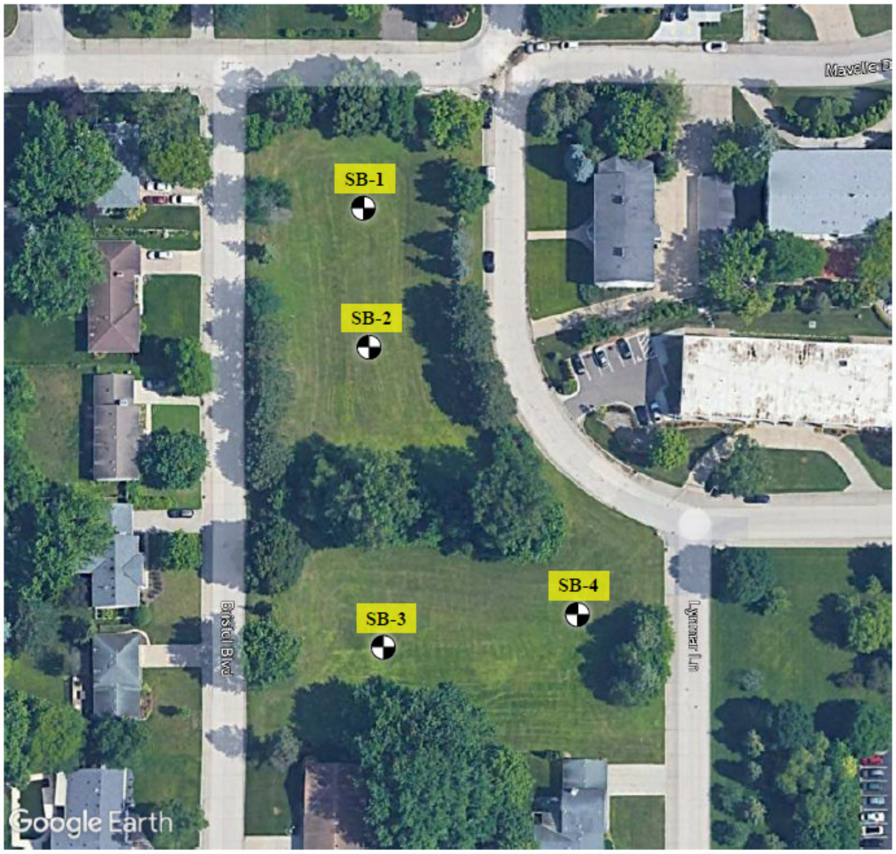


Figure 3-1. Soil boring locations

3.1.1 Depth to Groundwater

Two of the four soil borings, SB-2 and SB-4, were advanced to a depth of 30 feet below the ground surface to determine approximate depth to groundwater. Groundwater was observed approximately 23 feet and 24 feet below the ground surface, respectively. Groundwater this far below the surface will not hinder infiltration of surface water in Lynmar Basin.

3.1.2 Infiltration Capacity

The rate at which the stormwater infiltrates into the soil is dependent on several factors, including the rate and duration of stormwater supply, physical properties of the soil, such as its hydraulic conductivity and density, vegetation, and the moisture content of the soil. The maximum rate that water infiltrates into the soil under a given set of conditions is called the infiltration capacity. As mentioned above, an onsite soil investigation was conducted to better understand the underlying soils at the site and the anticipated infiltration capacity under existing conditions.

As part of the on-site soil investigation, the soils were characterized for each soil horizon or layer observed at each soil boring location. Although the soil layers varied at each boring location, in general the deeper soil horizons are comprised of silty sands and/or poorly graded sands, which are generally conducive for infiltration of stormwater. The more shallow soils are characterized by layers of sandy lean clay which have a slower infiltration rate than sandy soils without clay. The layers of sandy lean clay varied in depth and thickness at each location but were observed down to approximately 12 feet below the ground surface. To increase the infiltration rate through the sandy lean clay, the construction of infiltration trenches is recommended. A trench is excavated through the soils with slow infiltration capacity until it reaches the sandy soils with a higher infiltration rate. These trenches are then backfilled with loose sand from either on site (if available) or from off site. The infiltration trench connects the sandy underlying soils to the surface of the basin and bypasses the slower clay soils. Figure 3-2 shows an example of the recommended soil trenches to help promote stormwater infiltration in the proposed basin.

Figure 3-2. Lynmar Basin Stormwater Retrofit Conceptual Design with sand trenches (dashed white line)

Soil density (compaction) can also affect infiltration capacity of the soil. The more dense or compacted a soil is, the slower the infiltration rate. The soil investigation included conducting a standard penetration test on the various soil layers to determine soil density. The test involves dropping a 140 pound weight (hammer) from a height of 30 inches onto the soil sampling device in the bore hole. The number of blows it takes to drive the sampler 12 inches into the soil is known as the N value (blows per foot). The higher the number, the more dense or compacted the soil is. Results from the onsite soil investigation indicate that the observed N values for the layers of sand and silty sand were relatively high, indicating the soils are quite dense and it is recommended that underlying soils be loosened during construction to improve infiltration capacity. It is also recommended that all surface soil, regardless of whether its clayey or sandy, be loosened. This will increase infiltration in all surface soils and create a better growing environment for the vegetation in the basin.

In summary, results of the onsite soil investigation indicate that the site is conducive for infiltration of stormwater if the upper layers of soils in the basin can be modified and/or loosened and soil infiltration trenches are excavated and filled with sandy, loose soil. The underlying layers of sand and gravel are good for infiltration, and the water table is relatively deep.

3.2 Groundwater Mounding Analysis

The stormwater retrofit design concept includes expanding and lowering the bottom of the existing basin to be approximately one foot below the existing outlet pipe. Stormwater that is collected in the portion of the basin below the existing outlet pipe (often termed "dead storage") will infiltrate. As part of this feasibility study, the potential impact of increased infiltration in the Lynmar Basin on nearby groundwater levels was evaluated through a groundwater mounding analysis. The analysis was conducted to assess the potential for changes to the water table elevation resulting from the increased storage (temporary) and infiltration at Lynmar Basin, with specific focus on nearby structures.

A simple MODFLOW groundwater flow model was developed to simulate water infiltrating from the basin to the aquifer and analyze water table mounding. MODFLOW, developed by the United States Geological Survey (USGS), is the industry-standard groundwater flow modeling code. MODFLOW is a three-dimensional numerical model that uses finite-difference methods to solve the governing partial differential equations of groundwater flow. The model incorporated several key assumptions, including that the ground surface is flat, the soil is homogeneous, and the water spatially infiltrates evenly across the basin.

Results from the onsite soil investigation were used to estimate several model parameters. As mentioned previously, the soil borings showed the soil is mostly sand with a clay layer near the surface and discontinuous clay lenses 5 and 10 feet deep. The results of grain size analyses conducted as part of the soil investigation were used to estimate the bulk hydraulic conductivity of the soils. Soils with high hydraulic conductivity are preferable for infiltration, while low hydraulic conductivity soils slow infiltration and are less desirable. Based on the grain size analysis the soils under the basin are estimated to have a hydraulic conductivity range of 3 to 52 feet/day. A conservative hydraulic conductivity of 3 feet/day was used for the groundwater mounding analysis. For purposes of the groundwater mounding analysis, the initial groundwater elevation was estimated to be at 882 feet MSL and was based on water levels observed at the time of the soil boring investigation.

Three infiltration scenarios were evaluated using the MODFLOW model to evaluate the water table mounding:

1) a single "typical" precipitation event that fills the proposed one-foot deep "dead storage" volume below the existing storm sewer outlet

2) a single 100-year, 24-hour precipitation event that fills the entire Lynmar Basin
3) a series of events to represent a prolonged “wet period”, based loosely on monthly precipitation totals from the summer of 2019, a time period with higher-than-average rainfall.

Predicted water levels were simulated over time using the MODFLOW model, with results tracked at several locations including within the basin, at buildings to the north, south, east, and west of the basin, and 250 meters away from the deepest area of the basin (see Figure 3-3). The key assumptions and results are described further below for each of the modeled scenarios.

Figure 3-3. Locations of reported water table elevations for MODFLOW modeling

3.2.1 Single “Typical” Precipitation Event

The first modeled scenario was a single precipitation event with a runoff volume that fills the proposed one-foot deep “dead storage” volume below the existing storm sewer outlet (0.6 acre-feet). This precipitation event corresponds approximately to a one-inch rainfall event, based on the size of the basin in the conceptual design and the tributary drainage area under existing conditions. For purposes of the MODFLOW analysis, it was assumed that the infiltration rate from the basin is 12 feet/day (6 inches/hour), which is on the high end of infiltration rates that would be expected with sandy soils, but a conservative assumption in terms of the groundwater mounding analysis (rapid infiltration creates a higher potential for groundwater mounding).

Figure 3-4 shows the groundwater mounding results for the single precipitation event scenario, with groundwater elevations for the various locations depicted based on color (colors correspond to the color of the locations shown in Figure 3-3). As shown in the figure, groundwater elevations directly below the basin rise approximately 1.5 feet and elevations at the nearby structures (locations #4 and #8) rise less than one foot. The potential change in groundwater levels associated with the increased infiltration are simulated to remain below levels that would impact nearby structures. Note that the low basement elevation is estimated based on LiDAR elevation data from MDNR (2011) and it was assumed that the basement is 8 feet below the approximate ground surface elevation at the edge of the low structure(s).

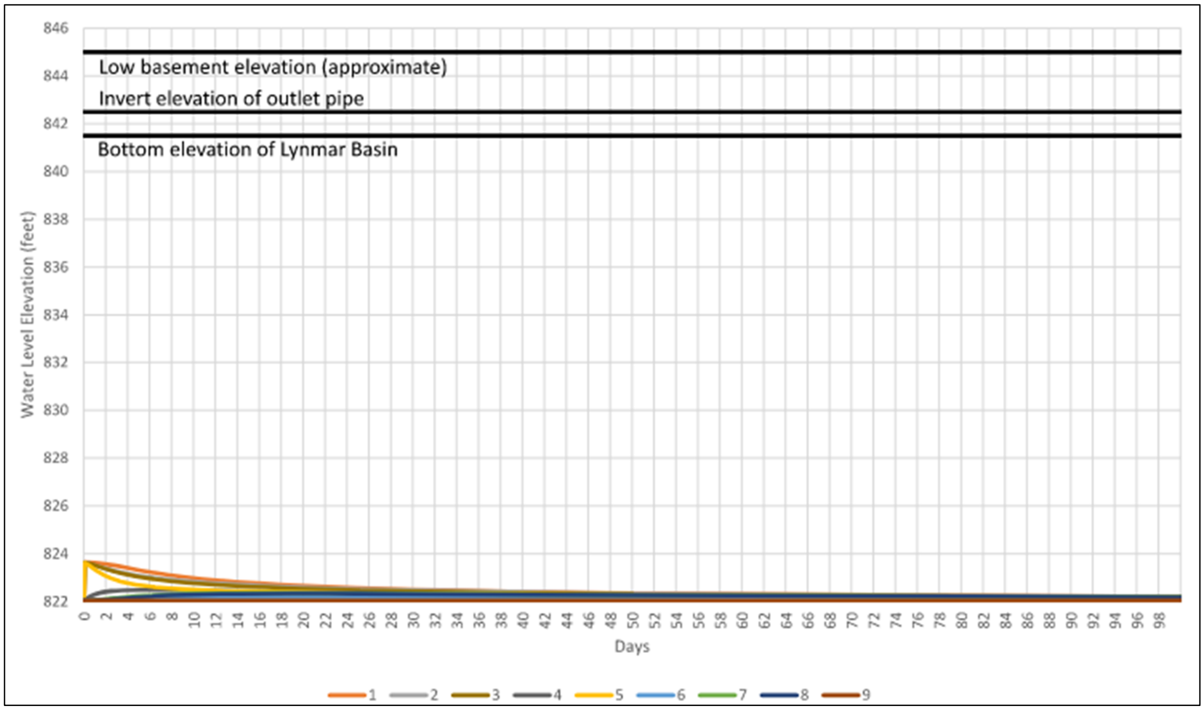


Figure 3-4. Groundwater mounding modeling results for single "typical" precipitation event

3.2.2 Single 100-year, 24-hour Precipitation Event

The second modeled scenario was a single 100-year, 24-hour precipitation event (7.5 inches) with a runoff volume that fills and exceeds the overflow elevation of the Lynmar Basin. In this scenario, stormwater will leave the basin via infiltration and through the existing storm sewer outlet pipe. A hydraulic analysis was conducted to calculate the approximate amount of water that will be infiltrated during a 100-year, 24-hour rain event, as opposed to water leaving through the storm sewer. For the MODFLOW analysis, it was assumed that 7.9 acre-feet of water infiltrates in approximately 15 hours, based on an infiltration rate of 6 inches/hour, similar to the previous scenario.

Figure 3-5 shows the groundwater mounding results for the single 100-year, 24-hour precipitation event scenario, with groundwater elevations for the various locations depicted based on color (colors correspond to the locations shown in Figure 3-3). As shown in the figure, groundwater elevations below the basin rise approximately 10 feet and elevations at the nearest structures (location #4) rise by approximately three feet. The potential change in groundwater levels associated with the increased infiltration are simulated to remain below levels that would impact nearby structures.

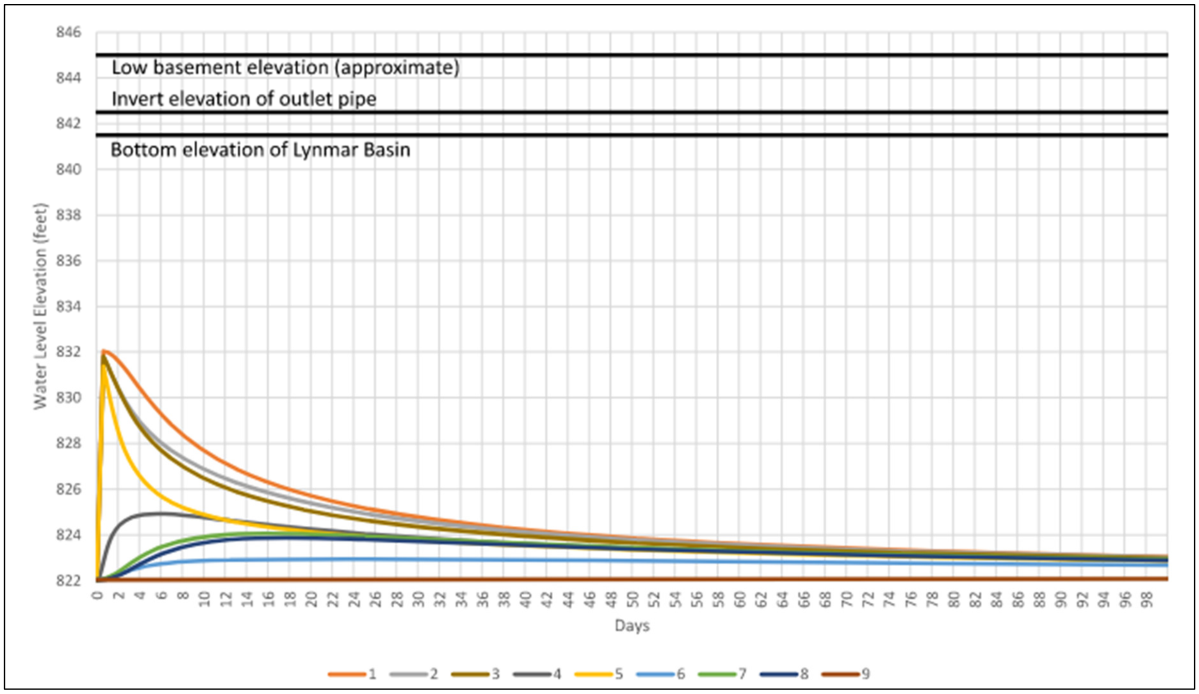


Figure 3-5. Groundwater mounding modeling results for 100-Year, 24-hour precipitation event

3.2.3 "Wet Period" Simulation

The third modeled scenario was a series of rainfall events throughout a four-month period to represent infiltration during a prolonged wet period. The amount of infiltration simulated in the MODFLOW model was loosely based on the monthly rainfall totals from the summer of 2019, which represents a wetter-than-average year. The 2019 "wet period" simulation included the months of June, July, August, and September, with about 3, 7, 6, and 4 inches of rain, respectively. Since the proposed dead storage volume of the basin corresponds to the amount of runoff from a one-inch rainfall event (approximately, assuming the existing tributary drainage area), the monthly rainfall totals were spread evenly throughout each month using periodic one-inch events (0.6 acre-feet of infiltration per event).

Figure 3-6 shows the groundwater mounding results for the prolonged wet period scenario, with groundwater elevations for the various locations depicted based on color (colors correspond to the locations shown in Figure 3-3). As shown in the figure, groundwater elevations below the basin rise approximately 6-8 feet and elevations at the nearest structures (location #4) rise by approximately four feet. The potential change in groundwater levels associated with the increased infiltration are simulated to remain below levels that would impact nearby structures.

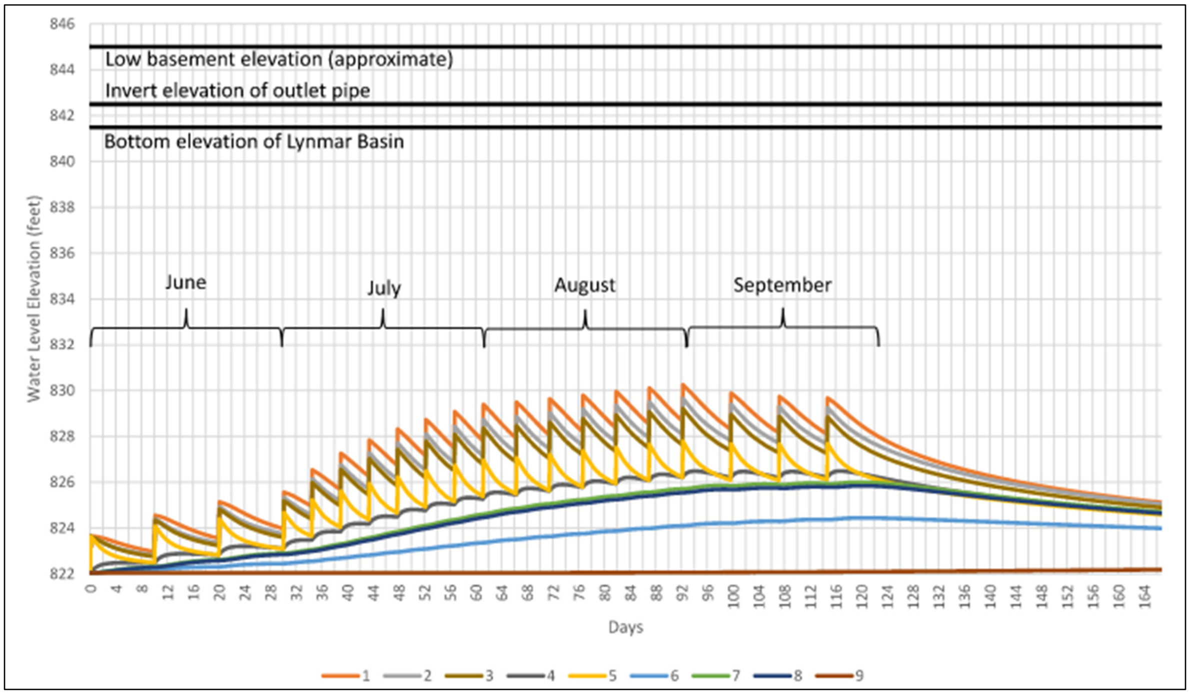


Figure 3-6. Groundwater mounding modeling results for "wet period" simulation

3.3 Tributary Drainage Area and Storm Sewer Retrofit Analysis

Under existing conditions, Lynmar Basin receives stormwater from a residential area of approximately 20 acres (Subwatersheds LE_14, LE_21, LE_29). Stormwater is conveyed to the basin via a storm sewer system that collects runoff from the low areas west of the basin along Heatherton Circle and Bristol Boulevard (see Figure 3-7). Also shown in Figure 3-7 is an approximately 16-acre subwatershed that drains to a low area on the east side of the basin at the intersection of Hazelton Road and Lynmar Lane (Subwatershed LE_24). Runoff that reaches this intersection is not directed into Lynmar Basin, but rather is collected and conveyed southward through the trunk storm sewer system down Lynmar Lane to West 72nd Street. This study considered the feasibility of capturing and redirecting stormwater from Subwatershed LE_24 to Lynmar Basin, including evaluating storm sewer modification options and estimating additional water quality benefits.

Figure 3-7. Subwatersheds near Lynmar Basin.

3.3.1 Storm Sewer Reconfiguration

Figure 3-7 shows the existing storm sewer configuration (five catchbasins, two manholes, and associated pipes) at the intersection of Hazelton Road and Lynmar Lane. Review of the storm sewer information provided by the City of Edina indicates that it will be feasible to reconfigure the storm sewer system to redirect runoff from Subwatershed LE_24 into Lynmar Basin. Capturing about half of LE_24 is relatively straightforward and only requires modification of two catch basins, short sections of pipe, and minimal patching of the concrete street. Capturing and conveying all of the runoff from Subwatershed LE_24 will require modification of all five catch basins, all their associated pipes, and replacement of nearly all the concrete pavement in the intersection. Given the large area tributary to this intersection, it is also recommended that high-capacity inlets be installed as part of the storm sewer reconfiguration to minimize roadway flooding during large storm events.

3.3.2 Water Quality Benefits

Redirecting Subwatershed LE_24 to Lynmar Basin will significantly increase the amount of runoff that reaches Lynmar Basin. The tributary drainage area to Lynmar Basin and associated volume retention and total phosphorus removal were compared for the following three scenarios:

Concept A- Basin Retrofit with existing storm sewer: the volume of Lynmar Basin and tributary drainage area are consistent with the assumptions from the conceptual design from the Conceptual Plan (September 2021)

Concept B- Basin Retrofit with half Subwatershed LE_24: the volume of Lynmar Basin is consistent with the September 2021 conceptual design, but the tributary drainage area includes half of Subwatershed LE_24. Storm sewer modifications required to redirect about half of LE_24 are relatively minor.

Concept C- Basin Retrofit with entire Subwatershed LE_24: the volume of Lynmar Basin is consistent with the September 2021 conceptual design, but the tributary drainage area includes all of Subwatershed LE_24. Storm sewer modifications and street repair required to redirect all of LE_24 are more significant than Concept B.

Table 3-1 summarizes the tributary drainage area, average annual runoff volume removal, average annual total phosphorus (TP) removal, and treatment equivalency for the three scenarios. Figure 3-8 compares the estimated average annual volume removal and total phosphorus removal for the three scenarios, as well as the corresponding treatment equivalency. The average annual volume removal and total phosphorus removal of the three scenarios were estimated using the MPCA Minimal Impact Design Standards (MIDS) calculator.

Table 3-1. Comparison of tributary drainage area, volume removal, TP removal, and treatment equivalency for three scenarios.

Scenario	Tributary Area [acres]	Impervious Area [acres]	Average Annual Volume Removal [acre-feet]	Average Annual TP removal [lbs]	Treatment Equivalency (Inches off of Impervious Area) [inches]
A- Lynmar Basin Retrofit[1]	19.8	5.5	15.6	12.8	1.3
B- Lynmar Basin Retrofit + Half LE_24 Subwatershed	28.0	11.1	23.9	19.5	0.6
C- Lynmar Basin Retrofit + LE_24 Subwatershed	36.2	16.8	29.2	23.8	0.4
[1] Note that the soil infiltration rate for Lynmar Basin was adjusted for this feasibility study based on results of the onsite soil investigation, so the average annual volume removal and TP removal differ from values reported in the September 2021 conceptual design report.					

The treatment equivalency is significantly reduced when runoff from Subwatershed LE_24 is redirected to Lynmar Basin. The treatment equivalency approximately represents the size of rainfall event that will fill the available dead storage in the proposed basin, assuming no (or minimal) runoff from pervious areas for these rainfall events. Under Scenario C, the proposed dead storage volume (volume below the existing storm sewer outlet) will fill much more frequently in comparison with existing conditions (i.e., the dead storage volume will fill in a 0.4 inch rainfall event, versus a 1.3 inch event). This results in a significant increase in infiltration from Lynmar Basin, and a reduction in stormwater runoff volume and total phosphorus to downstream Lake Edina. Given that the dead storage portion of the proposed basin will fill much more frequently under Scenarios B and C, vegetation may be more stressed and should be carefully selected to handle the potentially frequent wet conditions.

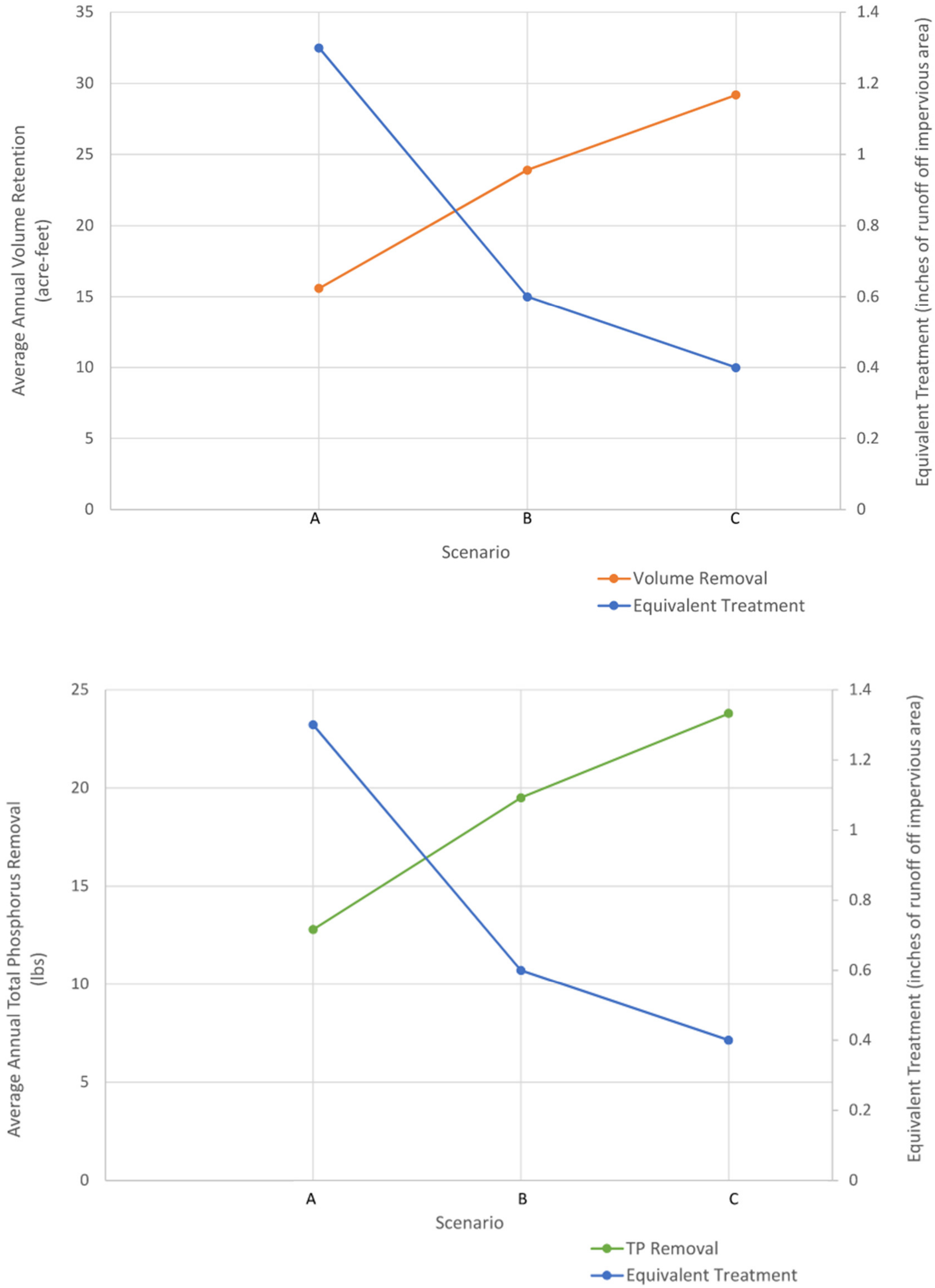


Figure 3-8. Comparison of runoff volume and total phosphorus removal and corresponding treatment equivalency for three scenarios

4 Project Benefits and Costs

4.1 Project Benefits

The Lynmar Basin stormwater retrofit concept designs will provide multiple benefits, including reduced stormwater runoff and pollutant loading to downstream Lake Edina (through infiltration) and reduced frequency of flooding at the intersection of Hazelton Road and Lynmar Lane. Additional co-benefits include enhanced nature resources and wildlife habitat, enhanced active and passive recreation opportunities within the park, and educational opportunities for park users.

The water quality, stormwater volume reduction, and flood storage benefits have been estimated for two concepts, Concepts A and C (see Table 4-1). Concept A is as proposed in *Lynmar Basin Stormwater Retrofit Concept Plan* for basin retrofit only. Concept C includes redirecting all of the 16.4-acre Subwatershed LE_24 to Lynmar Basin by modifying the storm sewer configuration at the intersection of Lynmar Lane and Hazelton Road. The water quality, stormwater volume reduction, and flood storage benefits are discussed in further detail below.

Table 4-1 Summary of water quality, volume reduction and flood storage benefits

Proposed Concept	Average Annual Volume Removal [acre-feet]	Average Annual TP Removal [lbs]	Additional Flood Storage Volume (acre-feet)
A- Lynmar Basin Retrofit	15.6	12.8	2.0
C- Lynmar Basin Retrofit + LE_24 Subwatershed	29.2	23.8	2.0

4.1.1 Water Quality and Stormwater Volume Reduction

Concept A – Basin Retrofit

As discussed in Section 3.3, the proposed infiltration basin will reduce the amount of stormwater discharged to downstream Lake Edina by approximately 15.6 acre-feet, which represents a 91% average annual reduction in stormwater runoff from the existing 20-acre watershed tributary to Lynmar Basin. The estimated annual total phosphorus removal is approximately 13 pounds.

Concept C – Basin Retrofit with Redirecting Subwatershed LE_24

The proposed infiltration basin with storm sewer reconfiguration to redirect Subwatershed LE_24 to Lynmar Basin will reduce the amount of stormwater discharged to downstream Lake Edina by approximately 29 acre-feet. This represents a 66% average annual reduction in stormwater runoff from the 36-acre watershed tributary to Lynmar Basin. The estimated annual total phosphorus removal is approximately 24 pounds. The estimated annualized cost per pound of total phosphorus removed is summarized in **Error! Reference source not found.**.

4.1.2 Flood Risk Reduction

In large storm events, flooding can occur at the intersection of Hazelton Road and Lynmar Lane, just east of the Lynmar Basin. To reduce the frequency of flooding at this intersection, the conceptual design includes excavating additional flood storage in Lynmar Basin. Based on the conceptual design plan developed in September 2021, the proposed grading and excavation provides approximately 2 acre-feet of additional storage in Lynmar Basin (0.6 acre-feet below the existing storm sewer outlet, 1.4 acre-feet above). Reductions in flood elevations resulting from the proposed excavation were evaluated in 2021 as part of the conceptual design development using the City of Edina's XP-SWMM model. Table 4-2 summarizes the estimated flood elevations in Lynmar Basin and the adjacent low area at the intersection of Hazelton Road and Lynmar Lane (Barr, 2021). Note that this feasibility study did not include additional flood modeling; however, predicted flood elevations for the 10- and 100-year rainfall events are not anticipated to change based on the proposed design changes evaluated.

Table 4-2 Lynmar Basin Stormwater Retrofit Flood Elevations

Scenario	10-year, 24-hour Peak Surface Water Elevation (feet MSL)[1]	100-year, 24-hour Peak Surface Water Elevation (feet MSL)[1]
Existing Conditions	851.2	854.4
Proposed Concept Plan A or C	850.0	853.9
Difference	1.2 feet	0.5 feet
[1] *Nine Mile Creek Watershed District Lynmar Basin Stormwater Retrofit Concept Plan* (Barr, 2021)		

Figure 4-3 shows a comparison of approximate inundation extents for the 10- and 100-year, 24-hour rainfall event under existing and proposed conditions. Under existing conditions, a 10-year, 24-hour rainfall event results in inundation of Lynmar Basin and the street in the adjacent intersection of Hazelton Road and Lynmar Lane. Under proposed conditions, inundation from the 10-year, 24-hour rainfall is reduced such that it stays within the Lynmar Basin and does not extend into the roadway, assuming there is sufficient conveyance capacity to get stormwater from the intersection to the basin.

Under existing conditions, a 100-year, 24-hour rainfall results in inundation that extends to include a larger portion of the roadway and the private property to the northeast of the roadway. Under proposed conditions, the increased flood storage volume in Lynmar Basin results in a lower flood elevation; however, the predicted inundation still extends to the structures on private property to the northeast of the roadway.

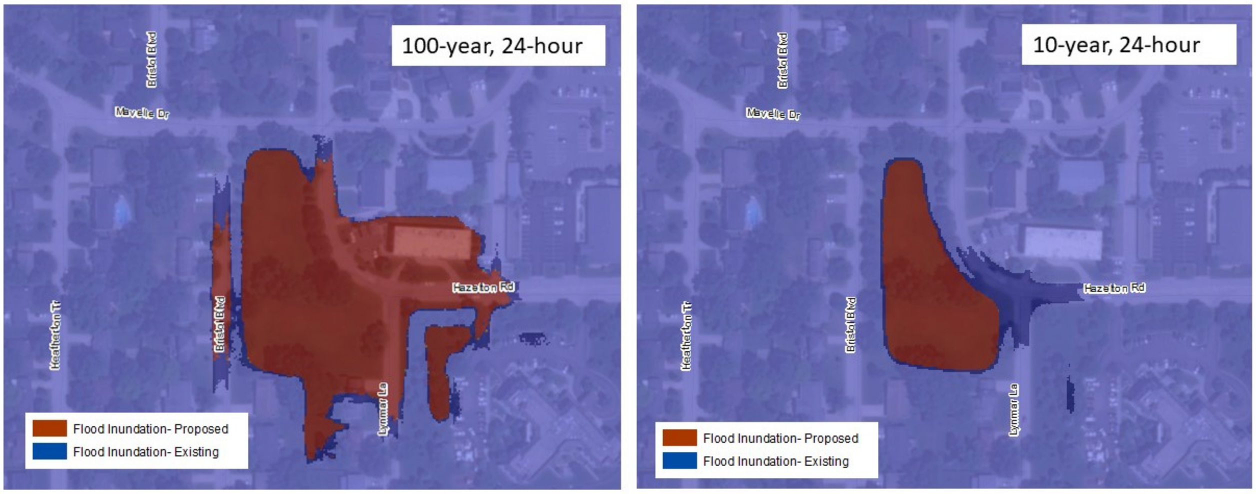


Figure 4-3. Comparison of flood inundation extents for the 100- and 10-year, 24 hour rainfall events.

4.1.3 Co-Benefits

Beyond the flood reduction and water quality benefits, the final concept design provides additional co-benefits, which include the added aesthetic value to the park, the local pedestrian connection via the added path, additional native plant diversity and enhanced habitat for pollinators and other wildlife. The proposed project also provides opportunities for public education through demonstration of stormwater management practices and interpretive signage. The project benefits are summarized in Figure 4-4.

The City of Edina has requested the project include 1:1 tree replacement for the number of trees removed on the site. A tree inventory was completed with removals calculated at 14 trees which would be replaced during construction.

4.2 Opinion of Probable Cost

Planning-level opinions of probable cost were developed for Lynmar Basin Concepts A and C. Concept A is the same as proposed in the *Lynmar Basin Stormwater Retrofit Concept Plan (Barr, 2021)*, but also includes incorporating infiltration trenches to promote infiltration in the basin. Concept C includes storm sewer reconfiguration at the intersection of Lynmar Lane and Hazelton Road to redirect Subwatershed LE_24 to Lynmar Basin. The opinions of probable cost are summarized in Table 4-3, along with the benefit/cost analysis for stormwater volume reduction, removal of total phosphorus, and the additional flood storage provided.

The opinions of probable cost, summarized in **Error! Reference source not found.**, generally correspond to standards established by the AACE. Class 3 opinions of cost were used based on the level of project definition, the use of parametric models to calculate estimated costs (i.e., making use of order-of-magnitude costs from similar projects), and uncertainty with an acceptable range of between -15% and

+20% of the estimated project cost. The more detailed opinions of probable cost for Concepts A and C are provided in Appendix B and C, respectively.

Table 4-3. Planning-level opinions of probable cost and benefit/costs for stormwater volume reduction, removal of total phosphorus, and the additional flood storage provided.

Proposed Concept	Planning-Level Cost Estimate[1]	Planning Level Cost Range (-15% - +20%)	Estimated Annualized Cost per Acre-foot of Runoff Reduced[2]	Estimated Annualized Cost per Pound TP Removed[2]	Flood Storage Unit Cost[3] [$/cubic feet of additional storage]
A- Lynmar Basin Retrofit	$998,000	$849,000 - $1,198,000	$3,900	$4,800	$11
C- Lynmar Basin Retrofit + LE_24 Subwatershed	$1,255,000	$1,067,000 - $1,506,000	$2,600	$3,200	$14

[1] Planning-level cost estimates do not include annual costs for operations and maintenance. Estimated costs do include engineering, design, and construction administration estimates (25%) and 30% construction contingency.

[2] Planning-level estimated annualized costs assume an annual maintenance cost of approximately 10% of estimated construction costs, a project life of 30 years, and an inflation rate of 3%.

[3] Flood storage unit costs are not annualized

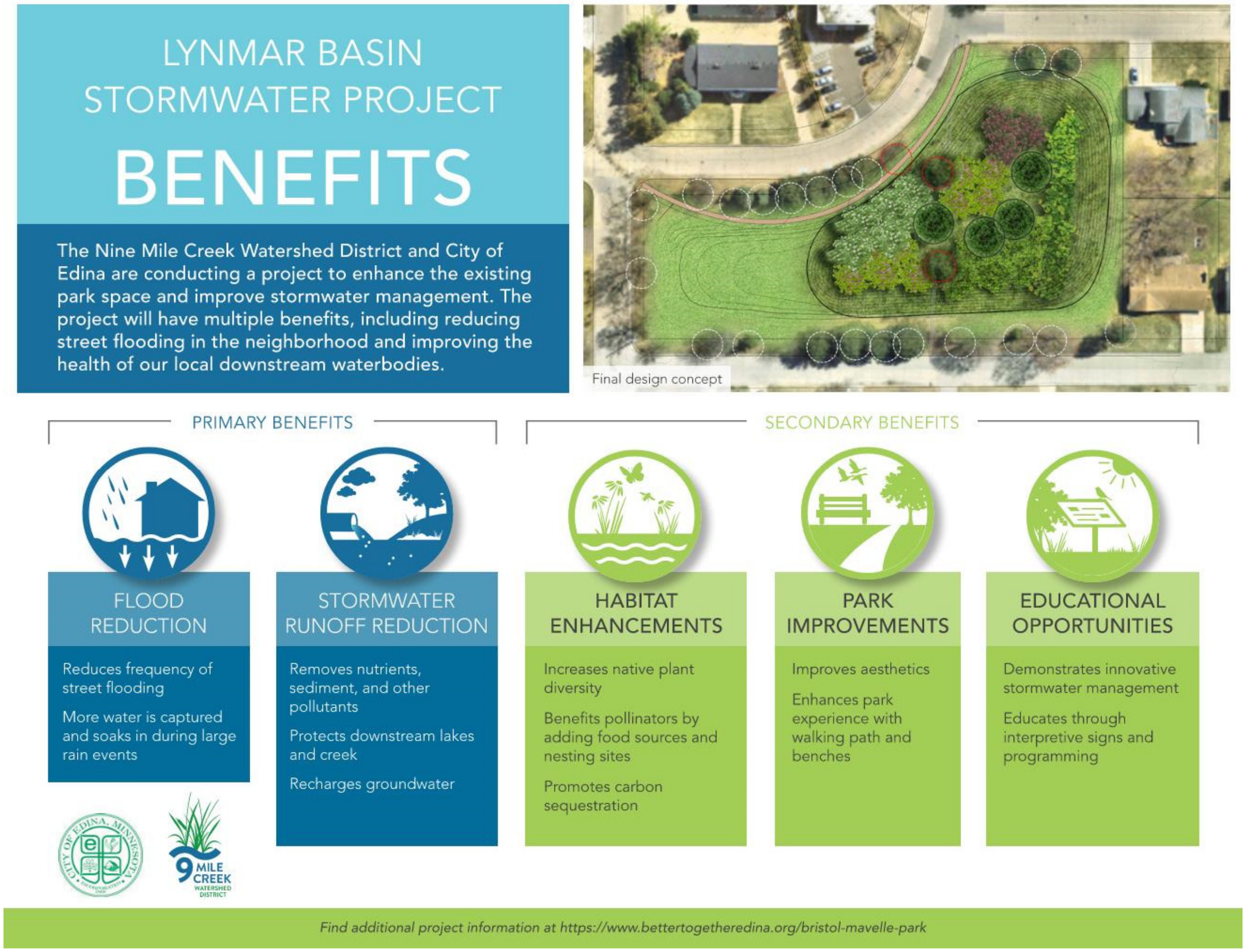


Figure 4-4 Project Co-Benefits Graphic

5 Conclusions and Recommendations

The stormwater retrofit design concept includes excavating and grading most of the basin and lowering the bottom of the existing dry basin by approximately one foot to promote stormwater infiltration and increase flood storage. This study focused on the feasibility of increasing infiltration in this location, including the following technical analyses:

- Evaluation of the infiltration capacity of site soils based on a site soil investigation
- Evaluation of potential impacts of increased infiltration on local groundwater levels through a groundwater mounding analysis
- Evaluation of directing additional runoff to the Lynmar Basin, including analysis of water quality benefits, storm sewer modifications necessary to convey the additional runoff to Lynmar Basin, and associated costs.

5.1 Infiltration Capacity

An onsite soil investigation was conducted to better understand the underlying soils at the site and the anticipated infiltration capacity under existing conditions. While the soil borings indicated silty sands and/or poorly graded sands in the deeper soil horizons, the more shallow soils are characterized by layers of sandy lean clay which have slower infiltration rates than sandy soils without clay. To increase the infiltration rate through the sandy lean clay, the construction of infiltration trenches at the bottom of the basin is recommended. The infiltration trench connects the sandy underlying soils to the surface of the basin and bypasses the slower clay soils.

Results from the onsite soil investigation also indicate that the soils are quite dense. It is recommended that the underlying soils in the bottom of the basin be loosened during construction to improve infiltration capacity. It is also recommended that all surface soil, regardless of whether its clayey or sandy, be loosened. This will increase infiltration in all surface soils and create a better growing environment for the vegetation in the basin.

5.2 Groundwater Mounding Analysis

A groundwater mounding analysis was conducted to assess the potential for changes to the water table elevation resulting from the increased storage (temporary) and infiltration at Lynmar Basin, with specific focus on nearby structures. Three infiltration scenarios were considered using a MODFLOW groundwater flow model, including:

1) a single “typical” precipitation event that fills the proposed one-foot deep “dead storage” volume below the existing storm sewer outlet
2) a single 100-year, 24-hour precipitation event that fills the entire Lynmar Basin
3) a series of events to represent a prolonged “wet period”, based loosely on monthly precipitation totals from the summer of 2019, a time period with higher-than-average rainfall.

Model simulations for these three scenarios indicate that the potential change in groundwater levels associated with the increased infiltration are expected to remain below levels that would impact nearby structures.

5.3 Tributary Drainage Area and Storm Sewer Retrofit Analysis

This study considered the feasibility of capturing and redirecting stormwater from Subwatershed LE_24 to Lynmar Basin, which would expand the tributary drainage area from approximately 20 acres to 36 acres. Redirecting Subwatershed LE_24 to Lynmar Basin will nearly double the amount of stormwater volume reduction achieved on an average annual basis, reducing the amount of stormwater discharged to downstream Lake Edina by an additional 13.6 acre-feet (an 85% increase). Redirecting Subwatershed LE_24 to Lynmar Basin will also nearly double the amount of phosphorus removal, reducing the amount of phosphorus discharged to Lake Edina by approximately 11 lbs on an average annual basis.

With redirecting Subwatershed LE_24, the proposed dead storage volume in Lynmar Basin will fill much more frequently in comparison with existing conditions (i.e., the dead storage volume will fill in a 0.4 inch rainfall event, versus a 1.3 inch event). With the increased frequency of inundation, the vegetation may be more stressed and should be carefully selected to handle the potentially frequent wet conditions.

Review of the existing storm sewer at the intersection of Lynmar Lane and Hazelton Road indicates that it will be feasible to reconfigure the storm sewer system to redirect runoff from Subwatershed LE_24 into Lynmar Basin. Capturing about half of LE_24 is relatively straightforward and only requires modification of two catch basins, short sections of pipe, and minimal patching of the concrete street. Capturing and conveying all of the runoff from Subwatershed LE_24 will require modification of all five catch basins, all their associated pipes, and replacement of nearly all the concrete pavement in the intersection.

Redirecting Subwatershed LE_24 to Lynmar Basin results in significantly higher reduction in stormwater volume and phosphorus removal, an 85% increase on an average annual basis compared with the concept of maintaining the existing tributary drainage area. While more expensive, the overall benefit/cost ratio for redirecting Subwatershed LE_24 to Lynmar Basin is favorable with regard to these benefits (see Table 4-1).

Given the large area tributary to this intersection, it is recommended that high-capacity inlets be installed as part of the storm sewer reconfiguration to provide sufficient conveyance capacity to the basin and minimize roadway flooding during large storm events. It is also recommended that the surface overflow between the roadway and Lynmar Basin be lowered to increase conveyance capacity.

5.4 Flood Risk Reduction

Based on the conceptual design plan developed in September 2021, the proposed grading and excavation provides approximately 2 acre-feet of additional storage in Lynmar Basin (0.6 acre-feet below the existing storm sewer outlet, 1.4 acre-feet above). This increase in flood storage reduces flood elevations during large storm events, eliminating street flooding in the 10-year, 24-hour rainfall event and reducing flood elevations in the 100-year event. The estimated unit cost for the additional flood storage is $11 per cubic foot of additional storage ($495,000 per acre-foot of additional storage) for Concept A (maintaining existing storm sewer configuration). While reconfiguring the storm sewer at Lynmar Lane and Hazelton Road (Concept C) would provide additional stormwater volume reduction and phosphorus removal benefits on an average annual basis, this project modification does not provide additional flood storage benefit. However, installing high-capacity storm sewer inlets and lowering the surface overflow between the roadway and Lynmar Basin would ensure sufficient conveyance capacity to more fully utilize the storage in Lynmar Basin during large storm events.

6 References

Barr Engineering Co. *Report Summary Lake Cornelia and Lake Edina Water Quality Study Use Attainability Analysis for Lake Cornelia (updated from 2010) and Lake Edina (first version).* Prepared on behalf of Nine Mile Creek Watershed District. July 2019.

Barr Engineering Co. *Lake Cornelia and Lake Edina Water Quality Improvement Project, Feasibility Study/Preliminary Engineering Report* Prepared on behalf of Nine Mile Creek Watershed District. June 2020.

Barr Engineering Co. *Lynmar Basin Stormwater Retrofit Concept Plan [draft]*. Prepared on behalf of Nine Mile Creek Watershed District. September 2021.

Appendices

Appendix A

Soil Boring Summary

December 9, 2021 HGTS Project Number: 21-1100

Mr. Matthew Kumka
Barr Engineering Company
4300 Market Pointe Drive
Minneapolis, MN 55435

Re: Soil Summary, Lynmar Basin Stormwater Retrofit, Edina, Minnesota.

Dear Mr. Krumka:

We have completed the soil borings for the Lynmar Basin Stormwater Retrofit project in Edina, Minnesota. Our services were performed in accordance with our contract with Barr Engineering Company (Barr) dated October 22, 2021 (Barr project/contract 23-27-1725.03) and the associated appendices and exhibits.

Briefly; our services included advancing 4 standard penetration test borings to nominal depths of 16 and 30 feet below the ground surface, performing laboratory grain size analyses and preparing a brief soil summary letter describing the soil and groundwater conditions encountered in the borings and presenting the results of the laboratory testing. Our services did not include any engineering analysis. The specific scope of services was provided in a Request For Proposal (RFP) dated October 7, 20201 and the above referenced contract.

Introduction

Project Description

We understand that Barr is contracted to provide design services to the Nine Mile Creek Watershed District for a stormwater management project at Lynmar Basin in Edina. To aid in preparing design and construction documents Barr retained HGTS to advance 4 soil borings to characterize subsurface soil and groundwater conditions.

Documents Provided

We were provided with a 2-page RFP which provided a description of the required scope of work and included a plan sheet that showed the project area and proposed soil boring locations.

Locations and Elevations

The soil boring locations were selected by Barr and were staked in the field by HGTS. The approximate locations of the soil borings are shown on Figure 1, Soil Boring Location Sketch (attached) that was prepared by HGTS using and aerial image obtained from Google Earth as a base.

HGTS obtained the GPS coordinates and ground surface elevations at the soil boring locations using GPS technology referencing US State Plane Coordinate System – Minnesota South – NAD 1983 (2011). GPS coordinates and the ground surface elevations are also shown on Figure 1.

Procedures

The standard penetration test borings were completed on November 16, 2021 by HGTS with a rotary drilling rig, using continuous flight augers to advance the boreholes. Representative samples were obtained from the borings, using the split-barrel sampling procedures in general accordance with ASTM Specification D-1586. In the split-barrel sampling procedure, a 2-inch O.D. split-barrel spoon is driven into the ground with a 140-pound hammer falling 30 inches. The number of blows required to drive the sampling spoon the last 12 inches of an 18-inch penetration is recorded as the standard penetration resistance value, or "N" value. The results of the standard penetration tests are indicated on the boring logs. The samples were sealed in containers and provided to HGTS for testing and soil classification.

A field log of each boring was prepared by HGTS. The logs contain visual classifications of the soil materials encountered during drilling, as well as the driller's interpretation of the subsurface conditions between samples and water observation notes. The final boring logs included with this report represents an interpretation of the field logs and include modifications based on visual/manual method observation of the samples.

The soil boring logs, general terminology for soil description and identification, and classification of soils for engineering purposes are also included in the appendix. The soil boring log identify and describe the materials encountered, the relative density or consistency based on the Standard Penetration resistance (N-value, “blows per foot”) and groundwater observations.

The strata changes were inferred from the changes in the samples and auger cuttings. The depths shown as changes between strata are only approximate. The changes are likely transitions, variations can occur beyond the location of the boring.

Results

Geologic Overview Based on the Geologic Atlas of Hennepin County the surficial geology of the on the project site consists of glacial outwash deposits composed of sand, loamy sand and gravel overlain by loess less than 4 feet thick (Minnesota Geological Survey, Geologic Atlas of Hennepin County, County Atlas Series, Atlas C-4, Plate 3, 1989).

Soil Conditions The soil borings encountered varying depths/thicknesses of topsoil and Fill that extended to depth ranging from about ½ to 4 ½ feet below the ground surface.

Below the topsoil or Fill the borings encountered both clayey and sandy soils composed of; sandy lean clay, silty clay, silty sand, poorly graded sand and poorly graded sand with silt.

N-Values, shown as blows per foot (bpf) on the boring logs, within the sandy soil **(**silty clayey sand, silty sand, poorly graded sand with silt and poorly graded sand) ranged from 3 to 25 bpf. These values indicated the sandier soils generally had a very loose to medium dense relative density. N-values in the clayey soils (silty clay and lean clay) mostly ranged from 5 to 18 bpf indicating a rather soft to very stiff consistency.

Groundwater Groundwater was encountered in 2 of the 4 the soil borings at depths ranging from about 23 ½ to 24 feet below the ground surface while drilling or after removing the augers from the bore holes. The observed water levels are summarized in Table 1.

Table 1. Observed Water Levels

Boring Number	Ground Surface Elevation (feet)	Approximate Depth to Water (feet)	Approximate Water Elevation (feet)[1]
SB-1	847.5	NE	-
SB-2	845.8	23 ½	822 ½
SB-3	844.8	NE	-
SB-4	845.1	24	821

Note 1: Water levels were rounded to the nearest ½ foot. NE = Not Encountered

Water levels were measured on the dates as noted on the boring logs and the period of water level observations was relatively short. Groundwater monitoring wells or piezometers would be required to more accurately determine water levels. Seasonal and annual fluctuations in the groundwater levels should be expected.

Laboratory Testing Barr selected 8 samples for laboratory grain size analyses. The portion passing the #200 sieve (P-200) are presented on the boring logs and are summarized in Table 2. The complete laboratory grain size analyses are attached.

Table 2. Summary of Laboratory Tests

Boring Number	Depth (feet)	P-200 Content (%) *
SB-1	7 ½ - 9	55 ½
SB-1	12 ½ - 14	4
SB-2	2 ½ - 6 ½	19 ½
SB-2	20 - 21 ½	11 ½
SB-3	3 ½ - 6 ½	13
SB-3	15 - 16 ½	9 ½
SB-4	4 ½ - 6 ½	8 ½
SB-4	20 - 21 ½	6

*Moisture content and P-200 content values rounded to the nearest ½ percent.

General

The data presented in this letter was obtained from a limited number of soil borings. Variations can occur away from the borings, the nature of which may not become apparent until additional exploration work is completed, or construction is conducted. The variations may result in additional construction costs and it is suggested that a contingency be provided for this purpose.

We made water level measurements in the soil borings at the times and under the conditions stated on the boring logs. The data was interpreted in the text of this report. The period of observation was relatively short and fluctuations in the groundwater level may occur due to rainfall, flooding, irrigation, spring thaw, drainage, and other seasonal and annual factors not evident at the time the observations were made. Design drawings and specifications and construction planning should recognize the possibility of fluctuations.

This report is for the exclusive use of Barr Engineering Company to use to design the proposed structures and prepare construction documents. In the absence of our written approval, we make no representation and assume no responsibility to other parties regarding this report. The data, analysis and recommendations, if any, may not be appropriate for other structures or purposes. We recommend that parties contemplating other structures or purposes contact us.

Haugo GeoTechnical Services has used the degree of skill and care ordinarily exercised under similar circumstance by members of the profession currently practicing in this locality. No warranty expressed or implied is made.

Thank you for the opportunity to assist you on this project. If you have any questions or need additional information, please contact Lucas Mol or Paul Gionfriddo at 612-729-2959.

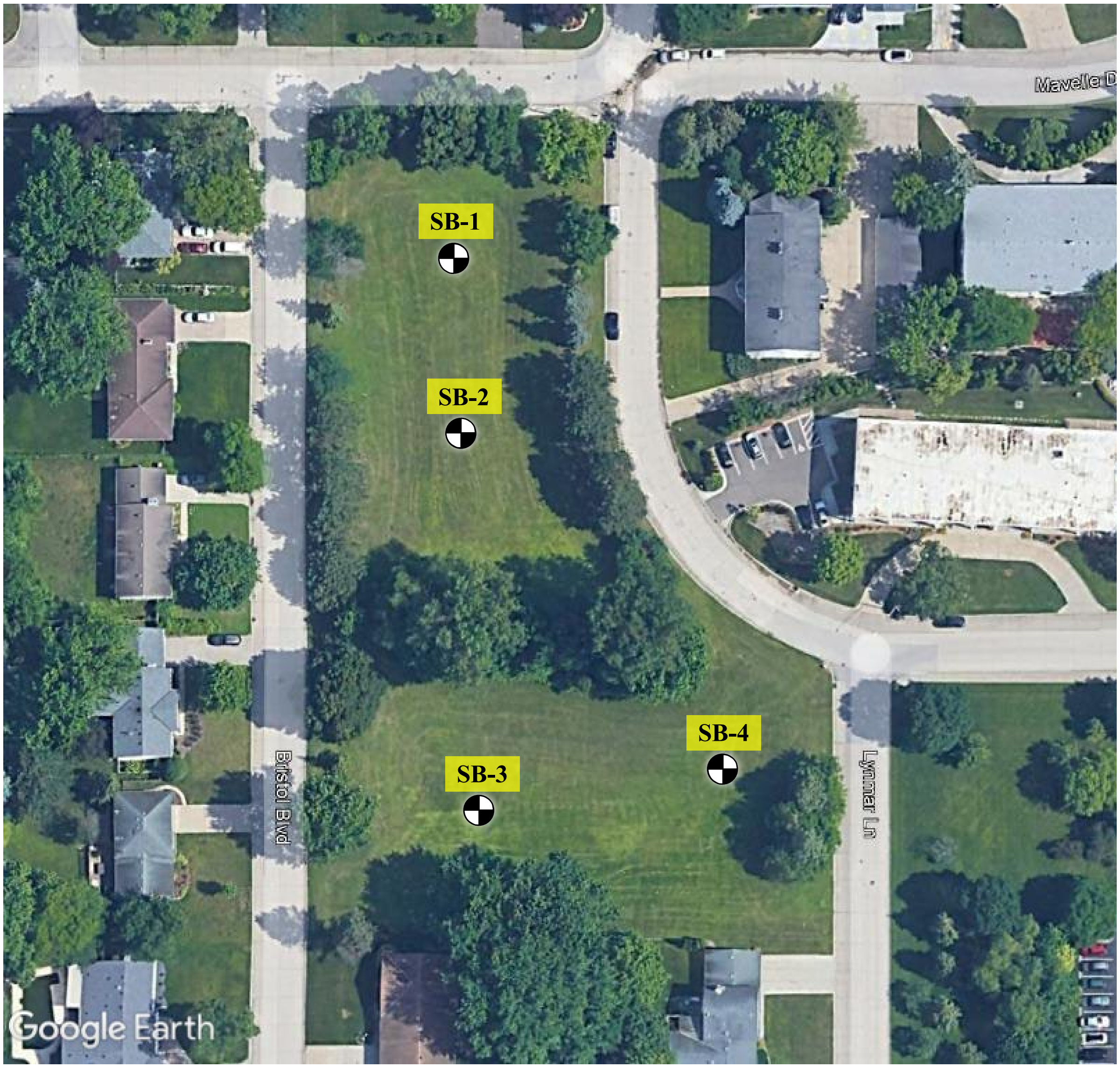
Sincerely,
HAUGO GEOTECHNICAL SERVICES

Lucas Mol
Project Manager

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.

Paul Gionfriddo, P.E.
Senior Engineer
License Number: 23093

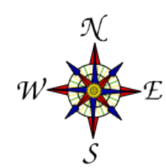
Attachments; Figure 1, Soil Boring Location Sketch
Soil Boring Logs, SB-1 thru SB-4
Grain Size Analyses, H-1 thru H-8
Descriptive Terminology



Legend

Approximate Soil Boring Location

Disclaimer: Map and parcel data are believed to be accurate, but accuracy is not guaranteed.
This is not a legal document and should not be substituted for a title search, appraisal, survey, or for zoning verification.



GPS Boring Locations

Boring Number	Elevation (US Feet)	Northing Coordinate	Easting Coordinate
SB-1	847.5	2797864.869144	1012157.6046835
SB-2	845.8	2797869.91863443	1012061.96552778
SB-3	844.8	2797880.04909144	1011854.59518402
SB-4	845.1	2798014.9007472	1011878.14274264

Referencing US State Plane Coordinate System – Minnesota South – NAD 1983 (2011)

Haugo GeoTechnical Services, LLC
2825 Cedar Avenue S.
Minneapolis, MN 55407

Soil Boring Location Sketch
Lynmar Basin
Edina, Minnesota

Figure #: 1
Drawn By: NA
Date: 10/26/21
Scale: None
Project #: 21-1100

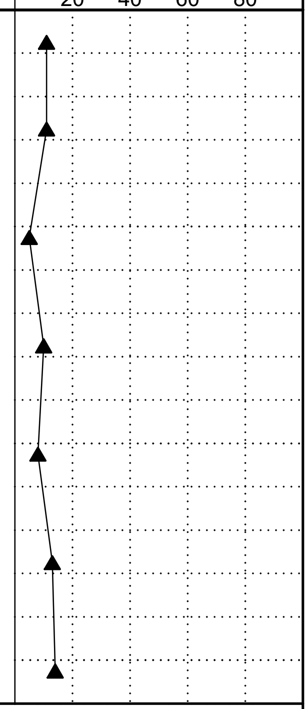
Haugo GeoTechnical Services
2825 Cedar Ave South
Minneapolis, MN 55407
Telephone: 612-729-2959
Fax: 763-445-2238

BORING NUMBER SB-1

CLIENT Barr Engineering
PROJECT NAME Lynmar Basin
PROJECT NUMBER 21-1100
PROJECT LOCATION Edina, MN
DATE STARTED 11/16/21 **COMPLETED** 11/16/21
GROUND ELEVATION 847.5 ft **HOLE SIZE** 3 1/4 inches
DRILLING CONTRACTOR HGTS 750-2
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger/Split Spoon
AT TIME OF DRILLING --- Not Encountered
LOGGED BY GD **CHECKED BY** PG
AT END OF DRILLING --- Not Encountered
NOTES
AFTER DRILLING --- Not Encountered

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	MOISTURE CONT. (%)	NOTES
0	Silty Sand, trace Gravel, dark brown, moist. (Topsoil/Fill)	SS 28	(56)	4-6-5 (11)		
	(CL) Sandy Lean Clay, black and brown, wet. (Fill)					
	(SC-SM) Silty Clay, brown, moist. (Fill)	SS 29	(50)	6-6-5 (11)		
5	(CL) Sandy Lean Clay, gray and brown, wet, rather soft to rather stiff. (Glacial Outwash)	SS 30	(44)	3-3-2 (5)		
	P-200=55.5% Grain Size Analysis H-1	SS 31	(56)	3-3-7 (10)		
10		SS 32	(67)	2-3-5 (8)		
	(SP) Poorly Graded Sand, fine to coarse grained, trace Gravel, brown, moist, medium dense. (Glacial Outwash) P-200=4.2% Grain Size Analysis H-2	SS 33	(56)	4-6-7 (13)		
15		SS 34	(33)	7-7-7 (14)		

▲ SPT N VALUE ▲ (20 40 60 80); PL MC LL (20 40 60 80); □ FINES CONTENT (%) □ (20 40 60 80)



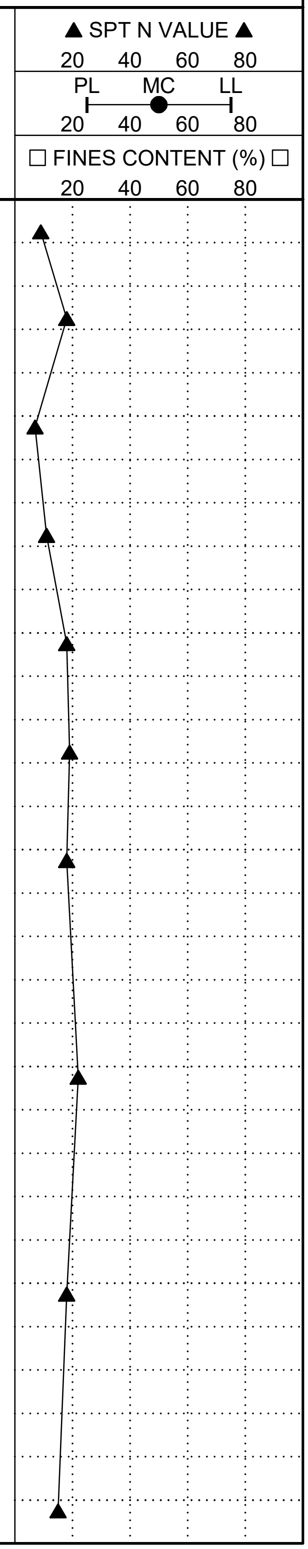
Bottom of borehole at 16.0 feet.

BORING NUMBER SB-2

Haugo GeoTechnical Services
2825 Cedar Ave South
Minneapolis, MN 55407
Telephone: 612-729-2959
Fax: 763-445-2238

CLIENT Barr Engineering
PROJECT NAME Lynmar Basin
PROJECT NUMBER 21-1100
PROJECT LOCATION Edina, MN
DATE STARTED 11/16/21 **COMPLETED** 11/16/21
GROUND ELEVATION 845.8 ft **HOLE SIZE** 3 1/4 inches
DRILLING CONTRACTOR HGTS 750-2
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger/Split Spoon
AT TIME OF DRILLING 25.00 ft / Elev 820.80 ft
LOGGED BY GD **CHECKED BY** PG
AT END OF DRILLING 23.40 ft / Elev 822.40 ft
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	MOISTURE CONT. (%)	NOTES
0	Silty Clayey Sand, trace Roots, dark brown, moist. (Topsoil)					
	(CL) Sandy Lean Clay, with Gravel, brown, wet, very stiff. (Glacial Outwash)	SS 18	(56)	3-4-5 (9)		
	(SM) Silty Sand, fine to coarse grained, trace Gravel, brown, moist, loose to medium dense. (Glacial Outwash)	SS 19	(56)	5-8-10 (18)		
5	P-200=19.6% Grain Size Analysis H-3	SS 20	(50)	6-5-2 (7)		
		SS 21	(56)	6-6-5 (11)		
10	(SP-SM) Poorly Graded Sand with Silt, fine to coarse grained, with Gravel, brown, moist to about 23.5 feet then waterbearing, medium dense. (Glacial Outwash)	SS 22	(56)	6-10-8 (18)		
		SS 23	(61)	7-9-10 (19)		
15		SS 24	(56)	7-8-10 (18)		
20	P-200=11.3% Grain Size Analysis H-4	SS 25	(94)	11-12-10 (22)		
25		SS 26	(56)	3-7-11 (18)		
30		SS 27	(56)	5-7-8 (15)		



Bottom of borehole at 31.0 feet.

Haugo GeoTechnical Services
2825 Cedar Ave South
Minneapolis, MN 55407
Telephone: 612-729-2959
Fax: 763-445-2238

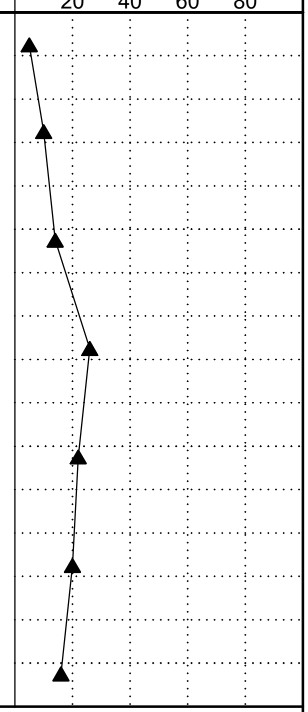
BORING NUMBER SB-3

CLIENT Barr Engineering
PROJECT NAME Lynmar Basin
PROJECT NUMBER 21-1100
PROJECT LOCATION Edina, MN
DATE STARTED 11/16/21 **COMPLETED** 11/16/21
GROUND ELEVATION 844.8 ft **HOLE SIZE** 3 1/4 inches
DRILLING CONTRACTOR HGTS 750-2
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger/Split Spoon
AT TIME OF DRILLING --- Not Encountered
LOGGED BY GD **CHECKED BY** PG
AT END OF DRILLING --- Not Encountered
NOTES
AFTER DRILLING --- Not Encountered

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	MOISTURE CONT. (%)	NOTES
0	Sandy Lean Clay, trace Roots, dark brown, wet. (Topsoil)	SS 11	(44)	1-2-3 (5)		
		SS 12	(33)	3-4-6 (10)		
5	(SM) Silty sand, fine to coarse grained, with Gravel, brown, moist, medium dense. (Glacial Outwash) P-200=13% Grain Size Analysis H-5	SS 13	(56)	3-6-8 (14)		
		SS 14	(56)	17-12-14 (26)		
10		SS 15	(56)	10-12-10 (22)		
		SS 16		8-8-12 (20)		
15	(SP-SM) Poorly Graded Sand with Silt, fine to coarse grained, with Gravel, brown, moist, medium dense. (Glacial Outwash) P-200=9.3% Grain Size Analysis H-6	SS 17	(50)	8-9-7 (16)		

Bottom of borehole at 16.0 feet.

▲ SPT N VALUE ▲ (20 40 60 80); PL MC LL (20 40 60 80); ☐ FINES CONTENT (%) ☐ (20 40 60 80)



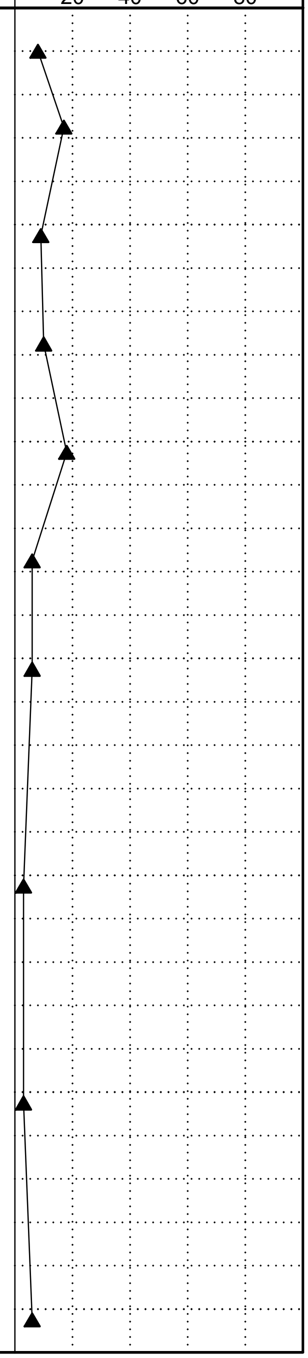
Haugo GeoTechnical Services
2825 Cedar Ave South
Minneapolis, MN 55407
Telephone: 612-729-2959
Fax: 763-445-2238

BORING NUMBER SB-4

CLIENT Barr Engineering
PROJECT NAME Lynmar Basin
PROJECT NUMBER 21-1100
PROJECT LOCATION Edina, MN
DATE STARTED 11/16/21 **COMPLETED** 11/16/21
GROUND ELEVATION 845.1 ft **HOLE SIZE** 3 1/4 inches
DRILLING CONTRACTOR HGTS 750-2
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger/Split Spoon
▽ **AT TIME OF DRILLING** 25.00 ft / Elev 820.10 ft
LOGGED BY GD **CHECKED BY** PG
▼ **AT END OF DRILLING** 24.20 ft / Elev 820.90 ft
NOTES
AFTER DRILLING ---

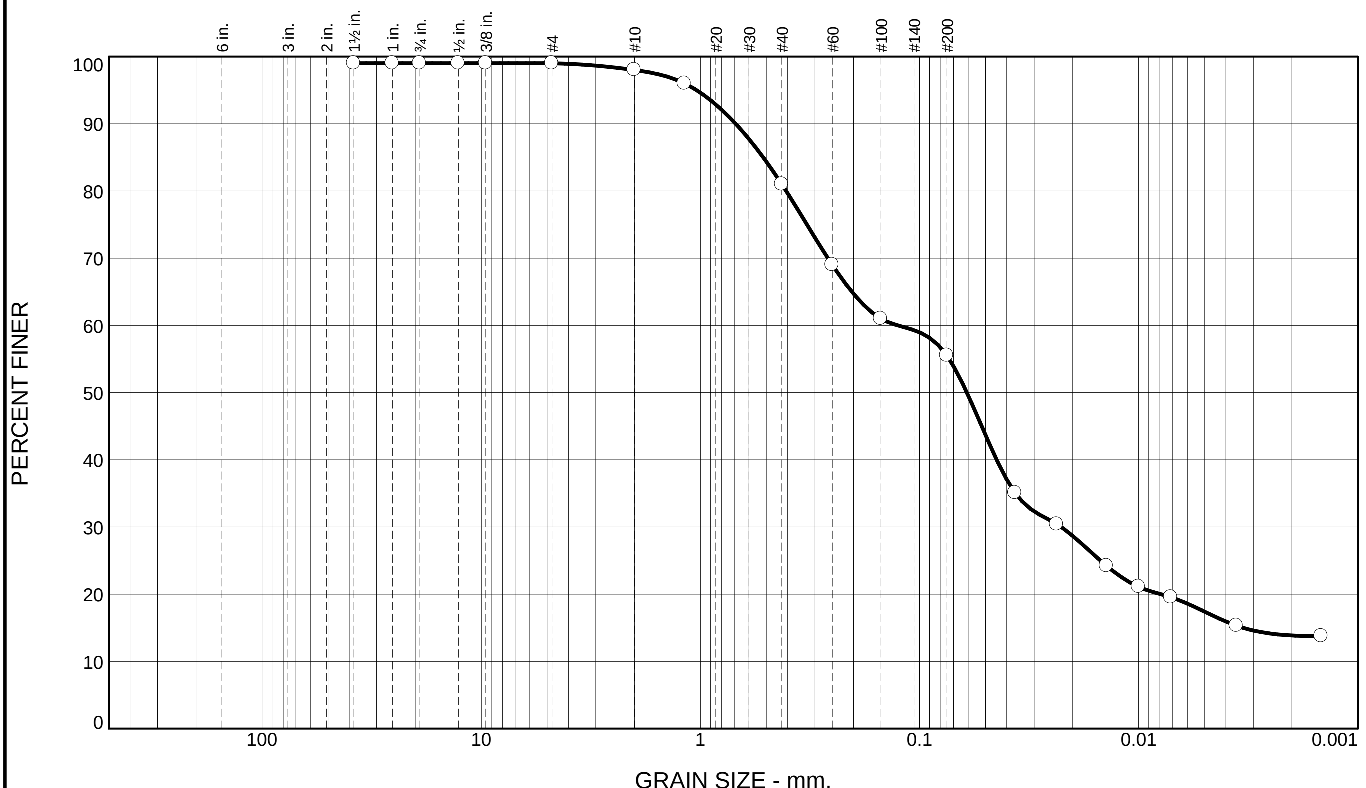
DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	MOISTURE CONT. (%)	NOTES
0	Clayey Sand, trace Gravel, dark brown, moist. (Topsoil/Fill)					
	Silty Sand, trace Gravel, Bituminous Debris, dark brown, moist. (Fill)	AU 1	(38)	2-3-5 (8)		
		SS 2	(44)	5-10-7 (17)		
5	(SP-SM) Poorly Graded Sand with Silt, fine to coarse grained, with Gravel, brown, moist, loose. (Glacial Outwash) P-200=8.3% Grain Size Analysis H-7	SS 3	(44)	8-6-3 (9)		
		SS 4	(39)	2-5-5 (10)		
10	(CL) Sandy Lean Clay, gray, wet, very stiff. (Glacial Outwash)	SS 5	(67)	6-9-9 (18)		
	(SP) Poorly Graded Sand, fine to medium grained, trace Gravel, gray and brow, moist, loose. (Glacial Outwash)	SS 6	(50)	5-3-3 (6)		
15	(SP-SM) Poorly Graded Sand with Silt, fine to coarse grained, trace Gravel, brown, moist to about 24 feet then waterbearing, very loose to loose. (Glacial Outwash)	SS 7	(44)	3-3-3 (6)		
20	P-200=6.2% Grain Size Analysis H-8	SS 8	(44)	3-2-1 (3)		
25	▼ ▽	SS 9		2-2-1 (3)		
30		SS 10	(100)	2-2-4 (6)		

▲ SPT N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
☐ FINES CONTENT (%) ☐ 20 40 60 80



Bottom of borehole at 31.0 feet.

Particle Size Distribution Report



% +3"	% Gravel	% Sand		% Fines	
		Coarse	Fine	Silt	Clay
		17.0	25.5	41.6	13.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	99.0		
1"	99.0		
3/4"	99.0		
1/2"	99.0		
3/8"	99.0		
#4	99.0		
#10	98.0		
#16	96.0		
#40	81.0		
#60	69.0		
#100	61.0		
#200	55.5		
0.0366 mm.	35.1		
0.0236 mm.	30.4		
0.0140 mm.	24.2		
0.0100 mm.	21.1		
0.0071 mm.	19.5		
0.0036 mm.	15.3		
0.0015 mm.	13.8		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.6901 D_{85}= 0.5167 D_{60}= 0.1262
D_{50}= 0.0608 D_{30}= 0.0226 D_{15}= 0.0033
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Assumed Sp. G. of 2.650

Location: SB-1 7.5 - 9 FT.
Sample Number: G-1

Date: 12-7-2021

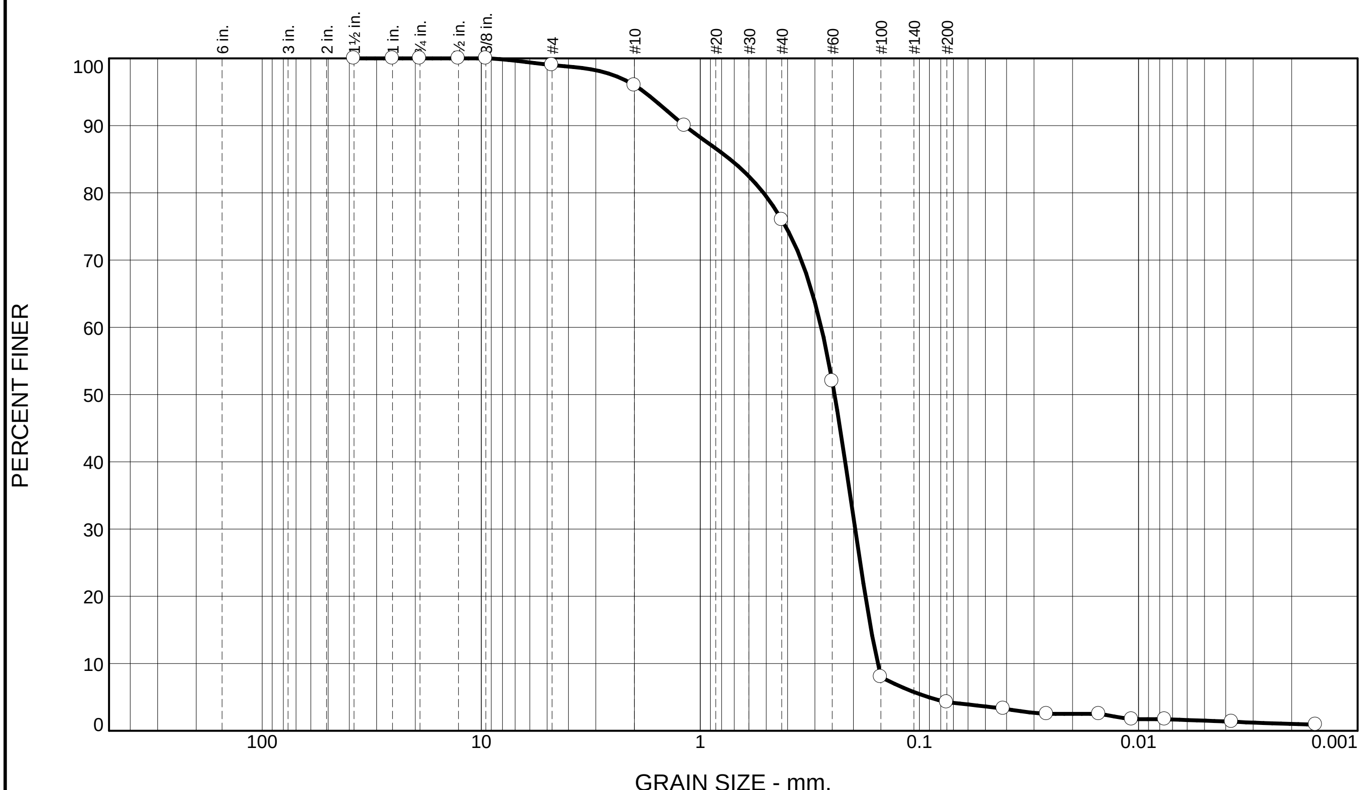
Haugo GeoTechnical Services
Maple Grove, Minnesota

Client: Barr Engineering
Project: Lymar Basin

Project No: 21-1000 **Figure**

Tested By: RR

Particle Size Distribution Report



% +3"	% Gravel	% Sand		% Fines	
		Coarse	Fine	Silt	Clay
0.0	4.0	20.0	71.8	3.2	1.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	100.0		
3/4"	100.0		
1/2"	100.0		
3/8"	100.0		
#4	99.0		
#10	96.0		
#16	90.0		
#40	76.0		
#60	52.0		
#100	8.0		
#200	4.2		
0.0413 mm.	3.3		
0.0262 mm.	2.5		
0.0151 mm.	2.5		
0.0107 mm.	1.7		
0.0076 mm.	1.7		
0.0038 mm.	1.4		
0.0016 mm.	0.9		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.1800 D_{85}= 0.7328 D_{60}= 0.2806
D_{50}= 0.2439 D_{30}= 0.1965 D_{15}= 0.1661
D_{10}= 0.1550 C_u= 1.81 C_c= 0.89

Classification

USCS= SP AASHTO=

Remarks

Assumed Sp. G. of 2.650

Location: SB-1 12.5 - 14 FT.
Sample Number: G-2

Date: 12-7-2021

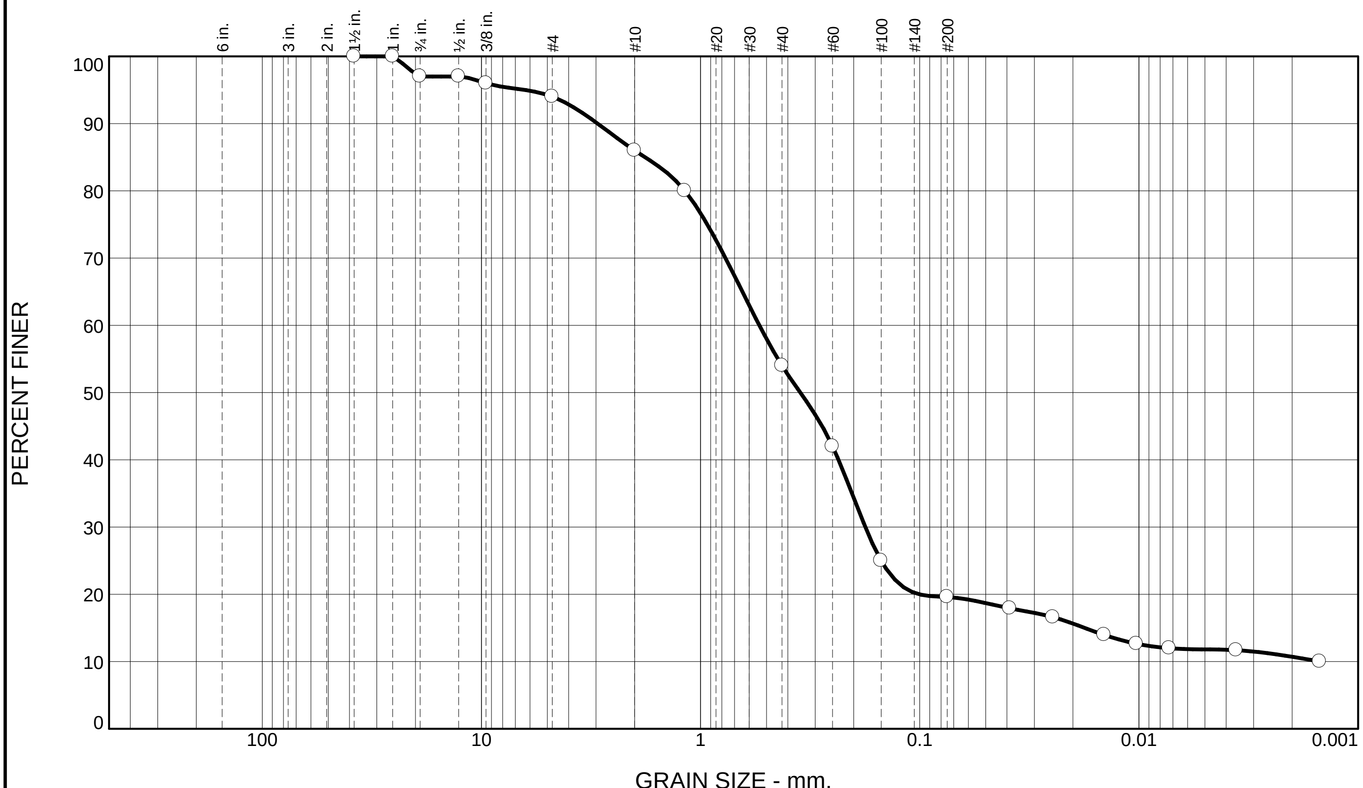
Haugo GeoTechnical Services Maple Grove, Minnesota

Client: Barr Engineering
Project: Lymar Basin

Project No: 21-1000 **Figure**

Tested By: RR

Particle Size Distribution Report



% +3"	% Gravel	% Sand		% Fines	
		Coarse	Fine	Silt	Clay
0.0	14.0	32.0	34.4	8.9	10.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	100.0		
3/4"	97.0		
1/2"	97.0		
3/8"	96.0		
#4	94.0		
#10	86.0		
#16	80.0		
#40	54.0		
#60	42.0		
#100	25.0		
#200	19.6		
0.0388 mm.	17.9		
0.0247 mm.	16.6		
0.0144 mm.	14.0		
0.0102 mm.	12.6		
0.0073 mm.	12.0		
0.0036 mm.	11.7		
0.0015 mm.	10.0		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 2.9519 D_{85}= 1.7939 D_{60}= 0.5394
D_{50}= 0.3506 D_{30}= 0.1771 D_{15}= 0.0177
D_{10}= 0.0015 C_u= 360.64 C_c= 38.88

Classification

USCS= AASHTO=

Remarks

Assumed Sp. G. of 2.650

Location: SB-2 5 - 6.5 FT.
Sample Number: G-3

Date: 12-7-2021

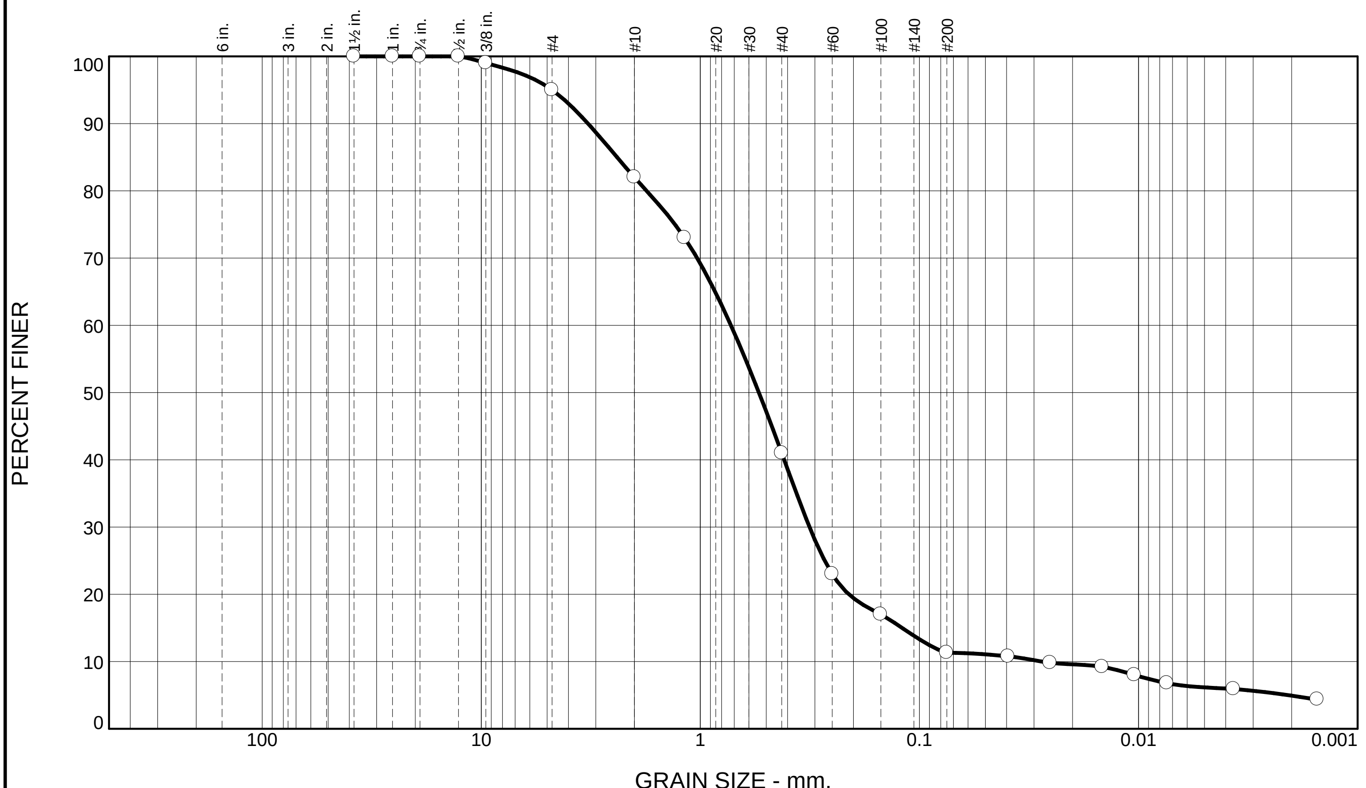
Haugo GeoTechnical Services Maple Grove, Minnesota

Client: Barr Engineering
Project: Lymar Basin

Project No: 21-1000 **Figure**

Tested By: RR

Particle Size Distribution Report



% +3"	% Gravel	% Sand		% Fines	
		Coarse	Fine	Silt	Clay
0.0	18.0	41.0	29.7	6.4	4.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	100.0		
3/4"	100.0		
1/2"	100.0		
3/8"	99.0		
#4	95.0		
#10	82.0		
#16	73.0		
#40	41.0		
#60	23.0		
#100	17.0		
#200	11.3		
0.0394 mm.	10.8		
0.0253 mm.	9.8		
0.0147 mm.	9.2		
0.0104 mm.	8.0		
0.0074 mm.	6.8		
0.0037 mm.	5.9		
0.0015 mm.	4.4		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 3.2566 D_{85}= 2.4007 D_{60}= 0.7253
D_{50}= 0.5406 D_{30}= 0.3175 D_{15}= 0.1199
D_{10}= 0.0277 C_u= 26.21 C_c= 5.02

Classification

USCS= AASHTO=

Remarks

Assumed Sp. G. of 2.6+50

Location: SB-2 20 - 21.5 FT.
Sample Number: G-4

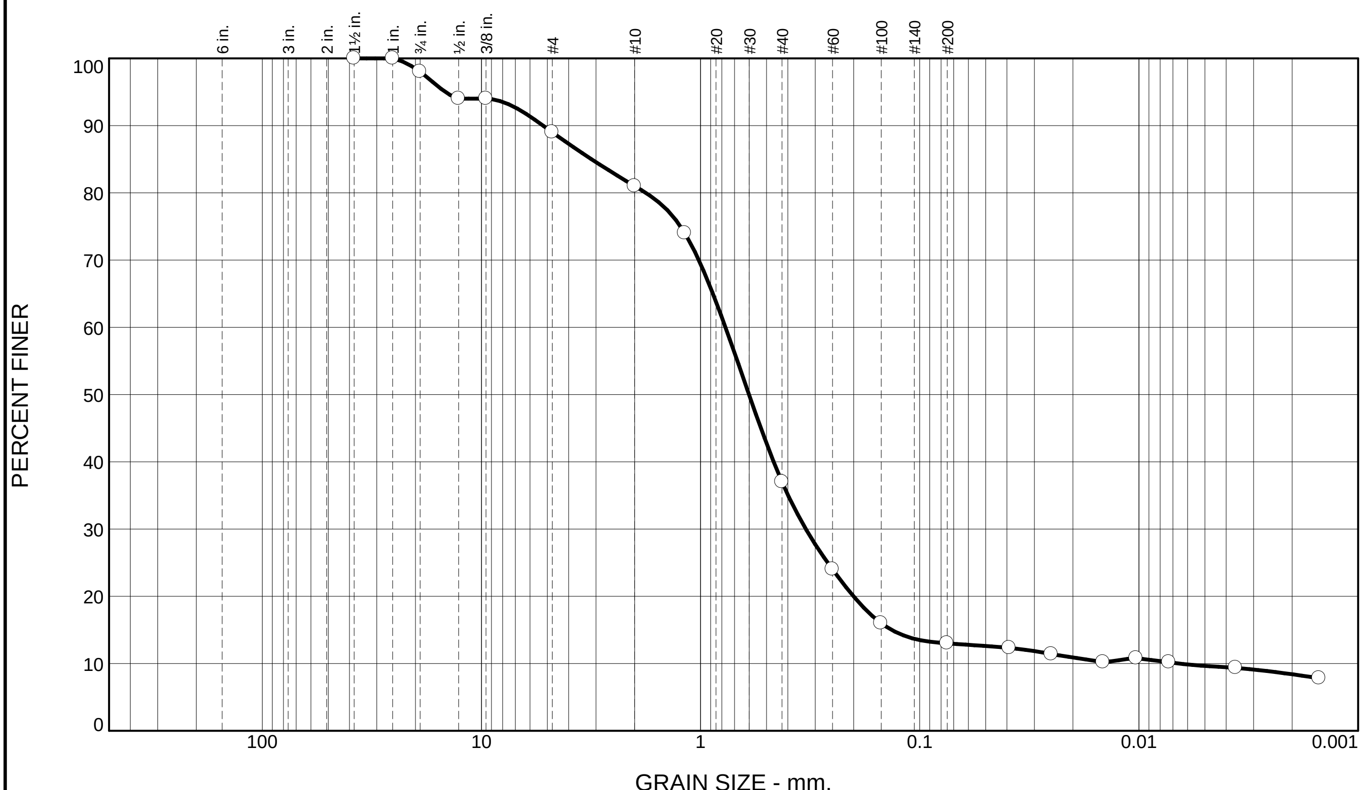
Date: 12-7-2021

Haugo GeoTechnical Services Maple Grove, Minnesota

Client: Barr Engineering
Project: Lymar Basin
Project No: 21-1000 **Figure**

Tested By: RR

Particle Size Distribution Report



% +3"	% Gravel	% Sand		% Fines	
		Coarse	Fine	Silt	Clay
0.0	19.0	44.0	24.0	4.6	8.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	100.0		
3/4"	98.0		
1/2"	94.0		
3/8"	94.0		
#4	89.0		
#10	81.0		
#16	74.0		
#40	37.0		
#60	24.0		
#100	16.0		
#200	13.0		
0.0390 mm.	12.3		
0.0251 mm.	11.4		
0.0146 mm.	10.2		
0.0103 mm.	10.8		
0.0073 mm.	10.2		
0.0036 mm.	9.3		
0.0015 mm.	7.8		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 5.2370 D_{85}= 3.1464 D_{60}= 0.7700
D_{50}= 0.6013 D_{30}= 0.3309 D_{15}= 0.1344
D_{10}= 0.0066 C_u= 117.07 C_c= 21.63

Classification

USCS= AASHTO=

Remarks

Assumed Sp. G. of 2.650

Location: SB-3 5 - 6.5 FT
Sample Number: G-5

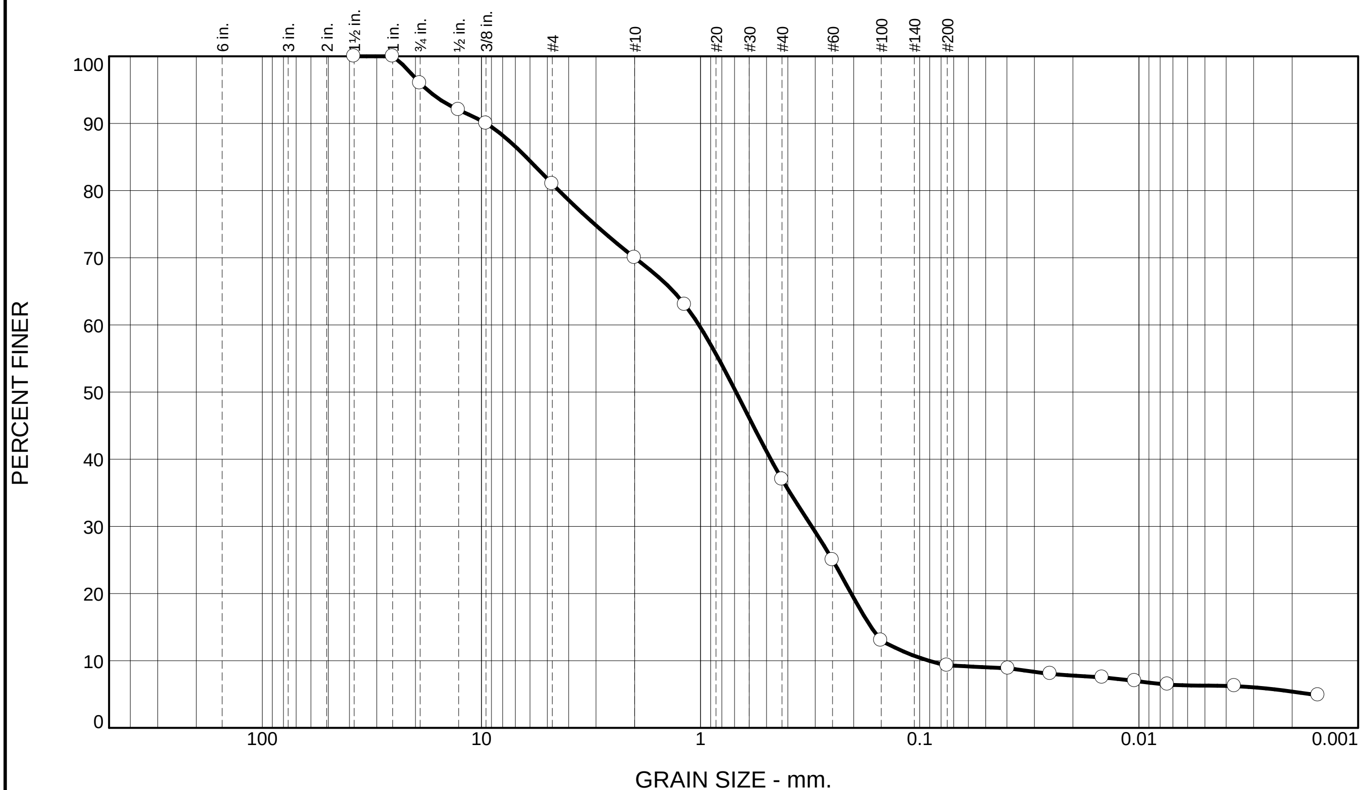
Date: 12-9-2021

Haugo GeoTechnical Services
Maple Grove, Minnesota

Client: Barr Engineering
Project: Lymar Basin
Project No: 21-1000 **Figure**

Tested By: RR

Particle Size Distribution Report



% +3"	% Gravel	% Sand		% Fines	
		Coarse	Fine	Silt	Clay
0.0	30.0	33.0	27.7	3.9	5.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	100.0		
3/4"	96.0		
1/2"	92.0		
3/8"	90.0		
#4	81.0		
#10	70.0		
#16	63.0		
#40	37.0		
#60	25.0		
#100	13.0		
#200	9.3		
0.0395 mm.	8.9		
0.0254 mm.	8.0		
0.0147 mm.	7.5		
0.0104 mm.	7.0		
0.0074 mm.	6.4		
0.0037 mm.	6.2		
0.0015 mm.	4.9		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 9.5250 D_{85}= 6.2570 D_{60}= 1.0185
D_{50}= 0.6891 D_{30}= 0.3112 D_{15}= 0.1666
D_{10}= 0.0911 C_u= 11.18 C_c= 1.04

Classification

USCS= AASHTO=

Remarks

Assumed Sp. G. of 2.650

Location: SB-3 15 - 16.5FT
Sample Number: G-6

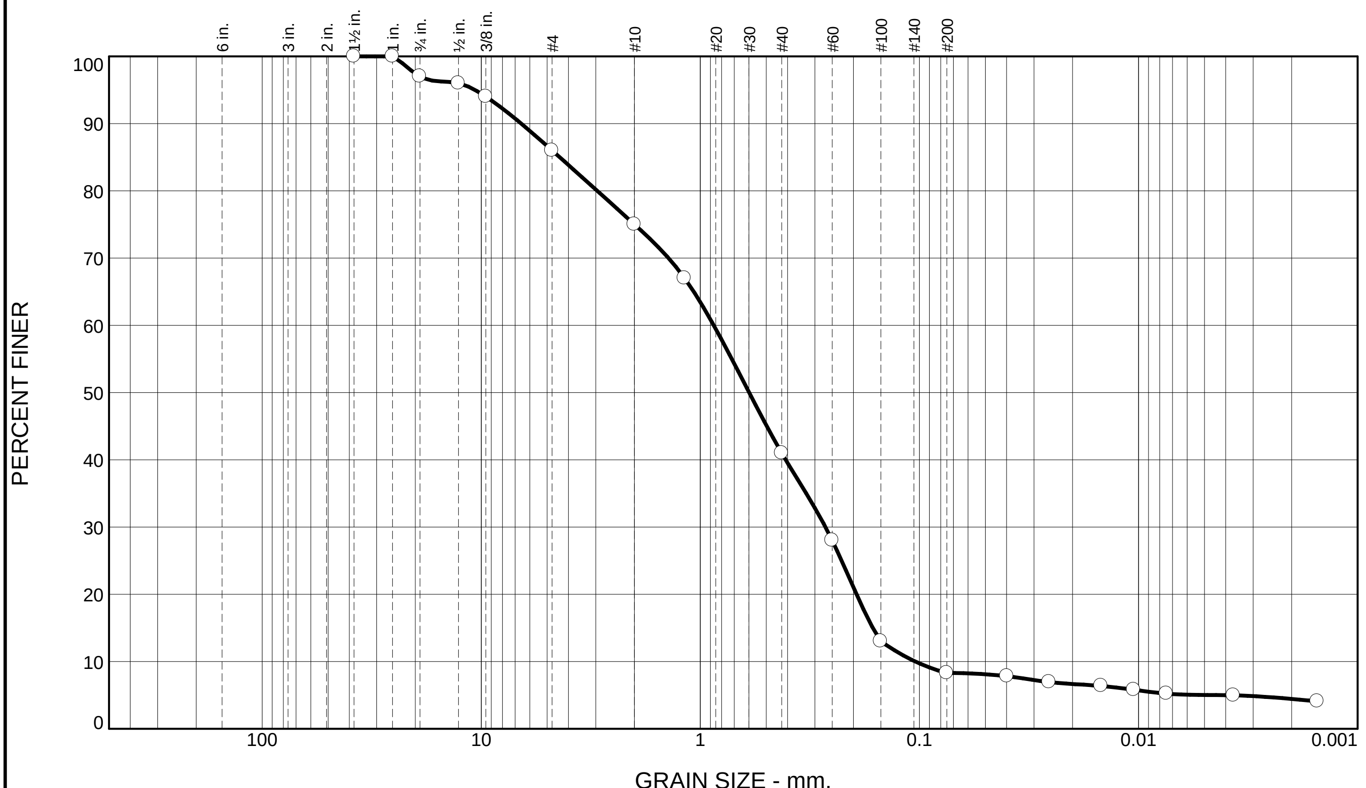
Date: 12-7-2021

Haugo GeoTechnical Services
Maple Grove, Minnesota

Client: Barr Engineering
Project: Lymar Basin
Project No: 21-1000 **Figure**

Tested By: RR

Particle Size Distribution Report



% +3"	% Gravel	% Sand		% Fines	
		Coarse	Fine	Silt	Clay
0.0	25.0	34.0	32.7	3.9	4.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	100.0		
3/4"	97.0		
1/2"	96.0		
3/8"	94.0		
#4	86.0		
#10	75.0		
#16	67.0		
#40	41.0		
#60	28.0		
#100	13.0		
#200	8.3		
0.0398 mm.	7.8		
0.0256 mm.	6.9		
0.0148 mm.	6.4		
0.0105 mm.	5.8		
0.0074 mm.	5.2		
0.0037 mm.	5.0		
0.0015 mm.	4.1		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 6.5718 D_{85}= 4.3873 D_{60}= 0.8685
D_{50}= 0.5987 D_{30}= 0.2686 D_{15}= 0.1632
D_{10}= 0.1044 C_u= 8.32 C_c= 0.80

Classification

USCS= AASHTO=

Remarks

Assumed Sp. G. of 2.650

Location: SB-4 5 - 6.5 FT
Sample Number: G-7

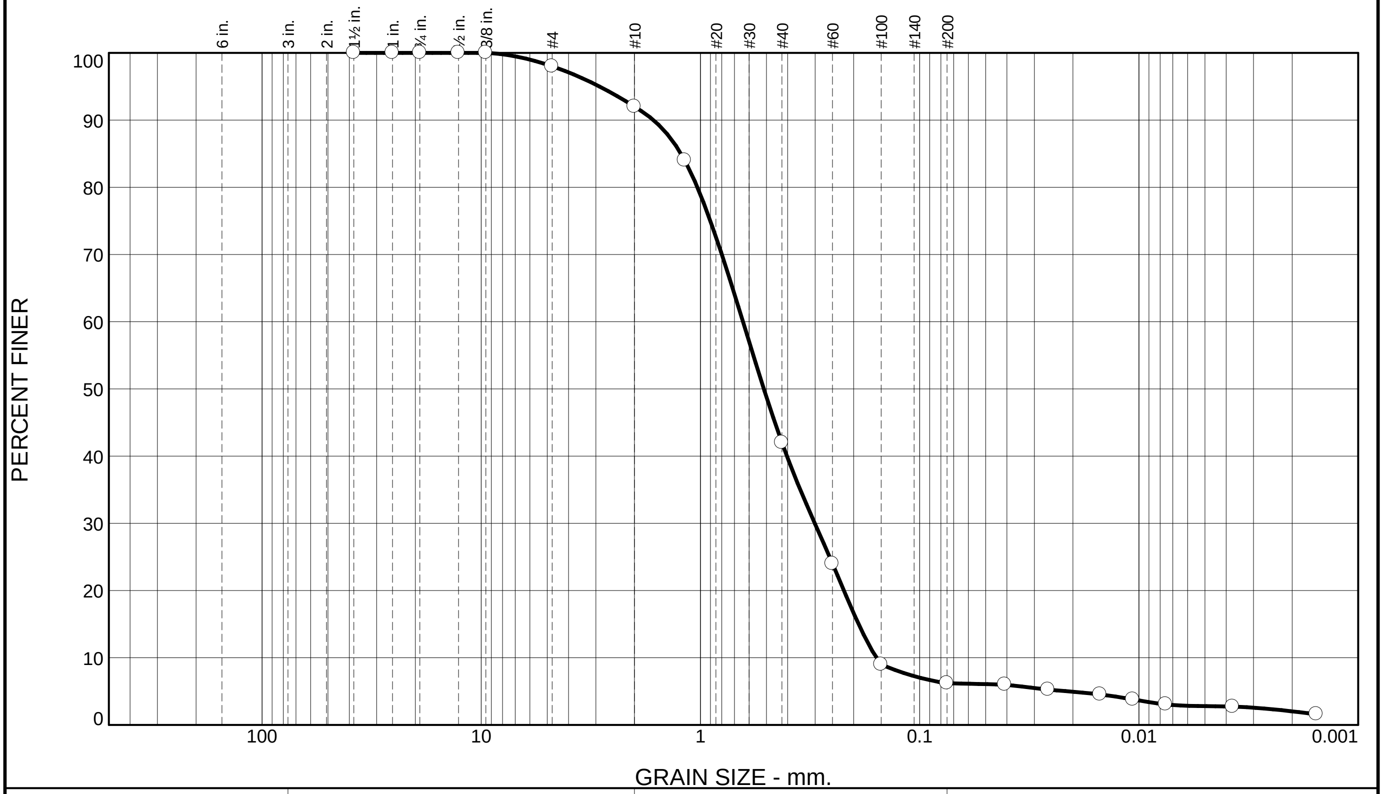
Date: 12-7-2021

Haugo GeoTechnical Services Maple Grove, Minnesota

Client: Barr Engineering
Project: Lymar Basin
Project No: 21-1000 **Figure**

Tested By: RR

Particle Size Distribution Report



% +3"	% Gravel	% Sand		% Fines	
		Coarse	Fine	Silt	Clay
0.0	8.0	50.0	35.8	4.2	2.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	100.0		
3/4"	100.0		
1/2"	100.0		
3/8"	100.0		
#4	98.0		
#10	92.0		
#16	84.0		
#40	42.0		
#60	24.0		
#100	9.0		
#200	6.2		
0.0409 mm.	6.0		
0.0259 mm.	5.3		
0.0150 mm.	4.5		
0.0106 mm.	3.8		
0.0075 mm.	3.1		
0.0037 mm.	2.7		
0.0015 mm.	1.6		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.6410 D_{85}= 1.2278 D_{60}= 0.6399
D_{50}= 0.5140 D_{30}= 0.3010 D_{15}= 0.1900
D_{10}= 0.1575 C_u= 4.06 C_c= 0.90

Classification

USCS= AASHTO=

Remarks

Assumed Sp. G. of 2.650

Location: SB-4 20 - 21.5 Ft.
Sample Number: G-8

Date: 12-7-2021

Haugo GeoTechnical Services Maple Grove, Minnesota

Client: Barr Engineering
Project: Lymar Basin

Project No: 21-1000 **Figure**

Tested By: RR

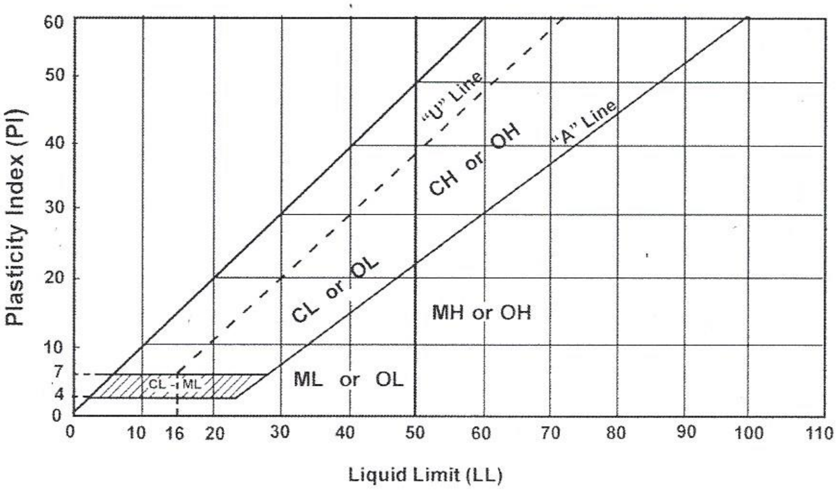
HAUGO GEOTECHNICAL SERVICES

Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification: Group Symbol	Soils Classification: Group Name [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	GW	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	GP	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	GM	Silty gravel [dfg]
			Fines classify as CL or CH	GC	Clayey gravel [dfg]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands 5% or less fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	SW	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	SP	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	SM	Silty sand [fgh]
			Fines classify as CL or CH	SC	Clayey sand [fgh]
Fine-grained Soils 50% or more passed the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	CL	Lean clay [kim]
			PI < 4 or plots below "A" line [j]	ML	Silt [kim]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [kimn]
				OL	Organic silt [kimo]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [kim]
			PI plots below "A" line	MH	Elastic silt [kim]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [kimp]
				OH	Organic silt [kimq]
Highly Organic Soils		Primarily organic matter, dark in color and organic odor		PT	Peat

a. Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
   GW-GM well-graded gravel with silt
   GW-GC well-graded gravel with clay
   GP-GM poorly graded gravel with silt
   GP-GC poorly graded gravel with clay
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥ 15% gravel, add "with gravel" to group name.
i. Sands with 5 to 12% fines require dual symbols:
   SW-SM well-graded sand with silt
   SW-SC well-graded sand with clay
   SP-SM poorly graded sand with silt
   SP-SC poorly graded sand with clay
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	OC	Organic content, %
WD	Wet density, pcf	S	Percent of saturation, %
MC	Natural moisture content, %	SG	Specific gravity
LL	Liqiuid limit, %	C	Cohesion, psf
PL	Plastic limit, %	∅	Angle of internal friction
PI	Plasticity index, %	qu	Unconfined compressive strength, psf
P200	% passing 200 sieve	qp	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders	over 12"
Cobbles	3" to 12"
Gravel	
Coarse	3/4" to 3"
Fine	No. 4 to 3/4"
Sand	
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Silt	< No. 200, PI < 4 or below "A" line
Clay	< No. 200, PI ≥ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose	0 to 4 BPF
Loose	5 to 10 BPF
Medium dense	11 to 30 BPF
Dense	31 to 50 BPF
Very dense	over 50 BPF

Consistency of Cohesive Soils

Very soft	0 to 1 BPF
Soft	2 to 3 BPF
Rather soft	4 to 5 BPF
Medium	6 to 8 BPF
Rather stiff	9 to 12 BPF
Stiff	13 to 16 BPF
Very stiff	17 to 30 BPF
Hard	over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise. Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.

Appendix B

Engineers Opinion of Probable Cost – Concept A

PREPARED BY: BARR ENGINEERING COMPANY	SHEET: 1	OF 1
	BY: KJN2/MDB3	DATE: 2/10/2022
FEASIBILITY STUDY - CONCEPT W/O STORM SEWER MODS (SCENARIO A)	CHECKED BY: JMK2	DATE: 2/17/2022
ENGINEER'S OPINION OF COST	APPROVED BY:	DATE:
PROJECT: Lynmar Stormwater Retrofit	ISSUED:	DATE:
LOCATION: Edina, MN	ISSUED:	DATE:
PROJECT #: 23/27-1725.05	ISSUED:	DATE:
OPINION OF COST - SUMMARY	ISSUED:	DATE:

Engineer's Opinion of Cost
Lynmar Stormwater Retrofit

ITEM	ITEM DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT COST	ITEM COST	NOTES
	Mobilization	LS	1	$54,100.00	$54,100.00	1,2,3,4,5,6
	Traffic and Pedestrian Safety Control Measures	LS	1	$7,500.00	$7,500.00	1,2,3,4,5,6
	Construction Layout and Staking	LS	1	$3,000.00	$3,000.00	1,2,3,4,5,6
	Erosion and Sediment Control	LS	1	$8,000.00	$8,000.00	1,2,3,4,5,6
	Clearing and Grubbing	LS	1	$5,000.00	$5,000.00	1,2,3,4,5,6
	Remove Tree and Stump (12" - 24" Diameter)	Each	6	$750.00	$4,500.00	1,2,3,4,5,6
	Remove Concrete Curb and Gutter	LF	20	$8.00	$160.00	1,2,3,4,5,6
	Common Excavation	CY	5,580	$19.00	$106,020.00	1,2,3,4,5,6
	Off Site Disposal of Excavated Material	CY	4,830	$18.00	$86,940.00	1,2,3,4,5,6
	Soil Loosening - 18" Depth	SY	3,020	$2.00	$6,040.00	1,2,3,4,5,6
	Planting Soil (12" depth - 75% sand, 25% leaf compost - MnDOT Grade II)	CY	1,010	$70.00	$70,700.00	1,2,3,4,5,6
	Furnish and Install MnDOT 3877 Type B Topsoil	CY	760	$50.00	$38,000.00	1,2,3,4,5,6
	72" Storm Manhole with SAFL Baffle	Each	1	$25,000.00	$25,000.00	1,2,3,4,5,6
	Construct Energy Dissipation Pad	Each	1	$4,500.00	$4,500.00	1,2,3,4,5,6
	4" Concrete Sidewalk with Compacted Class V Base	SY	351	$90.00	$31,600.00	1,2,3,4,5,6
	Turf Seeding	SY	5,621	$3.00	$16,863.00	1,2,3,4,5,6
	Erosion Control Blanket	SY	2,400	$3.00	$7,200.00	1,2,3,4,5,6
	3" Twice Shredded Hardwood Mulch	CY	670	$55.00	$36,850.00	1,2,3,4,5,6
	Straw Mulch	SY	1	$2,500.00	$2,500.00	1,2,3,4,5,6
	Custom Native Seed Mix with Cover Crop	AC	1	$5,500.00	$5,500.00	1,2,3,4,5,6
	Herbaceous Plugs	Each	800	$4.00	$3,200.00	1,2,3,4,5,6
	Herbaceous Plant (#1 Cont.)	Each	1,100	$17.00	$18,700.00	1,2,3,4,5,6
	Shrub (#2 Cont.)	Each	150	$45.00	$6,750.00	1,2,3,4,5,6
	Deciduous Tree (#20, Cont.)	Each	18	$480.00	$8,640.00	1,2,3,4,5,6
	4" Steel Landscape Edging	LF	840	$10.00	$8,400.00	1,2,3,4,5,7
	Common Excavation for Infiltration Trench	CY	675	$19.00	$12,825.00	1,2,3,4,5,7
	Off Site Disposal of 75% of Excavated Material	CY	500	$18.00	$9,000.00	1,2,3,4,5,7
	Excavate and Salvage from Infiltration Trench (25% of material excavated)	CY	200	$7.00	$1,400.00	1,2,3,4,5,7
	Import Clean Sand for Infiltration Trench	CY	500	$50.00	$25,000.00	1,2,3,4,5,7
	CONSTRUCTION SUBTOTAL				$614,000.00	1,2,3,4,5,6,7,8
	CONSTRUCTION CONTINGENCY (30%)				$184,000.00	1,4,8
	ESTIMATED CONSTRUCTION COST				$798,000.00	1,2,3,4,5,6,7,8
	ENGINEERING, DESIGN, AND CONSTRUCTION ADMINISTRATION (25%)				$199,500.00	1,2,3,4,5,6,7,8
	ESTIMATED TOTAL PROJECT COST				**$998,000**	1,2,3,4,5,6,7,8
	ESTIMATED ACCURACY RANGE	**-15%**			$849,000	1,2,3,4,5,6,7,8
		20%			$1,198,000	1,2,3,4,5,6,7,8

Notes

[1] Quantities based on Design Work Completed (10 - 40%).

[2] Unit Prices Based on Information Available at This Time.

[3] Limited Soil Boring and Field Investigation Information Available.

[4] This design level (Class 3, 10 - 40% design completion per ASTM E 2516-11) cost estimate is based on concept designs, alignments, quantities and unit prices. Costs will change with further design. Time value-of-money escalation costs are not included. A construction schedule is not available at this time. Contingency is an allowance for the net sum of costs that will be in the Final Total Project Cost at the time of the completion of design, but are not included at this level of project definition. The estimated accuracy range for the Total Project Cost as the project is defined is -15% to +20%. The accuracy range is based on professional judgement considering the level of design completed, the complexity of the project and the uncertainties in the project as scoped. The contingency and the accuracy range are not intended to include costs for future scope changes that are not part of the project as currently scoped or costs for risk contingency. Operation and Maintenance costs are not included.

[5] Estimate assumes that projects will not be located on contaminated soil.

[6] Estimate costs are to design, construct, and permit each alternative. The estimated costs do not include maintenance, monitoring or additional tasks following construction.

[7] Furnish and Install pipe cost per linear foot includes all trenching, bedding, backfilling, compaction, and disposal of excess materials

[8] Estimate costs are reported to nearest thousand dollars.

Appendix C

Engineers Opinion of Probable Cost – Concept C

PREPARED BY: BARR ENGINEERING COMPANY	SHEET: 1	OF	1
	BY: KJN2/MDB3	DATE:	2/1/2022
FEASIBILITY STUDY - REDIRECTING SUBWATERSHED LE_24 (SCENARIO C)	CHECKED BY: KAL	DATE:	
ENGINEER'S OPINION OF COST	CHECKED/REVISED BY: JMK2	DATE:	2/17/2022
PROJECT: Lynmar Stormwater Retrofit	ISSUED:	DATE:	
LOCATION: Edina, MN	ISSUED:	DATE:	
PROJECT #: 23/27-1725.05	ISSUED:	DATE:	
OPINION OF COST - SUMMARY	ISSUED:	DATE:	

Engineer's Opinion of Cost
Lynmar Stormwater Retrofit

ITEM	ITEM DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT COST	ITEM COST	NOTES
	Mobilization	LS	1	$68,500.00	$68,500.00	1,2,3,4,5,6
	Traffic and Pedestrian Safety Control Measures	LS	1	$7,500.00	$7,500.00	1,2,3,4,5,6
	Construction Layout and Staking	LS	1	$3,000.00	$3,000.00	1,2,3,4,5,6
	Erosion and Sediment Control	LS	1	$8,000.00	$8,000.00	1,2,3,4,5,6
	Clearing and Grubbing	LS	1	$5,000.00	$5,000.00	1,2,3,4,5,6
	Remove Tree and Stump (12" - 24" Diameter)	Each	6	$750.00	$4,500.00	1,2,3,4,5,6
	Remove Concrete Curb and Gutter	LF	20	$8.00	$160.00	1,2,3,4,5,6
	Common Excavation	CY	5,580	$19.00	$106,020.00	1,2,3,4,5,6
	Off Site Disposal of Excavated Material	CY	4,830	$18.00	$86,940.00	1,2,3,4,5,6
	Soil Loosening - 18" Depth	SY	3,020	$2.00	$6,040.00	1,2,3,4,5,6
	Planting Soil (12" depth - 75% sand, 25% leaf compost - MnDOT Grade II)	CY	1,010	$70.00	$70,700.00	1,2,3,4,5,6
	Furnish and Install MnDOT 3877 Type B Topsoil	CY	760	$50.00	$38,000.00	1,2,3,4,5,6
	72" Storm Manhole with SAFL Baffle	Each	1	$25,000.00	$25,000.00	1,2,3,4,5,6
	Construct Energy Dissipation Pad	Each	1	$4,500.00	$4,500.00	1,2,3,4,5,6
	4" Concrete Sidewalk with Compacted Class V Base	SY	351	$90.00	$31,600.00	1,2,3,4,5,6
	Turf Seeding	SY	5,621	$3.00	$16,863.00	1,2,3,4,5,6
	Erosion Control Blanket	SY	2,400	$3.00	$7,200.00	1,2,3,4,5,6
	3" Twice Shredded Hardwood Mulch	CY	670	$55.00	$36,850.00	1,2,3,4,5,6
	Straw Mulch	SY	1	$2,500.00	$2,500.00	1,2,3,4,5,6
	Custom Native Seed Mix with Cover Crop	AC	1	$5,500.00	$5,500.00	1,2,3,4,5,6
	Herbaceous Plugs	Each	800	$4.00	$3,200.00	1,2,3,4,5,6
	Herbaceous Plant (#1 Cont.)	Each	1,100	$17.00	$18,700.00	1,2,3,4,5,6
	Shrub (#2 Cont.)	Each	150	$45.00	$6,750.00	1,2,3,4,5,6
	Deciduous Tree (#20, Cont.)	Each	18	$480.00	$8,640.00	1,2,3,4,5,6
	4" Steel Landscape Edging	LF	840	$10.00	$8,400.00	1,2,3,4,5,7
STORM SEWER MODIFICATIONS PER FEASIBILITY STUDY						
	Remove existing CBs and replace with High Capacity CBs	EA	4	$10,000.00	$40,000.00	1,2,3,4,5,7
	New Manhole (72", 10' depth), including 2 existing pipe connections	EA	1	$12,000.00	$12,000.00	1,2,3,4,5,7
	New Manhole (96", 10' depth)	EA	2	$15,000.00	$30,000.00	1,2,3,4,5,7
	Common Excavation for Infiltration Trench	CY	675	$19.00	$12,825.00	1,2,3,4,5,7
	Off Site Disposal of 75% of Excavated Material	CY	500	$18.00	$9,000.00	1,2,3,4,5,7
	Excavate and Salvage from Infiltration Trench (25% of material excavated)	CY	200	$7.00	$1,400.00	1,2,3,4,5,7
	Import Clean Sand for Infiltration Trench	CY	500	$50.00	$25,000.00	1,2,3,4,5,7
	Remove Existing 18" Pipes	LF	145	$30.00	$4,350.00	1,2,3,4,5,7
	24" CPEP (0 - 8' depth)	LF	130	$60.00	$7,800.00	1,2,3,4,5,7
	36" CPEP (0 - 8' depth)	LF	65	$75.00	$4,875.00	1,2,3,4,5,7
	42" CPEP (0 - 8' depth)	LF	25	$90.00	$2,250.00	1,2,3,4,5,7
	42" Flared End Section with Trash Rack	EA	1	$2,500.00	$2,500.00	1,2,3,4,5,7
	Patch concrete road (8" with base)	SF	2,000	$20.00	$40,000.00	1,2,3,4,5,7
	CONSTRUCTION SUBTOTAL				$772,000.00	1,2,3,4,5,6,7,8
	CONSTRUCTION CONTINGENCY (30%)				$232,000.00	1,4,8
	ESTIMATED CONSTRUCTION COST				$1,004,000.00	1,2,3,4,5,6,7,8
	ENGINEERING, DESIGN, AND CONSTRUCTION ADMINISTRATION (25%)				$251,000.00	1,2,3,4,5,6,7,8
	EASEMENTS				$0.00	1,5,6
	ESTIMATED TOTAL PROJECT COST				**$1,255,000**	1,2,3,4,5,6,7,8
	ESTIMATED ACCURACY RANGE	**-15%**			$1,067,000	1,2,3,4,5,6,7,8
		20%			$1,506,000	1,2,3,4,5,6,7,8

Notes

[1] Quantities based on Design Work Completed (10 - 40%).

[2] Unit Prices Based on Information Available at This Time.

[3] Limited Soil Boring and Field Investigation Information Available.

[4] This design level (Class 3, 10 - 40% design completion per ASTM E 2516-11) cost estimate is based on concept designs, alignments, quantities and unit prices. Costs will change with further design. Time value-of-money escalation costs are not included. A construction schedule is not available at this time. Contingency is an allowance for the net sum of costs that will be in the Final Total Project Cost at the time of the completion of design, but are not included at this level of project definition. The estimated accuracy range for the Total Project Cost as the project is defined is -15% to +20%. The accuracy range is based on professional judgement considering the level of design completed, the complexity of the project and the uncertainties in the project as scoped. The contingency and the accuracy range are not intended to include costs for future scope changes that are not part of the project as currently scoped or costs for risk contingency. Operation and Maintenance costs are not included.

[5] Estimate assumes that projects will not be located on contaminated soil.

[6] Estimate costs are to design, construct, and permit each alternative. The estimated costs do not include maintenance, monitoring or additional tasks following construction.

[7] Furnish and Install pipe cost per linear foot includes all trenching, bedding, backfilling, compaction, and disposal of excess materials

[8] Estimate costs are reported to nearest thousand dollars.