Memorandum

To: Kirby Templin, City of Shakopee Water Resource – Environmental Engineer

From: Heather Nelson, PE
Joe Feuerstein, EIT

Date: April 29, 2020

Re: Quarry Lake Water Level Management Plan
WSB Project No. 015408-000

1. INTRODUCTION

Quarry Lake, located south of Blue Lake in the City of Shakopee (**Figure 1**), is a man-made lake created as a result of quarry operations. The lake does not have an outlet; therefore, the water levels in Quarry Lake have continued to rise and have become a concern for the City of Shakopee (the City). The City has engaged WSB to assist in developing a water level management plan to evaluate outlet options for long term lake level management at Quarry Lake.

In 2019, the water level at Quarry Lake started to inundate infrastructure previously constructed at Quarry Lake Park. Approximately one hundred million gallons of water were pumped out of the Lake over a two-month period to draw the water down approximately two feet to protect infrastructure while a water level management plan was developed. The cost of this emergency drawdown was approximately $55,000.

2. WATER BUDGET FOR QUARRY LAKE

The City would like to better understand the groundwater influences and consequences of outlet options. In order to accurately model how proposed improvements and future conditions would affect the Lake and surrounding areas, the existing drainage system was modeled. This was done by creating a water balance in the Lake and by quantifying existing conditions via modeling. The methods and results of these calculations and models are described in the sections below.

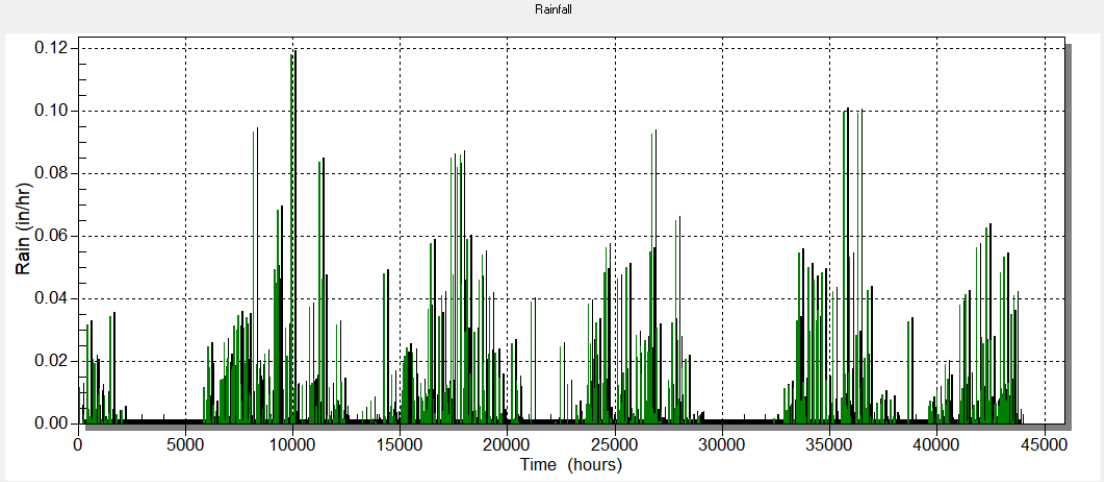
The hydrologic and hydraulic modeling were conducted using XPSWMM 2018.1. This software allows for simultaneous modeling of stormwater runoff and its hydraulic effects. ArcMap and Excel were used to calculate factors such as drainage areas, time of concentrations, and stage-storage curves.

The Shakopee City-wide model, developed in 2018, was the basis of the Existing Conditions model. This model was then clipped and revised to model the Quarry Lake area in greater detail.

Historic daily rainfall data from the St. Paul downtown airport[1] was used as a continuous storm in the model. Lake water surface elevation (WSE) observations were available from previous surveying and from City monitoring on 7/31/14 and 7/25/19, respectively. Rainfall data between these dates was used for the water budget. The continuous rainfall hydrograph from XPSWMM is shown in **Graphic 1** below:

[1] https://www.dnr.state.mn.us/climate/historical/daily-data.html?sid=217370&sname=ST.%20PAUL%20DOWNTOWN%20AIRPORT&sdate=por&edate=por

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Graphic 1: St. Paul Downtown Rainfall Data from 7/31/2014 to 7/25/2019.

Runoff influences on Lake water elevation were determined by survey data (where available) and lidar elevation data from Scott County to determine drainage areas. Drainage areas were modeled in XPSWWM. These areas are delineated in **Figure 2**.

Survey data was also used to create a stage-storage curve for the Lake. The stage storage for the Lake was used to determine water volumes in the water budget.

Curve numbers for each drainage area were calculated based on previous land use discussions with the City as a part of the Shakopee City-wide XPSWMM modeling in December of 2018.

Time of Concentration (TC) for each drainage area was calculated based on the Hydrology National Engineering Handbook's Watershed Lag Method. A minimum TC of 12 minutes was used for areas with pervious surface. For small, 100% impervious drainage areas in Quarry Lake Park, a minimum TC of 7 minutes was used.

Because the Lake has no outlet, evaporation was determined to be the primary means of water leaving the Lake system. Measured monthly pan evaporation rates from 2014-2019 collected by the DNR[2] were used in the model. Because Lake evaporation differs slightly from pan evaporation, a lake evaporation factor was needed. A factor value of 0.79 was used. This value was taken from the USCS Hydrology Guide[3] for Scott County Lakes.

Water surface elevation observations were noted in a 2014 survey of Quarry Lake a 721.0 ft. This was used as the initial WSE of Quarry Lake in the model. The 2019 observations by the City showed water levels had risen to 724.4 ft. in those five years. These hydraulic components were used between the WSE observation dates in the water balance below:

[2] https://www.dnr.state.mn.us/climate/wxsta/pan-evaporation.html
[3] Getting the Most Out of Your Raindrop: Hydrology Guide for Minnesota. Author: United States Soil Conservation Service.

Water Balance Equation

$$\Delta S = (P + Q_{in} + GW) - (E + Q_{out})$$

Where:

- ΔS: Change in Storage
- P: Precipitation
- Q_{in}: Runoff in
- GW: Net Groundwater Flow
- E: Evaporation
- Q_{out}: Runoff out (because there is currently no outlet, this value is zero)

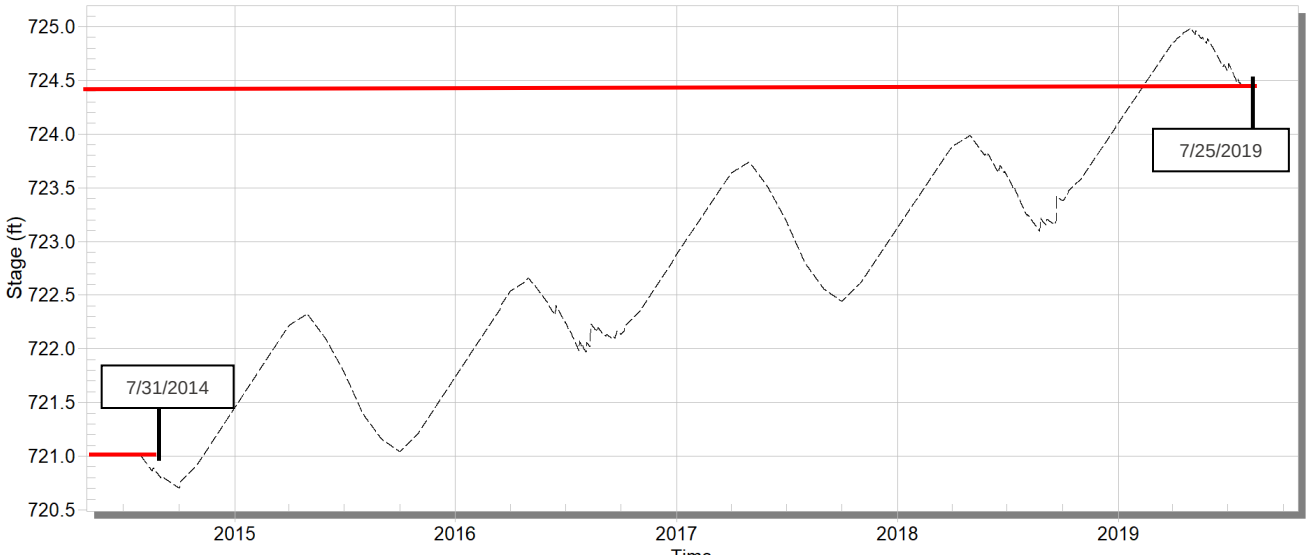
Rearranging to solve for the net groundwater flow this equation becomes:

$$GW = \Delta S - (P + Q_{in}) + E$$

The change in storage was calculated based on the stage storage curve for Quarry Lake. P, Q_{in} and E were calculated in the Existing Conditions XPSWMM model. Net groundwater flow volume was then divided by the time between observations to yield a **net groundwater flow rate of 0.310 cfs**.

This groundwater has multiple observed sources, including lateral seepage from the Prior Lake Outlet Channel and western ponds, and groundwater springs at the bottom of Quarry Lake which have been observed by the City of Shakopee Fire Department during training dives in the Lake. Previous City field measurements calculated the lateral seepage from the west to be 42.9 gpm, or 0.096 cfs. This is approximately 31% of the calculated groundwater inflow flow rate, we assume the remaining 69% of the calculated groundwater flow is from internal groundwater springs. Without detailed information from ground water monitoring wells and years of historical trends, exact groundwater influence cannot be determined.

The Existing Conditions XPSWMM model was ran with this calculated Quarry Lake inflow of 0.310 cfs to ensure the model was calibrated and the observed water surface elevation were achieved. The model, starting at 7/31/14 with an initial WSE of 721.0, ran until 7/25/19 and ended with a WSE of 724.4 ft., and was determined to be calibrated accurately. The modeled Quarry Lake stage information is shown below in **Graphic 2**:



Graphic 2: Calibrated Model Water Surface Elevation Results for Quarry Lake

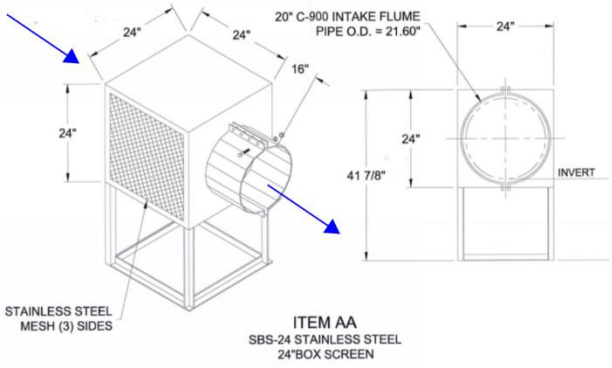
The calibrated model referenced above was used in the analysis of outlet alternatives described in the next section.

3. ALTERNATIVES FOR MANAGEMENT LAKE LEVELS

This task identified three alternatives for managing Lake levels, the pros and cons associated with each alternative, the impacts to existing infrastructure and trees, as well as costs and permitting requirement for each.

When evaluating the alternatives for management of Quarry Lake level the items listed below were considered under all alternatives:

- The DNR has indicated previously that an outlet for Quarry Lake will require filtration because the Lake is infested with Eurasian Milfoil a known invasive species. It is proposed that filtration will be provided in a drainage structure along the outlet pipe in each option. In this analysis, the filtering consists of installation of a box screen on the outlet pipe (see **Graphic 3** below). The screen would be placed in a 48-inch concrete manhole for access and maintenance. We will work with the DNR on a final design for filtering based on their requirements.

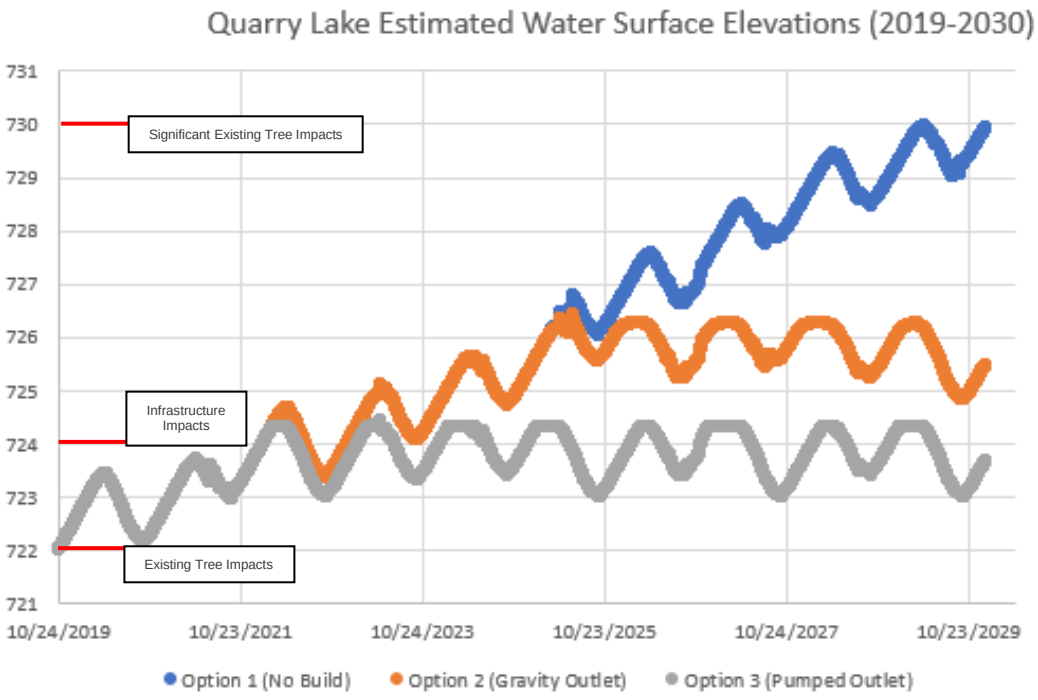


Graphic 3: Filtering Box Screen

- The goal of this analysis is to evaluate the impacts to existing infrastructure and trees from rising Lake levels. The As-Built plan for the 2015 Park Improvements can be found in **Figure 3**.

Modeling for each alternative was performed to predict how the water levels respond to the outlet alternative identified. Weather information from the past 10 years was copied to predict the weather/runoff data for the next 10 years. The hydrograph for each alternative is shown in **Graphic 4** below:

Graphic 4: Quarry Lake Estimated Water Surface Elevation for Outlet Alternatives – (Starting Elevation 722 after water level drawdown in 2019)



3.1 Alternative 1: No Build

This alternative is a no build alternative. Since the Lake does not have an outlet the water surface elevation is dependent on future weather patterns. Because the primary outlet for the Lake in this alternative is evaporation, high water levels remain for longer durations than as compared to other options. With this alternative, water levels continue to rise until either equilibrium between surrounding waterbodies is reached, or the Lake begins to overflow. Elevations of the surrounding waterbodies can be found on **Figure 1**.

This study did not involve installation of piezometers to measure groundwater elevations. It would take years of groundwater elevation data to accurately predict the horizontal and vertical flow of groundwater in order to accurately predict a potential equilibrium state for the Lake. Given the information provided by the City, it is known that the Lake's groundwater sources are both from lateral seepage and from bedrock springs, it's likely the Lake will continue to fill even after surface water levels match those of adjacent waterbodies. Based on this information, the probable "equilibrium elevation" for the Lake is approximately 740 ft. when the Lake can freely overtop to the north. The EOF location for Quarry Lake is shown on **Figure 1**.

Estimated High Water Level (HWL)
Graphic 4 above shows that the estimated projected HWL for Alternative 1 is estimated to be **730.0 ft.** by 2030. The increasing pattern of the water level will continue until the Lake is free to overtop, estimated to be at an elevation of 740 ft. The elevation of 740 ft. is estimated as the HWL for this Alternative.

Instructure Impacts
Impacts to existing infrastructure and trees are shown on **Figure 4**. Tree impacts have been quantified by the square foot impacted based on tree lines from survey information as well as aerial photographs.

Cost of Impacted Infrastructure
Much of the park would be inundated at the elevation of 740 ft. The estimated cost of impacted infrastructure is $1,400,000 shown in **Table 1**. Impacted infrastructure costs are based on the as-bid price for improvement performed in 2015.

Pros:
- No construction costs.
- No permitting required.

Cons:
- Water level will have a long rainfall bounce duration with no outlet.
- Water level is dependent on future weather patterns making the exact HWL unpredictable.
- Water level will continue to rise until Lake Emergency Overflow (EOF) Route is reached at 740.9 ft. At this point water will flow north over the railroad into private properties.
- Public infrastructure and trees are affected by the HWL.
- Private infrastructure (ski club) is affected by the HWL.
- The PLOC has overtopped into Quarry Lake during high flow events. This has the possibility to create even greater HWLs in Quarry Lake.

Permitting
There is no permitting required for this Alternative.

3.2 Alternative 2: Gravity Outlet

This alternative would install a gravity piped outlet from the Lake. Three locations for the gravity outlet were explored (see **Figure 5)**:

- **Option 2.1:** The first gravity outlet option explored was to install a pipe routed to the PLOC, south of the park's driveway entrance. The invert of the outlet pipe in the PLOC was estimated based on surveyed information as 728.5 ft this correlates to the elevation of the PLOC at this location. This correlates to a pipe invert at Quarry Lake of 728.8 based on an assumed 0.1% slope.
- **Option 2.2:** The second gravity outlet option explored was to install a pipe directly from Quarry Lake to the PLOC, north of the park's driveway. The invert of the outlet pipe in the PLOC was estimated based survey information as 727.6. This correlates to a pipe invert at Quarry Lake of 728.0 based on an assumed 0.1% slope.
- **Option 2.3:** Gravity outlet pipe is to route a pipe from the Lake north, and parallel to the Railroad before discharging into a more downstream section of the PLOC. The invert of the outlet pipe to the PLOC correlates to the invert of the culvert that crosses the railroad tracks. This elevation is 724.8, the correlating pipe invert at Quarry Lake is 725.9 based on an assumed 0.1% slope.

Given the information above and review from the City, Gravity Option 2.3 was identified as the preferred gravity outlet option because of its potential to control the Lake's water level to the lowest elevation and therefore limit impacts to existing trees and infrastructure. The information below relates to Gravity Option 2.3:

Estimated High Water Level (HWL)
Graphic 4 shows that the projected HWL to be **726.4 ft.**

Instructure Impacts
Impacts to existing infrastructure and trees are shown on **Figure 6**. Tree impacts have been quantified by the square foot impacted based on tree lines from survey information as well as aerial photographs.

Cost of Impacted Infrastructure
The estimated cost of impacted infrastructure and trees is $56,000 shown in **Table 1**. Impacted infrastructure costs are based on the as-bid price for improvement performed in 2015.

Construction Cost Estimate
A detailed cost estimate for the Alternative 2.3 is included in **Table 2**. The total estimated cost for installation of a gravity outlet is $212,000, with an estimated 50-yr life cycle cost of $287,000 (2020 dollars).

Permitting
Based on communication the City has had with the DNR, the DNR has indicated that since Quarry Lake is not a public water a constructed outlet would not require a permit.

Also, this option's proposed outlet runs by gravity flow and would always operate without human interference (valve), as a result a DNR Water Appropriation Permit is not required.

The section of the PLOC where this outlet discharge occurs is a public water. Therefore, a DNR work in public waters permits will be required to construct the FES discharge pipe to the PLOC.

Because the project is proposing to transport or divert invested water an Infested Water Appropriation permit is required through the DNR.

The permitting required for this option is as follows:

- MPCA NPDES Construction Stormwater Permit (<1 week to obtain)
- DNR Infested Water Appropriation Permit (90 days to obtain)
- DNR Work in Public Waters (30 days to obtain)

Pros:

- Lake water surface elevation is controlled without pumping.
- Lower construction cost than pumped option.

Cons:

- Projected water surface elevations encroach on existing infrastructure.
- Private infrastructure (ski club) is affected by the HWL.
- A larger drop from pipe inlet to outlet may be required for proper filtration of discharging water.
- Filtration device at outlet requires long term annual maintenance.

- Encroachment on Railroad property may occur. Land acquisition was not considered in cost estimates.
- A DNR Infested Water Appropriations Permit is required.
- A DNR Work in Public Waters Permit is required.

3.3 Alternative 3: Pumped Outlet

This alternative would install a lift station to pump water from the Lake in order to maintain the water surface elevation (**Figure 7**). The assumed pumping rate in the model for the lift station is 1 cfs. The model was set to pump when the Lake level reached an elevation 723.5 ft, and then the pump would stop when the elevation reached 723 ft. The pumped water would be routed through the existing water quality pond prior to discharge offsite.

Estimated High Water Level (HWL)
Graphic 4 shows that the projected HWL to be **724.4 ft.**

Instructure Impacts
Impacts to existing infrastructure and trees are shown on **Figure 8**. Tree impacts have been quantified by the square foot impacted based on tree lines from survey information as well as aerial photographs.

Cost of Impacted Infrastructure
This option has impact to existing trees and no impact to infrastructure. The cost of impacts is estimated as $22,000 shown in **Table 1**. Impacted infrastructure costs are based on the as-bid price for improvement performed in 2015.

Construction Cost Estimate
A detailed cost estimate for the pumped Alternative is included as **Table 3**. The total estimated cost for installation of a pumped outlet is $307,000, with an estimated 50-yr life cycle cost of $532,000 (2020 dollars).

Permitting
Based on communication the City has had with the DNR, the DNR has indicated that since Quarry Lake is not a public water a constructed outlet would not require a permit.

Because this alternative's proposed outlet would need to operate with human interference (valve), a DNR Water Appropriation Permit is required.

Because the project is proposing to transport or divert invested water an Infested Water Appropriation permit is required through the DNR.

The permitting required for this option is as follows:

- MPCA NPDES Construction Stormwater Permit (< 1 week to obtain)
- DNR Water Appropriations Permit (~90 days to obtain)
- DNR Infested Water Appropriation Permit (90 days to obtain)

Pros:

- Water surface elevations can be controlled by City, and water level management can be dynamic to meet City needs.

Cons:

- Filtration device at outlet requires long term annual maintenance.
- Long term maintenance is required for the lift station.

- Modifications to the existing water quality pond may be needed to accommodate additional flow from pumped lake water.
- More frequent maintenance may be required for the existing water quality pond due to the additional flow from the pumped lake water.
- Higher construction costs than gravity outlet option.
- A DNR Water Appropriations Permit is required.
- A DNR Infested Water Appropriations Permit is required.

4. CONCLUSION AND RECOMMENDATIONS

Below is a table summarizing costs and water levels of the three Alternatives.

Alternative	HWL (ft)	Construction Cost	50-yr O&M Cost (2020$)	Total Construction & O&M Costs	Estimated Infrastructure Impacts
No Build	740.0	$0	$0	$0	$1,400,000
Gravity Outlet	726.4	$212,000	$75,000	$287,000	$56,000
Pumped Outlet	724.4	$307,000	$175,000	$482,000	$22,000

Three Alternatives were explored as detailed in the sections above.

The no-build alternative would not control the lake level and modeling suggests that the water levels in the Lake will continue to rise unless weather patterns significantly change. The no-build will have the potential for extreme impacts to the existing infrastructure, therefore this alternative is not recommended.

The pumped outlet offers the City the flexibility to control the Lake level as needed. However, there is a larger construction cost and larger long-term maintenance costs. Therefore, this option is not recommended.

The gravity outlet controls the Lake level without the use of pumping. This option involves more infrastructure and tree impacts than the pumped option, however, trees replacement could occur on the park site and the trail could be rerouted. This option has a lower initial construction cost and lower long-term maintenance costs. For these reasons, the gravity outlet option is the recommended option.

Attachments:

Figure 1 – Project Location
Figure 2 – Existing Drainage Conditions
Figure 3 – As-Built Plan for 2015 Park Improvements
Figure 4 – No-Build Alternative Inundation Map
Figure 5 – Gravity Outlet Options
Figure 6 – Gravity Alternative Inundation map
Figure 7 – Pumped Outlet Option
Figure 8 – Pumped Alternative Inundation Map

Table 1 – Infrastructure Impact Cost
Table 2 – Gravity Alternative Estimated Costs
Table 3 – Pumped Alternative Estimated Costs

SHAKOPEE

Figure 1 Project Location

Quarry Lake Water Level
Management Study
City of Shakopee

WSE: 725.9' (7/24/2019)

Quarry Lake ultimate
EOF. Elev 739.9'

WSE: 730.8' (7/24/2019)

WSE: 724.4' (7/24/2019)

WSE: 740.0'

HWY 101

HWY 169

Innovation Blvd

Quarry Lake

Prior Lake Outlet Channel

Legend

- Project Location
- Property Boundaries
- Storm Culverts
- Storm Gravity Mains
- Storm Inlets
- Storm Manholes

N

0 500 Feet
1 inch = 500 feet

wsb

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SHAKOPEE

Figure 2 Existing Drainage Conditions

Quarry Lake Outlet Feasibility Study
City of Shakopee

Legend

- Surveyed Treeline (2015)
- Quarry Lake Drainage Areas

2015 Quarry Lake Park Improvements

- Stormwater Pond
- Impervious Surface
- Storm Inlets
- Storm Manholes
- Storm Gravity Mains
- Storm Culverts

County Lidar (2012)

- Index
- Intermediate

Innovation Blvd
Prior Lake Outlet Channel
Quarry Lake
QLP1
QLP2
BLA5A
BLA5C
BLA7A
BLA7C
BLA7D
BLA7E
BLA7F
BLA7G
BLA8A
7/31/2014 WSE: 721.0'
7/24/2019 WSE: 724.4'

N
0 350 Feet
1 inch = 350 feet

wsb

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FIGURE 3

BUILDING PAD PREPARATION:
CONTRACTOR SHALL ONLY USE GRANULAR BORROW TO BRING UP GRADES OF FUTURE AND ALTERNATE BUILDING AND GAZEBO PADS - NO COMMON FILL OR ON SITE SOILS SHALL BE USED IN THESE LOCATIONS, ALL PADS NOT PAVED DURING THIS PROJECT SHALL BE COVERED WITH 6" DEPTH OF TOPSOIL.

TRANSITION DIRECTION OF CROSS-SLOPE IN THIS AREA

FUTURE BUILDING PAD LOCATIONS

TRANSITION DIRECTION OF CROSS-SLOPE IN THIS AREA

TRANSITION DIRECTION OF CROSS-SLOPE IN THIS AREA

ADD FAIRCLOTH SKIMMER ON POND FOR DEWATERING AS NECESSARY (INCIDENTAL)

MATCH EXISTING

MATCH EXISTING

MATCH LINE

MATCH EXISTING

POND 1
BOTTOM – 728.0
NWL – 731.7
HWL – 735.7
ATLAS 14

ALTERNATE:
GAZEBO AREA

ALTERNATE:
AMPHITHEATER SEAT WALLS AND CONCRETE STAIRS

FUTURE:
CONCRETE STAIRCASES

LEGEND

	EXISTING TREE
930	EXISTING CONTOUR
930	PROPOSED CONTOUR
924.5	PROPOSED SPOT GRADE
	FLOW DIRECTION
	EROSION CONTROL FENCE
	FLOTATION CURTAIN
FV	FIELD VERIFY
TC	TOP OF CURB
GL	GUTTER LINE
CC	CURB CUT
TW	TOP OF WALL
BW	BOTTOM OF WALL
TS	TOP STEP
BS	BOTTOM STEP

- Soil compaction for all structural and paved areas to be as indicated in details and specifications (95-100% Standard Proctor Density). Contractor is required to ensure proper compaction and to provide testing results indicating proper compaction has been met.
- Soil compaction for all non-structural landscaped areas (including landscaping islands) shall be between 75%-80% of Standard Proctor or not to exceed 300 PSI for a minimum of the top 18" of soil. Compaction samples are to be taken after final grading of the site is complete. They are to be submitted and approved by the City of Shakopee's Natural Resources Dept. before installation of landscaping begins. Samples shall be randomly taken with even coverage of all landscaped areas. Submit sample results to the Shakopee Natural Resources Dept.- JBusiahn@ShakopeeMN.gov
  - Soils not meeting this requirement are required to be ripped/subsoiled to relieve compaction
- Subsoil shall be scarified before first lift of topsoil is applied.

0 30' 60'
Scale: 1" = 30'

1 / L5.0 GRADING ENL. PLAN - NORTH
1" = 30'-0"

NO.	DATE	BY	CHK	REVISIONS

Design By: CCA
Plan By: CCA
Checked By: CCA
Approved By: CCA

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED REGISTERED LANDSCAPE ARCHITECT UNDER THE LAWS OF THE STATE OF MINNESOTA.

CERTIFIED BY _____
REGISTERED LANDSCAPE ARCHITECT – CANDACE C. AMBERG, RLA
DATE: Jan. 19, 2016 LIC. NO: 40646

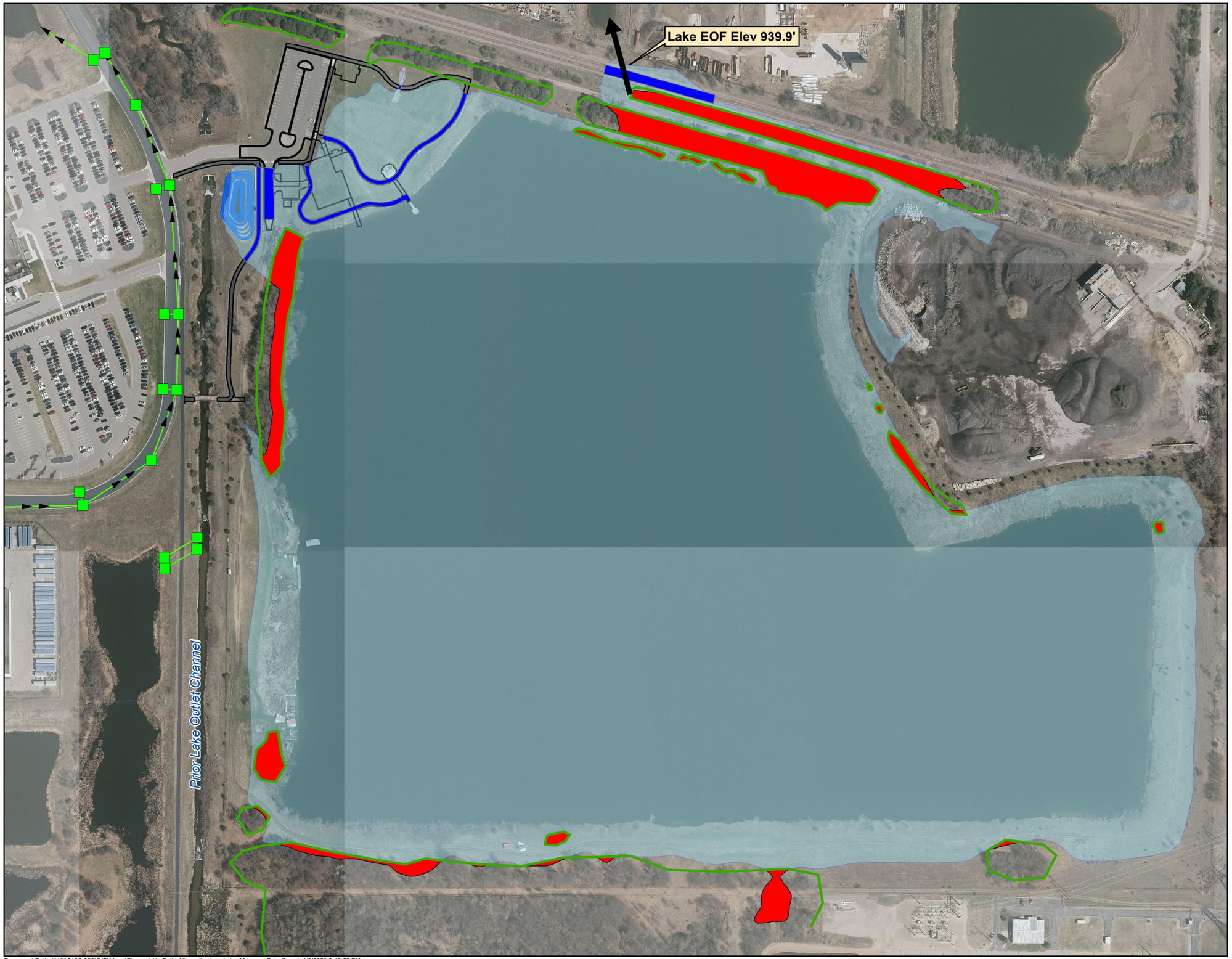
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SHAKOPEE
Quarry Park Site Development
City of Shakopee, Minnesota

CITY OF SHAKOPEE, MINNESOTA
Grading Enlargement Plan - North
CITY PROJ. NO. 2016-1

SHEET
L5.0

Date: Feb 1, 2016 **Drawing File:** k:\01756-130\cad\proposed\01756-130 quarry base.dwg, **Page Setup:** —, **Sheet Layout:** L5.0 Grading Plan Enlargement - North



SHAKOPEE

Figure 4 No Build Alternative Inundation Map

Quarry Lake Water Level Management Study
City of Shakopee

Legend

- Surveyed Treeline (2015)
- High Water Level (740.0')
- Existing Tree Impacts (158,500 SF)
- Infrastructure Impacts (37,950 SF)
- Stormwater Pond
- Impervious Surface
- Storm Inlets
- Storm Manholes
- Storm Gravity Mains
- Storm Culverts

N

0 250 Feet

1 inch = 250 feet

wsb

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SHAKOPEE

Figure 5
Gravity Outlet Options

Quarry Lake Water Level
Management Study
City of Shakopee

INV: 724.8'
INV: 724.8'
1120 LF @ 0.1%
Gravity Option 2.3
INV: 725.9'
INV: 727.6'
INV: 727.6'
Gravity Option 2.2
430 LF @ 0.1%
INV: 728.0'
INV: 728.1'
INV: 728.5'
290 LF @ 0.1%
Gravity Option 2.1
INV: 728.8'
Innovation Blvd
Prior Lake Outlet Channel
Quarry Lake
38418
BLA1-A
BLA5
QLP2
NWP6
NWP10
BLA4A
BLA5A
QLP1
NWP7
NWP2
NWP5
NWP8
NWP1
NWP9
NWP3
BLA5
BLA4B
NWP4

Legend

- PLOC within Public Waters Index
- Proposed Gravity Outlet
- Quarry Lake Drainage Areas
- Storm Inlets
- Storm Manholes
- Storm Gravity Mains
- Storm Culverts

N
0 150 Feet
1 inch = 150 feet

wsb

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SHAKOPEE

Figure 6 Gravity Alternative Inundation Map

Quarry Lake Water Level Management Study
City of Shakopee

Legend

- Surveyed Treeline (2015)
- High Water Level (726.4')
- Existing Tree Impacts (790 SF)
- Infrastructure Impacts (13,790 SF)
- Storm Inlets
- Storm Manholes
- Storm Gravity Mains
- Storm Culverts

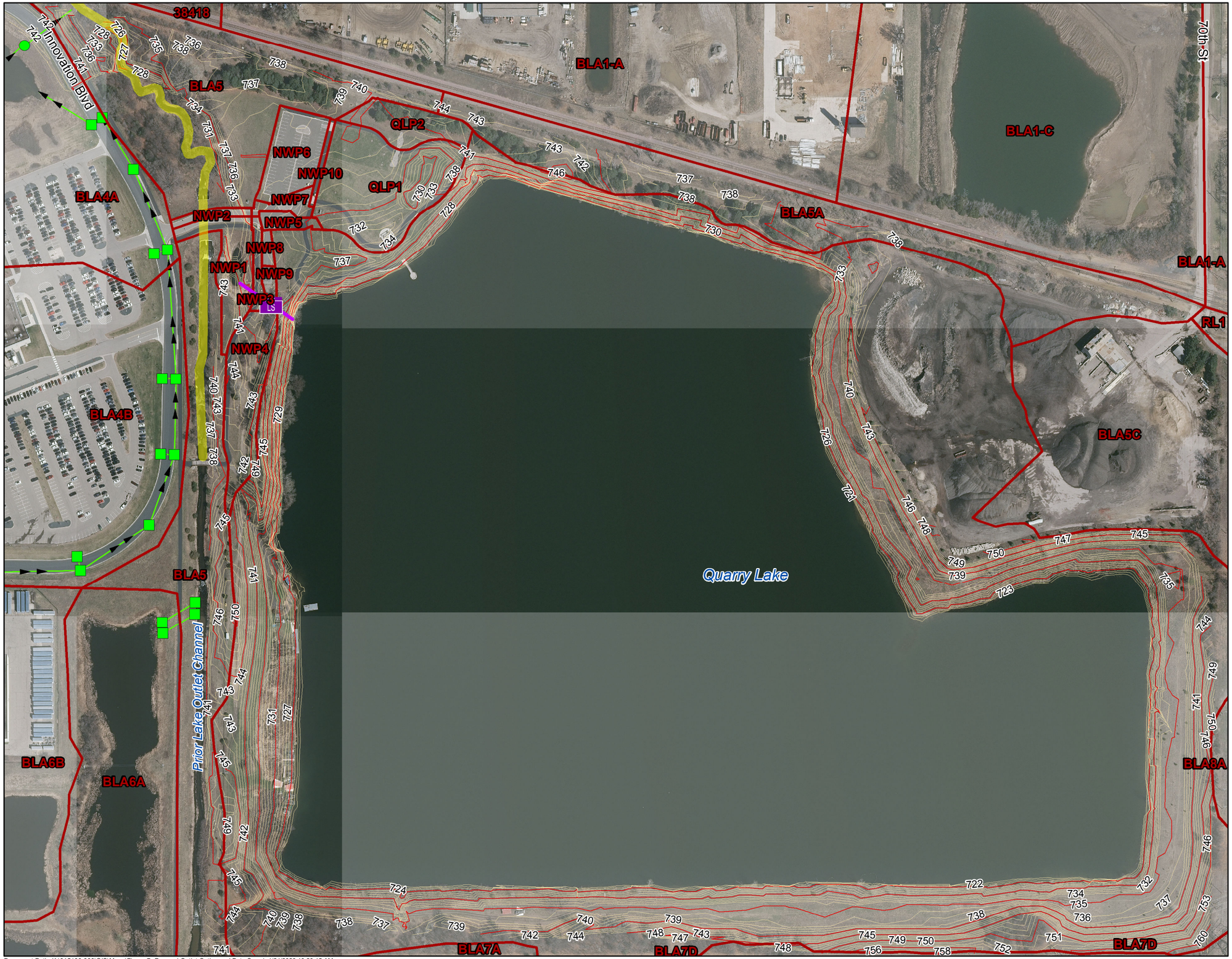
N

0 200 Feet

1 inch = 200 feet

wsb

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SHAKOPEE

Figure 7
Pumped Outlet Option

Quarry Lake Water Level
Management Plan
City of Shakopee

Legend

- PLOC within Public Waters Index
- Proposed Lift Station
- Proposed Lift Station Conduit
- Quarry Lake Drainage Areas
- Storm Inlets
- Storm Manholes
- Storm Gravity Mains
- Storm Culverts

Survey Data (2015)

- Major Contour
- Minor Contour

N

0 250 Feet

1 inch = 250 feet

wsb

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SHAKOPEE

Figure 8 Pumped Alternative Inundation Map

Quarry Lake Water Level
Management Study
City of Shakopee

Prior Lake Outlet Channel

Legend

- Surveyed Treeline (2015)
- High Water Level (724.4')
- Existing Tree Impact (7,490 SF)
- Infrastructure Impact (30 SF)
- Storm Inlets
- Storm Manholes
- Storm Gravity Mains
- Storm Culverts

N

0 200 Feet

1 inch = 200 feet

wsb

Document Path: K:\015408-000\GIS\Maps\Figure 8 Pumped Alternative Inundation Map.mxd Date Saved: 4/2/2020 2:24:51 PM

Table 1 - Infrastructure Impact Cost

SHAKOPEE, MINNESOTA 4/30/2020
QUARRY LAKE OUTLET
WSB PROJECT NO: 015048-000

Option 1 (No Build)

ITEM	UNIT	EST. QTY.	EST. COST	TOTAL EST. COST
Park Impacts (75%)	LS	**1**	**$ 893,615.25**	$ 893,615.25
Tree Impacts	SF	**158,500**	**$ 3.00**	$ 475,500.00
TOTAL				$ 1,400,000.00

Option 2 (Gravity Outlet)

ITEM	UNIT	EST. QTY.	EST. COST	TOTAL EST. COST
Trail Impact	SY	**77**	**$ 40.00**	$ 3,066.67
Big Block Retaining Wall Impact	SF	**100**	**$ 120.00**	$ 12,000.00
Tree Impacts	SF	**13790**	**$ 3.00**	$ 41,370.00
TOTAL				$ 56,000.00

Option 3 (Lift Station)

ITEM	UNIT	EST. QTY.	EST. COST	TOTAL EST. COST
Tree Impacts	SF	**7430**	**$ 3.00**	$ 22,290.00
TOTAL				$ 22,000.00

*Tree impact cost per SF based on replacement of 1 $150 tree every 50 sf

Table 2 - Gravity Alternative Estimated Costs

SHAKOPEE, MINNESOTA — **ENGINEER'S OPINION OF COST** — 4/30/2020

QUARRY LAKE OUTLET - GRAVITY

WSB PROJECT NO: 015048-000

		ITEM	UNIT	EST. QTY.	EST. COST	TOTAL EST. COST
ESTIMATED QUANTITIES ALTERNATIVE 2.3						
1	2021.501	MOBILIZATION	LUMP SUM	1	$ 25,000.00	$ 25,000.00
2	2501.503	24" HDPE PIPE	LIN. FT.	1,120	$ 75.00	$ 84,000.00
3	2501.502	24" PE PIPE APRON	EACH	2	$ 2,500.00	$ 5,000.00
4	2511.502	RANDOM RIPRAP, CLASS III	CU. YD.	50	$ 150.00	$ 7,500.00
5	2511.511	GEOTEXTILE FABRIC, TYPE IV	SQ. YD.	300	$ 5.00	$ 1,500.00
6	2575.605	SEEDING, MIX 60B (FERTILIZER & MULCH)	ACRE	1.3	$ 2,500.00	$ 3,213.96
7	2501.567	BACKFLOW PREVENTOR	EACH	1	$ 5,000.00	$ 5,000.00
8	2501.567	DRAINAGE STRUCTURE WITH FILTRATION DEVICE	EACH	1	$ 10,000.00	$ 10,000.00
9	2573.503	FLOATION SILT CURTAIN	LIN. FT.	250	$ 25.00	$ 6,250.00
					SUBTOTAL	$ 147,500.00

20% CONTINGENCY	$ 29,500.00
SUBTOTAL	$ 177,000.00

20% INDIRECT	$ 35,400.00
TOTAL	$ 212,000.00

SHAKOPEE, MINNESOTA — **ENGINEER'S OPINION OF LIFE CYCLE COST (50 YR)**

QUARRY LAKE OUTLET - GRAVITY

WSB PROJECT NO: 015048-000

LIFE CYCLE COST (50 YEARS)	EST. COST	EST. QTY.	TOTAL EST. COST
CONSTRUCTION COST	**$ 212,000.00**	1	$ 212,000.00
SEASONAL MAINTENANCE (FILTER)	**$ 500.00**	100	$ 50,000.00
ANNUAL MAINTANCE (SYSTEM)	**$ 500.00**	50	$ 25,000.00
TOTAL			**$ 287,000.00**

Table 3 - Pumped Alternative Estimated Costs

SHAKOPEE, MINNESOTA **ENGINEER'S OPINION OF COST** 4/30/2020

QUARRY LAKE OUTLET - PUMPED

WSB PROJECT NO: 015048-000

		ITEM	UNIT	EST. QTY.	EST. COST	TOTAL EST. COST
ESTIMATED QUANTITIES ALTERNATIVE 3						
1	2021.501	MOBILIZATION	LUMP SUM	1	$ 25,000.00	$ 25,000.00
2	2501.503	24" RC PIPE CULVERT CLASS III	LIN. FT.	40	$ 75.00	$ 3,000.00
3	2501.502	24" RC PIPE APRON	EACH	1	$ 2,500.00	$ 2,500.00
4	2501.503	12" HDPE PIPE	LIN. FT.	115	$ 65.00	$ 7,475.00
3	2501.502	12" HDPE PIPE APRON	EACH	1	$ 2,000.00	$ 2,000.00
5	2511.502	RANDOM RIPRAP, CLASS III	CU. YD.	50	$ 150.00	$ 7,500.00
6	2511.511	GEOTEXTILE FABRIC, TYPE IV	SQ. YD.	300	$ 5.00	$ 1,500.00
7	2575.605	SEEDING, MIX 60B (FERTILIZER & MULCH)	ACRE	0.4	$ 2,500.00	$ 1,104.80
8	2506.602	DRAINAGE STRUCTURE WITH FILTRATION DEVICE	EACH	1	$ 10,000.00	$ 10,000.00
9	2506.601	PUMP STATION WITH ELECTRICAL & CONTROLS	EACH	1	$ 150,000.00	$ 150,000.00
10	2573.503	FLOATION SILT CURTAIN	LIN. FT.	125	$ 25.00	$ 3,125.00
					SUBTOTAL	$ 213,204.80

20% CONTINGENCY	$ 42,640.96
SUBTOTAL	$ 256,000.00

20% INDIRECT	$ 51,200.00
TOTAL	$ 307,000.00

EASEMENTS	$ -
TOTAL	$ 307,000.00

SHAKOPEE, MINNESOTA **ENGINEER'S OPINION OF LIFE CYCLE COST (50 YR)**

QUARRY LAKE OUTLET - GRAVITY

WSB PROJECT NO: 015048-000

LIFE CYCLE COST (50 YEARS)	EST. COST	EST. QTY.	TOTAL EST. COST
CONSTRUCTION COST	**$ 307,000.00**	1	$ 307,000.00
SEASONAL MAINTENANCE (FILTER)	**$ 500.00**	100	$ 50,000.00
ANNUAL MAINTANCE (SYSTEM)	**$ 2,500.00**	50	$ 125,000.00
PUMP REPLACEMENT (AFTER 25 YEARS)	**$ 50,000.00**	1	$ 50,000.00
TOTAL			**$ 532,000.00**