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CITY OF MINNETONKA

STORMWATER MANAGEMENT

FEASIBILITY ANALYSIS

2019 RIDGEDALE DRIVE RECONSTRUCTION AND CRANE LAKE IMPROVEMENT PROJECT (BCWMC CIP #CL-3)

HENNEPIN COUNTY | MINNETONKA | MINNESOTA

AUGUST 13, 2018
Updated September 10, 2018

Prepared for:
City of Minnetonka
14600 Minnetonka Boulevard
Minnetonka MN 55345

WSB PROJECT NO. 010557-000

WSB

STORMWATER MANAGEMENT FEASIBILITY ANALYSIS FOR 2019 RIDGEDALE DRIVE RECONSTRUCTION AND CRANE LAKE IMPROVEMENT PROJECT (BCWMC CIP #CL-3)

Completed for

City of Minnetonka and Bassett Creek Watershed District

August 13, 2018, updated September 10, 2018

Prepared By:

WSB

CERTIFICATION

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 Professional Engineer under the laws of the State of Minnesota.

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I. INTRODUCTION AND PURPOSE

This document has been prepared to identify, and evaluate the need for and feasibility of implementing various stormwater management improvements that the City of Minnetonka could undertake as part of the 2019 Ridgedale Drive Reconstruction Project to best manage or improve stormwater quality in Crane Lake, as well as address storage, flooding, or rate control concerns that are present within the Ridgedale Drive right-of-way or the watersheds upstream or downstream of the conveyance system that is present within this right-of-way.

Sections III and **IV** are focused on only providing information directly related to evaluating/addressing stormwater conveyance, storage, and flooding problems that could/should be addressed as part of the Ridgedale Drive improvement project, which are not related to Crane Lake but were included in this report to provide the City of Minnetonka with direction on the design for these concerns as they complete the design for the roadway. This section of the report will be of more limited interest to the Board of Managers of the Bassett Creek Watershed.

Sections V and **VI** focus on improvement options that are specifically and directly related to Crane Lake water quality, and **Section VII-C** provides recommendations related to these options.

II. BACKGROUND

The Ridgedale Drive Reconstruction Project, anticipated to be constructed in 2019, consists of the reconstruction and reconfiguration of Ridgedale Drive from its intersection with Plymouth Road on the southwest corner of the Ridgedale shopping center, then east and north to its intersection with I-394 on the northeast side of the shopping center (**Figure 1**).

The current preferred alternative will change the roadway from an undivided multiple lane section to a single lane section with a landscape median and replace major intersections with roundabouts. This design will also reduce the amount of impervious surface over the project area by approximately two acres.

The project area is almost entirely within the Bassett Creek watershed and governed by stormwater rules promulgated by the Bassett Creek Watershed Management Commission (BCWMC). For linear reconstruction projects in this area that have a net reduction in impervious surface area, which is the case for this project, the Bassett Creek Watershed as well as City of Minnetonka rules do not require any additional stormwater management features or improvements be integrated into the design. However, the incorporation of best reasonable stormwater treatment technologies is encouraged if it is reasonable and practical to do so by these agencies and is desired by the owners of this project.

A review of soil information for the area indicate native soils are primarily organic, have a saturated water condition typically within a few feet of the surface, and low infiltration potential. These conditions limit use of some BMP options that otherwise might be considered on a similar project. Information on soils in the area are included in **Appendix A**.

A review of existing water quality date for the lake indicated the average total phosphorus concentration in the lake from 1972 to 2016 was .088 mg/l, chlorophyll a was .025 mg/l, and secchi depth transparency was one meter. More detailed information on the water quality of the lake can be found in the 2017 report on Crane Lake prepared by Barr Engineering for the Bassett Creek Watershed Management Commission.

A review of existing water quality concerns in the watershed also indicate chloride concentrations close to or slightly exceed the 230 mg/l chronic threshold level fore impairment have been observed in Crane lake, immediately downstream from the outlet of the storm sewer that directs runoff from the south side of the Ridgedale shopping center parking lot. Based on samples collected in July 2018 the chloride concentration of stormwater runoff present in Ridgedale Pond, which is immediately upstream of Crane Lake was 450 mg/l.

As part of the analysis of existing conditions related to conveyance system capacity and stormwater quality, as well as the development of the options for drainage system improvements provided within this document, we have completed new or reviewed and updated existing hydrologic and water quality models for the area and completed additional analyses to evaluate the feasibility and cost vs benefit of options identified. The results of this study on the need for conveyance system capacity improvements and additional water quality BMPs are provided in the following sections of this document.

III. EVALUATION OF CAPACITY AND CONDITION OF IN-PLACE STORMWATER CONVEYANCE SYSTEM.

Section not related to CIP project.

A. CAPACITY OF EXISTING SYSTEM.

The City of Minnetonka has a water resource management plan and hydrologic model for the area. The model has recently been updated to predict 100-year high water elevations for ponds in the area based on ultimate land use conditions, and utilization of the more intense Atlas 14 rainfall intensity frequency probability curves that have been adopted as the standard for this area.

The capacity of the pipes crossing under Ridgedale Drive to the pond appears adequate to convey runoff directed to them from the shopping center parking lot drainage system when they are not significantly impacted by pond tail water conditions.

The existing hydrologic modeling for the area does not fully evaluate catch basin capacity within the system. However, a review of the in-place system indicates that if adequate catch basin and lateral system capacity is provided in the parking lot, the depth of water in the parking lot during storm will not exceed 0.5 feet for smaller events (10-year return frequency) but will exceed 0.5 feet when the pond tail water elevation approaches the low elevation of parking lot. An additional evaluation of the capacity of parking lot catch basins, clogging impacts, and tail water on system may be warranted if flooding occurs during non-tail water driven events at too great a frequency, and or if reconstruction of parking lot drainage system is undertaken.

This hydrologic model predicts that Ridgedale Pond has a 100-year elevation of 931.3. Based on aerial contours, Ridgedale Pond (**Figure 2**) has adequate capacity to provide storage needed to prevent flooding of buildings adjacent to the pond, however, this elevation is 1.3 feet above the elevation of the lowest pavement area of the Ridgedale shopping center parking lot. For this event, the modeling indicates that this high-water elevation will take about 3.5 hours to recede to an elevation of 930 or less.

Runoff from a portion of Ridgedale Drive as well as much of the west and south side of the Ridgedale Shopping Center parking lot is directed to the Ridgedale Pond. This pond has a 54-inch RCP pipe that serves as the pond overflow/outlet and serves as a conveyance system for runoff directed to catch basins along Ridgedale Drive. This pipe directs water to the east to an outfall into Crane Lake.

The existing model indicates the capacity of this 54-inch storm sewer is adequate to accommodate runoff from the existing roadway for between a 10-year and approaching a 25-year return frequency storm without surcharge. A review of the road profile indicates adequate overflows are available to accommodate larger events without significant flooding of roadway.

B. EVALUATION OF CONDITION AND LIFE EXPECTANCY OF EXISTING 54-INCH TRUNK STORM SEWER PIPE UNDER RIDGEDALE DRIVE.

This 54-inch pipe was televised in 2017 to obtain information on its current condition. The televising report indicates that scaling and abrasion was observed in many areas of the pipe, and the pipe is in need of some maintenance related repairs, but that the structural integrity of the pipe is satisfactory and not in need of replacement.

Concrete pipe manufacturers indicate a pipe such as this should last between 50 and 100 years before needing replacement. Pipes placed in environments having soil pH values greater than 4, firm soil bedding, flatter slopes (less than 1%), and limited sediment bed load will have the longest service life within that range.

This pipe was installed in 1975, has a slope less than 1%, and has no known issues related to pH induced deterioration. On the other hand, it is subject to higher than average bed load sediment transport, and as a result, higher than average scouring forces are exerted on it. Based on these observations, we would anticipate this pipe should have a service life of 75 to 90 years, and this service life could likely be extended for additional years, perhaps significantly beyond the 100-year threshold if the pipe is maintained or re-lined to address scouring or other related issues. Maintenance under these conditions could be undertaken using trenchless pipe repair or replacement technology.

If the current pipe undergoes maintenance to address scouring but no major repair, would be expected to last for an additional 32 to 47 years, or until 2050 to 2065. Using trenchless technology pipe repair/replacement practices, contractors installing these improvements indicate these repairs will extend the service life of the pipe an additional 50 years over that provided by the existing pipe. Because these repairs can be deferred for many years, this approach has the capability to extend the service life of the pipe which has been identified as a priority outlet pipe by the City of Minnetonka until approximately 2100.

C. CONVEYANCE SYSTEM CAPACITY REQUIRED TO MEET CURRENT STANDARDS

Design standards for drainage from parking lots generally focus on maintaining water depths in parking lots to low enough depths to prevent parked cars in the lot from being damaged by ponded water. This typically required depths to be limited to 0.5 feet. The Current system allows water to be ponded to a depth of 1.3 feet in the lowest area, indicating some improvements may be warranted to address this condition.

Design standards for buildings require minimum of 2 feet of freeboard from pond high water levels to building openings. A review of topographic information for the area indicates that under existing conditions, buildings in this area have this freeboard available.

IV. OPTIONS FOR IMPROVEMENTS TO STORMWATER COLLECTION AND CONVEYANCE SYSTEM.

Section not related to CIP project.

Several Stormwater collection and conveyance system improvement options are available that have the potential to address the flooding or pipe deterioration issues and concerns identified in previous sections of this document. A listing of these options along with the cost and benefits related to these improvements is provided below.

1) INSTALL ADDITIONAL 30-INCH OUTLET FROM RIDGEDALE POND TO CRANE LAKE.

   To reduce ponded water elevations in the Ridgedale parking lot to 0.5 feet or less, an additional 30-inch conveyance system pipe from the pond to Crane lake could be constructed that would provide additional conveyance system capacity to lower the high-water level in Ridgedale pond to 930.5. However, installation of this pipe would not likely be practical unless it is completed in conjunction with a project to replace the existing 54-inch pipe as well. Furthermore, Bassett Creek watershed rules do not allow any increase in the rate of runoff generated from a given area, so this option, which would increase the peak discharge rate from this area, would only be feasible to implement if a variance to this policy from the Bassett Creek watershed is secured.

   Replacing the existing 54-inch storm sewer with new pipe using an open cut replacement approach is estimated to cost $650,000, and the cost to install a supplemental 30-inch pipe at the same time is estimated at $140,000, resulting in a total cost of $790,000.

2) INCREASE ELEVATION OF SHOPPING CENTER PARKING LOT.

   To reduce ponded water elevations in the parking lot to 0.5 feet or less, the shopping center could also raise the elevation of the low point of the parking lot by up to 1 foot or change the use of this area to something other than automobile parking that could accommodate periodic flooding to this depth.

   Prior to proceeding with this type of improvement, and to provide a more refined cost estimate on its' cost, further analysis should be undertaken to obtain the exact size and capacity information for the conveyance system serving the parking lot, to make sure that the parking lot drainage system is also adequate to convey water from the area without excessive ponding, as well as obtain additional soil and more exact topographic information.

   The cost to remove pavement, place fill, compact and re-pave the parking lot so it is no longer over .5 feet below the high-water level of Ridgedale Pond, is preliminarily estimated at $150,000, but additional soil boring information would be needed to refine this estimate.

   The cost to change the use of the parking lot in this low area could range from very low to very high and would be dependent on the intended use for the area in the future, and the cost for improvements needed to facilitate that use. Additional information on the cost for this option cannot be provided until further information is available, much of which would need be developed and further evaluated by the shopping center ownership.

3) PROVIDE ADDITIONAL STORMWATER STORAGE UNDER SHOPPING CENTER PARKING LOT.

Another option to reduce flood elevations is to provide additional storage for stormwater under the Ridgedale shopping center parking lot to the extent needed to reduce this water depth to a maximum of 0.5 feet. This option could also allow for a reduction in peak rate of stormwater runoff required to be discharged from shopping center parking lot to Ridgedale pond, and, depending on the size of the storage area and capacity of the future parking lot drainage system, could also reduce the 100-year flood elevation for Ridgedale pond.

Development of the costs/ benefits of this option will need to be deferred until it is known that the shopping center would view this as an option they would want to consider, and the size and configuration of the potential underground storage area can be better defined.

A preliminary review indicates the cost for implementation of this option would be significantly higher than that associated with the option of increasing the elevation of the parking lot, and it should be further noted that the implementation of this option would not provide any significant enhancement in the treatment of stormwater from this area as a high level of treatment is already provided downstream in Ridgedale pond, and this system would be providing a redundant level of treatment.

4) REPLACE EXISTING 54 INCH PIPE WITH NEW PIPE

To address existing pipe deterioration/longevity concerns, the existing 54-inch pipe could be replaced by conventional methods. This would require removal of the existing pipe by open cutting and replacing the existing pipe and manholes with new pipe and manholes. The cost for this improvement is estimated at $650,000 plus the cost associated with reconstruction of surface improvements, loss of access to businesses during construction, and other factors. This work would allow the service life of the pipe to extend to approximately 2100. This option would do nothing to address flooding concerns in parking lot. If flooding concerns would also like to be addressed as part of this project, as noted earlier, the installation of an additional 30-inch pipe could also be incorporated into this project for an additional cost of $140,000.

5) REHABILITATE EXISTING PIPE USING LINING MATERIAL INSTALLED WITH TRENCHLESS TECHNOLOGY.

To address pipe deterioration concerns, the existing pipe could also be rehabilitated in areas requiring maintenance using a trenchless technology approach. This would involve installation of a liner that would be cured in-place, without need for digging up the pipe, along with rehabilitation of manholes and other structures. The cost for implementing this option along the entire length of outlet pipe is estimated at $550,000, would extend the service life of the existing pipe by an additional 50 years and reduce/eliminate the cost and surface impacts related to the open cut conventional replacement approach. This work could be undertaken now or later when the pipe condition worsens. A general outline of the work anticipated to be completed as part of this option is provided on **Figure 4**.

6) UNDERTAKE ONLY MINOR MAINTENANCE TO ADDRESS SCOUR AND OTHER LIMITED CONCERNS.

This option involves limiting pipe maintenance work to only the areas that are observed to have the most scour occurring and putting off maintenance on the remaining areas of the pipe until they show more wear and deterioration. Selecting this option would require taking into full consideration that the structural condition of the existing 54-inch pipe is good, and that although scour is present in many areas of the pipe, there are only limited areas that scour is significant enough to require it to be addressed in the very near term. This option also reflects a perspective that scour related repairs that could be undertaken at any time in the future without digging up the pipe, and the current pipe, as it exists, has 30 to 50 years remaining on its expected service life. The cost for doing only selected maintenance in the most areas that this maintenance is anticipated at $75,000.

V. WATER QUALITY TREATMENT PROVIDED BY EXISTING SYSTEM

Runoff from the Ridgedale shopping center parking lot, is directed to Ridgedale pond, or a pond on the northeast side of the shopping center where physical and biological processes provide treatment for the runoff. Runoff from areas along Ridgedale Drive downstream of this area direct runoff into small pretreatment ponds adjacent to a downstream lake/wetland referred to as Crane Lake.

Information on the ability of Ridgedale Pond as well as the pond on the northeast side of the shopping center to treat stormwater from the watershed areas that direct runoff to the ponds was previously analyzed and provided in a report entitled *Crane Lake Water Quality and Sub-Watershed Assessment*. This report was prepared by Barr Engineering for the Bassett Creek Watershed Management Commission and dated June 2017. This report/study also included the development of a P8 water quality model for the area and information from this model was used in our evaluation of alternatives.

In addition to using the above information, an inspection and survey was completed for Ridgedale pond reflecting it has an average depth of approximately 5 feet, and approximately 20 acre-feet of dead-pool storage is available in the pond to enhance treatment. This information was consistent with that included in the P8 model that was previously completed.

The P8 water quality analysis of the watershed and pond completed by the Bassett Creek Watershed Management Commission predicts the pond in its existing condition removes approximately 94% of the Total suspended solids (TSS) and 72% of the total phosphorus (TP) directed to it from its' surrounding watershed.

Monitoring data for Crane Lake completed by the Bassett Creek Watershed also indicated the in-lake Chloride concentration for the Basin was typically above 200 mg/l, and periodically exceeded the chronic threshold value for impairment of 230 mg/l. This has been identified as a significant concern by the Watershed. Based on a sample of water collected in early July 2018, Ridgedale pond was observed to have in-basin chloride concentrations of 450 mg/l. Under existing conditions, limited if any removal of chlorides is projected to be provided by the removal mechanisms present in the pond due to the soluble nature of this pollutant.

A. WATER QUALITY TREATMENT REQUIRED TO MEET CURRENT STANDARDS

No additional treatment is required for this project as the amount of impervious surface will be reduced as part of this project; however, providing additional treatment is encouraged if it is reasonable and practical to do so and desired by the owner of the project.

VI. OPTIONS FOR STORMWATER TREATMENT: CRANE LAKE IMPROVEMENT PROJECT BCWMC CIP #CL-3.

Multiple treatment options are available that have the potential to improve the quality of water currently discharged downstream from the shopping center into Crane Lake. A listing of these options along with the cost and benefits related to these improvements is provided below:

1) DREDGE RIDGEDALE POND TO ADDRESS FUTURE MAINTENANCE NEEDS AND IMPROVE POLLUTANT REMOVAL EFFICIENCY.

Ridgedale Pond could be dredged to a greater depth to provide enhanced dead pool storage and potentially better treatment, and or slightly expanded to increase storage to offset loss of storage should the parking lot elevation be raised to reduce flood depths in parking lot.

Based on a review of the results of a P8 model analysis for this pond that was completed by Barr Engineering and a sediment depth survey that was completed by WSB, except for the area in the immediate vicinity of the parking lot pipe outfall into the basin, the depth throughout the pond is 5 to 6 feet deep, and only sediment removal near the pipe outfall is currently needed. P8 model simulations completed by Barr Engineering indicate that removal efficiencies for this basin exceed 90% for TSS and 70% for TP. These removal efficiencies are on the high end of the range of removal efficiencies for treatment ponds. Because this basin is already performing at very high removal efficiencies and does not require maintenance except for removal of a sediment delta, this project will not significantly increase the annual removal of TSS or TP from water being treated by this pond.

Should removal of the sediment delta be desired, based on removing 1,000 CY of material at $40 CY, and using a 30% engineering, legal, administrative and contingency factor of approximately 30%, the cost to complete this work is estimated at $50,000.

2) MODIFY RIDGEDALE POND OUTLET TO PROVIDE LOW FLOW DRAWDOWN/ ENHANCED TREATMENT IN-BETWEEN RAINFALL EVENTS.

This option would modify the Ridgedale Pond outlet to provide enhanced skimming and low flow drawdown treatment of stormwater during non-rainfall event conditions. This low flow enhanced treatment would be provided by directed runoff thru canister treatment cells, iron sand, or other tertiary treatment filtering mechanisms.

The system could be designed to direct runoff to these tertiary treatment filters in one of two ways. The first would be to modify the outlet to impound additional water, create a low flow gravity drawdown diversion, and direct this additional impounded water the tertiary treatment system.

The second related option would be like the first option, except instead of impounding additional water to create a gravity drawdown system, a low capacity pump (solar, electric or hybrid powered) would be installed that would allow for further drawdown of the pond and provide low flow treatment of stormwater stored in the pond in-between events. This option would also have the potential to increase live and dead pool storage in the pond between rainfall events, thereby potentially reducing the high-water level of the pond, and increasing treatment times for runoff directed to the pond.

Based on the added benefits related to the second option (providing a system that can provide more live pool storage between storms), concerns related to more flooding occurring if we impound more water between storms in the pond to allow for a gravity drawdown that was needed in the first option, and the second option's ability to make use of more locations for tertiary treatment, the second option was selected for more detailed evaluation.

Based on an estimated cost for construction of a lift station/pump/controls and force main at $100,000, the cost of iron sand or canister system at $150,000, and 30% for indirect costs, it is estimated the capital cost for implementation of this option would be approximately $300,000 plus the cost for periodic replacement of filter media, which is estimated at an additional $250,000 over the 30-year life expectancy for the project.

Because this option could not handle treatment of runoff during heavy rainfall events, it was estimated that enhanced treatment would only provide such treatment for approximately 50% of the annual runoff passing thru the treatment pond. This enhanced treatment would be estimated to increase the removal efficiency for TSS from approximately 94 to 97% and for TP from 72% to 90%. This would correspond to an increase in annual TSS removal from 38,400 to 39,000 lbs. (600 lbs.), and increase annual TP removal from 112 to 125 lbs. (13 lbs.)

Based on a 30-year life cycle cost of approximately $18,000/year, this BMP would remove TP at a cost of $1,384/pound.

As part of the development of public amenity related components of this project, if desired, the treated runoff from this BMP could potentially be integrated into those elements of the design if the components might include incorporation of a water feature such as an open channel stream, pond, waterfall, etc. This feature could also be further developed into a public education experience on how stormwater runoff is managed and lakes are protected.

3) REUSE STORMWATER FROM RIDGEDALE POND FOR IRRIGATION.

This option involves reuse of stormwater from the Ridgedale Pond for irrigation of proposed new vegetated median to be constructed as part of Ridgedale Drive improvements, or other selected areas. It is however understood that this option would only be feasible if chloride levels in water taken from this pond are low enough to not harm vegetation.

Based on testing of chloride concentrations in this basin in July 2018, the chloride concentration in the pond was determined to be 450 mg/l. Although this concentration is not high enough to immediately impact vegetation, higher concentrations are likely present in March through June, and prolonged exposure of vegetation to irrigation water having chloride concentrations that were observed in July testing, has the potential to cause future problems.

Furthermore, because the area to be irrigated will be limited to medians and other areas in right of way, the cost per acre to set up a stormwater reuse system in this location will be very high.

For the above reasons, we would not recommend implementation of this BMP as part of this project.

4) INSTALL STORMWATER TREATMENT BMPS IN RIDGEDALE SHOPPING CENTER PARKING LOT UPSTREAM OF RIDGEDALE POND OR EAST POND.

This option would involve installation of stormwater storage, iron sand filters, rain-gardens or other treatment cells on or under surface of the Ridgedale parking lot in areas upstream of the two treatment ponds that are in place on the northeast or south sides of the shopping center. It is anticipated installation of any of the above improvements would typically result in the removal of 80 to 90 % of the TSS and 40 to 60% of the TP from the raw previously untreated stormwater discharged from the parking lot. The cost for installation of these treatment cells would range from $100,000 to $250,000.

Although, the above option is a cost-effective option to provide treatment, P8 modeling for the areas that currently direct runoff to Ridgedale Pond or the east pond indicates that these ponds are already treating runoff from these areas equal to or in excess of the removal efficiencies noted above. As a result, installation of redundant treatment upstream systems upstream of these ponds will provide limited additional removal or benefits to downstream water bodies over that provided by the existing ponds, and installation of this type of BMP is not deemed cost effective and is not recommended in these areas for TP or TSS removal.

5) INSTALL STORMWATER RUNOFF BMP'S TO PROVIDE TREATMENT SYSTEMS FOR RUNOFF NOT CURRENTLY RECEIVING TREATMENT PRIOR TO DISCHARGE TO CRANE LAKE.

This option involves providing enhanced treatment for runoff from the Ridgedale Road right-of-way, and upland areas that are not currently receiving significant treatment prior to discharge to Crane Lake. A 13.4-acre area has been identified southeast of the shopping center that is not receiving a high level of treatment. An investigation into options for treatment in this area observed that use of an area on the east side of the parking lot located north of the hotel adjacent to Crane Lake would be ideal for this purpose.

Provided the City of Minnetonka can obtain the right to use this property for this purpose, the construction of a surface pond, or underground treatment system could be feasible in this area.

If an underground treatment area was constructed capable of providing dead pool storage for the first .5 inches of runoff from this area, it is estimated, at a cost of $10 cubic foot, he cost for constructing this type of BMP, including 30% for indirect costs, is estimated at 300,000.

Based on an untreated influent loading for TSS of 400 pounds/acre and for TP of 1.5 pounds/acre, with the BMP option described above, removal efficiencies for TSS and TP based on this design are estimated at 80% for TSS and 50% for TP. Based on this estimate, these BMPs would provide annual TSS/TP removal per acre of 320 pounds per acre TSS and from 0.75 pounds of TP per acre.

Based on a construction cost of $300,000, additional indirect costs of 30%, and annual maintenance costs of $5,000 per year, the life cycle cost for this improvement is estimated at $18,000 per year.

Based on the above, the cost per pound of TSS and TP removed is estimated at $4.20 per pound for TSS and $1,030 pounds for TP removed.

As part of the development of public amenity related components of this project, if desired, the treated runoff from this BMP could potentially be integrated into those elements of the design if the components might include incorporation of a water feature such as an open channel stream, pond, waterfall, etc. This feature could also be further developed into a public education experience on how stormwater runoff is managed and lakes are protected.

6) **PERIODICALLY DOSE STORMWATER PONDS WITH ALUM TO IMPROVE WATER QUALITY AND REDUCE RATE OF INTERNAL SEDIMENT NUTRIENT RELEASE.**

This project would involve periodic application of liquid aluminum sulfate to the ponds either by titrating the coagulant into the pond based on flow rates, or periodically batch treat the basins based on rainfall and or results of water quality sampling in the basin.

The treatment would be primarily used to improve the ponds ability to remove soluble phosphorus prior to discharge of this treated water to Crane Lake.

Based on a literature review, phosphorus removal exceeding 90% of pretreatment concentrations can be achieved provided it is properly applied and the system is properly maintained.

If it is assumed that the P8 model prepared by Barr Engineering is accurate, which indicates the ponds are removing approximately 72% of the phosphorus directed to them. This approach has the potential to increase this removal to in excess of 90%. However, for estimation purposes, because some events may not be able to be treated with optional dosing and mixing conditions, we would suggest a typical removal of 85% of TP be used. Using these estimates, the treatment would increase the removal percentage from 72 to 85%, and increase the annual removal predicted by this model by 20 pounds of TP annually.

Jar testing will be required to accurately estimate alum dosage rates and the corresponding cost for annual treatment; however, a cost estimate has been developed based on typical alum with polymer dosage rates applied by others in similar applications.

Based on annually treating 13 inches of runoff from the site, which would be typical for the non-winter months, approximately 100 acre-feet of runoff would need to be treated each season. Based on using a dosage rate of 0.1 ml/liter, approximately 400 gallons of reagent would be needed. Using $15 per gallon cost, reagent costs are estimated at $6,000 annually. It is also estimated that the lease cost to operate, monitor, and maintain equipment needed to facilitate this application would be approximately $12,000 annually, and coupled with $30% indirect costs would result in an annualized cost of $25,000 per year to operate.

Based on a 30-year application period, and an estimated annualized treatment cost of $25,000/year for phosphorus removal, this would correspond to a cost of approximately $1,250 /pound of TP removed.

7) **DIVERT HIGH CHLORIDE SNOW-MELT WATER TO REVERSE OSMOSIS TREATMENT SYSTEM**

This option involves construction of Snow melt diversion system that would route winter and spring low flow runoff with high chloride concentrations to an underground storage tank or to Ridgedale pond, and then pump it into a reverse osmosis treatment system. Treated water with low chloride concentrations would then be discharged into Crane Lake. The system would also require the discharge of backwash effluent to the sanitary sewer, which would need to be approved by MCES.

The reverse osmosis system would include installation of a wet well and submersible pump that would direct high chloride runoff diverted to the system to two skid mounted treatment systems constructed in series. The first skid would house the manifold, filtration and controls for filtering the water before it reaches the RO. This skid would also be housed in an enclosure would also have insulation and the appropriate heaters to assure the filtration units wouldn't freeze.

The second skid would house the RO in an enclosure which would have insulation and appropriate heaters to assure the unit would not freeze. It would have appropriate lighting and vents. All controls to operate the RO will be installed in the enclosure with the RO.

Based on current available information on influent quality, the filtration skid would need to include 2 x 25 micron filters and 2 x 5 micron filters. This could change if future water sampling completed during the design process reveals contaminant levels significantly different than those estimated as part of this feasibility analysis.

The filters and RO system would be connected to the sanitary sewer system to allow for the disposal of back-wash water. The proposed reverse osmosis system is estimated to treat water at a rate of 50 GPM, and at that rate, would produce between 30 and 40 GPM clean water that would be discharged to Crane Lake, and 10 to 20 GPM of backflush water that would need to be discharged to the sanitary sewer. The system would reduce concentrations of chloride in snow melt runoff from over 1000 mg/l to less than 10 mg/l.

We anticipate this system would only be operated continuously during times when salt is being applied to melt snow and ice, snow is melting, and or during times when light rainfall is washing off previous applied salt. Based on a review of monthly average precipitation data for the area, between December and April, approximately 6.3 inches of precipitation falls in the form of rain and snow, and about 3 inches of runoff is generated from impervious surfaces in this area during this time.

For the area, directly tributary to Ridgedale Pond, this would correspond to a runoff volume of 24 acre-ft. If this runoff was not allowed to be directed to Crane lake, either thru diversion or treatment, it is anticipated that over 75% of the chloride loading currently being directed to Crane lake from the Ridgedale pond watershed could be eliminated.

The cost to furnish and install the RO and pump station is estimated to range from $350,000 to $450,000, If an additional tank is installed to capture the water from the parking lot, this could increase the cost by an additional $150,000, resulting in a total project cost with contingency estimated to range from $500,000 to $600,000.

The cost to operate the system will also include costs for power, discharge of effluent to sanitary sewer, labor and materials needed to facilitate on-going operation and maintenance, and monitoring. Based on information developed by others in the operation of similar systems, the total cost for construction and operation of this type of system typically runs between 6 and 7 cents per gallon of water treated, plus the cost for disposal of backwash effluent to the sanitary sewer. If the system was operated at 50 gallons per minute for 4 months (December 15 to April 15) this would correspond to approximately 24 acre-ft. of snow melt water being treated. his represents approximately 20% of the total volume of runoff from the site annually. The annualized cost for this treatment is estimated to range from $50,000 to $70,000.

For water treated by this system, it is anticipated this project could increase the annual removal efficiency for TSS from 94 to 98%, TP from 72 to 95%, and from 0% to 95% for chloride removal. This would correspond to an increased removal of 300 lbs. of TSS, 6 lbs. of TP, and 49,000Lb of Chlorides (Chloride removal based on an estimated average flow weighted mean concentration of chloride in untreated water of 750 mg/l.)

8) DIVERT HIGH CHLORIDE SNOW-MELT RUNOFF TO SANITARY SEWER

This option involves construction of Snow melt diversion system similar to that described for the RO filter option, but instead of directing the snow melt water to the RO system and discharging 20 to 40 percent of this water in the form of backwash effluent to the sanitary sewer, all the winter and spring low flow runoff with high chloride concentrations would be routed directly to the sanitary sewer, eliminating the need for the RO system. Conventional storm water treatment would be provided prior to discharge of this snow melt water to the sanitary sewer.

This system would consist of installing a pump or gravity low flow outlet from a collection/pretreatment tank or Ridgedale pond and direct this runoff to the sanitary sewer, when chloride concentrations in the pond exceed designated allowable discharge concentrations. Concentrations of chlorides could be monitored using conductivity as a surrogate indicator to ensure only snow melt runoff with unacceptably high concentrations of chlorides would be diverted to the sanitary system.

It is anticipated that similar to the RO system, the diversion would have an average capacity of 50 gallons per minute (0.1 CFS). This system would provide reductions in pollutant concentrations like the RO system, but would not require installation of the system. The system would now not include the cost for construction and operation of the RO system, but would have increased costs for disposal to the sanitary sewer.

The capital cost to install a pretreatment system for this runoff, as well as needed pumps/ valves, and monitoring equipment is estimated at $150,000, and the cost to discharge 24 ac-ft. of snow melt water to the sanitary sewer is estimated at $32,000 based on a treatment cost of $4 per 1000 gallons.

Based on the above estimates, the annual cost for this BMP which would include costs to construct, operate and pay treatment fees to MCES each year, is estimated at $45,000, using a 25-year life expectancy. Based on using this estimated annualized treatment cost, which is 25% less than the RO option, the cost per pound removed for TSS, TP and Chlorides would be $150/ lb., $7500/lb. and $0.94/lb. respectively for these three pollutants.

Although implementation of this option may require significant permitting effort, the approach is innovative and could be applied in other areas with similar runoff concerns. Furthermore, given the only other pragmatic option for Chloride management is to reduce use of salt for deicing, development of this option in areas where reducing salt use to the extent needed cannot be accomplished, may be the only way to address the Chloride impairments of many of our Water Resources.

VII. RECOMMENDED IMPROVEMENT OPTIONS

A. PIPE CAPACITY/ FLOODING ISSUES

To address Pipe Capacity/ flooding issues, the most cost-effective approach to address this issue is to increase elevation of parking lot or change use of parking lot in those locations to accommodate periodic inundation. **(Conveyance System Improvement Option 2)**

The analysis further indicated that since pond high water elevations will only back up into parking lot to a depth that would cause damage for events that exceed a 25-year return frequency, and should inundation occur, water will only be present for up to 3 hours, further capacity increases to the pond outlet to address this issue may not be warranted.

B. STORM SEWER PIPE DETERIORATION

To address pipe deterioration concerns, given that the pipe is structurally sound and has at least 50 years of service life remaining without replacement, it is recommended that the City implement actions needed to address deficiencies outlined in maintenance report**. (Conveyance System Improvement Option 5**) This would involve addressing observed scouring in selected areas by lining, paving invert, and or performing maintenance needed to address other deficiencies identified in inspection report. This option will not defer action to repair known deficiencies to a later date.

C. STORMWATER TREATMENT TO REDUCE THE SUSPENDED SOLIDS AND PHOSPHORUS LOADING TO CRANE LAKE.

(See **Table 1**)

1) **Implement BMPs to treat runoff that now is directed to Crane Lake untreated.** Our investigation revealed that approximately 13 acres are now directing runoff to Crane Lake without benefit of treatment, and some form of treatment should be provided for this runoff if possible. As part of this project, this could be accomplished by building a pond or underground treatment system in the south-east part of the study area, either in the shopping center or east side of hotel parking lot adjacent to Crane Lake. **(Stormwater treatment Option 5)**

   Coarse sedimentation and skimming designs would provide the most cost-effective removal of these pollutants but would also provide lower removal percentages. Could also consider higher cost per pound/ higher removal percentage design options in these locations as well, depending on the size and location of property that could be secured for this purpose.

   As part of the development of public amenity related components of this project, if desired, the treated runoff from this BMP could potentially be integrated into those elements of the design if the components might include incorporation of a water feature such as an open channel stream, pond, waterfall, etc. This feature could also be further developed into a public education experience on how stormwater runoff is managed and lakes are protected.

2) **Implement Alum enhancement modification to Ridgedale pond and or East pond to increase removal of soluble phosphorus and other pollutants.** This option, which would involve either periodically dosing, or regularly titrating a flocculation reagent into the pond based on flow, was found to be one of the more cost-effective options for reducing downstream nutrient loads to Crane Lake. **(Stormwater Treatment Option 6)**

3) Move ahead with further evaluation and permitting of innovative high chloride snowmelt diversion project (Stormwater treatment Option 8)

If chloride impairment of Crane Lake is significant concern, and the City or other project partners wish to work toward implementation of this option, a more refined plan and formal request to MCES to allow controlled discharge of high chloride melt water to Sanitary Sewer during the winter months should be submitted on behalf of the project partners to allow for a formal evaluation of the use of the MCES system for this purpose.

A preliminary submittal this concept has been reviewed by MCEs at a staff level, and additional discussions with MCES will need to be held to fully define if and to what extent the sanitary sewer system in this area can be utilized for this purpose.

Should MCES allow this discharge to the sewer, the capital cost associated with implementation of improvements to facilitate this snowmelt diversion is preliminarily anticipated to range from $100,000 to $150,000 but could change depending on permit conditions, along with annual costs for discharge of snow melt water anticipated to range from $20,000 to $35,000 annually.

Table 1: Features, Costs, and Benefits of Recommend Options

Recommended Options		Watershed Area (ac)	Pollutants Addressed	Raw Loading (lb/yr)[1]	Existing % Removal	Proposed % Removal	Pollutant Removal (per year)	Total Project Capital Cost	Annualized 30-year Life Cycle Cost	Cost / lb of Pollutant Removed	Notes
Option 1	Construct pond or underground treatment system in hotel parking lot (CL-417B)	13.4	TSS	5360	0	80	320 lb/ac 4300 lbs	$390,000.00	$18,000.00/year[4]	TSS: $4.20/lb	1. Existing information from *Crane Lake - Water Quality and Subwatershed Assessment* dated June 2017. 2. This option will treat 24 ac-ft per year, which assumes 3-inches of snowmelt runoff volume for the winter months based on monthly average precipitation data. 3. Limited capital costs as this is a lease option. 4. Assumes $5,000 maintenance cost per year during 30-year life cycle 5. Assumes $32,000 in MCES treatment charges and $8,000 maintenance per year.
			TP	20.1	0	50	0.75 lb/ac 10.0 lbs			TP: $1,800.00/lb	
Option 2	Implement Alum enhancement in Ridgedale Pond (CL-410)	97.9	TP	149.2	72	85	0.20 lb/ac 20 lbs	N/A[3]	$25,000.00/year	TP: $1,250/lb	
Option 3	Monitor and divert chloride concentrated snowmelt effluent from mall parking lot to sanitary sewer[2]	97.9	TSS	40,077	94	100	36.9 lb/ac 3610 lbs	$150,000.00	$45,000.00/year[5]	TSS: $12.50/lb	
			TP	149.2	72	100	0.43 lb/ac 41.8 lbs			TP: $1,080.00/lb	
			Chloride	52,600	0	95	50,000 lb			Cl: $0.90/lb	

FIGURES

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CITY OF MINNETONKA

Ridgedale Drive Improvements (S.A.P. 142-153-008)
City of Minnetonka, Minnesota

Preferred Alternative

August 6, 2018

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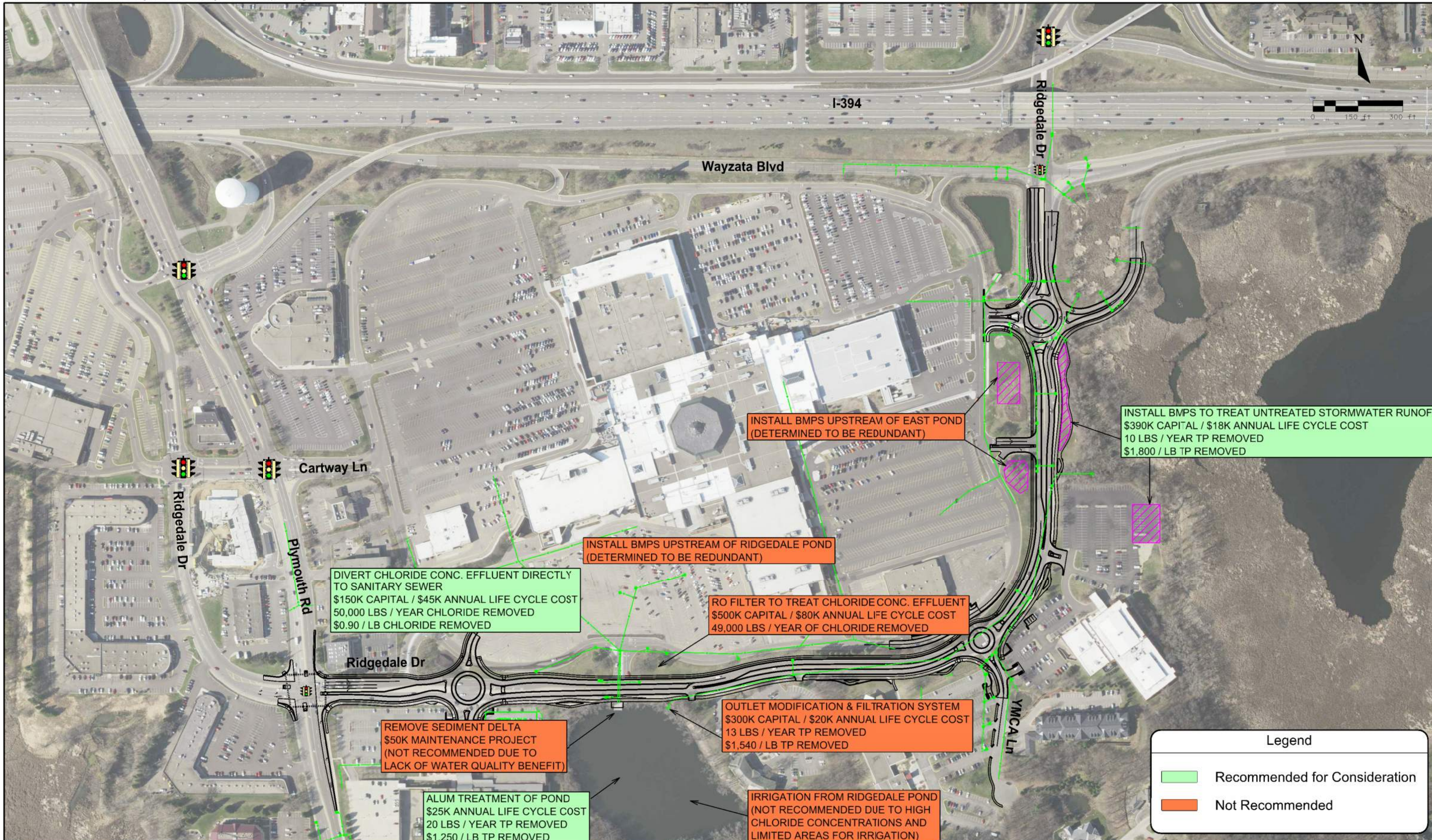
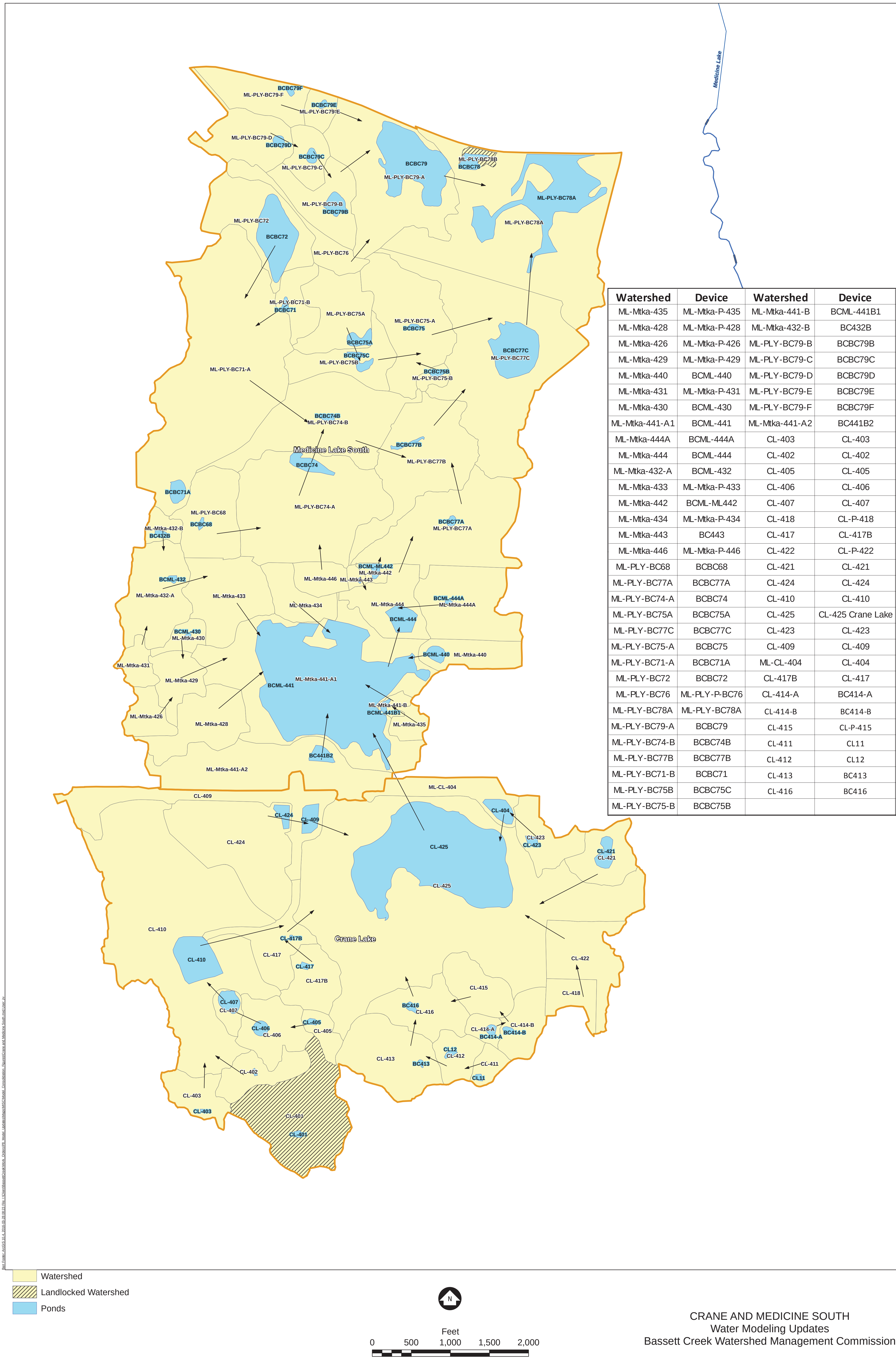


CITY OF MINNETONKA

Ridgedale Drive Improvements (S.A.P. 142-153-008)
City of Minnetonka, Minnesota

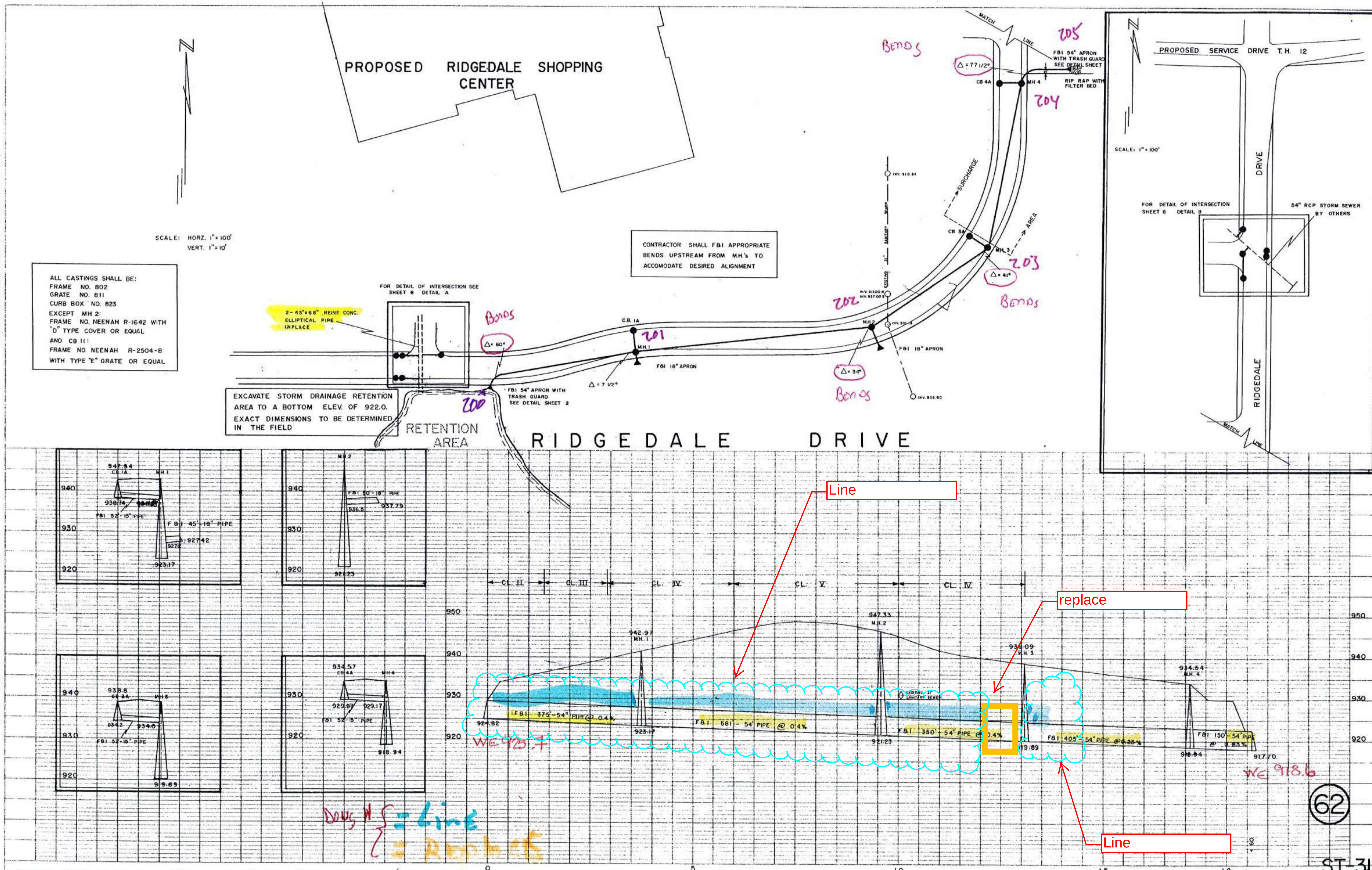
Water Quality Treatment Options

September 10, 2018



Watershed	Device	Watershed	Device
ML-Mtka-435	ML-Mtka-P-435	ML-Mtka-441-B	BCML-441B1
ML-Mtka-428	ML-Mtka-P-428	ML-Mtka-432-B	BC432B
ML-Mtka-426	ML-Mtka-P-426	ML-PLY-BC79-B	BCBC79B
ML-Mtka-429	ML-Mtka-P-429	ML-PLY-BC79-C	BCBC79C
ML-Mtka-440	BCML-440	ML-PLY-BC79-D	BCBC79D
ML-Mtka-431	ML-Mtka-P-431	ML-PLY-BC79-E	BCBC79E
ML-Mtka-430	BCML-430	ML-PLY-BC79-F	BCBC79F
ML-Mtka-441-A1	BCML-441	ML-Mtka-441-A2	BC441B2
ML-Mtka-444A	BCML-444A	CL-403	CL-403
ML-Mtka-444	BCML-444	CL-402	CL-402
ML-Mtka-432-A	BCML-432	CL-405	CL-405
ML-Mtka-433	ML-Mtka-P-433	CL-406	CL-406
ML-Mtka-442	BCML-ML442	CL-407	CL-407
ML-Mtka-434	ML-Mtka-P-434	CL-418	CL-P-418
ML-Mtka-443	BC443	CL-417	CL-417B
ML-Mtka-446	ML-Mtka-P-446	CL-422	CL-P-422
ML-PLY-BC68	BCBC68	CL-421	CL-421
ML-PLY-BC77A	BCBC77A	CL-424	CL-424
ML-PLY-BC74-A	BCBC74	CL-410	CL-410
ML-PLY-BC75A	BCBC75A	CL-425	CL-425 Crane Lake
ML-PLY-BC77C	BCBC77C	CL-423	CL-423
ML-PLY-BC75-A	BCBC75	CL-409	CL-409
ML-PLY-BC71-A	BCBC71A	ML-CL-404	CL-404
ML-PLY-BC72	BCBC72	CL-417B	CL-417
ML-PLY-BC76	ML-PLY-P-BC76	CL-414-A	BC414-A
ML-PLY-BC78A	ML-PLY-BC78A	CL-414-B	BC414-B
ML-PLY-BC79-A	BCBC79	CL-415	CL-P-415
ML-PLY-BC74-B	BCBC74B	CL-411	CL11
ML-PLY-BC77B	BCBC77B	CL-412	CL12
ML-PLY-BC71-B	BCBC71	CL-413	BC413
ML-PLY-BC75B	BCBC75C	CL-416	BC416
ML-PLY-BC75-B	BCBC75B		

CRANE AND MEDICINE SOUTH
Water Modeling Updates
Bassett Creek Watershed Management Commission



AS-BUILT (2-75) SHEET 3 OF 6

APPENDIX A

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET No: **20-20245**   Log of Boring No. **A-22 (p. 1 of 1)**

Project: **Ridgedale Drive; Minnetonka, MN**

DEPTH IN FEET	Surface Elevation ___ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	%-#200
	1' Bituminous pavement	FILL			SU						
1	Weathered bituminous		82	M	SS	18					
2–4	FILL, mostly clayey sand, a little gravel, brown (A-6) Hyd. Group D		9	M	SS	20	15				
5–6	SANDY LEAN CLAY, a little gravel, brown and gray, very stiff, lenses and laminations of lean clay, laminations of sandy silt (CL) (A-6) Hyd. Group D	TILL	17	M	SS	22	19				
7–11	CLAYEY SAND, a little gravel, very stiff to stiff, laminations of sandy silt, lens of sand (SC) (A-6) Hyd. Group D		17	M	SS	24	12				
			9	W/M	SS	10	15				
12–14	SANDY LEAN CLAY, a little gravel, gray and brown, stiff, laminations of sandy silt (CL)		9	M	SS	17	21				
	END OF BORING										

DEPTH:	DRILLING METHOD	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
0-12½'	**3.25" HSA**	**6/25/18**	**10:55**	**11.5**	**9.5**	**9.6**		**9.4**

BORING COMPLETED: **6/25/18**

DR: **SG** LG: **SB** Rig: **91C**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP 20-20245.GPJ AET+CPT+WELL.GDT 8/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET No: **20-20245** Log of Boring No. **A-23 (p. 1 of 1)**

Project: **Ridgedale Drive; Minnetonka, MN**

DEPTH IN FEET	Surface Elevation ____ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	%-#200
0–7	FILL, mostly lean clay, slightly organic, trace roots, black, a little light brown (A-6) Hyd. Group D	FILL									
1			8	M	SS	15	32				
3			10	M	SS	14	45				
5.5			7	M	SS	16	45				
7–20	SANDY LEAN CLAY, a little gravel, brown to brown and grayish brown mottled, very stiff (CL) (A-6) Hyd. Group D	TILL									
8			16	M	SS	23	18				
10.5			16	M	SS	24	19				
13			21	M	SS	24	20				
15.5			23	M	SS	19	20				
20–31	SANDY LEAN CLAY, a little gravel, gray, very stiff to stiff (CL) (A-6)										
20.5			20	M	SS	0					
25.5			14	M	SS	21	19				
30.5			11	M	SS	0					
31	**END OF BORING**										

DEPTH:	DRILLING METHOD
0-29½'	**3.25" HSA**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
						None

BORING COMPLETED: **6/22/18**

DR: **DS** LG: **SG** Rig: **1C**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP 20-20245.GPJ AET+CPT+WELL.GDT 8/3/18

AMERICAN
ENGINEERING
TESTING, INC.

SUBSURFACE BORING LOG

AET No: **20-20245** | Log of Boring No. **A-27 (p. 1 of 1)**

Project: **Ridgedale Drive; Minnetonka, MN**

DEPTH IN FEET	Surface Elevation ________ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	%-#200
0–1	13.5" Bituminous	FILL									
1–2.5	FILL, mostly sand with silt and gravel, brown (A-1-b) Hyd. Group A		103	M	SS	16					
2.5–4.5	FILL, mixture of sandy lean clay and clayey sand, a little gravel, brown, gray and dark brown (A-6) Hyd. Group D		13	M	SS	20	13 11				
4.5–7	CLAYEY SAND, a little gravel, gray, stiff (SC) (A-6) Hyd. Group D	POSSIBLE FILL	14	M	SS	16	15				
7–9.5	CLAYEY SAND, a little gravel, gray, a little brown, very stiff (SC) (A-6) Hyd. Group D		16	M	SS	20	15				
9.5–14.5	SANDY LEAN CLAY, a little gravel, gray and brown, very stiff, laminations of sandy silt (CL) (A-6)	TILL	21	M	SS	18	16				
			15	M	SS	22	17				
	END OF BORING										

DEPTH:	DRILLING METHOD	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
0-12½'	**3.25" HSA**							**None**

WATER LEVEL MEASUREMENTS

BORING COMPLETED: **6/25/18**

DR: **SG** LG: **SD** Rig: **91C**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP 20-20245.GPJ AET+CPT+WELL.GDT 8/3/18

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET No: **20-20245**

Log of Boring No. **A-28 (p. 1 of 1)**

Project: **Ridgedale Drive; Minnetonka, MN**

DEPTH IN FEET	Surface Elevation ______ MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	%-#200
0–4	FILL, mostly clayey sand, a little gravel, trace roots, brown to black and gray (A-6) Hyd. Group D	FILL									
1			7	M	SS	15	9				
3			9	M	SS	17	15				
4–12	FILL, mostly sandy lean clay, a little clayey sand and gravel, gray, dark brown and brown (A-6) Hyd. Group D										
5.5			5	M	SS	19	19				
8			16	M	SS	20	21				
10.5			8	M	SS	18	20				
12–14	ORGANIC CLAY WITH SAND, trace roots, black and dark gray, firm (OH) (A-8)	SWAMP DEPOSIT OR TOPSOIL	6	M	SS	10	63				
14–18	SANDY LEAN CLAY, a little gravel, trace roots, gray and light gray, stiff, laminations of sandy silt (CL) (A-6)	TILL	14	M	SS	20	17				
18–31	SANDY LEAN CLAY, a little gravel, brown to gray, very stiff (CL) (A-6)										
20			19	M	SS	18	15				
25			17	M	SS	18	15				
30			22	M	SS	18	15				
31	**END OF BORING**										

DEPTH: DRILLING METHOD	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
0-29½' 3.25" HSA							**None**

WATER LEVEL MEASUREMENTS

BORING COMPLETED: **6/25/18**

DR: **SG** LG: **SB** Rig: **91C**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

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City of minnetonka
Where quality is our nature

Ridgedale Drive Improvements
City of Minnetonka, Minnesota

Figure 1
AET 20-20245

Boring Layout
June 5, 2018