

FINAL Report for Swede Hollow Park Daylighted Stream Analysis and Feasibility Study



1. INTRODUCTION AND PROJECT BACKGROUND

1.1 Description of the Park and Project Area

The City of Saint Paul owns property known as Swede Hollow Park. The park includes a valley and the surrounding area consisting of a portion of the historic stream of Phalen Creek. This valley was host to immigrant populations as they established themselves in the region. It had other uses as well, including a grain mill. After declaring the housing a health hazard the City cleared the area, and turned it into a park.

The historic stream once flowed from Lake Phalen, through Swede Hollow and into the Mississippi River. The construction of East Seventh Street required filling and bridging at the end of the stream valley. Because of this, the stream was placed in a storm sewer pipe to complete its route to the river. The west overflow for Lake Phalen was constructed in 1943, while the east overflow was constructed in 1991. Prior to 1943, the sewer records for Ocean Street (located near the east side of the Swede Hollow or Phalen Creek watershed) indicate the historic stream once flowed to an 84" diameter stone storm sewer in Ocean Street, which eventually drained through Swede Hollow. Today Lake Phalen overflows through the "Beltline" storm sewer system, not through Swede Hollow.

The storm sewer was extended through the valley, into the surrounding neighborhoods. Prior to 1998 two significant clearwater connections to Phalen Creek once flowed through Swede Hollow, one from the Hamm's Brewery, and the other from the 3M main plant property. Clearwater flows from Hamm's ended in 1998, while flows from 3M ended in 2005. According to records, the Hamm's Brewery connection contributed about 3 to 4.5 cubic feet per second (cfs) of clearwater flow, while the 3M connection contributed between 0.5 and 1.0 cfs of clearwater flow. To develop the stream as a park resource, stream daylighting was constructed circa 1988 by diverting water from a 108" diameter storm sewer and allowing it to daylight into a small channel system. The channel flows to a small constructed pond where it deposits sediments from the sewer. The pond then overflows into the existing stream channel.

The closing of the Hamm's Brewery and the nearby manufacturing in the late 1990's eliminated the base flow through the park. At present the park is "fed" by local neighborhood drainage which is largely associated with rainfall events. The sewer pipe is large; however flow is seasonal and fluctuates greatly with storm events.

The existing system was not designed with pollutant removal or water quality improvements in mind. The daylighted stream, intended for aesthetic appeal, now deposits large amounts of sediment in the Upper Pond that is difficult to maintain, then flows through a mostly-hidden stream corridor. It is believed that the designers underestimated the sediment load.

In addition, no assessment of site conditions contributing to the stream and Lower Pond was completed, nor was modification of the pond overflow design suggested. The Lower Pond at the bottom of the valley is shallow, unattractive, and is often filled with floating plant growth and surface scum.

1.2 Project Purpose

The daylighting diverter structure constructed in 1988 takes water from the bottom of the large 108” diameter storm sewer. This design could significantly reduce the sediments from the urban storm sewer collection system reaching the river. In addition, low flow conditions in the large sewer would be completely diverted from reaching the river until after flowing through the park. Combined, these situations could provide significant treatment and pollutant removal opportunity.

The City’s goal for Swede Hollow Park is that the daylighted stream will provide aesthetic appeal to the park, while treating the stormwater flowing through it, and provide habitat for park wildlife. Stormwater treatment could include removal of sediments and turbidity, nutrient filtration, and natural site infiltration. With water quality improvements as it flows through the system, it is anticipated that natural wildlife habitat will be improved as well, improving the aesthetic appearance of the ponds. It is anticipated that the overflow water re-entering the storm sewer to the river will have much-improved water quality.

This project proposes scientific and engineering study of the stream source storm sewer, existing daylighted stream channel system, and the natural stream course in the lower portion of the park to provide a basis for improvement recommendations and decision making. Recommendations will be developed for management practices of source pollutant and sediment loads, and for ecological and engineering design of the stream for improved aesthetic appearance, water quality, pollutant removal, and wildlife habitat.

It is the intent of the City to use the results of this study for future funding requests required to implement the recommendations.

1.3 Project Partners

The City of Saint Paul Parks & Recreation worked with Emmons & Olivier Resources, Inc. (EOR) to conduct this study, and develop improvement recommendations to achieve the stated goal. In addition, the City requested and received funding for this study from Capitol Region Watershed District (CRWD). To refine the improvements, the City formed a work group of stakeholders from the City, CRWD, and Friends of Swede Hollow to interact with the study findings and recommendations, and to support future improvements.

2. STUDY

2.1 Existing Conditions

To fully understand how water moves through the park, numerous data records were reviewed. This data ranged from historical sewer pipe plan & profile drawings to more current topographical & utility surveys. See Table 1 for a list of the reviewed data. In addition, multiple site visits and field investigations of several storm sewer pipes took place.

The original Phalen Creek stream flowed through Swede Hollow at an elevation much lower than today's park. Historical sewer plans show the stream was approximately 20' to 25' lower than the existing daylight pond (Upper Pond), at an elevation close to a sanitary sewer pipe that exists today. Storm sewer pipes, often referred to in the data records as clearwater pipes are approximately 4' to 10' lower than the Upper Pond.

The existing network of sewer pipes traversing under Swede Hollow includes a complex system of sanitary and storm sewer pipes & tunnels. Near the location of the daylighting diversion structure, the network includes a 9'-4" x 9'-4" semi-elliptic sanitary sewer pipe and three storm sewer pipes ranging in size from 48" to 108" diameter.

The first storm sewer network investigated drains approximately 250 acres of stormwater runoff from neighborhoods north and west of the park. In the park it begins as a 90" concrete pipe that traverses the west side of the hollow and reduces to a 72" corrugated metal pipe near the Upper Pond. This pipe then increases to an 84" corrugated metal pipe south of the Middle Pond and eventually connects to an 11' x 11' concrete tunnel north of the Lower Pond. Both the 72" and 84" pipes were proposed to both be internally lined with a fiberglass or plastic material circa 2003.

On November 7, 2012 the first pipe network was "televised" using a camera mounted on a rubber tired sled-type robot as well as walked and videotaped by hand. The investigation started at the 90" pipe manhole west of the daylighting diversion structure and preceded south and downstream approximately 250' to a point adjacent to the Upper Pond. The video investigation showed the 90" pipe to be generally in satisfactory working condition with no ground water infiltration through cracks or pipe section joints. In addition, it showed the three pipes as shown on data records were present. The video investigation also showed the 72" pipe to be in satisfactory working condition with the exception of some debris or disturbed lining near the downstream limits of the televising. In addition, the investigation confirmed the 72" pipe to be lined as proposed circa 2003.

The second storm sewer network investigated drains approximately 1,000 acres of stormwater runoff from neighborhoods to the north. In the park it begins as the 108" concrete pipe previously discussed and traverses the middle of the park, with the daylighting diversion structure north of the Upper Pond. The daylighting diversion structure consists of a concrete manhole, 21" concrete pipes, and a metal shear gate used most likely for maintenance purposes.

Sewer records indicate the 108" pipe continues through the park where it transitions to a 9'-4" x 9'-4" concrete tunnel south of the Middle Pond. Further downstream, the tunnel transitions into the 11' x 11' concrete tunnel to which the first storm sewer network connects. The 11' x 11' concrete tunnel transitions to a 16' x 14' concrete tunnel at the very downstream end of the park.

The second pipe network was "televised" on November 7, 2012, using the same method as the first network. The complete connection made between the 108" pipe and the daylighting diversion structure was videotaped to the maximum extent possible. The 21" connection pipes appear to be in acceptable condition. However, approximately 3" of sediment sits on the bottom of the 21" pipes. In comparison, the 108" pipe was generally clean. Though, the daylighting diversion structure inside the 108" pipe exhibited some damage or deterioration to the metal components of the structure.

The third storm sewer network investigated drains approximately 70 acres of stormwater runoff from neighborhoods to the east (and possibly more to the north). In the park it consists of a 48” concrete pipe that begins at a connection to a sanitary sewer diversion structure approximately 200’ south of Minnehaha Avenue, near the former Hamm’s Brewery building. Sewer records indicate that the 48” pipe and sanitary diversion structure were built circa 1987, and it is believed that stormwater flows into the 48” pipe from an upstream stone and brick sewer to the north. However, this assumption was not confirmed. An additional investigation conducted as part of a different study will be required to confirm the drainage area to the north.

As the 48” pipe leaves the sanitary diversion structure, it heads south and traverses the park east of the 108” pipe. At the location of the daylighting diversion structure, the 48” pipe is approximately 9’ lower than the 108” pipe. For comparison purposes, the semi-elliptic sanitary sewer pipe previously referred to is 18’ to 20’ lower than the 48” pipe in this location. The 48” pipe continues south until it connects to the 108” pipe with a junction structure north of the Middle Pond. The 48” pipe is approximately 10’ to 12’ lower than the existing park trail system near the Upper Pond, with the 108” pipe an additional 10’ to 12’ lower than the 48” pipe.

Following a preliminary presentation of the hydrologic and hydraulic model analysis completed in December 2012, it was determined the third pipe network should be “televised”. This pipe network was “televised” on February 13, 2013 using the same methods previously described. The investigation started at the 48” pipe manhole located east of the daylighting diversion structure, and preceded north and upstream approximately 400’ to a point where it connects to the sanitary diversion structure. At the time of the February 13th televising there appeared to be very low base flow of less than a quarter cubic feet per second (cfs).¹ This length of pipe appeared to be in satisfactory working condition. Although, in some pipe section joints located near the bottom quarter of the pipe diameter there were gaps with standing water. While no measureable water appeared to be flowing through the pipe joints, the 48” pipe was wet near the joints which suggests, at least, minor seepage. Further investigation of the pipe showed water staining at about one-third of the pipe diameter, encrustation along the water flow line as well as some concrete surface scaling. Also, minor cracking near the top of the pipe was observed. The investigation stopped at the sanitary diversion structure when the televising equipment could no longer proceed due to a step up in the upstream pipe invert. Water flowing through the 48” pipe was observed to be coming from upstream and north of the sanitary diversion structure.

An investigation of the downstream pipe was performed as well. The televising started at the 48” pipe manhole, and preceded south approximately 360’ to the junction structure where this pipe connects to the 108” pipe. While the condition of the pipe appeared to be in satisfactory working condition, it exhibited similar conditions as those observed upstream.

The flow observed in the 48” storm sewer pipe must be confirmed by an additional study not part of this project. It is possible that the observed flow is seasonal.

¹ *The televising that took place on February 13, 2013 occurred after the hydrologic and hydraulic modeling analysis described in Section 3.1. The modeling was not updated to include the February 13, 2013 findings.*

A location map of the existing storm sewer pipes discussed above can be found in Figure 1. Existing Storm Sewer Pipe Location Map. In addition, locations, diagrams and photos of the televising investigation can be found in Figures 5 – 10C.

3. RESULTS AND DISCUSSION

3.1 Model of Storm Sewer and Daylighting Diverter Flow Dynamics

The next step included an analysis of the flow dynamics of the storm sewer as well as other water sources flowing through the existing daylighting diversion structure and daylighted into the stream. Additional water sources contributing flow to the stream, including storm sewer and groundwater seepage, were also identified and evaluated.

For the analysis, a hydrologic and hydraulic model of the storm sewer pipe networks, diversion structures, open channels (stream), and ponds was prepared using XP-SWMM modeling software. This software is based on the United States Environmental Protection Agency’s Storm Water Management Model. The model allows for continuous simulation of rainfall, runoff, and stormwater moving through pipes. The precipitation record used was from April 1st to October 31st, 1999. The year 1999 had average precipitation, where during the months of spring through fall water can freely flow (i.e. no frozen conditions) through the stream.

For the hydrologic and hydraulic analysis, modeling was completed under four scenarios, which can be found in Table 3. XP-SWMM Modeling Scenarios.

Based on the modeling results, stormwater management discharge rates and volumes would be used to inform the “Qualitative and Quantitative Assessments” for developing concept plans for water resource improvement options. The main conclusions drawn from the modeling analysis were:

- Diverting the 90” pipe into the daylight pond is not prudent, because this pipe doesn’t have significant baseflow associated with it, and its high peak flows would cause severe erosion at the downstream outlet to the Upper Pond.
- Adjustments made to the daylighted diversion structure (21” pipe connected to the 108” pipe) would not add substantial flow to the stream.
- Diverting the 48” pipe into the Middle Pond means at least 1 cfs of sustained water flow throughout spring, summer, and fall. As part of this study, visual observation of storm sewer flow has only occurred in the winter when no runoff has been witnessed.² However, the flow may be seasonal and must be confirmed by an additional study not part of this project.

² *The hydrologic and hydraulic modeling analysis was completed after the November 7, 2012 televising schedule. However, during this televising schedule the third pipe network was not investigated and flow assumptions were only based on visual observation from the ground surface. See Section 2.1 for subsequent televising of the 48” pipe network.*

- Harvesting groundwater adjacent to the paved pedestrian trail and more directly & efficiently routing it downstream of the Middle Pond means at least 1 cfs of sustained water flow throughout the spring, summer, and fall below this pond.

See Figures 11 – 15 for additional modeling results. In addition, a complete description of the optional improvements can be found in section 3.3 Proposed Plan of Improvements.

3.2 Analyze Stream System Water Quality Issues and Potential Water Quality Improvements

As part of the study, water quality monitoring was performed and an assessment of groundwater seepage was conducted on August 10, and September 4, 2012. The monitoring and assessment took place during base flow conditions at select sites along the stream for phosphorus (Total Dissolved Phosphorous/Total Phosphorous or TDP/TP), nitrogen ions, fluoride, and *Escherichia coli* (*E. coli*). The objective of this sampling was to identify potential sources of nutrients affecting water quality in the stream. The testing and results are discussed in a memo dated October 29, 2012 and revised August 18, 2013. See figure 2.

Key conclusions from this monitoring and assessment were:

- High *E. coli* and high total dissolved phosphorus (TDP) to total phosphorus (TP) ratios in the Upper Discharge and Stream sites indicate a potential source of dissolved nutrients and *E. coli* to the stream.
- Low fluoride and phosphorus concentrations in the Upper Discharge and Stream suggest that any potential wastewater contributions to the Upper Discharge site are very diluted with groundwater inputs.
- Lower TDP/TP ratios and nitrate/nitrite levels below detection limit in the Lower Pond site suggests that these nutrients provided by the Upper Discharge are being used for algal or other plant growth.
- The TP concentration and dominance of duck weed in the Lower Pond indicate that the overall water quality of the Lower Pond was within the expected range for its size and depth.

All data considered, the harvesting of quaternary groundwater to augment stream flows would not appear to have a detrimental effect on water quality. Nevertheless, further investigation of the groundwater seeping areas is recommended as part of an additional study not part of this project.

See Figure 2. Water Quality Monitoring Data Analysis for the complete memo discussing the monitoring analysis.

3.3 Proposed Plan of Improvements

Following the water quality analysis and storm water modeling, a plan of 14 optional improvements was prepared. Concepts included additional water sources and corridor improvements. Each concept was

evaluated for recreational, ecological, and stormwater management benefits. In addition, pros & cons and conceptual cost estimates were developed to determine the merit of further assessment. The 14 optional improvements were presented at a stakeholder meeting on January 10, 2013. Staff from the City of Saint Paul Parks & Recreation and Capitol Region Watershed District attended as well as members of Friends of Swede Hollow. Of the 14 optional improvements, only six were selected by the stakeholder group for further assessment at the stakeholder meeting on January 10th. The initial selection was based primarily on the cost-benefit of each option. However, the Friends of Swede Hollow discussed the improvements at their February 13th meeting and developed additional opinions of the optional improvements.

See Figures 19 and 20 for letters drafted by the Friends of Swede Hollow on February 27 and March 13, 2013; Figures 3 and 4 as well as Table 2 for a location map and list of the 14 original optional improvements; and Figures 16 – 18 for CAD drawings of options 4A, 4B, 5, 7 and 10.

The initial six (6) options selected for further evaluation include 4A, 4B, 5, 7, 9, and 10. A description of each option follows:

- Options 4A and 4B

For this option, a proposed storm sewer pipe (pipe) will connect to the existing 48” pipe that drains to the 108” pipe. The existing junction of these two pipes is located approximately 165’ northeast of the Middle Pond. The proposed connection would be made with a manhole structure that diverts low flows through a smaller (18” to 27”) pipe and outlets just upstream of the Middle Pond. The design includes two options for a pre-treatment method that would prevent sediment, trash, and other debris from entering the Middle Pond. Option 4A includes a small forebay or depression (similar to the existing Upper Pond) located at the end of the outlet pipe. Option 4B includes a mechanical device known as a dynamic separator and SAFL Baffle that pre-treats stormwater in an engineered underground concrete vault. This pre-treatment method would be installed in-line with the outlet pipe. These two options for pre-treatment would be designed with easy maintenance in mind, and would need to be designed in conjunction with St. Paul Public Works Sewer Utility.

Based on the modeling results, and “televising” investigation, options 4A and 4B may contribute to the overall water quality by adding an additional water source to the stream system. However, as previously mentioned an additional investigation (conducted as part of a different project) will be required to confirm sustained water flow occurs through other parts of the season (spring, summer, fall). In addition, water quality monitoring will need to be performed to ensure the additional water source is not too high for phosphorus, nitrogen ions, fluoride, and *Escherichia coli* (*E. coli*).

- Option 5

For this option, an 8” draintile with surface inlets would be installed on either side of the paved pedestrian trail to capture and redirect ground water to the second half of the lower stream and part of the Middle Pond. This option will serve two purposes: first it will provide a remedy for the ground water crossing the surface of the trail, an on-going maintenance problem, and second it will move ground water runoff in a more direct route to the lower stream possibly making it more visible.

Based on the modeling results, option 5 may contribute to the overall aesthetics of the lower section of the park through more efficient use of its water source.

- Option 7

For this option, an existing 4' x 8' surface drain which currently collects stormwater runoff from the stream would be modified. Low flows would be redirected to the stream and Lower Pond instead of draining to the City storm sewer. The grate of the drain could either be raised or a landscaped berm could be built around the drain. Both of these methods would keep the grate on the drain, and still allow for stormwater runoff to remain in the creek for longer periods. Higher water flows would still be able to enter the drain. As part of this improvement, a maintenance path would need to be built for service vehicles. This path would be built in an environmentally friendly manner and would blend into the surrounding landscape.

In addition, an existing 36" flared end section (FES) which currently collects stormwater runoff from the stream, approximately 200' southeast, would be modified in a similar manner. The existing riprap berm would need some minor improvements, and a riser-pipe type structure may be added to the FES to keep low flows in the Lower Pond.

These improvements may contribute to the overall aesthetics of the lower section of the park by retaining water in the stream and pond system.

- Option 9

For this option, improvements would be made to the lower stream starting at the outlet of the Middle Pond, and proceeding to the surface drain discussed in option 7. Improvements would include reconstruction of the portion of the stream that drains the Middle Pond, as well as incorporating subtle features throughout that allow patrons to visit the stream edge.

Through repositioning of existing boulders and adding new rock, the stream would be stabilized to handle increased flow leaving the Middle Pond. In addition, the boulders and rock may add riffles and pools that create visual and auditory interest for patrons. Furthermore, stream sections connecting to the harvested groundwater discussed in option 5 would be made in order to introduce more water flow. Pedestrian crossings made of cut stone could be placed to form pathways that allow visitors to explore the stream network first hand.

Improvements to stabilize the stream and control erosion & sedimentation would contribute to corridor aesthetics and the overall water quality by limiting sediment deposition and impacts on native vegetation. In addition, the improvements would enhance recreational use by providing opportunities for interaction with the stream.

- Option 10

For this option, improvements would be made to improve the Lower Pond's aesthetics and water quality. The Lower Pond is shallow, and is often filled with floating plant growth and surface scum. By increasing the water depth, different vegetation species could be introduced to the pond thereby enhancing wildlife habitat, water quality, and overall aesthetics for the lower portion of the park.

Modifications include changes to the pond's outlet control structure to increase the water depth by one to three feet. The current structure "exhibits" small sink holes immediately adjacent to it, warranting a further investigation of the structural integrity of the structure as part of an additional study, not part of this project. Rebuilding the structure and modifying the internal design will increase the pond water depth.

3.4 Permit Requirements

In the State of Minnesota, impacts to areas that may be classified as a wetland require a delineation (map) and approval by the Local Government Unit (LGU). Once the delineation has been approved, a plan for the proposed land alteration must be submitted and reviewed by the LGU and Technical Evaluation Panel (TEP). Members of the TEP typically include the LGU (Municipality, Watershed District, Watershed Management Organization), County Soil and Water Conservation District (SWCD), Minnesota Board of Water and Soil Resources (BWSR), United States Army Corps of Engineers (COE), and in some instances the Minnesota Department of Natural Resources (DNR). If the area to be altered is determined to be a wetland, a permit may be required.

In addition, land altering activities such as grading with heavy equipment will require a permit for earthmoving activities and erosion & sediment control. Permits from the City of Saint Paul, Capitol Region Watershed District (CRWD), and the Minnesota Pollution Control Agency (PCA) may be required depending on the extent of grading.

Furthermore, connections made to City storm sewer pipe may require that work be performed by a Contractor licensed by the City of Saint Paul.

- Wetland permitting may be required for options 5 and 9.
- Erosion & Sediment Control permitting may be required for option 4A, 4B, 5, 9, and 10.
- Licensed plumbing contractors may be required for option 4A, 4B, 5, 7, and 10.

3.5 Engineer's Estimate for Implementation

To aid in securing future funding for implementing the recommended changes, accurate conceptual construction estimates have been prepared for each option. The cost estimates include a qualitative description of the effort necessary to design and implement each option. To determine the costs to implement each option, a conceptual level design was used as well as 2014 construction costs and a 30%

contingency. See Table 4. Estimated Costs for Preferred Water Resource Improvements for design, construction, and 20-year operations & maintenance and inspection costs.

4. CONCLUSION

4.1 Findings and Recommendations

At the stakeholder meeting on January 10, 2013, a clear direction was made regarding the most desired optional improvements to assess further. Based on that meeting, six of 14 concepts are discussed in more detail in Section 3.3 Proposed Plan of Improvements.

Moving forward, all six of the selected options will require field research, engineering and design details. In addition, some of the options will require further investigation to ensure the assumptions made in Section 3.1 Model of Storm Sewer and Daylighting Diverter Flow Dynamics are correct.

Options 4A and 4B will require further investigation of the upstream storm sewer pipe networks. This additional analysis should include confirmation of sustained water flow as well as water quality. Further investigation may include: review of historic as-built construction plans, office and field research of storm sewer pipe networks and corresponding drainage areas, subsurface exploration through televising, and water quality monitoring for phosphorus, nitrogen ions, fluoride, and *Escherichia coli* (*E. coli*).

Options 7 and 9 should also, include additional field research of the existing structures to ensure the proposed concept improvements will not reduce any unknown function of the inlet structures.

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