Implementing a Successful Stormwater Pond Rehabilitation Program: Exploring Short-Term Actions and Defining a Long-Term Plan

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ABSTRACT

Stormwater ponds, also known as wet ponds, "NURP" ponds, or retention basins, are a necessary component for land development in order to manage stormwater runoff. Stormwater ponds in many cases were built with no forward thinking or budget forecasting to address maintenance. Stormwater ponds within urban settings were typically built to control runoff rates to minimize downstream flooding and erosion. These ponds are now viewed also as a mechanism to capture and settle pollutants.

A lack of maintenance has led to reduced effectiveness in providing rate control and improving water quality. If a long-term plan is not defined, costs become burdensome and a rehabilitation program must be enacted; and many cities throughout Minnesota are in this category. Regulations continue to squeeze city budgets and this paper will cover current and expected regulations.

Information is provided on current maintenance practices by Minnesota cities both in the Twin Cities metropolitan area and the greater State. Do cities have standardized schedules for inspection? How are inspections conducted? What are the determining factors that trigger maintenance? Permitting requirements for sediment removal will be explored in addition to addressing disposal of possible contaminated sediments.

The intent of this paper is to provide cities information on the steps that can be taken to address a lack of maintenance. The paper mainly focuses on major rehabilitation, or pond dredging, and the path needed to accomplish this task from start to finish. Long term maintenance protocols are discussed to help guide cities with preventative measures.

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1.0 INTRODUCTION

A news release on July 20, 2009 by the Twin Cities Metropolitan Council provided insight into the growing metro population. From 2000 to the end of 2008, the population has grown by 228,000 people equating to a total of 2.87 million. A few of the fastest growing communities within that time frame were Shakopee, Woodbury, and Blaine. Figure 1 portrays the boundaries of the metro area which currently consists of 7 counties.

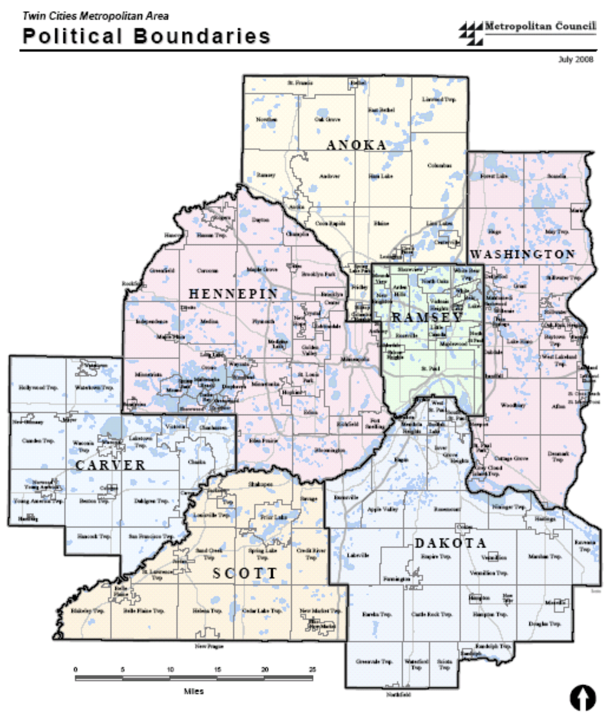

Figure 1: Met Council Boundary Map

Source: Metropolitan Council, 2009

As populations continue to increase the need persists for Best Management Practices (BMPs) to mitigate the impact of increasing impervious areas. Whether a residential development, or new commercial center, the most common form to manage stormwater is through the construction of a stormwater pond. The number of these man-made ponds continues to increase, not only in the metro, but throughout the State of Minnesota, as development and redevelopment occurs.

Assets such as roadways and bridges get much attention because they are noticeable to the public; the public has expectations of maintenance and rebuilding to keep the transportation system functioning. On the other hand stormwater water ponds have not been given the attention to meet system needs. As the public becomes more environmentally aware and regulations increase for stormwater quality, the successful management of these assets is critical.

Consequences of poor maintenance have reached recent headlines in both local and regional newspapers which are continued reminders of increased public awareness. A Pioneer Press article from September 10, 2008 was titled "Toxic Trouble Building Up: As Suburban Stormwater Retention Ponds Age, Their Polluted Sediment is a Problem with No Easy Solution." The story goes on about how local residents petitioned the city of White Bear Lake to address excessive sediment deposits.

A more recent story on August 26, 2009 in the Minnesota Sun Current Newspaper is titled, "Edina Residents Petition City to Clean Up Pond." The residents believe the pond to be polluted and in need of cleanup and dredging. The Edina City Council chose to encourage residents to install native buffers around the pond instead of expending an estimated $500,000 for full-scale dredging.

These articles continue to show that these ponds originally built for flood control purposes are now filling with sediment and scientists estimate the useful life is at about 30 years (Anna Kerr, Pioneer Press quote, 2008).

Residents are not the only driving force for action; cities currently face arduous regulations by numerous environmental agencies. Future regulatory actions are expected to become more cumbersome and expensive. The bottom line is inadequate maintenance and new permit requirements are now forcing cities to rehabilitate stormwater ponds and establish long-term maintenance protocols.

1.1 OBJECTIVE

The objective of this paper is to provide municipalities within the State of Minnesota a guide to work from in developing a stormwater pond rehabilitation program to fit its specific needs. The information will provide a stepped process towards reaching the goal of rehabilitating stormwater ponds; in other words, returning these assets back to a condition that meets original design intent. This paper serves also as a reminder to cities that a system-wide stormwater pond sedimentation problem exists and needs to be addressed.

1.2 WORK PLAN

This report will first cover current practices regarding stormwater ponds by numerous cities throughout the State. A questionnaire was mailed to sixty seven cities of which forty two responded; providing great insight into current stormwater pond practices.

This report will cover current regulations that directly affect stormwater ponds. Insight will be provided into possible future regulations and the direction the regulatory agencies want to proceed.

Cities need to understand the state of current stormwater pond assets; this requires inventories and inspections. This report provides suggestions and specific examples of practices by other entities in accomplishing this task. Next, this report provides guidance for prioritizing stormwater pond rehabilitation to help cities develop a ranking matrix that best fits it needs.

Once a stormwater pond is identified as a priority, a rehabilitation strategy is needed, which is considered part of the long-term plan. An overview of competing strategies will be covered along with permitting and disposal requirement. Information on costs to rehabilitate stormwater ponds will be provided to help cities transition from short-term actions (inventory, inspection, and prioritization) into a long-term rehabilitative effort. This will allow for planning level costs to be determined to help create a long-term capital improvement program.

Lastly, long-term maintenance protocols will be briefly discussed, which will help avoid the situation many cities currently face; premature failure of stormwater ponds.

2.0 DEFINING A STORMWATER POND

A stormwater pond, also known as a wet pond, is typically man-made and constructed to retain a permanent pool of water. Stormwater ponds were installed during rapid development periods to mainly control rate of runoff in upland areas. Wet ponds usually require a sizable tributary area to maintain a permanent pool of water. Minimum contributing watersheds should be at least 10 acres, but not more than one square mile (Barr 2001). Figure 2 depicts a typical wet pond profile.

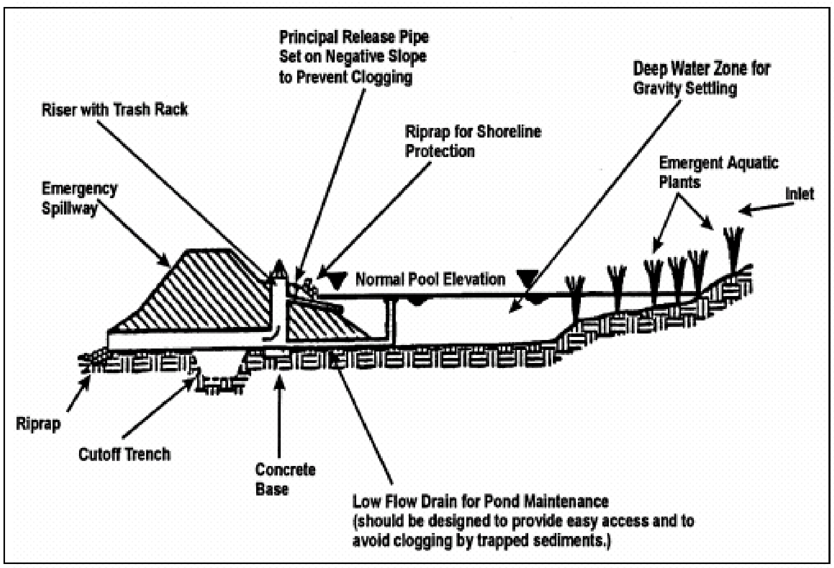

Figure 2: Typical Wet Pond

Source: Maryland Department of the Environment, 1986

Wet ponds should not be confused with other Best Management Practices (BMPs) such as infiltration basins and raingardens that focus on volume reduction. Stormwater ponds have a moderate to high capacity for removing most urban pollutants if designed properly (Barr 2001). Typical urban pollutants consist of nutrients, hydrocarbons, and suspended solids. Wet retention ponds are known to remove roughly 80% of total suspended solids and 40% of total phosphorus if constructed properly. The steps below further describe how a wet pond functions (MOE 2003):

The water first flows into a sediment forebay which is a small basin located before the main pond. Most old designs did not have such as feature. Stormwater flowing into a wet pond is diluted by the permanent pool and between storm events; sediment trapped in the permanent pool has time to settle as long as the design avoids short-circuiting.

In addition to the permanent pool of water, wet ponds have an active storage volume, also known as a flood pool, which provides reserve capacity to capture water and slowly drain it over time back down to the permanent pool. The pond outlet controls the rate of release thereby preventing downstream flooding and erosion.

Outlets are designed to detain water in the pond long enough to allow sediment removal and to alleviate erosion and flooding concerns. Designs now consist of multiple outlets but many older ponds had only one controlling outlet.

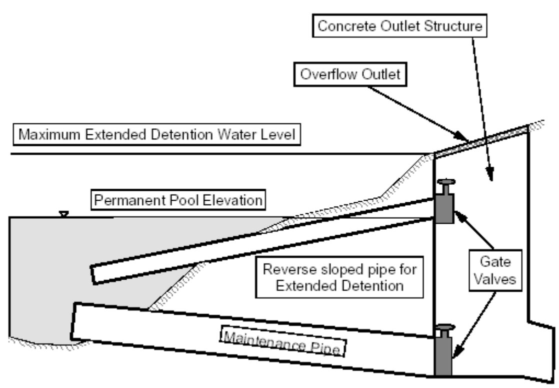

Figure 3: Outlet Configuration

Source: MOE 2003

Before moving to the next section it is beneficial to describe design characteristics of a wet pond because at some point evaluation of inspection results will be needed to understand if general design standards are being met. The William W. Walker method accounts for a 2.5-inch, 24-hour storm event in designing the permanent pool and accommodates sediment accumulation for up to 25 years (Walker Design, 1987). The pond design needs to have a minimum surface area, proper depth, considerations for plug flow, sediment storage design, and consideration of control structure/piping. If further design information is desired the Barr Engineering Company's report written on behalf of the Metropolitan Council, "Minnesota Urban Small Sites BMP Manual," is an excellent resource in addition to the study by William Walker in 1987 written for the Saint Paul Water Utility and Vadnais Lake Area Water Management Organization.

3.0 REGULATIONS

Stormwater regulations are continuing to become more burdensome to cities in Minnesota. As mentioned before, stormwater infrastructure has become more visible to the public as seen through recent petitions and calls for cities to clean up stormwater ponds.

3.1 EXISTING REGULATIONS

The Environmental Protection Agency issued guidelines after the Federal Water Pollution Control Act was amended in 1972 (33 U.S.C. §1251 et seq. (1972). This act is now best know as the Clean Water Act (CWA). The EPA provides the following summary:

> 33 U.S.C. §1251 et seq. (1972)
>
> The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, but the Act was significantly reorganized and expanded in 1972. "Clean Water Act" became the Act's common name with amendments in 1977.
>
> Under the CWA, EPA has implemented pollution control programs such as setting wastewater standards for industry. We have also set water quality standards for all contaminants in surface waters.
>
> The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained. EPA's National

> Pollutant Discharge Elimination System (NPDES) permit program controls discharges. Point sources are discrete conveyances such as pipes or man-made ditches. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters.

The 1972 amendments began focusing enforcement on limiting discharges from point sources in addition to regulating the amount of pollutants in a given water body (ref. EPA History, Water, accessed 10/21/09).

Amendments to the CWA in 1987 directed the EPA to establish phased NPDES requirements for storm water discharges. As a result the EPA set forth regulations in November of 1990 addressing storm water discharges from municipal separate storm sewer systems (MS4s) (55 FR 47990). Under Phase I of the Storm Water Program, only those MS4s which served a population of 100,000 or more were required to apply for a NPDES permit (EPA 1996, OWM). Subsequently in 1999 the EPA established the Phase II program for operators of construction activities disturbing equal to or greater than one acre of land and less than five acres of land (EPA 2005) and also for small MS4's located in urban areas in order to:

- Reduce to the discharge of pollutants to the "maximum extent practicable" (MEP);
- Protect of water quality; and
- Satisfy the appropriate water quality requirements of the Clean Water Act

Therefore the NPDES Construction Site Permit is now required for all construction activities disturbing one or more acres of land. This is enforced by the MPCA with delegated authority of the EPA's Clean Water Act and Minnesota Statute 115.01 – 115.09.

The Phase II Rule defines a stormwater management program for a small MS4, within a federally designated urban area, as a program composed of six elements that, when implemented together, are expected to reduce pollutants discharged into receiving water bodies to the MEP. These six program elements, or minimum control measures, are (EPA, Stormwater Discharges from MS4s):

1) Public Education and Outreach on Stormwater Impacts;
2) Public Involvement/Participation;
3) Illicit Discharge Detection and Elimination;
4) Construction Site Runoff Control;
5) Post-Construction Stormwater Management in New Development and Redevelopment;
6) Pollution Prevention/Good Housekeeping for Municipal Operations.

Establishing and reporting on these six elements is needed as part of the National Pollution Discharge Elimination System permit (NPDES). The report is commonly referred to as a Storm Water Pollution Prevention Program (SWPPP). Minimum control measures 3, 5, and 6 all relate to stormwater ponds through inventory requirements, maintenance, and preventing water quality impacts. The current MS4 General Permit became effective June 1, 2006.

To summarize, the NPDES MS4 permit is regulated by the MPCA with authority of the EPA's Clean Water Act and Minnesota Statute 115.01 – 115.09 and Minnesota Administrative Rules 7001. Again this is for MS4's within federally designated urban areas.

Also, an additional burden to some urban cities was enacted in 2006 when thirty cities were selected in Minnesota (Select MS4s) mandating a non-degradation assessment and report which is above and beyond the normal permit requirements.

The City of Maplewood, for example, is one of the 30 Selected MS4s and, therefore, the City has completed a loading analysis and has prepared this report to comply with the requirements of the permit. The non-degradation assessment consists of determining the change in loading of annual runoff volume, total suspended sediment (TSS), and total phosphorus (TP) between 1988 and current conditions (2005) and between current conditions and projected future conditions (2020) (Non-deg Report Nov. 2007). The MPCA's March 2006 Permit Guidance Manual states that "Nondegradation is achieved if the 1988 levels of flow and pollutants can be achieved." The Selected MS4 can demonstrate that 1988 loading levels can be achieved through implementing additional Best Management Practices which is incorporated in the Select MS4s non-deg report.

Watersheds and cities, in most cases, require grading permits for sites that cause disturbance equal to or greater than one acre. Some cities require grading permits for any site disturbances, even under one acre, in order to enforce construction site conditions, and to enforce construction of BMPs to help meet the requirements set forth in the Clean Water Act in order to reduce pollutants to the maximum extent practicable. Best management practices such as wet retention ponds are examples of BMPs that help meet this goal.

3.2 POTENTIAL REGULATIONS

Many stormwater ponds in Minnesota are 20 years and older and continue to fill with sediment. PAHs accumulate in the sediment as recently discovered in White Bear Lake. Coal tar based deal-coats are emerging as a major source of PAHs, some which are potent carcinogens (PAHs Aug 2009).

In 2009 the Minnesota Legislature passed a bill stipulating the restriction on state agencies in purchasing coal tar sealant effective July 1, 2010. This is a first step regulation to help stem the future cost of stormwater pond sediment disposal. According to an MPCA article on Coal-tar-based Driveway Sealcoats in September 2009 it was noted that Home Depot and Lowe's recently ceased the sale of this product because it contains high concentrations of polycyclic aromatic hydrocarbons (PAHs).

To gather more information in Minnesota on the prevalence of PAH's in stormwater ponds, Judy Crane, PhD, with the MPCA is conducting testing on sediments in residential and commercial/industrial stormwater ponds throughout the twin cities metro area. Sampling was completed in October 2009 of fifteen ponds of which five received flows from industrial land use, five from residential, and five from commercial (Judy Crane 2009).

This will be a first step to understand the extent of pollutants, especially Polycyclic Aromatic Hydrocarbons (PAHs), in stormwater ponds in the twin cities metro area. According to Dale Thompson, Supervisor for the MPCA in the Municipal Permitting Division, the study will help form new permit requirements that could be implemented in 2011 (Dale Thompson 10/08/09).

Also according to Thompson the 2011 MS4 permit will likely require inventory mandates on stormwater ponds including pond size, depth, and tributary area. The permit could also include guidance on stipulating techniques to understand the pond depth and sediment present. However this may only be required at the time the municipality dredges a stormwater pond. According to Thompson it is important to know if the proper volume exists in the pond to ensure proper treatment is occurring (Dale Thompson 11/11/09).

Anti-degradation will also play a role in the new permit for all MS4's. According to an April 2009 letter from Scott Fox, MPCA Hydrologist, to Select MS4's regarding their Non-Degradation reporting; additional information will be required. The Select MS4's may be required to development and implement a process to evaluate the effectiveness of the BMPs in the stormwater management system. This is to ensure assumptions of treatment capability are accurate. Also Select MS4's may be required to development and implement volume reduction strategies to mitigate the increase in volume loading. All MS4's should keep these items in mind because it is likely that all MS4's may be required to address anti-degradation as part of the new 2011 MS4 General Permit.

The existing NPDES MS4 General permit was issued to cities in 2006 and extends for a period of five years. The permit renewal can go many different directions in terms of additional regulations and mandates. In response to continued confusing regulations and increasing mandates numerous municipalities have banded together to form the Minnesota Cities Stormwater Coalition (MCSC). This is a fee based organization that provides help to cities in implementing various federal and state stormwater requirements. The service also is a conduit allowing cities to express concerns to the MPCA and other state agencies involved with stormwater compliance.

Mary Lynn with the MPCA conveyed, at the MS4 Stakeholder meeting on November 11, 2009, that the process will soon begin in formulating the new general permit. The first stakeholder input meeting will likely be held in January 2010. February through April of 2010 will consist of approximately two to three additional stakeholder meetings. The new permit language will be drafted from April to September 2010. Mary said the public notice may be sent out in October or November of 2010 and will allow input and feedback from stakeholders. Once the feedback is received, revisions will be made November 2010 through April 2011. The revised permit is likely to go to the MPCA Board in April or May of 2011 with issuance expected on June 1, 2011.

4.0 CURRENT PRACTICES

Now that a foundation has been set it is useful to understand current practices of cities throughout the State of Minnesota. How important is stormwater pond rehabilitation to cities? What are obstacles in implementing a rehabilitation program for ponds that have been neglected over the past few decades?

A questionnaire form was mailed to sixty seven cities throughout the State, mostly directed to the City Engineer. The cities were randomly chosen and range in population of 5,000 to 380,000. There were forty-two respondents equating to a 63% turnout. Each of the questions is provided within this report. The following were the final results to the first five questions.

How important is it to ensure stormwater ponds are functioning as designed?

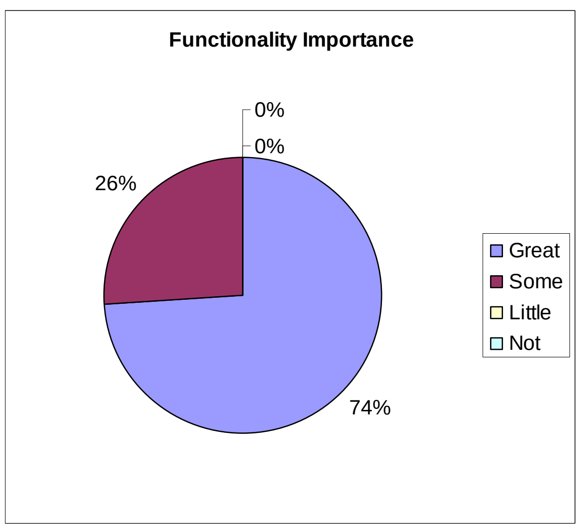

Figure 4: Importance of Stormwater Pond Functionality

Source: M. Thompson 2009 Survey

In Figure 4, the response shows roughly 75% of cities find there is great importance in ensuring stormwater ponds are functioning properly, while no cities chose little or no importance.

How important is it to rehabilitate and implement a long-term maintenance approach to stormwater ponds?

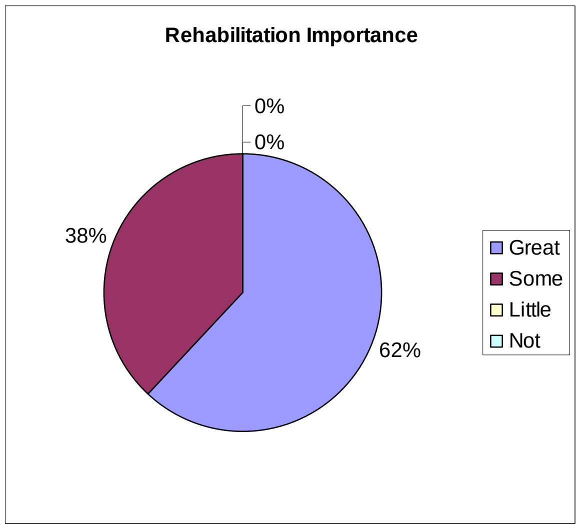

Figure 5: Importance of Stormwater Pond Rehabilitation

Source: M. Thompson 2009 Survey

Again the response shows a majority, just under 2/3rd's, see implementing a long-term maintenance approach and rehabilitating ponds as a great importance. Also no cities thought this was of little or no priority.

Does your city currently have a stormwater pond rehabilitation/maintenance program? If yes, please briefly describe.

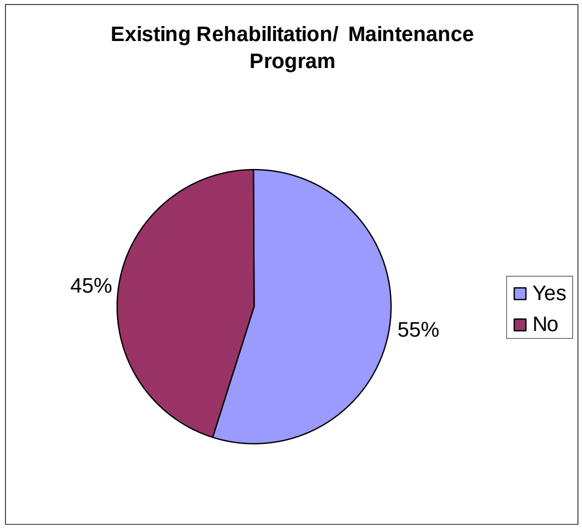

Figure 6: Current Rehabilitation/ Maintenance Program
Source: M. Thompson 2009 Survey

Just over half of the cities claim to have a stormwater pond rehabilitation/maintenance program. From reviewing the individual responses it was clear that most cities have only limited routine maintenance programs which follow the current NPDES permit requirements. Only four cities referred to their program as involving some type of dredging activities. Common responses were:

- Visual inspection of 20% of stormwater ponds annually
- Visual inspection of 20% of inlets/outlets annually
- Sediment removal near outfalls only on an as-needed basis
- Maintenance on as-needed basis or reactive to resident complaints

Does your city systematically test for pollutants in the sediment and water of stormwater ponds?

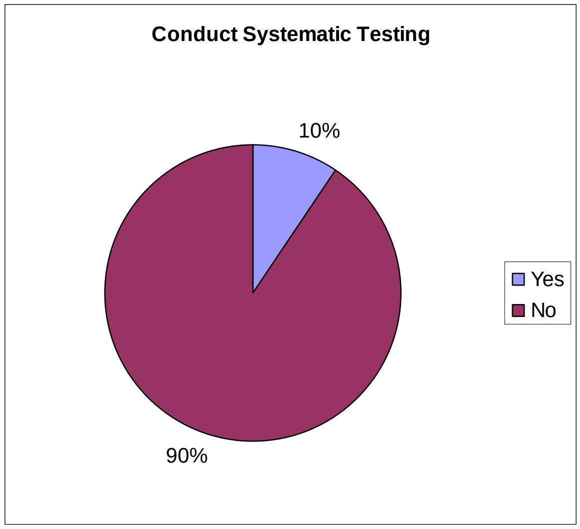

Figure 7: Cities Testing of Pollutants in Sediments
Source: M. Thompson 2009 Survey

The responses show it is clear that cities do not have systematic testing in place of stormwater ponds. If pond dredging activities are required testing must be conducted to determine the pollutant concentrations within the sediments. Sediments are then classified into three categories for disposal purposes which will soon be discussed.

What do you feel is the main driver to rehabilitate and implement a long-term maintenance approach for stormwater ponds?

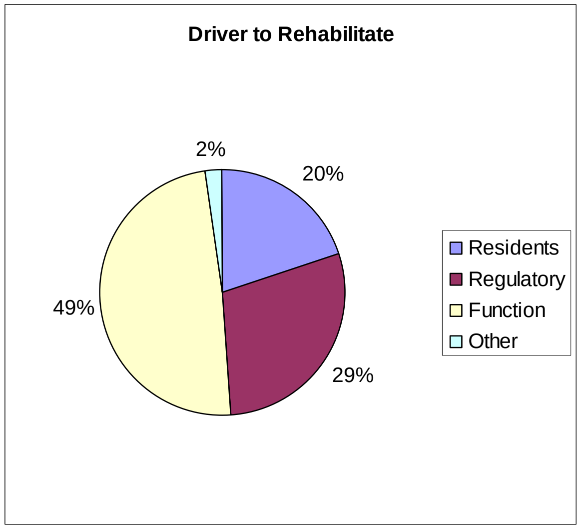

Figure 8: Main Driver of Rehabilitation of Stormwater Ponds
Source: M. Thompson 2009 Survey

Roughly half (49%) of the respondent cities said proper functioning was the main driver to rehabilitate stormwater ponds with regulatory pressure (29%) a distant second followed by city residents (20%).

As seen from the survey results stormwater pond rehabilitation is an important and relevant issue to cities and this report provides a guide for cities to follow by breaking down actions that can be taken both in the short-term and long-term. First short-term actions is discussed.

5.0 SHORT-TERM ACTIONS

What can cities do now to start addressing rehabilitation and long term management of stormwater ponds? The first step consists of short-term actions to help a city understand its current infrastructure. The process consists of three basic steps: Inventory, inspection, and prioritization. These first steps should be planned into a city's operating budget. Cities will have to determine if current staff is adequate to perform these tasks or if consulting services may be needed. Overall the staff leader needs to properly budget a portion of its operating budget towards short-term actions while capital budgets will be discussed for long-term rehabilitative efforts.

5.1 INVENTORY

As part of the MS4 permit requirement most cities were required to map existing stormwater ponds. However, evaluation is needed to ensure the municipality has a full inventory including details on each stormwater pond.

Illicit discharge detection and elimination section of the NPDES permit MNR040000 states:

> You must develop, if not already completed, a storm sewer system map by June 30, 2008, or on another date established by the Commissioner, showing the location of:
> 1) Ponds, streams, lakes and Wetlands that are part of your system;
> 2) Structural pollution control devices (grit chambers, separators, etc.) that are part of your system;
> 3) All pipes and conveyances in your system as a goal, but at minimum, those pipes that are 24 inches in diameter and over; and

4) Outfalls, including discharges from your system to other MS4s, or waters and Wetlands that are not part of your system (where You do not have operational control); structures that discharge storm water directly into groundwater; overland discharge points and all other points of discharge from your system that are outlets, but not diffuse flow areas.

For inventory purposes the city of Maplewood considers publicly maintained stormwater ponds as those receiving any amount of runoff from city land and/or public right-of-way. A system-wide inventory is critical before starting the inspection process.

As part of the pond inventory the following steps are needed:

1) Mapping/Attributes
2) Public vs. Private
3) Access Review

Stormwater ponds can be mapped within Geographical Information System (GIS) by utilizing aerial photography, existing maps, or Global Positioning System (GPS) information. GIS is a good tool for mapping system-wide assets because it quickly provides specific information in a search such as stormwater ponds. GIS maps could then even differentiate between man-made and natural ponds. GIS attributes can include pond name, ID#, pond size, average depth, bottom elevation, operating depth, volume, access limitation, owner, and year built amongst other pertinent information once collected. The municipality needs to name the stormwater ponds in the mapping system. Identifiers should be used that easily reference a drainage basin. For example if the sub-watershed flows to Blue Lake then the first upland stormwater ponds could be identified as BL-1, BL-2, and so on. Each city should choose a system that best fits their needs and may be driven on past mapping practices.

One inventory example is the city of Minnetonka. According to Liz Stout, Water Resources Engineer, the city undertook inventory and inspection of its system in order to implement a rehabilitation program. The process has taken about two years (Liz Stout October 2009). Barr Engineering Company was hired to perform the analysis and a draft report was completed in September of 2009. The study was commissioned to help determine a cost effective approach to address pond maintenance. The city wanted to become proactive rather than handling pond maintenance through citizen complaints.

Due to the vast numbers of ponds and wetlands in the city of Minnetonka the stormwater pond inventory excluded DNR public waters and focused on two categories according to the Barr Report:

1) Constructed stormwater ponds
2) Stormwater wetlands with piped inlets
    a. Type 4 (deep marsh)
    b. Type 5 (shallow open water)

Since MS4 permits currently only require constructed stormwater ponds to be inspected and maintained, the city chose to focus on the 247 constructed stormwater ponds found during the inventory process. These were further broken down into publicly maintained vs. privately maintained. The city identified 190 as city maintained after reviewing if the ponds accepted public waters and also verified no agreement was in place with a Homeowners Association or similar entity.

The city of Rochester began developing a GIS system for mapping and data management of stormwater ponds in 2003 to better address ownership issues, MS4 requirements, as-built information, and maintenance agreements (Mike Kraszewski, Stormwater U Presentation). Rochester followed the following format in producing its data layers in GIS:

1) Stormwater pond points and pipes entered first

2) Input pond data using construction plans
3) Located missing water features by reviewing aerial photography
4) Development of three general classes of public and private water features
    a. Stormwater ponds
    b. Other BMP's
    c. Other water features

This allowed the city to easily isolate the stormwater pond layer in GIS and pull up corresponding attribute information relating to each ponds' characteristics such as" Pond ID, Year Built, Surface Area, Depth, Volume, Owner, Access description, and parcel ID number to name a few.

Another example is the Minnehaha Creek Watershed District which started creating a BMP Inventory according to Nat Kale and Leah McIntosh (BMP Inventory Presentation Oct. 2009). The District's first attempt was with GPS and due to the scope of the coverage area this method was very slow and cumbersome. The second attempt consisted of GIS/Aerial Photography. According to Nat, using the aerial images the inventory was created within GIS. It provides both a visual map and spreadsheet style inventory. For example a digitized pond in GIS can be clicked and the following attributes come up on the computer screen:

1) ID
2) Permit #
3) BMP Type
4) Description
5) Inspection Date
6) Jurisdiction
7) Responsible Party

To avoid duplicating inventory efforts it is highly encouraged that municipalities closely work with their local Watershed Management Organization (WMO), in addition to Counties, and other units of government.

Once ponds are mapped cities need to determine the responsible party for maintenance. The first step is conducting a drainage analysis to verify if runoff from city land and/or public right-of-way is flowing into the subject pond. If yes, then the municipality may have responsibility for maintenance unless an agreement stipulates otherwise. Recently cities have become more diligent about requiring developers to sign an operations and maintenance agreement stipulating that the city has no obligation for ongoing maintenance and cost. For example, the city of Rochester requires owners of new developments to prepare an agreement stipulating the owners' responsibility including inspection, maintenance, and costs. The owners are fully responsible and if no action is taken to remedy a deficiency, the city has the right to complete the work and charge associated costs back to the owner. Similarly, the city of Maplewood now requires all developers to enter into a stormwater maintenance agreement stipulating the owners' responsibilities and also permitting access onto the site for inspection by both the city and the watershed district.

Few cities have a defined stormwater pond policy in place. The city of Plymouth is one of the few that has adopted a Pond Maintenance Policy (March of 2005) which includes verbiage on inventory. The policy addresses past pond maintenance agreements and provides an option for property owners to terminate past agreements if certain criteria are met such as: 1) The pond is part of the city's overall drainage system; 2) The proper ponding easements are dedicated; 3) The proper access agreements are dedicated. After old agreements are dissolved the city of Plymouth takes ownership of the pond and updates its inventory including associated recorded easement and access rights granted. This allows the city to have better control of its overall drainage system while also obtaining ponding and access agreements at no fee. If easements are not granted, then the city will not accept responsibility.

It is important for each municipality to define its own program and how to define public versus private and related issues. Some cities want more control over the overall drainage system and are willing to take over responsibility of ponds that may be privately owned, while other cities do not want to take on additional responsibilities.

Overall, it is important for the mapping of the ponds to be completed, preferably in a GIS which will allow for easily accessed attribute information and layer isolation. The attributes collected need to include necessary information about the pond in order to understand its relevance. Sample attributes may include pond name, ID#, year built, ownership, access considerations, surface area, volume, current average depth, original average design depth, normal and high water levels, volume, and number of inlets and outlets. It is understood that some of the attributes listed above will have to be input after inspections are conducted; short-term actions may be reiterative. For example, current average depth will only be known after a survey of the pond bottom is conducted as discussed in the next section; Inspections.

5.2 INSPECTIONS

Inspection is also considered a short-term step. Currently, it was found that most municipalities only inspect outfall areas of ponds and not the entire body of water. The results of the survey show a majority of cities inspect 20% of their outfall annually in order to meet MS4 permit requirements. The in depth inspection process should begin only after assets are inventoried and city staff has secured operating budget dollars to perform system-wide inspections.

The MPCA provides only routine inspection guidance to help meet current permit requirements. Stormwater ponds are recommended to be inspected at a rate of 20% per year. This allows a city to cycle through all of its ponds over the 5 year permit period. Table 1 provides useful information for municipalities regarding inspections. Again this mainly deals with routine maintenance, not rigorous inspections that would convey whether or not pond rehabilitation (dredging) is needed.

What	When	How
Basins and ponds (Part V.G.6.b.3) including storm-water ponds and infiltration basins	20% annually, all within 5 years	• Determine if basin or pond inlet(s) and outlet(s) are in good working condition and able to perform their intended function. • Identify and record scour, erosion, significant sedimentation, or other problems at or around the pond banks, inlets or outlets. • Where the basin or pond is intended to provide storm-water quality treatment, in most cases, treatment is accomplished primarily through settling of sediment particles. The depth of various portions of the basin or pond should be determined, recorded and tracked over time. This data determines when the basin or pond will be too shallow to perform its function and allows for appropriate action. Measuring the depth of the pond at a few consistent locations through the ice in the winter may be sufficient to determine the depth of the pond for this purpose. • In some cases, storm-water quality treatment is accomplished through biological (such as plant uptake,) or chemical actions (such as alum addition,) or physical diversion to other systems. In these cases, inspection and recording procedures should be established to determine whether the basins or ponds systems are able to perform these functions. • Identify and record materials within the device that are deteriorating and releasing pollution into the storm-water system. • Immediately schedule and conduct needed maintenance. • Record anticipated and actual work dates. • Additional information is available in Metropolitan Council Environmental Services - *Urban Small*

Table 1: Inspection Guidance

Source: MPCA, January 2004

This table provides very limited guidance to determine if full rehabilitation of a pond is needed. It generally mentions that the depth should be determined to ensure the pond is functioning properly. A more rigorous application is needed for municipalities to understand the condition of its ponding infrastructure in regards to sediment build-up.

The first step to inspection is making a site visit to stormwater pond and documenting general maintenance needed including bank erosion, vegetation overgrowth, and outfall and outlet structure condition. Some of this information may already be available as part of past inspections in meeting the MS4 permits requirements. The more rigorous analysis is gathering information which allows comparisons of the current condition against the as-built condition. Locating of old as-built plans will be required in addition to performing a bathymetric survey of the pond.

According to the EPA a bathymetric survey is:

> "The measurement of the depths of water bodies from the water surface. It's the marine equivalent to topography. Bathymetric surveys are generally conducted with a transducer which both transmits a sound pulse from the water surface (usually attached to a boat) and records that same signal when it bounces from the bottom of the water body. An echosounder attached to the transducer filters and records the travel time of the pulse. At the same time that the pulse occurs, a GPS unit can record the location of the reading. After many of these readings are taken, corrections are made based on fluctuations in the water surface elevation that may have occurred during the survey. The individual points are then mapped; easily done in a GIS.
>
> "Bathymetric surveys are used to characterize contaminated sediment sites for a number of reasons. The surveys record the sediment surface prior to remediation to assist in the remediation process. Surveys taken over time assist project managers in determining the transience of bottom sediments. This information can determine whether the contaminated sediment is stable or is susceptible to re-suspension. Surveys can also check on the efficiency of dredging operations (EPA, Bathymetric Surveys)."

In the report by Barr Engineer Company for the city of Minnetonka the survey was performed by physically measuring the depth from the water surface to the pond bottom using a rod. According to the Barr Report, sonar/radar was not utilized to calculate depths because vegetation and organics caused errors especially in such shallow waters. A Geographical Positioning System, known as GPS, was used to log the location of each depth measurement. The edge of water around the pond was recorded using GPS as well as surveying the water elevation of the stormwater pond.

Information can then be downloaded to a CADD program or similar in order to create a triangulated irregular network, also known as a TIN. This current permanent pool volume can then be calculated using this information. It is important to note that the permanent pool volume is that below the outlet pipe invert. Or if no outlet exists, it is that volume below the emergency pond overflow elevation.

At this point the pond sedimentation can be calculated by comparing as-built files with collected data. In most cases as-built information is difficult to find therefore it is important to measure both the top and bottom elevation of the sedimentation layer. Using a rod this can be done by feeling the first resistance which is usually a softer layer. The bottom of the sediment layer on the other hand will be firm signifying the bottom of the pond in most cases.

The city of Rochester compares original grading plans to uploaded survey points to understand the amount of sediment buildup (Mike Kraszewski, Stormwater U Presentation). If excessive sediments are found within a pond it is then placed on its capital improvement program for rehabilitation.

Next a calculation should be performed to verify that the Walker Method is met. Again, this requires that the permanent pool volume be at least equal to that volume produced by a 2.5”, 24 hour storm event. The Soil Conservation Service (SCS) hydrologic guide can be utilized. For example assuming a 15 acre residential area with 1/3 acre lots (30% impervious) with Type B Soils then the curve number (CN) is 72. Therefore a 2.5” rainfall only produces 0.53” of runoff. This can then be used to calculate the volume:

V = [(0.53”)*(1’/ 12”)]* [(43,560 sq.ft. / acre)*(15 acre)] = 28,858 cubic feet

If the Walker Method for volume is not met for the existing condition or as-built design then considerations should be given to increase the permanent pool depth through dredging of sediments, excavating additional volume in the permanent pool, or manipulating the outlet pipe elevation or structure. General guidance suggests that stormwater pond rehabilitation should occur upon sediment filling in excess of 50% of the permanent pool volume.

5.3 PRIORITIZATION

Prioritization is important if funding is limited because the assets chosen for maintenance must provide the greatest benefit within the system.

Cara Geheren, the City Engineer of Victoria, presented prioritization criteria for standard maintenance which includes pond age, inspections records, apparent sediment and proximity to sensitive downstream waters (Stormwater U Inventory Presentation, Oct. 2009). Funding also heavily weighs into the decision according to Geheren.

The city of Burnsville performs annual pond dredging generally limited to outfall areas. Each year funding is allocated to this program and prioritization is based on citizen complaints, high priority downstream waters, wetland rankings, and annual inspection results (Daryl Jacobson Interview, Nov. 4, 2009). According to Daryl the street crew performs the inspections according to current MS4 permit requirements and this is one component that helps in the decision and prioritization making process.

In the city of Minnetonka fifty four ponds were selected based on potential likelihood of sedimentation also taking into consideration the relative significance of the pond in the overall stormwater management system (Draft Barr Report, 2009). According to the report, selection was based on factors such as the pond size, the size and land-use of the tributary area, and the proximity to sensitive downstream water bodies. The city of Minnetonka appears to be a leader in performing full bathymetric surveys to understand the effect of sedimentation on the entire pond. Most cities only deal with outfalls. The prioritization Minnetonka uses is very important because it will be investing in full scale dredging in the future and there is a need to identify ponds that will best improve the water quality of its stormwater system.

The city of Maplewood will need to make similar prioritization decisions during implementation of a rehabilitation program. One technique that will weigh in is the classification of wetlands. Currently the city has Class 1 through 5 wetland designations, with Class 1 having the highest value. The City is currently in the process of updating its wetland ordinance to come in line with that of the Ramsey-Washington Metro Watershed District (RWMWD). This will provide consistency in identifying high priority resources on a system-wide basis. Manage A, B, and C will be the new wetland classifications with Manage A having the highest priority.

Each municipality will have to determine its own factors for prioritization. The Minnetonka example is a good one because they discounted smaller ponds with little treatment capability or larger ponds that received little public stormwater. The focus was on those assets predicted to have the most sedimentation build-up and was just upstream of sensitive water bodies.

It is recommended that each municipality develop a ranking matrix based on factors such as:

1) Downstream sensitive waters
    a. High priority wetlands
    b. Impaired water bodies

2) Pollutant removal capability
    a. Based on pond size / permanent pool storage provided
    b. Percent of sedimentation of permanent pool volume
3) Safety
    a. Historical flooding
    b. Side slopes
4) Ability to perform work
    a. Construction access
    b. Easements / ownership
    c. Permitting
5) Citizen involvement
    a. Resident complaints
    b. Resident participation in process

In developing a ranking matrix it is important to involve numerous stakeholders in order to get more buy-in. Stakeholders could include city staff, city council, citizen groups, city commissions, watershed, and the chamber of commerce. The task force should focus on finding consensus on a ranking matrix taking into account the views and concerns of all parties.

6.0 LONG-TERM PLAN

Securing the necessary funding to return stormwater ponds back to their as-built condition is a long-term process. A systematic approach is needed to rehabilitate stormwater pond assets which include securing funding to allow for conducting of capital improvements.

In an interview with White Bear Lake Engineer, Brent Thompson on October 28, he referred to the past news article on the city referring to such high costs for rehabilitation. He stated that Varney Lake is one referenced in the article and is about 10 acres. He continued that the estimate is roughly $500,000 to dredge the pond and dispose of Tier 3 soils. He conveyed that there are roughly 10,000 cubic yards that need to be removed. Due to the high costs Brent stated that the city of White Bear Lake is waiting on the results of a study by John Gulliver at the University of Minnesota on soil re-use as part of a PAH study.

It is important to identify the different strategies of rehabilitation including a discussion on costs. It is important to understand how other cities currently fund stormwater pond related maintenance and improvements. It is important to note that funding sources from cities do not currently address the great expense that will come when major pond rehabilitation (full-scale dredging) is required.

To start this section it is necessary to understand how cities finance routine maintenance of stormwater pond improvements. It is likely that this funding source will be the same used to finance rehabilitation (dredging) once inventory, inspection, and prioritization are complete. The last two results from the questionnaire are listed below. Again the results represent answers from forty two cities out of the sixty seven polled.

How does (or, would) your city fund stormwater rehabilitation/maintenance?

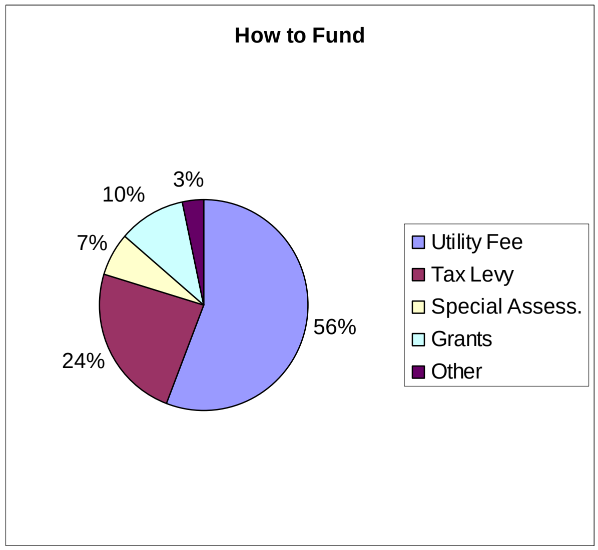

Figure 9: Funding Sources for Stormwater Pond Rehabilitation/ Maintenance
Source: M. Thompson 2009 Survey

Over half of the respondent cities have a stormwater utility fee in place to help support maintenance activities as part of the NPDES permit program.

Please list a major obstacle you feel is keeping cities from implementing a more rigorous stormwater pond rehabilitation/maintenance program?

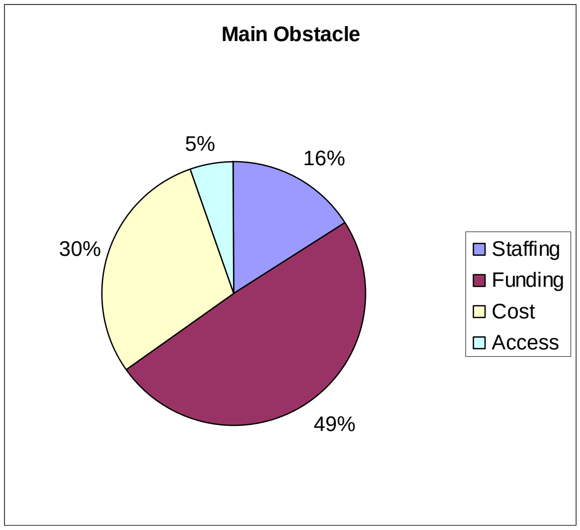

Figure 10: Main Obstacle Preventing Rehabilitation/ Maintenance
Source: M. Thompson 2009 Survey

Roughly half of the cities said funding was the main obstacle in to implementing a more rigorous program. The high cost of rehabilitation such as full-scale dredging was mentioned as another inhibitor. The lack of staffing was also an obstacle, in addition to not having the legal access to a public stormwater pond.

An adequate funding source is crucial to be able to rehabilitate stormwater ponds. In 1983 Minnesota Statutes Section 444.075 authorized local governments to levy user charges against users of the use and availability of stormwater facilities (Metropolitan Council, 2007). According to a Metropolitan Council Survey of metro communities in 2007 it was found that eighty three utilized stormwater utility fees. The number of communities utilizing this fee has rapidly increased in the metro with increased regulations required of the NPDES permit program in order to meet standards set forth in the Clean Water Act. The mean user fee is $41 per year for a residential property. The 2007 fee study results can be found in the Appendix B.

For those cities without a utility fee it should be determined if this funding source is needed to address future improvements such as pond rehabilitation. For those cities that already utilize the user fee, the rates will need to be increased to address pond rehabilitation. Most cities currently use revenues to address replacement of old pipes during street reconstruction projects, street sweeping, and routine ponds maintenance activities. In order to get a handle on rehabilitation, the next section will cover strategies and associated costs.

6.1 REHABILIITION PROCESS

After short-term actions have been completed by a municipality generally consisting of stormwater pond inventory, inspection, and rehabilitation priority; the rehabilitation needs to occur to restore a stormwater pond to its original as-built condition to restore treatment capability. Before pond dredging occurs testing and permitting requirement knowledge is needed.

6.1.1 Testing and Permitting

Once a municipality determines pond dredging is needed an estimate must be made of the volume of sediment to be dredged. The MPCA provided guidance on testing and permitting in June 2009 (Modified Characterization and Permit Approach for Urban Stormwater Ponds). It should be noted that the MPCA does not require a dredging permit for smaller maintenance type projects but speaking with the MPCA for guidance is recommended. Table 2 provides guidance on sampling and permitting for municipalities.

Estimated Volume of Dredge Material (cubic yards)	Number of samples for Particle Size Distribution recommended	Maintain records at the MS4	Minimum recommended number of samples for analysis	Permit review required if >3000 cubic yards of sediment & exceeds level 1
0 to 100	0	Y	0	
100 to 500	1	Y	1	
500- to 3,000	2	Y	2	
3,000-30,000	3	Y	3	Y
30,000-100,000	5	Y	5	Y
100,000-500,000	6	Y	6	Y
500,000-1,000,000	8	Y	8	Y
1,000,000	X>8	Y	>8	Y

Table 2: Sampling and Permitting

Source: MPCA June 2009 Guidance

After the minimum number of core samples is collected, testing must confirm whether 93% or more of the sediment is retained on the #200 sieve. If so then the sediment can be assumed to be Management Level 1. The following describes the three types of sediment management levels (MPCA Best Management Practices for the Management of Dredged Materials):

- Level 1: Suitable for use or reuse on properties with a residential or recreational use category;
- Level 2: Suitable for use or reuse on properties with an industrial use category; and,
- Level 3: Contact MPCA staff for additional information on regulatory requirements for disposal or other use

If less than 93% of the sediment is retained on the #200 sieve then the samples need to be analyzed for contaminants and concentrations. The lab results will then determine whether the dredged material is Management Level 1, 2, or 3. For more detailed information on the determination of the Management Levels, the soil reference values can be found in Appendix C.

The range of each core sample which includes the sieve analysis and contaminant level testing can be expected to cost $2,000 to $3,500 as recently found from testing in the city of Maplewood. Varying testing firms will supply quotes depending on a number of variables. It is recommended that municipalities conduct a request for quotes from at least three testing firms in order to select the services that provide the best value.

Due to increased dredging activity needs by municipalities the MPCA developed a separate guidance document in June 2009 titled "Modified Characterization and Permit Approach for Urban Stormwater Ponds." As shown in Figure 11 on the following page, municipalities need to follow the decision chart to understand if a construction stormwater permit and dredge supplement form is needed. If Management Level 2 sediments are to be re-used and exceed 3,000 cubic yards then this warrant is met.

However, as seen in Figure 11, if sediment is Management Level 1 then dredge re-use approval is not required but a construction stormwater permit is needed if the re-use site disturbs over one acre. If Management Level 2 sediment is dredged but there is 3,000 cubic yards or less then re-use approval is not needed by the MPCA but the municipality must ensure the sediment is re-used on an industrial use property. Management Level 3 sediments description was recently modified and defined as "having significant contamination and must be managed appropriately for the specific contaminants present. If PAHs are the only contaminants present they may be treated to reduce the contaminant levels by a proven treatment method if there is an operating permitted facility. Level 3 materials may also be re-used or disposed of at a permitted landfill with an approved industrial waste management plan (MPCA 2009)."

A permit for Management Level 3 is not required if taken to a permitted landfill. If treatment is to occur to reduce management levels due to PAH's then cities should contact the MPCA for further information about permitted operating facilities and permit requirements.

Finally, it is important to remember that if the re-use site has a disturbance of over one acre, a construction stormwater permit is required. Other permits that may be required as part of the dredging process involve but are not limited to cities, Department of Natural Resources, Army Corp of Engineers, and watershed districts.

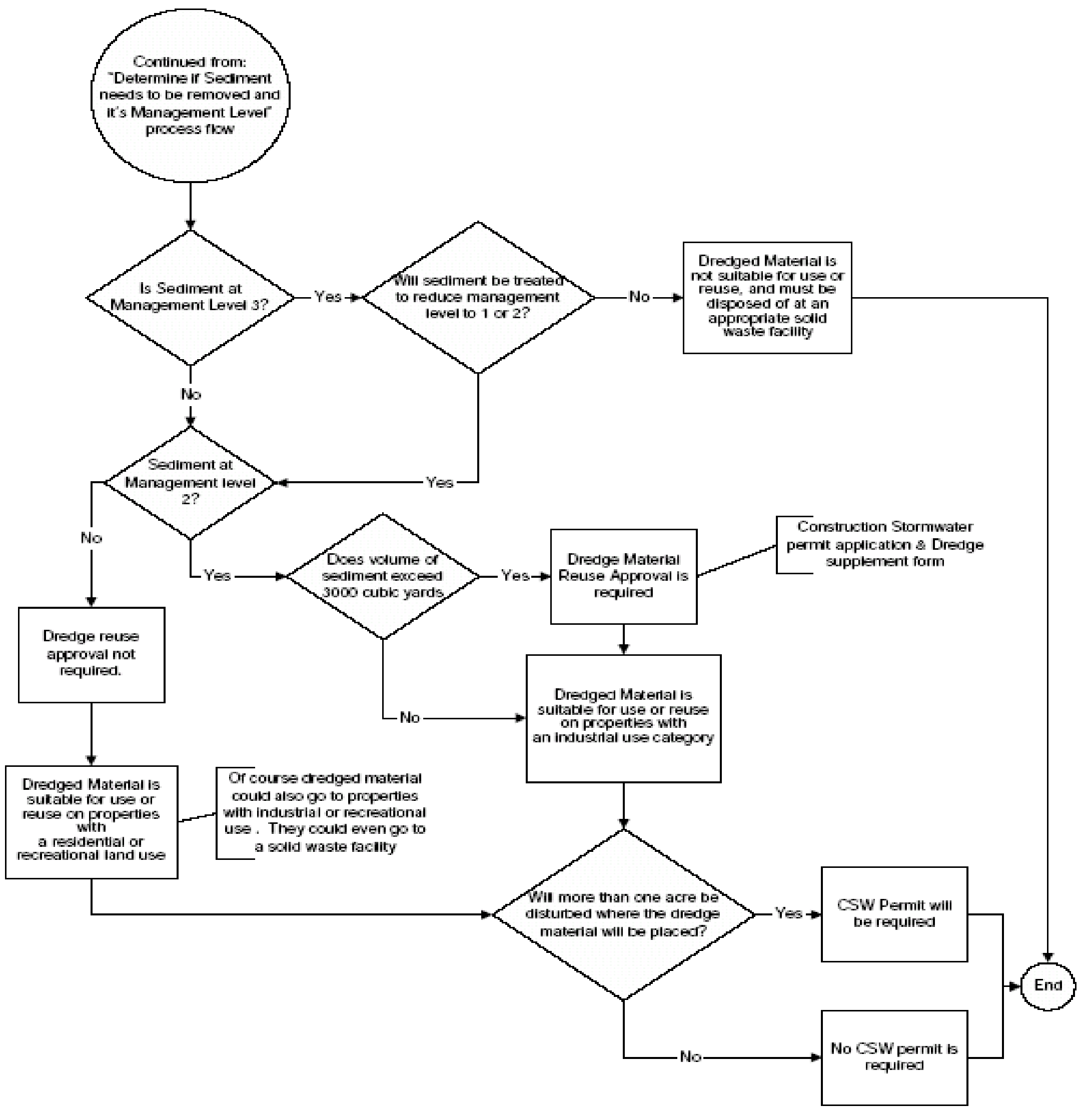

Figure 11: Dredged Material Placement Decision Chart
Source: MPCA, June 2009

6.1.2 Dredging and Disposal Costs

To help the city of Minnetonka develop planning level cost estimates Barr Engineer Company identified several recent projects from 2005 to 2009 within the metro area (September 2009 Draft Report) to use in developing a cost equation. The cost equation was developed based on mobilization, site preparation, sediment excavation and disposal, minor storm sewer work, and erosion control. The cost equation also included an additional 30% and 20% for engineering/administration and contingency, respectively. Table 3 provides planning level costs but it should be noted that the costs do not include restoration, sediment testing characterization, disposal costs for contaminated sediment, major storm sewer work, or land/easement acquisition.

Table 3 is based on the following equation formulated by Barr Engineering Company to better understand planning level costs for dredging projects:

$$C = 78{,}515 * V^{0.6727}$$

where:

C = Estimated pond dredging cost (2009 dollars)

V = Sediment volume to be excavated (acre-feet)

Pond Excavation Volume Range		Approximate Unit Cost
acre-feet	cubic yards	$ per cubic yard
0 to 0.5	0 to 800	75
0.5 to 1	800 to 1,600	55
1 to 2	1,600 to 3,200	43
2 to 5	3,200 to 8,100	32
>5	>8,100	25

Table 3: Planning Level Pond Dredging Costs

Source: Liz Stout, City of Minnetonka

The Barr Engineering Company's equation is extremely useful in helping a city determine its planning level costs. However, as mentioned previously this does not include certain items such as sedimentation characterization and contaminated sediment disposal costs.

It is in the best interest of cities to re-use materials to avoid disposal costs. Marty Long, owner of Minnesota Mulch and Soil, has led the effort on re-use and has recently obtained beneficial use permits from the MPCA to allow for the treating of dredged materials. He has partnered with cities and watersheds to take dredged materials at a reduce price compared with landfills. Minnesota Mulch and Soil has treated Management Level 2 dredged materials through mixing with other materials in order to meet Management Level 1 criteria. The new material can then be used in boulevards and other residential areas (Minnesota Mulch and Soil).

For municipalities to better understand the full cost of pond dredging, contaminated sediment disposal costs must also be taken into account. With the increasing findings of PAH's and other high concentrations of contaminants, cities should assume disposal costs will play a role in a rehabilitation project. As of October 2009 there are twenty one landfills in Minnesota that accept mixed municipal solid waste (MPCA). These are the facilities that are authorized to accept contaminated dredged materials. According to Tom Lance, a Senior Industrial Account Manager for Waste Management, he represents three landfills in the State located in Burnsville, Elk River, and Glencoe (Phone Interview, November 10, 2009). Tom expressed that dredged material brought to the landfill is based on tonnage and pricing is the same whether it is Management Level 2 or 3. Landfills are required to put a 6" daily soil cover over the garbage over the waste and dredged materials help in accomplishing this task. According to Tom the current price for disposal at the landfills is about $10 per ton but has slight fluctuations depending on expected volume of soil. On average one cubic yard of conditioned dredged material weighs 1.4 tons. Therefore this equates to a disposal cost of $14 per cubic yard. Tom mentioned that Minneapolis recently, in 2009, had a project where 14,000 tons of material was disposed at a price of $8.55 per ton. This equates to just under $12 per cubic yard. So there appears to be a slight economy of scale. Tom recommended that if the contaminated sediment was soupy that it should be stockpiled and allowed to dry out prior to bringing it to the landfill. Overall, Tom said between the three landfills approximately 195,000 tons of material is accepted each year to help it meet its alternative daily cover requirement.

Overall this information can now help a city determine planning level costs for pond rehabilitation. The following example summarizes this process.

Question:

A city has determined that 5,000 cubic yards of sediment that must be removed from a public stormwater pond. It is estimated that Management Levels 2 or 3 will be encountered. What are the necessary testing, permitting, and approximate costs to complete the project?

Answer

1) Using MPCA guidelines it is found that 3 core samples are required since it falls within the range of 3,000 to 30,000 cubic yards. The testing cost can be estimated on a per sample basis therefore using the previously provided information $3,000 per sample is used. **All testing costs will be $9,000.**
2) Since the 5,000 cubic yards exceeds 3,000 cubic yards a permit may be required from the MPCA if the material is to be re-used.
3) As a result of the testing it is found that the there is less than 93% retained on the #200 sieve, so testing is conducted for contaminants and concentrations.

The result is a Management Level 3. No permit is needed since sediment will be disposed of at an MPCA permitted landfill.

4) The soil is taken to a landfill at a cost of $14 per cubic yard. Multiplying by 5,000 cubic yards the **disposal cost is $70,000.**
5) Finally utilizing the Barr Engineering Company equation:

   $C = 78{,}515 * V^{0.6727}$; where C = cost (2009 $); V = volume (acre-feet)

   Convert 5,000 cubic yards to acre-feet by multiplying by 27 and then dividing by 43,560 to get 3.1 acre-feet.

   $C = 78{,}515 * 3.1^{0.6727}$ = **Dredging cost of $168,070**

6) Lastly add up the costs; $9,000 + $70,000 + $168,070 = **$247,070.**

Municipalities should begin considering conducting planning level estimates immediately after the short-term action of inventory, inspection, and prioritization is complete. City Engineers and Public Works Directors must take a proactive approach in beginning to plan for increasing revenues from stormwater utility fees or other funding sources in order to meet inevitable stormwater pond rehabilitation needs.

6.1.3 Dredging Techniques

Next it is useful to have a general understanding of the methods and equipment used to dredge stormwater ponds. Sediment removal from stormwater ponds can be categorized into either mechanical or hydraulic dredging.

<u>Mechanical Dredging</u>

A backhoe/excavator is commonly used in Minnesota for removing stormwater pond sediments (Scott Sobiech, Barr).

Mechanical dredging can occur either from the shore, from barges, in the pond, or from temporary fill areas within the pond. Mechanical dredging can occur any time of the year in Minnesota depending on preference and site conditions. Backhoes/excavators can work along the shoreline in non-winter months or within stormwater ponds if pond lowering is feasible and dry conditions exist. Dragline dredging may be a better option for removing sediments not reached from the shore with a backhoe if pond lowering is not possible.

Winter dredging consists of draining the pond prior to freezing in some cases, then once the ground is frozen a backhoe or excavator can drive out onto the stormwater pond bottom and remove frozen sediment as seen in Photo 1.

Photo 1: Excavator Performing Winter Dredging
Source: Scott Sobiech, Barr Engineer, Stormwater U Presentation

According to Greg Nelson with Barr Engineering Company backhoes are used for most dredging applications in Minnesota for stormwater ponds. Also dredging projects typically begin at the beginning of the year to allow for equipment to access via the frozen surface and to minimize disturbance to the vegetated ground at the site. Most dredging contracts stipulate that a contractor must remove a specified depth of sediment and it is the contractors' responsibility to identify the means and methods for accomplishing the task. According to Nelson, most excavating contractors break the "clean" ice and stack it on shore above the normal water elevation. Ice removed containing frozen sediment is loaded for disposal. The excavation then begins and at times excavators work in tandem so as not to tracking back and forth over the frozen stormwater pond (Photo 2). Dewatering of stockpiled dredged material typically occurs overnight and loaded and hauled by trucks the following day.

Photo 2: Excavators Performing Winter Dredging

Source: Scott Sobiech, Barr Engineer, Stormwater U Presentation

Other types of mechanical dredging involve equipment such as cranes with clamshell buckets, in addition to dragline dredging which utilizes a bucket, cable, and boom as seen in Photo 3.

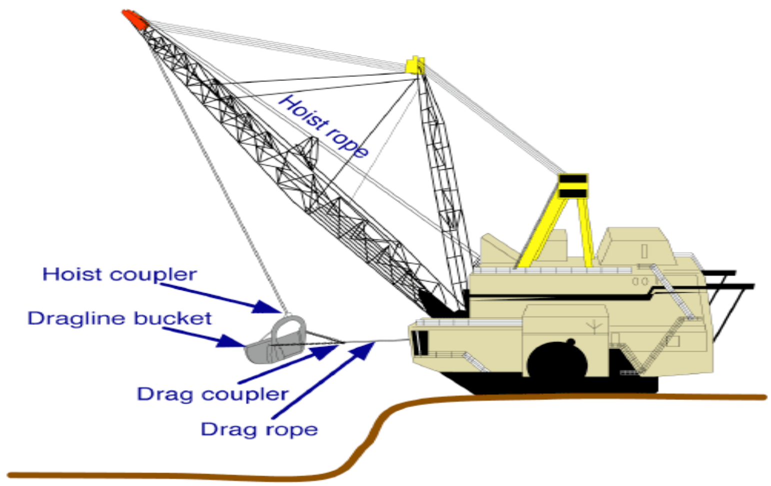

Photo 3: Dragline Dredger

Source: http://images.absoluteastronomy.com/images/encyclopediaimages/d/dr/dragline_excavator.png

Hydraulic Dredging

The other common type of dredging is hydraulic dredging which occurs in non-winter months and involves a dredge boat with a cutter head that grinds and sucks up the mucky sediment and pumps it to shore via a floating pipeline. This technique can be compared to a vacuum cleaner where the sediments are slightly disturbed, sucked into a pipe and discharged onto a secured located on the shore. The main problem with this method is the storage of the slurry and separating the solids from liquids. Geo-textile bags or settling basins must be used on the shore to allow sediments to be separated from clear water. Photo 4 is of a hydraulic dredge with the cutter head shown in red.

Photo 4: Hydraulic Dredge with Cutter Head

Source: www.tug44.org

For smaller applications a small boat with attached pump can be used or utilizing the pump from shore to suck up very loose and fine sediments that do not need agitation to suck up. Photo 5 shows a pump being utilized from the shore of a very small basin which is sucking up very fine sediments.

Photo 5: Pumping Equipment Dredging from Shore

Source: Scott Sobiech, Barr Engineer, Stormwater U Presentation

Overall the two main techniques for dredging are through means of mechanical or hydraulic. The specific method and type of equipment necessary is dependent on many factors that a contractor would take into account in order to provide a competitive construction bid.

6.1.4 Tracking Dredging Activities

It is important for a project inspector representing the owner to be actively involved with dredging activities. Verifying sediments are removed to specified depths is needed by performing a survey of the excavation site. During project development the inspector needs to ensure the contractor obtains all necessary permits as conveyed in the project specifications. Overall the selected excavating contracting needs to adhere to the most recent guidance on managing dredged materials written by the Minnesota Pollution Control Agency.

On site activities should include documenting dredging activities including type of equipment on site, hours of operation, number of dump trucks leaving the site, estimated volume removed, photos, and other detailed notes.

Dewatering of dredged material is important prior to hauling off site for re-use or to a landfill. According to the MPCA a permit is not needed if stockpiling on site is less than one year. The stockpile must be stabilized though, to prevent erosion and downstream sedimentation. Other dewatering methods could include utilizing a belt-press or centrifuge (Sobiech).

The inspector should ensure the sediment is disposed of at the proper location dependent upon the sediment Management Level. A signature of receipt of disposed material and intended re-use declaration should be signed by the person accepting the dredged material for re-use (Sobiech).

7.0 MAINTENANCE PROTOCOLS

On-going maintenance and prevention practices are also an important part of the life-cycle process of stormwater ponds. Prevention techniques to limit sediment and other pollutant loading to ponds could be explored through amending city ordinances and general standard practices. Polycyclic aromatic hydrocarbons (PAH's) are a major source of recent pollutant findings. Cities should begin to consider adopting ordinances that prevent the use of coal-tar-based sealants used for driveways and parking lots. Taking preventative action now could have a considerable savings in the future in terms of disposal costs of sediments as we are recently finding through the city of White Bear Lake.

Cities need to develop best practices such as maintaining consistent street sweeping schedules, especially in early spring prior to rain events flushing the sand into the storm sewer system. Also the removal of sediments from structural pollution control devices such as grit chambers and sediment sump manholes needs to performed on an as-needed basis to ensure removal of sediments before being flushed downstream and filling in the permanent pool volume of stormwater ponds.

Strictly enforcing erosion and sediment control plans for development sites is crucial. If sites are not properly contained and stabilized sediments will be flushed downstream thereby shortening the life-cycle of the stormwater pond's treatment capability. Inspections of construction sites need to be performed prior to expected storm events and directly after to ensure protection of downstream resources.

Also inspect directly around the stormwater pond to look for eroded banks and scouring at pond outfalls. If banks are not stabilized or velocity dissipation is not provided, scouring of the slopes can significantly contribute to the sediment loading to the pond. Each municipality should set priorities for preventative measures in order to protect stormwater ponds. Most cities already have procedures in place but it is important to look at stormwater ponds as a critical component of the stormwater treatment system and adjust practices as needed.

To summarize, it is critical to implement erosion prevention and sediment control techniques during construction projects in order to limit sediment discharge to downstream stormwater ponds. Street sweeping, cleaning out grit chambers and sump manholes, and cleaning catch basins can help increase the span between rehabilitation periods. It is also important to implement city ordinances that help prevent high cost sediment disposal requirements. A simple first step could be banning the use of coal-tar-based sealcoats in order to reduce the prevalence of polycyclic aromatic hydrocarbons.

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8.0 CONCLUSION AND RECOMMENDATION

In recent years the media and general public are becoming more vigilant about the condition of stormwater ponds. This has increased pressure for additional regulations and also for cities to become proactive in addressing rehabilitation of these essential assets. As found from polling results from the forty two municipalities throughout the State, 100% said that it is of some or great importance that stormwater ponds function as designed. Also, 100% of respondents said that it is of some or great importance that these assets be rehabilitated and long-term maintenance plans be implemented to better address stormwater ponds. On the other hand, of the forty-two respondents, just over half have a current maintenance or rehabilitation program. Those municipalities without a current program must quickly begin a routine maintenance program and then start the transition towards implementing a rehabilitation process. And those cities already performing routine maintenance need to now consider rehabilitating neglected stormwater ponds.

To summarize, a successful rehabilitation program can be implemented by taking these short and long-term steps:

SHORT-TERM

1. **Inventory**
    - <u>Mapping</u> (GIS Mapping using orthophotos, existing maps, GPS)

      Attribute table should include pond name, ID#, owner, type (constructed or natural wetland), surface area, average depth, bottom elevation, operating depth, volume, access limitations; and other necessary information required by a municipality.
    - <u>Public vs. Private</u>

Identify the owner of all stormwater ponds in the system to understand responsibilities. Ponds that accept public water from the ROW or city property should be categorized as “public” unless an agreement or policy states otherwise. Review historical files for development projects and homeowner association documents to verify ownership.

- Access Review

  Public stormwater ponds must be reviewed for adequate access in order to maintain or rehabilitate. Obtain easements and right of entry as needed.

2. **Inspection**
   - Bathymetric survey

     This allows the sedimentation depths to be calculated. The top layer of sediment is compared to the as-built files. If no as-built files exist then the survey should attempt to determine original pond bottom elevation.
   - Calculate sedimentation

     Estimated volume of sediment should be calculated by comparing original bottom with current bottom (top of sediment layer).
   - Ensure adequate permanent pool volume

     Verify the storage is adequate as determined by using the Walker Method (2.5”, 24-hour storm event which allows for roughly 25 years of sedimentation). This is to determine if additional pond excavation above and beyond sediment removal is needed.

3. **Prioritization matrix**
   - Downstream sensitive waters

     High priority wetlands and impaired water bodies.
   - Pollutant removal capability

     Consider pond size and permanent pool storage provided.

- Safety

  Based on historical flooding issues, pond bank stability, pond slopes.
- Ability to perform work

  Review if adequate construction access and easements are available. Check to see if there may be permitting restrictions.
- Citizen involvement

  Use resident complaints and feedback to help drive the matrix.

LONG-TERM

1. **Rehabilitation**
   - Testing and Permitting

     Once a stormwater pond has been prioritized to be rehabilitated, sediment testing within the pond needs to be conducted in order to determine sediment management levels. Also, the estimated excavation volume will determine permitting requirements. This information will be used in writing the project specifications for the contractor to properly bid the project construction cost.
   - Dredging and Disposal Costs

     Sediment testing, dredging, and disposal costs should be calculated to help determine if the project is feasible given available funding source(s). Understanding planning level costs is critical to this decision. Also expanding excavation should be considered beyond original as-built design if Walker Method is not met with sediment removal as determined from the inspection process. This cost would need to be analyzed separately from the methods provided in this report.
   - Specify Dredging Technique if necessary

The owner can specify the dredging technique but it may come at an additional cost if a contractor has a better method. It is recommended to allow a contractor flexibility in the means and methods, which will likely translate into a more competitive bidding environment. To summarize, mechanical dredging in the winter is most common in Minnesota utilizing a backhoe/excavator. Other forms of mechanical excavation include utilizing a dragline dredger or crane with clamshell bucket. Less common is hydraulic dredging which can occur from a floating dredge or utilizing pumps from shore.

- Tracking Dredging Activities

  Once the project is bid and a construction contract is awarded it is crucial that proper inspection occur. The owner's inspector needs to verify correct permits were obtained, verify quantity of sediment removed, verify tracking reports, perform as-built survey, and ensure that the recipient of dredged materials signs a declaration of acceptance and intent for the re-use of dredged sediment. If management levels do not allow for re-use then the inspector must verify the material was properly disposed of at an MPCA permitted landfill. In addition to these major points, the inspector must ensure the contractor is properly addressing site controls such as dewatering, erosion prevention, and sediment control.

2. **Maintenance Protocols (Long-Term)**

   - Erosion prevention and sediment control

     Cities must always ensure construction sites are utilizing best management practices (i.e... silt fence and fiber blankets) to prevent sediment from flowing downstream. Cities must also perform street sweeping on a regular basis especially in early spring. Cities must install and regularly clean sump manholes and grit chambers just upstream of ponds.

- <u>Routine pond maintenance</u>

  Cities must conduct regular inspections of stormwater ponds to verify proper functioning of inlets and outlet and address any scouring concerns. Trash pickup, vegetation management, catch basin cleanup, and minor removal of sediment deltas needs to occur on a routine basis. These activities can help increase the time between rehabilitation treatments.

- <u>Ordinances</u>

  Cities can adopt ordinances that ban use of products containing polycyclic aromatic hydrocarbons which will ultimately decreases disposal costs.

3. **Funding**

   Finally, in order to successfully move forward with rehabilitative efforts, cities need to plan for large capital expenditures. Cities need to perform planning level cost estimates and program prioritized projects in the capital improvement program. In order to program the projects in the capital budget the staff must ensure proper revenues are incoming through sources such as stormwater utility fees and the general tax levy. Cities need to analyze stormwater utility fee rates to determine increases to allow for a proactive approach by addressing rehabilitation. Fee increases are likely in order to start meeting the rehabilitative need. Many cities do not take into account stormwater pond rehabilitation costs in their current rate structures. For those cities without a stormwater utility fee, it may be time to re-evaluate if this path is sustainable. The most politically acceptable solution is the stormwater utility fee which was authorized by the Minnesota Legislature in 1983. The revenue collected is better tracked and must be directly invested into stormwater related activities. Lastly, cities must prepare for the inevitability of system-wide stormwater pond rehabilitation. Based on numerous factors such as public awareness, regulations, and improper functioning, the rehabilitative effort will likely occur sooner than later.

8.1 DELTA (Δ) INFRASTRUCTURE SYSTEMS ENGINEERING

Stormwater ponds are and will remain an integral part of the stormwater management system. Unlike bridges and roads, these assets are more obscure yet have the similar importance. Stormwater ponds make development possible by controlling runoff rates which prevents downstream erosion and flooding. But more recently these assets are being recognized for their value in removing pollutants from stormwater runoff. Cities must begin treating these assets with the same care as roads and bridges which in many cases will require rehabilitation due to lack of maintenance and sedimentation prevention. Stormwater ponds must be addressed on a system-wide basis to maintain the necessary functionality of these invaluable infrastructure assets.

Rehabilitation of these assets will take a great amount of additional funding that most cities have not yet accounted for. A financial management framework must be developed to ensure these assets are properly addressed and rehabilitated.

Cities need to begin tracking stormwater ponds in an asset management system. Even by taking the short-term steps outlined in this report, cities can produce a full accounting of these assets and begin to better track life cycle and needs.

Lastly, stormwater ponds are an integral part of a cities infrastructure system network and all cities need to start treating these unseen assets as they do roads and bridges.

9.0 FUTURE RESEARCH NEEDS

Collecting additional information on specific project costs based on sediment management levels is needed. Extensive information is not known at this time but as cities begin rehabilitating stormwater ponds, additional information will become available to allow for a more accurate cost equation.

Further research is needed to understand how the type of land-use affects a stormwater pond's rate of sedimentation and pollutant concentrations. Judy Crane from the MPCA is currently gathering samples from stormwater ponds located in residential, commercial, and industrial land-use areas. This could be the first step in understanding a correlation between pollutants types/concentrations and specific land-use zones. This information could be a valuable tool to help cities with a prioritization matrix in order to realize the greatest benefit on a limited budget.

Once cities begin inspecting stormwater ponds this data could be assembled and used to understand the rate of sedimentation within certain land-use areas. The useful life of a stormwater pond within a land-use area could be better defined by knowing the current sediment volume and when the pond was originally constructed. In addition to better understanding defining a pond's useful life, the cost of pond rehabilitation within residential, commercial, and industrial land-use areas should be better defined. Just as information in this report helps with planning level costs, equations could be developed to further refine cost estimates within each land-use area, with the understanding disposal costs may vary widely based on pollutant loading variations.

10.0 RESOURCES

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APPENDIX A

No.	City	Population	Functionality Importance				Rehabilitation Importance				Existing Rehabilitation/ Maintenance Program		Conduct Systematic Testing		Driver to Rehabilitate				How to Fund					Main Obstacle			
			Great	Some	Little	Not	Great	Some	Little	Not	Yes	No	Yes	No	Residents	Regulatory	Function	Other	Utility Fee	Tax Levy	Special Assess.	Grants	Other	Staffing	Funding	Cost	Access
1	Albert Lea	18,000	1				1					1		1		1			1	1					1		
2	Bemidji	15,000		1			1					1		1	1				1								
3	Blaine	57,000	1				1				1			1		1			1						Need for testing pond sediment		
4	Bloomington	89,000	1				1				1		1		1		1		1						1		
5	Brainerd	13,350		1				1			1			1		1			1	1						1	
6	Brooklyn Park	72,000	1				1				1			1			1		1						1		
7	Burnsville	61,000		1				1			1			1			1		1						1		
8	Chaska	23,000		1				1				1		1			1		1						Difficulty in operation		
9	Chisholm	4,960		1				1				1		1			1			1	1	1		1			
10	Coon Rapids	63,000	1					1				1	1				1		1								1
11	Eagan	65,000	1				1				1			1		1			1							1	
12	Elk River	23,000	1				1					1		1	1					1					1		
13	Grand Rapids	10,000	1				1				1			1			1		1						1		
14	Hastings	23,000	1				1				1			1			1			1					1		
15	Hopkins	17,000	1				1				1			1				1	1						Low priority		
16	Hugo	12,000	1				1					1		1			1			1					1		
17	Inver Grove Heights	33,000	1				1					1		1			1			1						1	
18	Lakeville	50,000	1					1			1			1		1			1							1	
19	Little Canada	10,000		1				1			1			1		1				1				1			
20	Mankato	40,000		1				1				1		1			1		1						1		
21	Marshall	13,000	1					1			1			1			1		1							1	
22	Minneapolis	382,618	1				1				1			1		1	1		1						1		
23	Monticello	11,000	1				1				1			1		1			1	1		1	1		1		
24	Moorhead	36,012	1				1				1			1		1			1					1			
25	North Branch	10,300	1				1				1			1	1				1	1	1				1		
26	North St. Paul	12,000		1			1				1			1		1			1						1		
27	Oakdale	28,000		1				1			1			1			1		1						Too many agencies		
28	Owatonna	25,000	1					1				1		1			1		1			1				1	
29	Plymouth	72,000	1				1				1		1			1			1							1	
30	Ramsey	24,000	1					1				1		1		1			1					1			
31	Red Wing	16,000	1				1					1		1			1		1						1		
32	Richfield	33,000	1				1				1			1	1				1			1			1		
33	Rochester	100,845		1				1			1			1	1				1							1	
34	Roseville	34,000	1				1					1		1			1		1					1			
35	Shokopee	32,000	1				1					1		1	1		1						1	1			
36	Shoreview	28,000	1				1				1			1			1		1	1					1		
37	South St. Paul	20,000	1					1				1		1			1		1							1	
38	St. Cloud	68,000	1				1					1		1			1			1		1				1	
39	Stillwater	18,000	1					1				1		1			1		1						1		
40	Vadnais Heights	13,000		1				1				1		1	1				1	1							1
41	White Bear Lake	25,000	1				1					1	1		1					1	1				1		
42	Woodbury	59,000	1				1				1			1		1			1		1	1				1	
		TOTALS	31	11	0	0	26	16	0	0	23	19	4	38	9	13	22	1	33	14	4	6	2	6	18	11	2

Questionnaire mailed and compiled by Michael W. Thompson, 2009. Forty-two respondents out of sixty-seven polled.

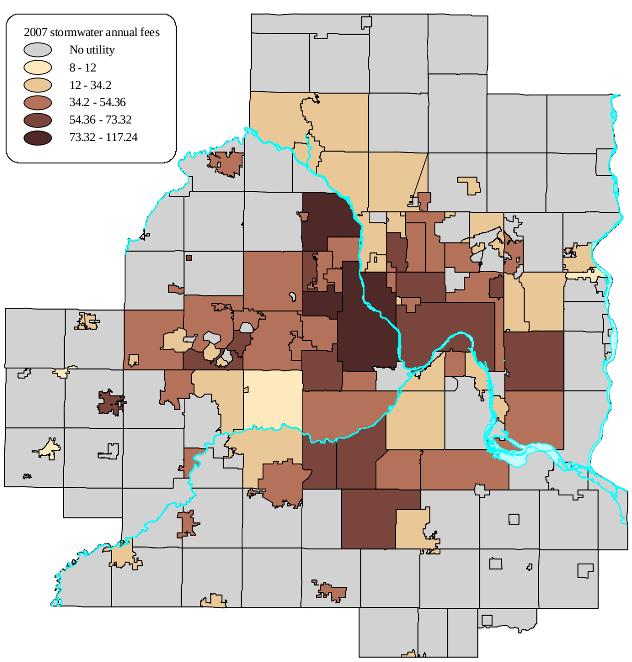
APPENDIX B

Financing Water Quality Management & Stormwater Utilities

Financing stormwater facilities became a little easier and a great deal more predictable in 1983 when the Minnesota Legislature authorized local governments to create "stormwater utilities" (Minnesota Statutes section 444.075). This legislation authorizes communities and counties to levy user charges for the use and the availability of stormwater facilities and for connections to them. One metropolitan area watershed district also has used this provision of the law to create a stormwater utility. Funds obtained through a stormwater utility fee must be dedicated to the purpose for which they were obtained. This allows a community to look ahead several years, plan for facilities and programs necessary to meet local needs and federal and state requirements for stormwater management, and build a fund with the fees that will allow it to meet the needs in an orderly fashion.

As requirements for stormwater management have grown over the last 20 years, so has the number of communities that have created a stormwater utility. A 2007 survey by the Metropolitan Council shows that 83 communities now have a utility (see **Map 1**). This is a significant increase since the 1997 survey that reported 45 utilities.

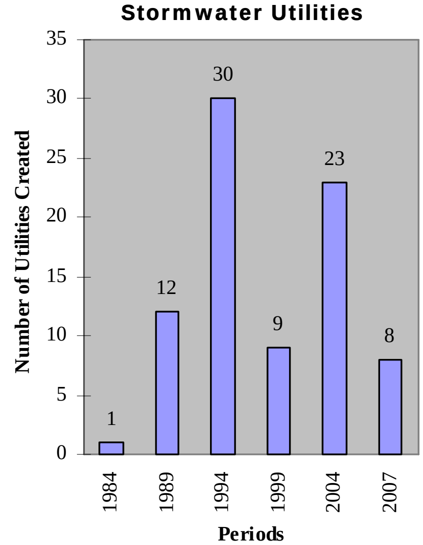
Map 1. 2007 Stormwater Utility Fees
(in dollars)



Note: the stormwater utilities for Blaine and St. Paul Park, while shown on this map, will not be in effect until Jan. 1, 2008.

Figure 1, which depicts the formation of utilities since 1983, shows two periods with a large increase in the formation of stormwater utilities. The first increase, in 1990 to 1994, is related to the Minnesota Board of Water and Soil Resources' adoption of rules for watershed plans and local stormwater management plans. For the first time the preparation of local stormwater management plans was mandated by statutes and state rules; communities reacted by creating a dedicated source of revenue that would allow them to meet the mandate.

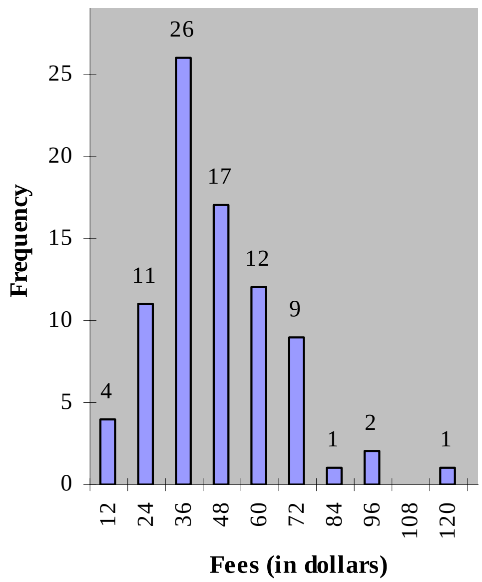
Fig. 1. Formation of Stormwater Utilities



The second sharp increase in utilities came during the 2000-2004 period. This period saw the U.S. Environmental Protection Agency impose new rules for municipal stormwater management for every urban area with 10,000 or more inhabitants or a population density of 1,000 or more persons per square mile. These new rules implemented best management practices, monitored runoff discharges and met various other requirements spelled out in a permit issued to a community under the National Pollutant Discharge Elimination System (NPDES) permit program. In the metropolitan area, 120 out of 185 communities must have an NPDES permit for stormwater management (see **Table 1**).

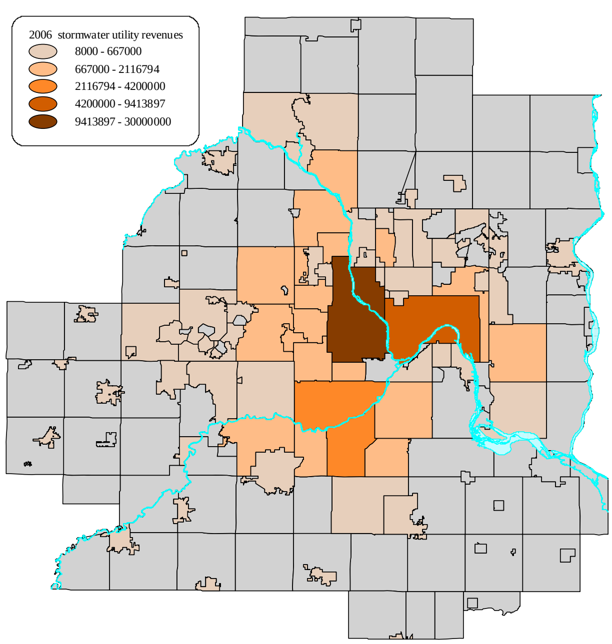
Figure 2 depicts the range in utility fees for 2007. The mean annual fee charged by communities is nearly $41 with a low of $8 and a high of about $117.

Fig. 2. Distribution of Stormwater Utility Fees



As reported by 78 utilities, in 2006, this fee-based revenue ranged from $30 million in Minneapolis to $8,000 in Watertown (**Table 1** and **Map 2**). Total revenues for 2006 reported by these 78 utilities exceeded $81 million, while expenses for stormwater were $79 million.

Map 2. 2006 Stormwater Utility Revenues
(in dollars)



Some communities had a surplus, which they banked for the future when more expensive projects may be implemented. This practice allows communities to steadily maintain the utility charge.

The stormwater utility charge is generally used for operation and maintenance of stormwater facilities, construction and improvements, as well as costs associated with activities required of communities under the federal NPDES permit process. Seventy-two percent of the communities use the fees for permit activities or water quality management. Eighty-nine percent of them provide exemptions from the fee for such land use as public streets and highways, public parks and undeveloped land. Fifty percent of the communities with a stormwater utility provided credits for stormwater facilities constructed and maintained by property owners.

The 1983 law that enables communities to create stormwater utilities is an invaluable tool for meeting increasing stormwater management requirements. The required dedication of the revenues provides transparency in the finances of the stormwater utility—a plus with local residents.

For more information about the Metropolitan Council's Stormwater Utility Survey, please contact:
Marcel Jouseau, 651-602-1145;
marcel.jouseau@metc.state.mn.us.

Metropolitan Council
Environmental Services

Table 1. Twin Cities Metropolitan Area – Stormwater Utility Fees
Communities beginning A-R (continued on back)

Community	Utility	Created	2007 Fee	MS4	NONDEG
Andover	Yes	2003	24.76	Yes	Yes
Anoka	Yes	2003	21.12	Yes	
Apple Valley	Yes	1988	47.76	Yes	Yes
Arden Hills	Yes	1993	34.60	Yes	
Belle Plaine	Yes	1999	33.00		
Birchwood Village	No			Yes	
Blaine	Yes	2007	21.00	Yes	Yes
Bloomington	Yes	1988	54.36	Yes	Yes
Brooklyn Center	Yes	1991	51.44	Yes	
Brooklyn Park	Yes	2002	96.00	Yes	Yes
Burns Twp.	No			Yes	
Burnsville	Yes	1992	70.80	Yes	Yes
Carver	Yes	2004	39.96	Yes	
Centerville	Yes	1997	20.00	Yes	
Champlin	No			Yes	
Chanhassen	Yes	1994	31.20	Yes	Yes
Chaska	No			Yes	Yes
Circle Pines	Yes	2005	36.00	Yes	
Columbia Heights	Yes	1999	29.52	Yes	
Coon Rapids	Yes	2002	34.20	Yes	Yes
Corcoran	No			Yes	
Cottage Grove	Yes	2001	42.00	Yes	Yes
Credit River Twp.	No			Yes	
Crystal	Yes	1991	37.20	Yes	
Dayton	No			Yes	
Deephaven	Yes	1994	60.00	Yes	
Dellwood	No			Yes	
Eagan	Yes	1990	30.56	Yes	Yes
East Bethel	No			Yes	
Eden Prairie	Yes	1994	12.00	Yes	Yes
Edina	Yes	1985	57.56	Yes	Yes
Elko New Market	Yes	2000	54.00		
Empire Twp.	No			Yes	
Excelsior	Yes	1999	31.92	Yes	
Falcon Heights	Yes	1986	39.00	Yes	
Farmington	Yes	1989	34.00	Yes	Yes
Forest Lake	No			Yes	
Fridley	Yes	1985	13.20	Yes	
Gem Lake	No			Yes	
Golden Valley	Yes	1992	88.00	Yes	
Grant	No			Yes	
Greenwood	No			Yes	
Ham Lake	No			Yes	
Hastings	No			Yes	
Hilltop	No			Yes	
Hopkins	Yes	1989	54.00	Yes	
Hugo	No			Yes	
Independence	No			Yes	
Inver Grove Heights	No			Yes	Yes
Jackson Twp.	No			Yes	
Jordan	Yes	1995	37.08		
Lake Elmo	Yes	2003	30.00	Yes	
Laketown Twp.	No			Yes	
Lakeville	Yes	1994	63.00	Yes	Yes
Landfall	No			Yes	
Lauderdale	Yes	1994	30.00	Yes	
Lexington	No			Yes	
Lilydale	No			Yes	
Lino Lakes	No			Yes	
Little Canada	No			Yes	
Long Lake	Yes	1999	43.20	Yes	
Loretto	Yes	2003	66.00	Yes	
Louisville Twp.	No			Yes	
Mahtomedi	Yes	2001	42.08	Yes	
Maple Grove	No			Yes	Yes
Maple Plain	Yes	2005	35.64	Yes	
Maplewood	Yes	2003	49.44	Yes	Yes
Mayer	Yes	2005	8.00		
Medicine Lake	No			Yes	
Medina	No			Yes	
Mendota	No			Yes	
Mendota Heights	Yes	1993	20.00	Yes	
Minneapolis	Yes	2005	117.24	Yes	
Minnetonka	Yes	2003	48.60	Yes	Yes
Minnetonka Beach	No			Yes	
Minnetrista	Yes	1992	36.00	Yes	
Mound	Yes	2001	25.92	Yes	
Mounds View	Yes	1993	30.00	Yes	
New Brighton	Yes	1994	58.60	Yes	
New Hope	Yes	1991	73.32	Yes	
New Prague	Yes	1992	31.68		
Newport	No			Yes	
North Oaks	No			Yes	
North St. Paul	Yes	1990	64.20	Yes	
Northfield	Yes	1986	25.27	Yes	
Norwood Young America	Yes	2003	12.00		
Oak Grove	No			Yes	
Oak Park Heights	Yes	1999	12.00		
Oakdale	Yes	2002	20.00	Yes	
Orono	Yes	2001	39.16	Yes	
Osseo	Yes	2007	36.00	Yes	
Pine Springs	No			Yes	
Plymouth	Yes	2001	51.96	Yes	Yes
Prior Lake	Yes	1993	36.00	Yes	Yes
Ramsey	Yes	2000	31.16	Yes	
Richfield	Yes	1985	39.60	Yes	
Robbinsdale	Yes	1985	47.40	Yes	
Rogers	Yes	2002	36.00		

Table 1. Twin Cities Metropolitan Area – Stormwater Utility Fees
Communities beginning R-Z (continued)

Community	Utility	Created	2007 Fee	MS4	NONDEG	Community	Utility	Created	2007 Fee	MS4	NONDEG *
Rosemount	Yes	1992	42.88	Yes	Yes	Stillwater	Yes	1996	18.00	Yes	
Roseville	Yes	1984	60.60	Yes		Sunfish Lake	No			Yes	
Savage	Yes	1994	70.56	Yes	Yes	Tonka Bay	Yes	1993	13.60	Yes	
Shakopee	Yes	1985	33.73	Yes	Yes	Vadnais Heights	Yes	1992	36.00	Yes	
Shoreview	Yes	1991	43.60	Yes		Victoria	Yes	1997	40.00	Yes	
Shorewood	Yes	1993	60.48	Yes		Waconia	Yes	1992	60.24	Yes	
South St. Paul	Yes	2003	30.00	Yes		Watertown	Yes	2003	18.00		
Spring Lake Park	No			Yes		Wayzata	Yes	1991	39.96	Yes	
Spring Lake Twp.	No			Yes		West Lakeland Twp.	No			Yes	
Spring Park	No			Yes		West St. Paul	Yes	2006	37.00	Yes	
St. Anthony	Yes	1992	52.00	Yes		White Bear Lake	No			Yes	
St. Bonifacius	Yes	2004	20.00	Yes		White Bear Twp.	Yes	1992	24.00	Yes	
St. Louis Park	Yes	2000	46.00	Yes	Yes	Willernie	No			Yes	
St. Paul	Yes	1986	57.80	Yes		Woodbury	Yes	1992	66.00	Yes	Yes
St. Paul Park	Yes	2007	32.00	Yes		Woodland	No			Yes	

* Utility — An ordinance that authorizes the community to charge a fee on each property for stormwater management.
2007 Fee — The yearly dollar amount charged an average residential property for stormwater management.
MS4 — A community with a separate storm sewer system which is required to meet federal requirements for stormwater management.
NONDEG — A community that is not allowed to increase its stormwater pollutant loads to streams or lakes above that of year 1988 level.

Metropolitan Council
Environmental Services
390 Robert St. North
St. Paul, MN 55101-1805

TO:

APPENDIX C

Table 5: Dredged material soil reference values

Parameter	Level 1 Soil Reference Value (SRV) (mg/kg, dry weight	Level 2 Soil Reference Value (SRV) (mg/kg, dry weight)
In-organics-Metals		
Arsenic	9	20
Cadmium	25	200
Chromium III	44,000	100,000
Chromium VI	87	650
Copper	100	9,000
Lead	300	700
Mercury	0.5	1.5
Nickel	560	2,500
Selenium	160	1,300
Zinc	8,700	75,000
Barium	1,100	18,000
Cyanide	60	5,000
Manganese	3,600	8,100
Organics		
PCBs (Total	1.2	8
Aldrin	1	2
Chlordane	13	74
Endrin	8	56
Dieldrin	0.8	2
Heptachlor	2	3.5
Lindane (Gamma BHC)	9	15
DDT	15	88
DDD	56	125
DDE	40	80
Toxaphene	13	28
2,3,7,8-dioxin, 2,3,7,8-furan and 15 2,3,7,8-substitued dioxin and furan congeners	0.00002	0.000035
Polycyclic Aromatic Hydrocarbons (PAHs)		
Quinoline	4	7
Naphthalene	10	28
Pyrene	890	5,800
Fluorene	850	4,120
Acenaphthene	1,200	5,260
Anthracene	7,800	45,400
Fluoranthene	1,080	6,800
Benzo (a) pyrene (BAP)/BAP equivalent	2	3
*Benzo (a) anthracene	*Dibenz (a,h) anthracene	*3-Methylcholanthrene
*Benzo (b) fluoranthene	*7H-Dibenzo (c,g) carbazole	*5-Methylchrysene
*Benzo (j) fluoranthene	*Dibenzo (a,e) pyrene	*5-Nitroacenaphthene
*Benzo (k) fluoranthene	*Dibenzo (a,h) pyrene	*1-Nitropyrene
*Benzo (a) pyrene	*Dibenzo (a,i) pyrene	*6-Nitrochrysene
*Chrysene	*Dibenzo (a,l) pyrene	*2-Nitrofluorene
*Dibenz (a,j) acridine	*1,6-Dinitropyrene	*4-Nitropyrene
*Dibenz (a,h) acridine	*1,8-Dinitropyrene	
*7,12-Dimethylbenz[a]anthracene	*Indeno (1, 2, 3-cd) pyrene	

***The results for these analytes should be added together and treated as the BAP equivalent which is compared against the soil reference value for Benzo (a) pyrene, above**