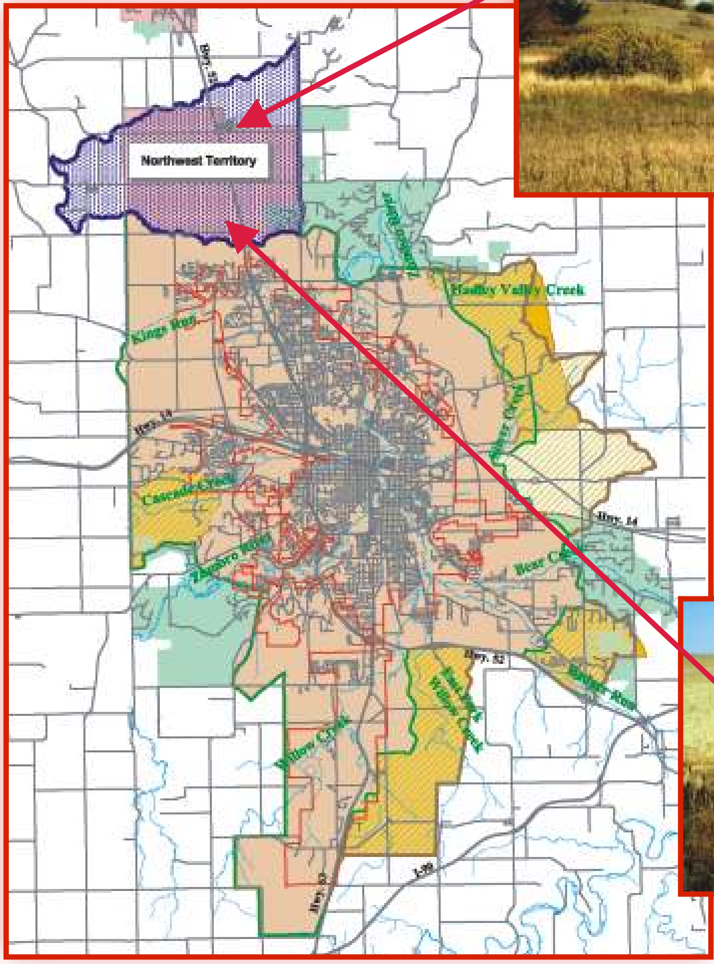
ROCHESTER MINNESOTA

Rochester

Storm Water Management Plan

Northwest Territory Addendum

March 2004



Bonestroo
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Anderlik &
Associates
Engineers & Architects

Rochester Storm Water Management Plan
Northwest Territory Addendum

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1. Introduction

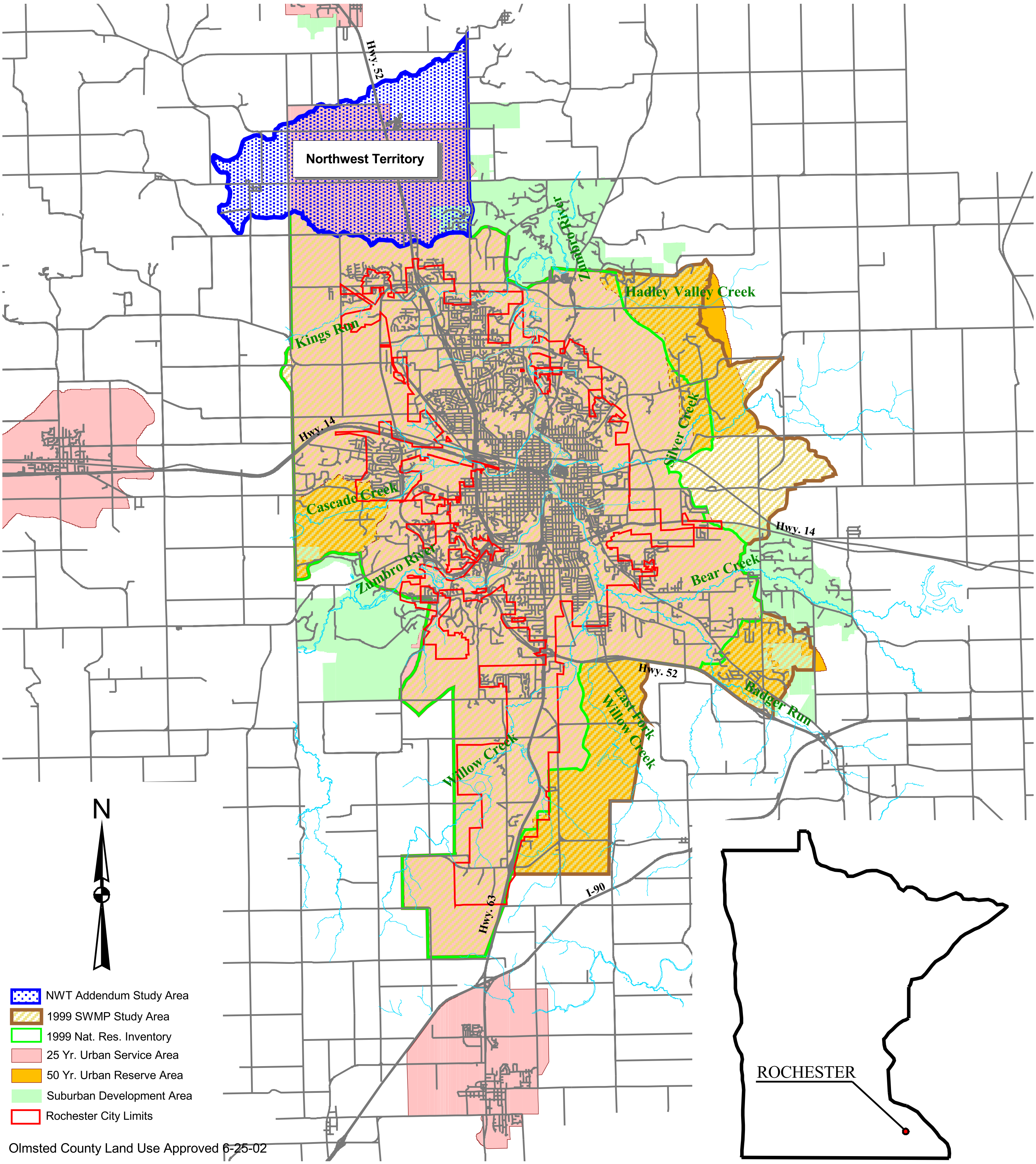
In response to rapid population growth, the City of Rochester undertook a storm water planning effort in 1995. A Steering Committee was formed to guide the development of Rochester's Storm Water Management Plan (SWMP), which was published in 1997 and updated in 1999. This report, the "Northwest Territory Addendum" (NWTA), was prepared as an Addendum to the 1999 SWMP to assess the geographic area known as the Northwest Territory, which was added to the City's 25-year Urban Service Area in 1999. This region is expected to undergo a significant transformation from rural agricultural land use to residential, commercial and industrial land uses in the near future. Figure 1-1 illustrates the study area for the original SWMP, as well as the location of the major drainage District that encompasses the portion of the Rochester Urban Service Area known as the Northwest Territory.

The following excerpt from the 1999 SWMP summarizes the main intent of the SWMP and this Addendum to that plan.

"The plan creates a balance between development and natural resources that meets the needs of individuals, businesses, and the community while integrating natural processes with resources. Citizens, agencies, developers, and industry work together to implement the plan and to collectively manage growth by creating developments that accomplish surface water management goals and create more desirable properties."

This Addendum builds upon the concepts, framework and knowledge developed for the 1999 Rochester SWMP. Using an integrated approach, storm water quantity and quality, wetlands and natural resources have been evaluated to create a comprehensive guide for the development of the storm drainage infrastructure in this study area. Capital improvements were identified and area charges were calculated to determine funding needs for the extension of storm water management facilities into this area.

Aside from the geographic area being evaluated, the approach to prepare this Addendum differs only slightly from the 1999 SWMP. Listed below is a summary of notable differences between this Addendum and the 1999 SWMP:



LOCATION MAP - NORTHWEST TERRITORY

ROCHESTER, MINNESOTA

FIGURE 1-1

ROCHESTER STORM WATER MANAGEMENT PLAN - NORTHWEST TERRITORY ADDENDUM

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- The basic principles and tenets established by the Steering Committee for the 1999 SWMP are integrated into this Addendum. The planning process for this Addendum utilized a technical focus group comprised of City and County staff to provide input and information.

- The 1999 SWMP presented several alternatives for financing options to implement the infrastructure costs. This Addendum relies on the 1999 SWMP as the source for financing alternatives and does not include a discussion of this subject. An area charge is the preferred method for assessing costs and fees for infrastructure expansion as determined in the 1999 SWMP and is also utilized in this Addendum.

- This Addendum integrates discussions and recommendations for the protection and management of wetland resources within the Northwest Territory, unlike the 1999 SWMP. Analysis and recommendations for the protection and management of wetland areas located in the original SWMP study area are contained in the 1998 Rochester Comprehensive Wetland Management Plan.

- The 1999 SWMP format has been utilized for this NWTA. However, the 1999 SWMP addressed NPDES recommendations and requirements in Chapter 7 and this chapter has been replaced by the topic of wetlands in the NWTA. The reader is encouraged to refer to the 1999 plan for details on the NPDES program and requirements.

The 1999 SWMP divided the City of Rochester into eight major drainage Districts. The NWTA creates an additional major drainage District for planning and management purposes. While this report is considered an Addendum to the original 1999 SWMP, it is important to note that this report serves to define management practices and development guidelines specific to the Northwest Territory and the resources contained within the Northwest Territory. Should discrepancies be discovered between this Addendum and the 1999 SWMP, this Addendum shall take precedence as the planning document.

The contents of this Addendum serve to create a framework for decisions when reviewing urban development concepts for the area. Additional engineering and design will be required based on site-specific criteria at the time improvements are implemented.

1.1. Study Area

The NWTA study area of 7,540 acres was formed by a combination of existing roadways and minor drainage District boundaries that encompass the Urban Service Area within the Northwest Territory. Figure 1-1 illustrates the NWTA study area and the current Urban Service Area boundaries. The NWTA study area is roughly bounded on the south by 65th Street NW and on the east by 18th Avenue NW. The west boundary lies approximately one-half mile west of County Road 3, encompassing the town of Douglas. From there, the north study area boundary progresses until rejoining 18th Avenue NW.

There are four minor drainage Districts within the Northwest Territory major drainage District. The general location and corresponding acreage are summarized in the following table.

Table 1-1 NWTA Minor Drainage Districts

Minor Drainage District	Abbreviation	Acreage
West	NW-1	1,237
Central	NW-2	3,089
East	NW-3	1,504
Northeast	NW-4	1,710*
TOTAL		**7,540**

*547 acres of NW-4 are located within the 25-yr Urban Service Area

It is important to note that Districts NW-1 and NW-4 are largely outside of Rochester's Urban Service Area. The land and water resources within Districts NW-1 are not specifically detailed and assessed as part of this Addendum. District NW-1 is included to more accurately model the downstream storm water conveyance, detention, and treatment system. Details are also not included in this Addendum for the area in NW-4 located outside of the 25 Urban Service Area. District NW-4 includes area located outside the study area. Evaluation of these additional portions of District NW-4 is included to ensure that the proposed drainage system does not negatively impact the downstream developed properties.

The remaining minor Districts (NW-2, NW-3, and the portion of NW-4 located within the 25-yr Urban Service Area) were further broken down into Subdistricts. A list of these Subdistricts and their sizes can be found in Appendix A. The location of these minor Districts and Subdistricts are shown on Maps 1 through 3 and are specifically labeled on Map 2, found at the back of this report.

1.2. General Description

The Northwest Territory is anticipated to receive considerable future development as the City of Rochester continues to grow. The anticipated future population in this study area is estimated to grow to 30,000 people. The existing transportation network is only moderately developed. The minor roads are constructed at the perimeter of township sections. The minor arterial roads are a combination of gravel and paved rural section. Trunk Highway (T.H.) 52 passes through the study area. Construction has begun on improvements to the segment of T.H. 52 within the study area. Plans include reconstruction of the T.H. 52 mainline, design and construction of overpasses at 65th Street NW and 85th Street NW, and design and construction of a vehicle interchange at 75th Street NW.

2. Goals and Policies

2.1. Background

The 1999 SWMP utilized the guidance of a Steering Committee to assist with the establishment of goals and policies for that plan. Due to the size of the original study area and the complexity and diversity of resources that exist in the original study area, it was essential to gather input from a broad base of individuals with experience and expertise relevant to the development of the management plan.

The Northwest Territory Addendum study area is much smaller than the 1999 SWMP study area and the resources in the area are physically less complex. This allowed for this Addendum to rely on the original goals and policies that were developed for the 1999 SWMP. These guidelines reflect the collective interests and expectations for the City of Rochester for water resources management as related to: existing natural features within the study area, future development, and regulatory compliance with natural resource-related ordinances.

2.2. General Objectives, Goals, and Policies

This Section presents the goals and policies taken directly from the 1999 SWMP that form the framework of the City's storm water management strategies, including the Northwest Territory Addendum study area. The general objectives of the 1999 SWMP and this Addendum are as follows:

- **Minimize** flooding, erosion and sedimentation problems generated by surface flows.
- **Improve** water quality in all protected waterbodies by treating runoff from the upstream drainage area.
- **Protect** groundwater quality and quantity by allowing for passive treatment and infiltration of storm water.

- **Promote** groundwater recharge by creating additional ponding areas.

- **Protect and Enhance** water recreational facilities and fish and wildlife habitat.

- **Preserve** vegetation around storm water detention areas by leaving them in a natural state to promote wildlife habitat, maintain natural aesthetics, and reduce maintenance.

- **Reduce,** to the greatest practical extent, the public capital expenditures necessary to upgrade the storm water system to meet water quantity and quality standards.

Refer to Section 2.3, pages 16-22 of the 1999 SWMP for further details.

3. Land Characteristics

3.1. Topography and Drainage

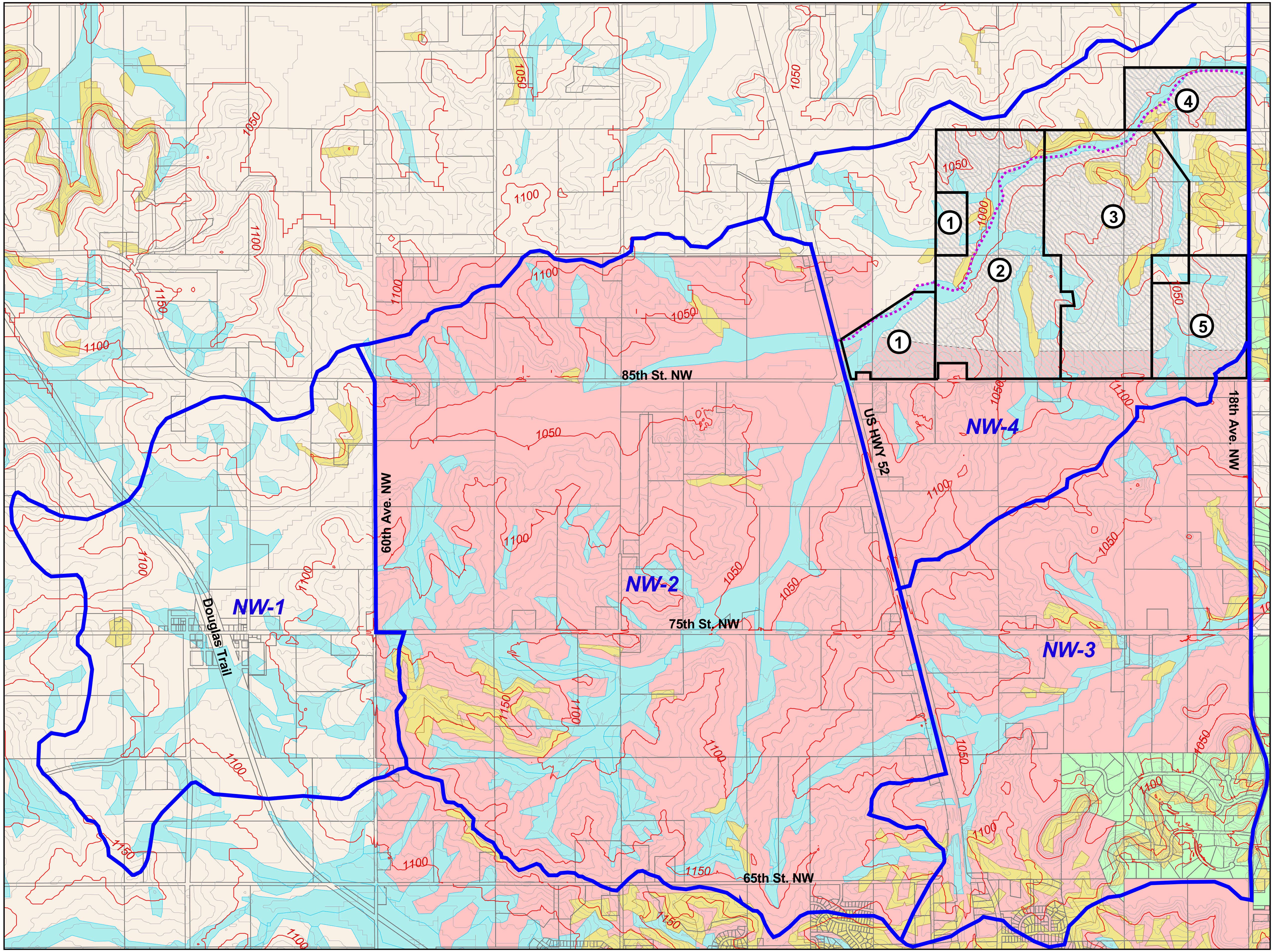
The Northwest Territory ranges in elevation from a low of about 985 to a high of 1188 feet above mean sea level. Figure 3-1 illustrates 10-foot contour data for the study area. The area is well-drained, consisting of a system of intermittently wet natural channels which dissect the terrain. The upstream portions of the drainage system are characterized by moderately steep to steep slopes, ranging from 12% to 35%. Best management farming practices have preserved the stability of the land cover that drains the watershed.

The dendritic (tree-like) drainage network precludes a significant amount of existing depressional storage. There are no lakes or ponds within the study area. Historically, several wetland complexes have existed, however, many of them have been drained for agricultural purposes. Chapter 7 provides a detailed overview of wetlands within the study area.

DNR Public Waters and FEMA Floodplain information has been examined within the limits of the NWTA study area. No FEMA floodplain restrictions were found in the HVA study area. One DNR protected water (stream) was found and can be seen on Map 1, located at the end of this report.

3.1.1. District NW-1

This area is characterized by rolling hills and moderate topographic relief. Slopes are approximately 5%, but the central portion of the drainage area is relatively flat. The Douglas Trail, a Minnesota Department of Natural Resources (DNR) state trail, has been developed along this level part of the watershed. The drainage of NW-1 is reasonably developed. There are several small valleys in the upper portion of the watershed which direct overland flow to small grassed ditches or channels. These visible paths of surface flows are oriented towards the northeast. The flows converge immediately downstream of the Douglas Trail into a defined shallow waterway and exit the drainage area under 60th Avenue NW between 75th Street NW and 85th Street NW.



City of Rochester

CONSTRAINTS TO DEVELOPMENT

DUE TO SOIL TYPE

Rochester Storm Water Management Plan - Northwest Territory Addendum

Figure 3-1

Legend

- Minor Drainage Districts
- Highly Erodible Soils
  Soil Classifications: 11C 27C 73F 99D2 173F 251F 251G 283E 301C 309D 322C 322D 322E
- Hydric & Floodplain Soils
  Soil Classifications: "Floodplain Soils" "Hydric and Floodplain Soils" "Hydric Soils"
- Developed Properties
  1. Oronoco Estates Mobile Home Park
  2. Shamrock Enterprise Quarry
  3. Minnesota PCA Closed Landfill Site
  4. Oronoco Prairie Scientific & Natural Area
  5. Wetland Banking Site
- 25 Yr. Urban Service Area
- Suburban Development Area
- Resource Protection Area
- DNR Protected Water - Tributary Stream
- Minor Contour (10' interval)
- Major Contour (50' interval)

N W E S

2000 0 2000

Feet

ROCHESTER MINNESOTA

March 2004

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1) Data in map are in Olmsted County Coordinate System.
2) Olmsted County Land Use Approved 6-25-02.
3) Soil Survey information is distorted due to process of original map digitization.
Acquired from LMIC in 2003 - last update (conversion to shapefiles) in 2001.

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3.1.2. District NW-2

District NW-2 is comprised of numerous undulating rises and high points. The ridges lead to the formation of somewhat steep (5% - 12%) upstream valleys and a well-developed drainage network. The topography in the upstream reaches of the minor District is complex, with the direction of surface flows following several orientations. The northeast portion of the watershed becomes level and wide, due to the confluence of the two stream channels that have formed. The channels converge adjacent to the Oronoco Estates mobile home park, northeast of the intersection of Highway 52 and 85th Street NW.

3.1.3. District NW-3

This drainage area has irregular slopes, ranging from 4% to 35%. In the southern portion of this watershed, steep slopes and small valleys are common. Here, knobs of resistant bedrock remain while less resistant soils have eroded and formed the channels that drain predominantly towards the east boundary of the study area. Several tributary drainageways exist that converge to one defined channel. Generally, storm water runoff is conveyed by this main channel and exits the drainage area at a major culvert crossing under 18th Avenue NW just north of 75th Street NW. There are other existing minor culvert crossings under 18th Avenue NW but these are considered negligible in terms of overall District drainage area and crossing capacity.

3.1.4. District NW-4

The topography in District NW-4 consists of gradual rises and valleys. Land slopes vary between approximately 4% and 10%. The lowest elevation in the study area is located in this watershed. Although some slopes are moderate to fair in steepness, the overall change in elevation is gentle. District NW-4 is drained by one main channel that runs through the central portion of the area. This channel has been designated by the DNR as a Protected Water from T.H. 52 to the Zumbro River confluence. Several tributary channels feed to this main channel. The main channel discharges to the east under 18th Avenue NW.

3.2. Soils

3.2.1. Associations

Four types of major soil types are present. These soil groups, or associations, are characterized by certain drainage, relief and erosion parameters. Several minor soil types can be found within general soil types that serve to expand upon the general soil definition. General soils maps are primarily used for broad planning purposes. Details on the soils included in each association can be found in the Olmsted County Soil Survey (USDA-NRCS).

The most prevalent group in the Northwest Territory is the Racine-Floyd-Maxfield association (as classified by soil group #2 in the Olmsted County soil survey). This soil group has been formed both in loamy and silty sediments as well as in the underlying loamy glacial till. Soil group #2 consists of nearly level and gently sloping, well drained to poorly drained silty soils on uplands and upland drainageways. This association covers all of District NW-1, all of District NW-2 except the northeast portion, all of District NW-3 except the southeast portion, and approximately half of District NW-4.

In contrast, the Rockton-Channahon-Atkinson association (soil group #3) is the least prevalent soil group in the study area. Soil group #3 consists of nearly level to sloping, well drained loamy soils on uplands. This association is located in the upper northern portion of District NW-4, north of the main channel. This area is dominated by soils formed in a loamy mantle and in the underlying clayey residuum over bedrock.

The Timula-Port Byron association (soil group #6) is found in areas formed in loess. This soil group is typically characterized by well drained silty soils on uplands, but the terrain can range from nearly level to very steep slopes. The Timula-Port Byron association is found in the south half of District NW-3.

The Mt. Carroll-Marlean-Arenzville association (soil group #7) is very similar to Timula-Port Byron association with silty soils that are formed in loess and found on nearly level to steep slopes. Soil group #7 differs in that it additionally consists of moderately well drained soils and is found in floodplain regions as well as uplands. This association is located primarily in District NW-4. Soil group #7 is found in the region of the main channel that drains to the South Fork Zumbro River.

The Surficial Geology Plate of the Olmsted County Geologic Atlas indicates the presence of a large area of glacial till overlying the study area. The till can act as a confining layer that precludes migration of surface water to underlying soil and bedrock units. However, in areas where the till is dissected, the till edge can allow the discharge of the subsurface water to the ground surface. Further discussion is provided in Section 5.3 regarding surface water-groundwater interactions, modeling and management.

3.2.2. Hydric and Floodplain Soils

Section 3.2 of the 1999 Rochester SWMP discusses the significance of hydric soils in determining the presence of wetlands. In the 1999 SWMP, Table 3-1 lists the soil types that are identified on the Olmsted County hydric soil list. The Rochester-Olmsted Planning Department uses the "hydric" and "hydric and floodplain" soils categories as indicators of possible wetland locations. The "hydric and floodplain" and "floodplain" soil categories are used to identify flood prone areas. Figure 3-1 illustrates and identifies the combined locations of these three soil categories within the NWTA study area.

3.2.3. Highly Erodible Soils

Section 3.2 of the 1999 Rochester SWMP discusses the significance of highly erodible soils. In that Section, Table 3-2 lists the highly erodible soils as identified in the Rochester Zoning Ordinance and Land Development Manual Information Supplement. Figure 3-1 illustrates where these highly erodible soils occur within the NWTA study area.

3.3. Wetlands

Within the Northwest Territory, numerous wetlands were identified by the National Wetlands Inventory (NWI). Infra-red aerial photographs were reviewed to locate other potential wetlands. Where property access was possible, wetland sites identified via both methods were field-verified to assess the status and quality of the wetlands.

Wetlands can provide water quality and quantity benefits. Wetland systems can serve to attenuate peak flows and allow nutrients, sediments and pollutants to settle out of suspension. In the Northwest Territory study area, many of the wetlands have been drained in order to sustain farming practices.

Section 7 of this Addendum provides more details on wetland information and resource management.

3.4. Land Use

The existing land use within the study area is predominantly agricultural. As noted above, the unincorporated rural service District of Douglas is included within the study area. Other residential developments include the Oronoco Estates mobile home park, and the Bandel Woodland Estates, Hillcrest North, Hidden Oaks, and Hidden Oaks Valley subdivisions.

The Douglas Trail is an important feature that is located in District NW-1. This paved trail provides recreational opportunities such as bicycling and hiking.

The land use in the Northwest Territory is dominated by agriculture, however, minor District NW-4 contains several sites that will hinder the future development of this area including: a rock and gravel quarry, an asphalt batch plant, and the closed Oronoco Sanitary Landfill. Sanitary wastewater treatment ponds are also located in NW-4 to treat wastewater from the Oronoco Estates mobile home park. The 80-acre Oronoco Prairie Scientific and Natural Area and a large wetland banking site are present at the eastern-most edge of NW-4. Figure 3-1 illustrates the land use activities that dominate area NW-4.

4. Stream Corridors

4.1. Introduction

The extensive existing network of intermittent stream channels within the Northwest Territory conveys storm water runoff, typically from west to east. The existing channels are shown on Map 1, located at the end of this report. The existing channels are situated in areas where soil types and conditions (i.e., “hydric,” “hydric and floodplain,” and “floodplain” soils categories) inhibit development. The proposed storm drainage network utilizes these existing intermittent stream channel drainageways. Under fully developed urban conditions, the proposed open channels will likely be perennially wet.

The natural, open spaces along existing channel areas provide travel corridors for wildlife. It also allows for potential native habitat restoration opportunities, such as wetlands. The proposed channel system augments these qualities by providing linear aquatic habitats. Visual and recreational enjoyment can be attained if the proposed channels are thoughtfully designed.

These features and functions lend themselves to the idea of designating, for planning purposes, multi-functional “stream corridors” that extend beyond the banks of the existing and proposed channels. The stream corridors preserve the natural drainageways, provide buffers between the channels and developed areas, allow for the future development of bicycle or pedestrian paths, provide green space and connectivity between the area’s natural resources, and allow for the movement of wildlife through fully developed areas. The following features were incorporated to define the limits of stream corridors:

- Slopes of 18% or greater (slopes of 12% or greater were used in the 1999 SWMP criteria)
- “Hydric,” “hydric and floodplain,” and “floodplain” soils locations as classified by the Rochester-Olmsted Planning Department (see Section 3.2.2 for details)
- Wetlands (both National Wetland Inventory and infra-red aerial photograph interpreted wetlands)
- Forested land identified by Minnesota Land Cover Classification System
- 100-yr high water levels for detention basins
- 50 feet from the top of bank of channels within the defined stream corridor (on both sides of the channel)

The location and extent of the stream corridors designated using these criteria is shown on Map 1 at the back of this report. A minimum stream corridor width of 50 feet from the edge of each channel bank was established. However, using the criteria noted above resulted in an average stream corridor width of approximately 500 feet.

The identification of stream corridors does not necessarily preclude development within these corridors. Their designation does, however, help identify areas where conservation design principles and natural resources stewardship should be promoted to maximize retention and restoration of the natural areas with all their functions and values.

Many of the proposed regional storm water detention basins are located within these designated stream corridors. The in-line design approach is usually not ideal for water quality purposes due to pond "flushing" during large storm events. The in-line arrangement of ponds can be beneficial for water quantity purposes, or flow rate control, when peak flows within the channel are excessive. This design approach was proposed in order to take advantage of existing road crossings to serve as control structures for ponds, where possible. The in-line design of ponds within the conveyance system allows for the direct control of peak flows and velocities within the stream corridor. This approach will protect and stabilize upstream areas from excessive erosion and downstream areas from sediment deposition. This approach also maximizes developable land by integrating the pond system into the established corridors.

4.2. Survey of Stream Corridors

Each stream corridor was evaluated utilizing a variety of techniques. USGS topographic maps and aerial photographs were studied to determine the locations of existing stream channels. Infra-red aerial photographs were utilized to assess natural communities and wetland sites within and adjacent to the streams. Critical channel sections were visited in the field to better understand existing channel conditions as well as to verify slope and conveyance capacity. In some cases, residents and business owners adjacent to stream corridors were interviewed for historic accounts of peak water levels observed within or extending beyond existing channels.

Based on a determination of the magnitude of the drainage areas, as well as the observation of numerous existing large road crossings, large runoff volumes within the channels were expected under existing conditions. However, site inspections of existing stream channels and roadside ditches revealed little visual evidence to support the preliminary conclusion that high discharge flows would occur. Debris, downstream channeling, and high water marks were not apparent in many areas where significant volumes were anticipated. These observations were supported by anecdotal evidence from local individuals who indicated that stream overflow conditions were historically rarely experienced. Based on these field observations it is suspected that infiltration of runoff and groundwater recharge is likely very significant in these drainage areas. Implementing the proposed stream corridors as well as the proposed channel drainage system may have the benefit of promoting infiltration of runoff and groundwater recharge. However, storm water runoff can convey pollutants to the groundwater as a result of infiltration. Section 10.1 of the 1999 Rochester SWMP provides a discussion of the region's groundwater sensitivity to contamination by surface water. As well, a further discussion of infiltration as it relates to computer modeling can be found in Section 5.3.

4.3. Description of Stream Corridors

It is recommended that the numerous existing natural channels within the study area be retained, utilized, and maintained for storm water management as development occurs in the Northwest Territory, rather than constructing a trunk storm sewer system and filling existing channels. Most of these natural channels are encompassed by the stream corridor created by the criteria listed in Section 4.1. In addition to natural channels, the stream corridors contain agricultural land that is currently in production, wetlands, and some forested land cover, as well as non-wooded upland.

4.3.1. North Fork

As can be seen on Map 1, found at the back of this report, the North Fork stream corridor is located in Districts NW-1, NW-2 and NW-4. Under existing conditions the stream corridor is only intermittently wet with no base flow. There are two main branches that comprise this corridor.

North Fork – Upper Branch

The Upper Branch stream corridor begins west of the Douglas Trail, just southwest of the unincorporated rural service District of Douglas. The combination of existing forest cover, wetlands and recreational amenities in District NW-1 are ideal for the establishment of a stream corridor. A wide and stable vegetated swale exists immediately east of the Douglas Trail that continues at a low grade throughout the upper portion of District NW-2 where the land cover is predominantly open and consists of active agricultural use.

For much of its length, the Upper Branch corridor runs adjacent to 85th Street NW for much of its length, until passing under T.H. 52. Here it joins with the Lower Branch and passes north of the Oronoco Estates mobile home park. Old-field grasses and low-growing vegetation dominates the corridor at this point. Although the corridor encompasses an area of industrial use after the mobile home park (i.e., a rock and gravel quarry and asphalt batch plant), it provides connectivity to valuable natural resources further downstream, specifically the DNR Scientific and Natural Area (the Oronoco Prairie SNA) that has been established at the downstream end of the study area. The stream corridor allows for significant wildlife habitat and travel. The stream exits the study area at 18th Avenue NW north of 85th Street NW. This channel ultimately connects with the South Fork Zumbro River, near the southern terminus of Lake Zumbro.

<u>North Fork – Lower Branch</u>

The Lower Branch stream corridor originates in District NW-2. The upper reaches of the corridor are steep and narrow. At the upstream reach, the corridor primarily consists of two separate, defined open channel tributaries. The west corridor segment contains a large wetland basin that was previously drained for agricultural purposes, as well as some forested land on upland slopes. The east corridor segment also contains areas with wetland communities.

These segments converge immediately downstream of the 75th Street NW road crossings. At this point the channel becomes significantly wider and shallower. The corridor is a vegetated swale with a stable bed and side slopes. The surrounding land use is predominantly agricultural, with very minimal shade cover. The Lower Branch corridor flows northeast through NW-2 and intersects a small wetland prior to where it crosses into NW-4 under T.H. 52 at 85th Street NW. The flow discharges into a ditch and then converges with the Upper Branch immediately upstream of the Oronoco Estates mobile home park.

4.3.2. South Fork

The South Fork originates in District NW-2 and flows through District NW-3. Under existing conditions, the stream corridor is only intermittently wet with no base flow. The upstream portion begins with two separate, defined open channels. The upper channel of this stream corridor contains wetlands classified as unique and natural. The stream corridor segments converge downstream of T.H. 52 just south of 75th Street NW. Upstream of T.H. 52, the corridor is surrounded by agricultural land use and there is minimal tree cover within the corridor. After the confluence, the South Fork stream corridor follows a northeasterly path, until it crosses under 75th Street NW and then under 18th Avenue NW, where it leaves the study area. At these lower reaches the corridor becomes more wooded and provides more diverse habitat for a variety of wildlife.

4.4. Stream Corridor Management

As previously mentioned, agricultural best management practices within the study area have preserved the integrity of the numerous natural channels that convey storm water runoff. Without proper future management, the morphological and biological integrity of the open and stream-filled channels will be degraded as development occurs. Efforts will need to be made during future development to help control erosion, maintain water quality, reserve necessary stream capacity, and protect aquatic communities. It should be reiterated that the identification of stream corridors does not necessarily preclude development within these corridors. Their designation does, however, help identify areas where conservation design principles and natural resources stewardship should be promoted to maximize retention and restoration of the natural areas with all their functions and values. Chapter 4 of the 1999 SWMP contains the strategies and practices that can be used to protect the streams and their directly connected ecosystems.

5. Storm Water Quantity

5.1. Background

As noted in the 1999 Rochester SWMP, the main purpose of the storm water quantity planning component is to serve as a guide for the expansion of the storm drainage system. This Section addresses the anticipated changes to the hydrologic regime that will occur as land use patterns shift away from the current agricultural emphasis. As the area develops, the amount of impervious land surface increases. This amplifies the volume and rate of runoff which, if uncontrolled, will increase the occurrence of local flooding and erosion damage to existing natural and constructed systems. This Section focuses on managing the increase in runoff and provides suggestions for the expansion of the storm drainage system to accommodate future development. Section 5.1 in the 1999 Rochester SWMP provides a detailed overview of the regional approach for managing storm water quantity and the associated watershed benefits.

Typically, trunk storm sewers are routinely used for storm water conveyance in developed areas. However, the regional conveyance system for the Northwest Territory study area is proposed to utilize the existing open channels. The study area contains an extensive system of well-defined channels that are considered an amenity to the area, thus they are proposed to be utilized in the future and incorporated in the proposed stream corridor. In coordination with the design of trunk storm sewers, open channels are retained in locations where future watershed development will likely result in discharge flows that would otherwise require a trunk storm sewer pipe size of 30 inches or greater. The locations of open channels within the Study Area are shown on Map 2, located at the end of this report.

5.2. Design Criteria

The following Sections provide information on the criteria applied to the design of the regional storm water quantity system. For further details regarding the rationale and underlying principles of the design criteria, refer to Section 5.2, pages 60-64 of the 1999 Rochester SWMP.

5.2.1. Precipitation

The precipitation design criteria used for the NWTA is identical to that used in the 1999 Rochester SWMP. The City of Rochester uses a 10-year frequency storm event for storm sewer design, while the greater of the 100-year, 24-hour frequency rainfall event or the 10-day snowmelt event is used for overland drainage and pond storage design.

5.2.2. Storm Water Runoff

Future runoff quantities are evaluated on the basis of the anticipated land use for an area. The design criteria include the hydrologic factors of runoff coefficient (C), runoff curve number (CN) and time of concentration (T_c). Future development conditions for the study area have not been specifically identified in Rochester Land Use Plan and Zoning Map amendments at the time of this Addendum. A mix of residential densities as well as industrial and commercial areas will likely comprise the land use. Thus, storm water runoff for the Northwest Territory was analyzed assuming a uniform curve number (CN) value of 76. This value represents a hypothetical average of moderate CN values for low-density residential land use and high CN values for commercial/industrial land uses.

For purposes of the model, normal antecedent moisture conditions (AMC II) were assumed. Similar to the 1999 SWMP, this Addendum assumes a uniform coverage of B type soils when determining the CN values for the specified land uses. The time of concentration is the time required for runoff generated in the upstream reaches of a watershed to reach the watershed outlet and is determined based on ground cover, ground slope, and distance the runoff travels. Values for the Tc were derived by varying combinations of the previously mentioned criterion. A minimum time of concentration of 15 minutes was used for this study. Runoff coefficient (C) values (for use in the Rational Method) are based on interpolations of Table 5-1 from the 1999 SWMP, Section 5.2.2, page 63.

5.3. Computer Modeling

The computer modeling software XP-SWMM was utilized to maintain consistency between the 1999 Rochester SWMP and this Addendum. Results of the computer model for the water quantity system are presented in Appendix B. The maximum peak discharge rates for the 100-year, 24-hour storm event are presented in Appendix B for all proposed pond locations. The conceptual maximum acreages the storm water ponds will cover during the 100-year, 24-hour storm event are indicated on Map 1.

The Olmsted County Geologic Atlas (Surficial Geology Plate) indicates a broad region of glacial terrace deposits in the NWTA study area, chiefly sand and gravel, which offer little resistance to surface water infiltration. The modeling of the proposed storm water system is conservative in that it does not include the suspected infiltration in the watershed area. Over time, the suspected high infiltration rates could be diminished due to the sedimentation of fine particles washed downstream during construction and from developed areas. Unless the pond and channel system is maintained as infiltration basins and infiltration swales, the system will eventually lose the existing infiltration capacity. Thus, the proposed system was designed to account for the total anticipated volume of runoff, neglecting the likely infiltration due to shallow bedrock.

The modeling of the proposed storm water system also does not account for the potential effect of groundwater exfiltration. As stated in Section 3.2.1, the soils and subsurface geologic conditions that are present in the NWTA study area can allow for the discharge of subsurface water to the ground surface in areas where the glacial till is dissected. At the time of development, a detailed model should be created to account for the potential impact of groundwater release, particularly as a result of additional till fractures due to development activities.

The watershed drainage area for the NWTA included a substantial area outside of the City's Urban Service Area. This includes nearly all of District NW-1 and the majority of District NW-4. Basic modeling of District NW-1 was required to produce the information upon which downstream watershed systems could be based. Further discussion of District NW-1 can be found in Section 12.2.

All of District NW-4 was included in the modeling effort although only the upstream portion of this District is located within the Urban Service Area. All of District NW-4 was modeled to ensure that existing high water levels were reproduced or reduced with a fully developed upstream area. Further discussion of District NW-4 can be found in Section 12.5.

5.4. Storm Water Conveyance Requirements

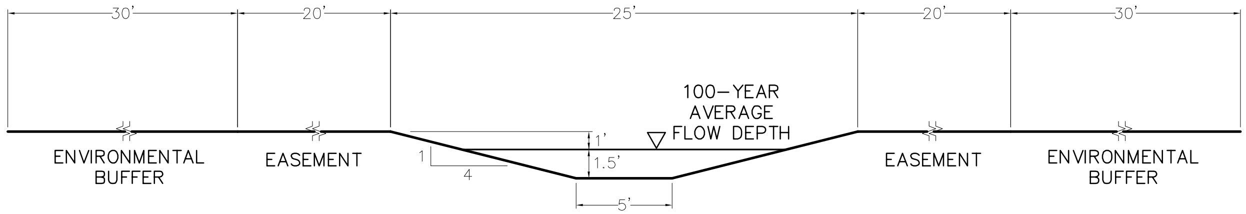
The 1999 Rochester SWMP outlines storm water conveyance requirements, which is predicated on utilizing storm sewer pipes as drainage conduits in areas with no apparent natural channels. In that plan, pipe capacity was determined based on the Manning's equation.

The approach used in this SWMP Addendum differs in that existing and proposed open channels are anticipated to serve as the primary method for transporting storm water runoff. For modeling and cost estimating purposes, a trapezoidal cross-section with 4:1 maximum side slopes (4-feet horizontal to 1-foot vertical) was the basis for design wherever existing and proposed open channels are used. The same Manning's formula was used to determine channel capacity using a roughness coefficient (n) of 0.030. Some situations will allow for the use of pipes rather than the proposed channels, though all such instances will be required to satisfy the criterion outlined in Section 8.3 of this Addendum.

The Trunk Storm Channel system portrayed on Map 2 provides a schematic layout of the future open channel drainage system. The designated locations are for planning purposes only. The final location and size of the channels will be determined at the time these areas develop.

Three types of channels are proposed for the NWTA study area. The channel types are classified based on their design conveyance capacity. Typical cross-sections for these channels are shown in Figures 5-1 and 5-2. All channels include a 20-foot maintenance buffer adjacent to each bank. The City of Rochester's Tall Grass and Weed Regulation, especially section 48.04 (b), should be consulted for proper maintenance of buffer vegetation. All channels include a one-foot freeboard above the 100-year average flow depth. The required freeboard was derived by estimating the flow depth of a discharge that is 25% greater than the maximum level of the design capacity.

TYPE 1



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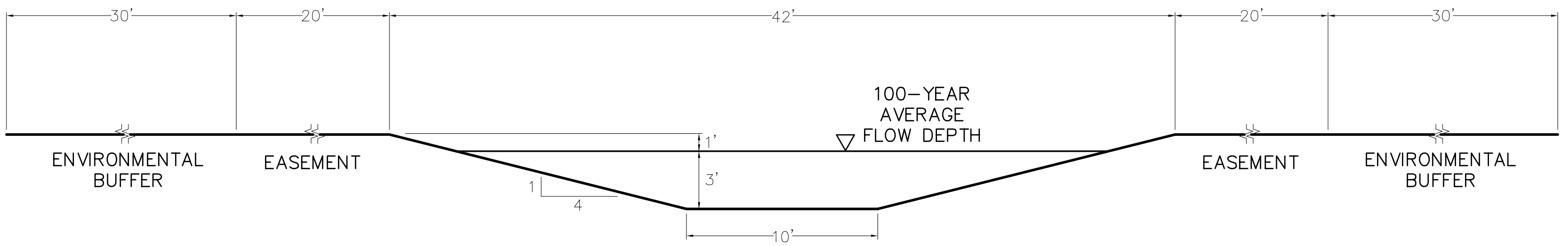

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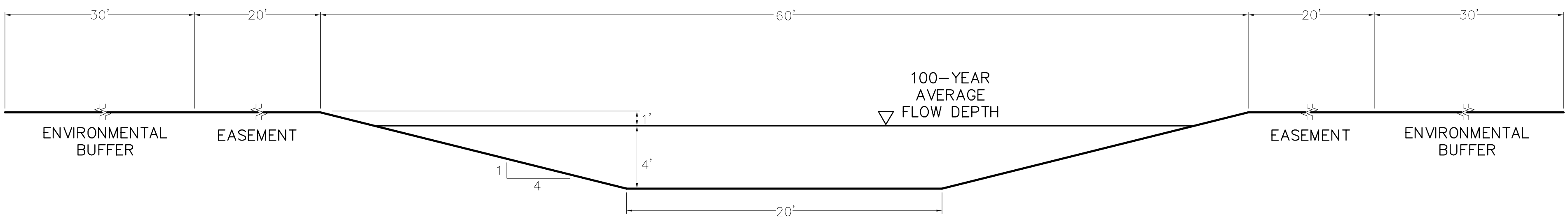

NOTE: SEE FIGURE 5-2 FOR TYPICAL CROSS SECTIONS

MINIMUM CHANNEL WIDTH & BUFFER REQUIREMENTS

ROCHESTER, MINNESOTA

FIGURE 5-1

ROCHESTER STORM WATER MANAGEMENT PLAN – NORTHWEST TERRITORY ADDENDUM

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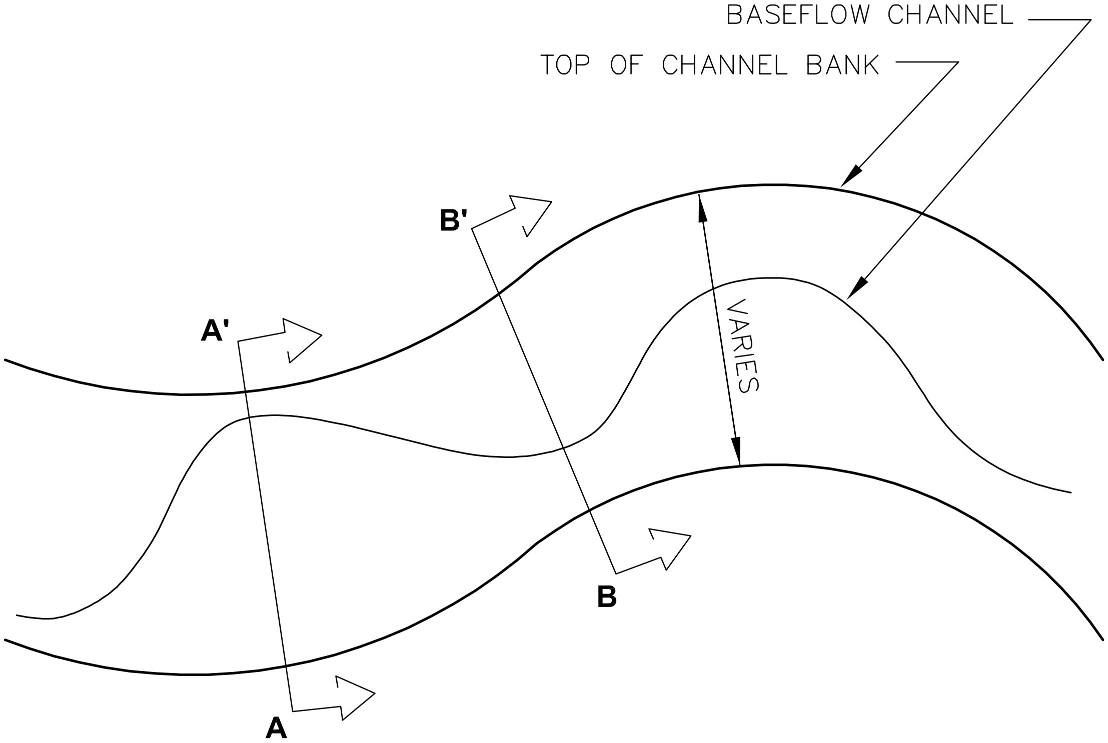
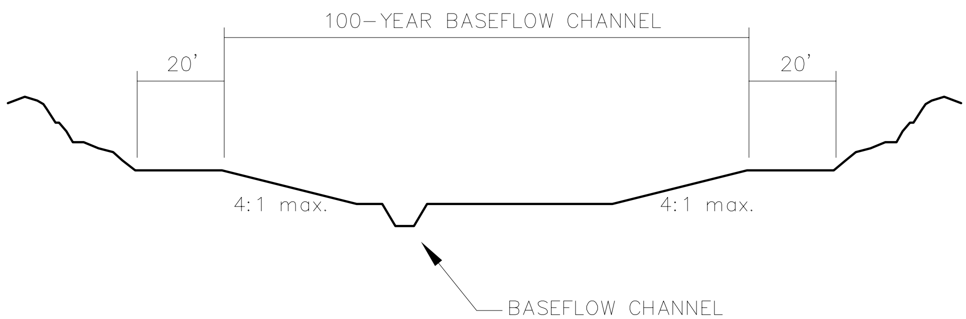
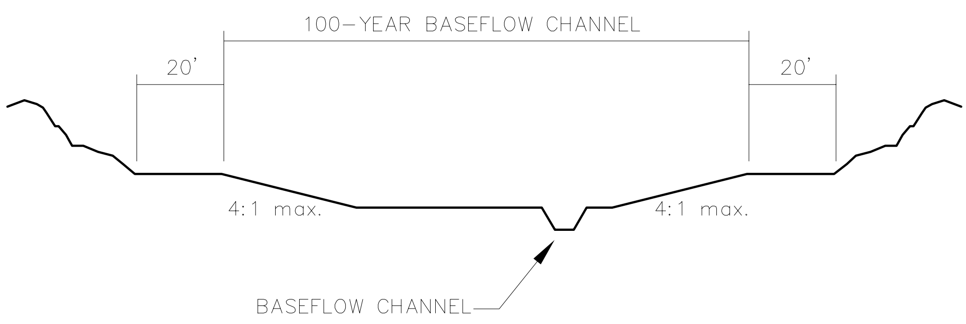
BUFF_REQ.DWG 2-2-27 COMM. 363-01-128



PLAN VIEW



SECTION A-A'



SECTION B-B'

TYPICAL CHANNEL CROSS SECTIONS

CITY OF ROCHESTER FIGURE 5-2

ROCHESTER SWMP - NORTHWEST TERRITORY ADDENDUM

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TYP_CHAN_XSEC.DWG 3-21-02 COMM. 36301128

Table 5-1 illustrates the classification and criteria for the three channel types for the NWTA.

Table 5-1 Channel Classifications

Channel Classification	Typical Slope	100-yr Design Conveyance Capacity	Maximum Design Conveyance Capacity[1]
Type NWT-I	1.5%	0-150 cfs	188 cfs
Type NWT-II	0.75%	151-500 cfs	625 cfs
Type NWT-III	0.25%	501-900 cfs	1125 cfs

[1]This is 25% above the highest discharge value for 100-yr design conveyance capacity.
cfs = cubic feet per second

Proposed capital improvement investments to the three stream types are considered under one of two approaches:

- Stream stabilization – This includes incorporating materials and components that will protect the stream channel from degrading or eroding as a result of receiving increased volumes under developed conditions. Stabilization techniques include minor shaping, seeding (MN/DOT 26B "ditch mix" is recommended), placement of erosion control blanket where needed, and mulching and disk anchoring.

  For planning and cost estimation purposes, stabilization efforts are included in this SWMP Addendum at all reaches where existing channels are already defined with conveyance capacities that are sufficient to accommodate proposed discharges. The specific reaches should be identified and defined during the design and implementation phases of the storm water system. (Map 2 shows a schematic layout of the conveyance system and potential channel classifications.)

- Stream improvement – This includes existing reaches that require substantial deepening and/or widening of the channel in areas where the existing drainageway does not have sufficient conveyance capacity to accommodate runoff under fully developed conditions. Stream reaches that are significantly unstable should also be considered under this approach. The specific reaches should be defined during the design and implementation phases of the storm water system.

  For planning and cost estimation purposes, stream improvements are included in this SWMP Addendum at all proposed reaches where substantial slope or channel deepening or widening is anticipated. Improvement activities will include significant channel excavation and regrading, installation of step weirs every 500 feet for Type NWT-I channels and every 1,000 feet for Type NWT-II channels, as well as activities noted in stream stabilization, to improve the stability and capacity of the stream. The design criteria of each specific reach should be defined during the design and implementation phases of the storm water system. (Map 2 shows a schematic layout of the conveyance system and potential channel classifications.)

Specific criteria for determining stream stabilization or improvement efforts can be applied at the time of development or infrastructure improvement implementation. The following criteria are guidelines to help distinguish between channel investment needs.

- Conveyance capacity – Affected reaches should be modeled at the time of proposed development. The existing channel conveyance capacities should be compared to proposed runoff discharges as well as the criteria outlined in Table 5-1. If existing channel conveyance capacities are sufficient under proposed conditions, then stabilization efforts should be required. If additional capacity is needed, then improvement efforts will be required.

- Grade/slope – In reaches where sufficient conveyance capacities exist, longitudinal slopes up to 2% should not require improvement measures. Reaches with longitudinal slopes from 2-4% will likely require step weirs and selective placement of rip-rap. Reaches with slopes greater than 4% are typically highly unstable. Storm water flows are recommended to be piped in areas with longitudinal slopes greater than or equal to 4%.

- Velocity – Where channel velocities are anticipated to be greater than 5 feet per second (fps), erosion of grassed channels is likely. The design of channels that will produce high velocities should be avoided. When high velocities are unavoidable, step weirs and selective placement of rip-rap should be considered.

5.5. Storm Water Detention Basin Requirements

Incorporating ponding areas as recommended in this NWTA is important to maintain channel stability. The pond system provides rate control and allows discharge rates to fall within the prescribed limits for the designated channel type. Ponding areas provide the necessary storage required to retain high intensity storm water runoff peaks and reduce the possibility of flooding downstream. The storage requirements established for each pond must be maintained to prevent property flooding. The discharge flow rates computed for each ponding area must also be maintained to ensure that the storage volume provided is used and downstream flows are not exceeded. The peak flows indicated in the plan for proposed basins occur at the high water level, usually under pressurized conditions. Any pond discharge between 6 and 20 cubic feet per second (cfs) will have a two-stage outlet while any discharge above 20 cfs will have a three stage outlet.

Because of the permeable nature of the terrace deposits, the shallow depth to bedrock, and the fracture flow conditions in the uppermost limestone bedrock, a site-specific investigation of soil conditions, geologic features and infiltration capacity is recommended prior to any improvements for construction of storm water ponds or other storm water management infrastructure improvements. As well, site-specific land use, soils and geological features should be considered at the time of development to properly size ponds. Any implementation of a retention facility or other infrastructure improvement should be designed and carried out in conformance with the City of Rochester's engineering design standards. The Zoning Ordinance and Land Development Manual of the City of Rochester, Minnesota, effective January 1, 1992 and updated October 7, 2002, provides guidance on these standards and general requirements.

6. Storm Water Quality

6.1. Background

The main purpose of the storm water quality portion of the 1999 SWMP is to provide guidelines for protecting and improving the water quality of Rochester's lakes, streams, wetlands and ground water. This Section of the NWTA discusses the recommended practices for implementing construction and post-construction best management practices (BMPs) in the Northwest Territory as required by the NPDES Phase II rules to meet the intent of the 1999 plan. Construction BMPs are intended to reduce the pollutant loads associated with construction phase activities, while post-construction BMPs are intended to reduce the pollutant loads associated with urban land use.

6.1.1. Best Management Practices

The City recognizes that it is essential to promote, preserve, and enhance the quality of the water resources in the study area, and to protect those resources from adverse effects caused by changes in land use. To protect water quality in the study area, erosion control measures are essential in limiting the loading of sediments, phosphorus, and other pollutants and minimizing the need for future restoration programs.

The implementation of erosion control is most important during the construction phase of development when erosion rates can be 10 to 100 times the rate of undisturbed areas. In areas where extensive development is taking place, storm water discharging to streams and wetlands frequently contains substantial quantities of solids and other pollutants. Even with extensive erosion control practices, sediment, dissolved contaminants, and airborne particulates can enter the City's surface waters.

Table 6-1 indicates the standard storm water best management practices that should be considered during the preparation of all development grading plans that are submitted to the City for review. Refer to Section 50.01(2) of the Rochester Code of Ordinances and the City's grading plan checklist for identification of the information to be included in a grading plan (Internet accessible at www.ci.rochester.mn.us). Further information can also be found in the Zoning Ordinance and Land Development Manual of the City of Rochester, Minnesota, effective January 1, 1992 and updated October 7, 2002.

In addition to the BMPs listed in Table 6-1, City Staff may require additional practices based on the specific conditions of a particular grading site. The MPCA's Urban BMP Handbook is one resource that provides information on many more best management practices that are available.

Table 6-1 Construction BMPs

Practice	Intended Result
Temporary Sediment Basins	Limit sedimentation rate during construction
Seeding Requirement / Schedule	Stabilize soils soon after grading completion
Storm Sewer Inlet Protection	Prevent sediment from entering storm sewer
Filter Fabric Fence Placement	Limit sediment in overland flow
Fit Development to Existing Terrain	Limit changes in topography and drainage
Limit Area of Disturbance	Reduce the amount of exposed soils
Phasing of Earth Work	Limit amount of soil exposed at one time
Scarification of Surfaces to be Seeded/Sodded	Maintain infiltration rates and promote establishment of vegetation
Stabilized Vehicle Exit	Reduce amount of mud tracking onto streets

Even with the best and most expensive solids removal system in place, contamination of ponds, streams and wetlands will occur if land developers and land owners do not conscientiously manage their activities. Developers must utilize best management practices to minimize erosion during home construction in addition to the mass-grading phase. Property owners must use care in the development of their yards and sodding of bare areas. Debris is frequently raked from lawn areas before and after sodding and left in the street gutters which, if not cleaned up, will be washed into the storm sewer, eventually reaching public waters.

Seeding and mulching is the most effective method of controlling erosion at the point of inception. The establishment of turf and disk anchoring of mulch stabilize the soil to help prevent erosion from occurring. Disturbed areas should be seeded as soon as grading is completed or if disturbed areas will be left for long periods of time. The Minnesota Department of Transportation Specification Book provides a detailed description of seed mixtures and placement guidelines.

Stabilized vehicle exits provide an area where mud from vehicle tires can be removed. This reduces tracking of mud onto local streets where it can enter the storm sewer system and be transported to downstream waterbodies. A major portion of soil that is tracked onto streets occurs during the building construction phase of development. Prior to the construction of the foundation or basement of structures, a minimum size of 1-inch clean should be placed in the driveway location to provide a stable access to the site.

It is important that an inspection program and enforcement procedures be developed for erosion control on construction sites. The Minnesota Pollution Control Agency reviews and enforces erosion control for construction sites disturbing one or more acres through the NPDES program. However, a limited number of MPCA staff is responsible for the entire state and are not likely to field inspect a particular site unless a violation is reported. The protection of local water resources is best served through regular site erosion control inspections. Additionally, the City has a Storm Water Pollution Prevention Plan that addresses construction site and post-development erosion control as part of its storm water management permit for municipalities.

The City requires that grading permit applications address the manner in which soil erosion and sedimentation will be minimized during site development. Conformance with erosion control plans should be field checked during the early phases of mass grading and periodically until turf has been established on the site.

6.1.2. Conservation Practices

Several conservation practices are essential in reducing the rate of erosion and sedimentation. Conservation practices can significantly preserve water quality downstream. The City of Rochester will give consideration to proactive and preventative measures and will strive to find partners for addressing conservation practices. The following list highlights some of the more common conservation practices.

1. *Implementation of regional storm water basin approach* - Regional storm water facilities can reduce discharge rates and improve water quality for large drainage areas when properly designed and located in a watershed. Regional facilities are recommended and described in Chapter 12.

2. *Buffer Areas* - The establishment of buffer areas along existing and future drainageways and streams provide filtration of sediments and pollutants in storm water runoff and stabilize stream banks against erosion and stream meandering.

3. *Top Soil* - A minimum of four inches of good quality top soil should be placed over disturbed areas to aid in the establishment of vegetative cover for soil stabilization. When needed, proper fertilization is recommended.

4. *Preservation of Existing Wetlands* - Existing wetlands provide natural water quality ponding for storm water runoff and contaminant filtration capacity. When wetland impacts cannot be avoided and minimized, they must be mitigated according to the Wetland Conservation Act provisions, preferably at the subwatershed level, to provide replacement of water quality functions.

5. *Location of Development* - Areas with existing steep slopes or areas of highly erodible soils should be preserved to the greatest extent possible. These areas are identified on Figure 3-1.

6. *Sedimentation Ponds* - Areas with moderate to highly erodible soils may require permanent on-site sedimentation ponds prior to discharging runoff to downstream regional storm water facilities. Proposed development within areas containing highly erodible soil units shall include permanent BMPs to minimize chronic erosion problems. Additional conservation practices may be required at the discretion of City Staff.

7. *Ravines and Stream Banks* - An on-going program should be developed to field identify ravine and stream bank stabilization problem areas based on information collected on the geology of the stream bed, soil conditions and anticipated land use.

8. *Bioretention and Biofiltration* - The use of bioretention (rainwater gardens, infiltration trenches, depressed medians and parking lot islands) and biofiltration (grassed swales) should be encouraged where site conditions are suitable. These practices can provide treatment and some measure of volume control of storm water.

6.1.3. Storm Water Basins

Storm water basins, also referred to as detention ponds, are the most common and cost-effective BMP used for treatment of post-construction storm water runoff. Although other BMPs are available, storm water ponding areas are the most utilized means to reduce the amount of pollutants being transported into receiving waters. They provide locations where sediments and many pollutants can settle out and be effectively removed from storm water runoff.

In coordination with the 1999 SWMP, this NWTA uses a regional storm water pond approach by locating storm water facilities to serve approximately 75- to 200-acre drainage areas. The regional approach provides for more efficient maintenance by centralizing pond areas in fewer locations. This approach also provides cost-effective design by maximizing the total provided ponding volume while minimizing the required land acquisition and construction expenditures.

Map 1 shows effective locations for storm water basins, all of which provide water quality treatment functions. However, the preliminary locations are identified in areas that provide for the economical and effective construction of these facilities, but are for planning purposes only and may not be constructed in the exact locations shown.

6.2. Storm Water Management Basin Types

This NWTA incorporates large-scale regional ponds into the infrastructure for storm water management. The final engineering of these regional ponds will likely feature 2- or 3-cell designs. The proposed regional ponds identified in the NWTA serve the combined functions of rate control, sediment removal and nutrient removal. Section 6.2 of the 1999 SWMP provides more detail about the types of storm water management basins, their characteristics, and their respective benefits.

6.3. Design Criteria for Water Quality

Special attention should be given to the design of water quality ponds in areas of high infiltration. It is desirable and highly recommended to pre-treat concentrated runoff prior to infiltration. Storm water quantity and quality ponds should be designed to maximize infiltration rates where practicable.

The design criteria for wet detention basins outlined in Section 6.3 of the 1999 SWMP are to be used for the design of ponds proposed within the NWTA study area. The area and depth of ponds proposed in future developments may differ from the values presented here, but the wet volumes recommended in this NWTA should be maintained so that the prescribed phosphorus loading of the system is not exceeded.

6.4. Water Quality Model

To maintain consistency with the 1999 SWMP, the same computer modeling software (XP-SWMM & P8) and approach was utilized for the NWTA. Section 6.4 of the 1999 SWMP provides an overview of the water quality modeling process. Appendix C lists the results of the water quality modeling process.

7. Wetlands

7.1. Background

7.1.1. Wetland Inventory and Assessment Method

The wetland inventory was organized within the context of the 1999 SWMP and this NWTA. Wetland identification numbers used for the wetland inventory are based on the minor drainage Districts defined in the NWTA. Wetland identification numbers used in this plan are based on the minor District numbers followed by a number or letter to identify the wetland within that District. A number was used for the identification of the wetland if the wetland is shown on the National Wetland Inventory Map. A letter was used for the identification if the wetland was not on the National Wetland Inventory Map. The wetland designations, locations, estimated boundaries, and classifications are shown on Map 1 and 3.

The wetland inventory and assessment process involved the following steps:

- Identification of wetlands within the project area
- Review of existing data about the project area, including "hydric" and "hydric and floodplain" soils, rare features records, DNR inventory data, and other sources
- Field inventory and assessment of each site where access was allowed
- Infra-red aerial photograph review for sites where access was not granted or confirmed
- Qualitative ranking of each community according to criteria established by MnRAM
- Qualitative ranking of each wetland, based on community type and quality
- Storm water susceptibility rating for each site, based on community type and quality
- Determination of potential mitigation and/or banking sites, based on ease of hydrologic restoration and size of basin
- Obtain permission from property owners to access wetland(s)

7.1.2. Wetland Mapping

The ARC/INFO® Geographic Information System (GIS) was used to aid in the inventory and final mapping of wetlands within the study area. The GIS database provides the City with a map that can be updated and integrated with other GIS-mapped data. The locations of wetlands, their estimated boundaries, and their wetland management classifications are used to guide the protection strategies applied to each.

Preliminary layouts for future development should consider the wetland boundaries on the map as a guide. The City Zoning Ordinance and Land Development Manual requires that wetlands information be submitted as part of the general development plan, platting, and grading plan processes. As a rule, property owners and developers delineate wetland boundaries early in the development process to avoid filling, draining, or dredging of jurisdictional wetlands and buffer zones.

7.1.3. Minnesota Routine Assessment Method Version 2.0

Wetlands are valued for the wide range of functions they perform, such as improving water quality, attenuating floodwater, recharging ground water, and providing wildlife habitat. Recently, wetland scientists have developed methods to assess the functions of individual wetlands. The assessment evaluates characteristics such as plant community diversity and structure, connectivity to other habitat types, location in the watershed, and a wide range of other factors. The assessment is like a “report card” which evaluates the wetland’s functions and quality.

The Minnesota Routine Assessment Method Version 2.0 (MNRAM) was used to assess the functions of the wetlands field-visited for this plan. This method was developed by the Minnesota Interagency Wetland Group as a field evaluation tool to assess wetland functions on a qualitative basis. It is intended to document the field observations and interpretations of professionals who have had training and experience in wetland science. This method is not intended to be a rigid procedure, but rather an aid to complement trained observation and interpretive skills with additional qualitative evaluation.

Thirty-nine of the 54 mapped wetlands within the Northwest Territory were visited by trained personnel and assessed for Floral Diversity/Integrity and Wildlife Habitat wetland functions. All property owners that had wetlands within their property were contacted for access. There were 14 wetlands that access was not granted or access from the property owner was not confirmed during the inventory effort. These wetlands were assessed utilizing infra-red aerial photographs. A copy of the modified field version of MNRAM is presented in Appendix D. Each wetland was assessed and assigned a rank that reflected the value of the functions it provides. Wetlands were ranked as Exceptional, High, Medium/High, Medium, Medium/Low, Low or Not Applicable for each function assessed. Summaries of the wetland functions assigned to each wetland assessed, infrared review and field visits completed are presented in Appendix E.

All of the MNRAM data sheets were entered into a database to be used by the City. The database allows for quick retrieval of information for each wetland and allows queries to be performed to complete special searches within the database. For example, a search can be done to list all the wetlands that have high floral diversity.

7.1.4. Procedures for Wetlands Not Inventoried as Part of this Plan

Wetlands shall be further assessed and delineated at the time that a project is proposed. Map 3 of this Addendum shows the classification of wetlands that have already been field visited and classified for management utilizing a filled out MNRAM forms. A wetland professional hired by the applicant or the City shall apply the MNRAM assessment for additional wetlands that may be found on-site at the time of the delineation. The cost of the assessment, if conducted by the City, will be charged back to the applicant. The City will determine the ranking for each wetland function using the completed MNRAM form submitted by the applicant. The City or the applicant may request the use of a Wetland Conservation Act Technical Evaluation Panel to make a decision on the ranking of the wetland's functions. Final classification of the wetlands will be determined by the City using the information contained within the completed MNRAM and applying the criteria outlined in Section 7.2.1.

7.2. Wetland Management and Protection

7.2.1. Wetland Management Classification Methodology

After completion of functional values assessments, each wetland was classified to determine which future management recommendations would apply, based on functional value and its integrity as compared to other wetlands in the area. These management classifications were developed in 1995 with input from a Wetland Focus Committee, a subset of the 1999 SWMP Steering Committee, and were applied to the NWTA wetlands.

Wetlands have been classified into four categories: Unique, Natural, Ecosystem Support, and Ag/Urban Impacted, using floral diversity/integrity and wildlife habitat as the main criteria. These two functional values offer the best description of the wetlands' current conditions and how those compare to unaltered conditions.

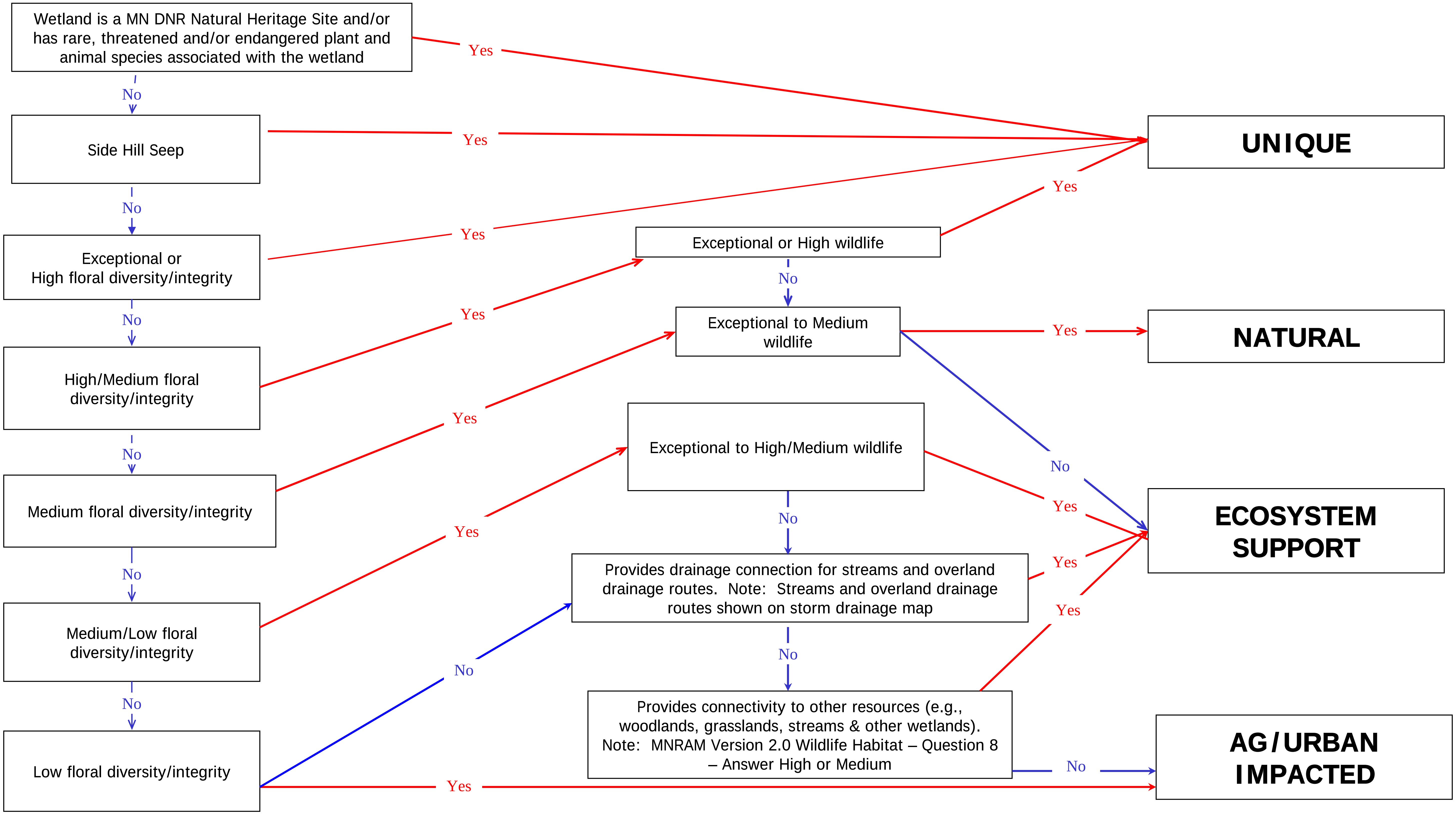
Other criteria were also considered in refining the management classifications and goals. For example, wetlands may be classified as *"Ecosystem Support"* based on the value of the upland ecosystems that surround them or their physical connection and/or drainage to other systems, though they may have low floral diversity and moderate wildlife habitat. Other criteria tailored for the City of Rochester and used in the classification of wetlands include the following:

- *Connectivity* - Proximity or direct connections to other wetlands and uplands increases wetland capacity to provide support to other systems such as woodlands, grasslands, other wetlands, and streams and increases habitat value for many species.
- *Habitat Components* - Wetland capacity provides seasonal or intermittent habitat components (e.g., amphibian breeding areas and resting/feeding area for migratory waterfowl/shorebirds).
- *Alteration* - The degree to which the wetland has been altered and manipulated by human activities, such as agricultural tillage, storm water discharges, or other urban development.
- *Location/Size* - Larger wetlands that are part of complexes or connected to valuable aquatic or terrestrial resources are usually assumed to be of higher value than extremely small and isolated remnants.

The Management Classification Flow Chart, as shown in Figure 7-1, describes the decision making process used to determine how each wetland has been classified for management. A summary description of each of the classifications is provided in the following Section. Appendix E lists the classification for each wetland in the Northwest Territory study area.

7.2.2. Wetland Classification Summary

Unique Wetlands: The classification "unique" is used for wetlands that exist in a largely unaltered state or have hydrogeomorphic conditions to create side hill seep wetlands. Side hill seeps, even those with low floral diversity, are included in this classification because the ground water filtration and recharge functions warrant this level of protection. Side hill seeps typically develop where ground water discharges as surface water due to the presence of terminal edges of confining layers. They are most common along the edges of existing river valleys, at the till edges associated with ancient buried river valleys, and at the bases of slopes separating stream terraces. Construction concerns were also a factor that caused side hill seep wetlands to be placed under this classification because construction in these areas can result in instability and flooding.



Wetland Management Classification Flow Chart **Figure 7-1**

Rochester, Minnesota

Rochester Storm Water Management Plan – Northwest Territory Addendum

363-01-128 ***cad / wetlandchrt***

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Natural Wetlands: Natural wetlands have remnant plant communities that are in a largely unaltered state and typically show little sign of impact from surrounding land usage. The vegetative communities of these wetlands are characterized by a diversity of plant species with a mixed dominance of certain species. Natural Wetlands differ from Unique wetlands because the plant communities indicate moderate disturbances (e.g., haying, grazing) and, as a result, may contain some (typically less then 50%) invasive species.

Ecosystem Support: These wetlands have usually been altered by human activities, and may be perceived as low quality systems with little value. However, the wetland inventory and assessment indicates that these areas have important values related to the integrity of upland ecosystems that surround them, or they provide linkage and/or drainage to other systems, including flood storage and ground water recharge.

Ag/Urban Impacted Wetland: This classification is for wetlands in urban or agricultural areas that are significantly altered or highly degraded from past land use practices. It does not infer that all wetlands located in agricultural or urban land use areas are highly degraded. On the contrary, as can be seen on Map 3, located at the end of this report, several high quality Unique and Natural wetlands are present in the agricultural areas of the Northwest Territory study area. Additionally, Ag/Urban wetlands differ from Ecosystem Support wetlands because they are isolated and do not provide the same drainage values or habitat links to other systems.

7.2.3. Storm Water Protection

One of the purposes of this wetland inventory was to determine storm water protection guidelines for wetlands. There are many types of wetlands, each determined by its hydrology and vegetative composition. The wetland's sensitivity to storm water input is dependent on the wetland community type and the quality of its plant community. Some wetlands (e.g., sedge meadows with carex species) are sensitive to disturbance and will show signs of degradation unless water quality, water level fluctuation (i.e., "bounce"), and the inundation period of water are maintained to pre-development conditions. On the other hand, there are other wetlands (e.g., floodplain forests) which are better adapted to handle the fluctuating water levels and influx of sediment often associated with storm water.

Site visits to the wetlands included a determination of the wetland plant community (or communities) and an assessment of Floral Diversity using the key provided in MNRAM Version 2.0. The *Guidance For Evaluating Urban Storm Water and Snowmelt Runoff Impacts To Wetlands* (prepared by the State of Minnesota Storm Water Advisory Group) was used as a guide in the determination of wetland sensitivity to storm water. This document divides wetlands into classifications that include: highly susceptible to degradation, moderately susceptible to degradation, slightly susceptible to degradation, and least susceptible to degradation. Each wetland in the study area has been given a susceptibility classification that is shown on Map 1. The following procedures were used to determine a wetland's susceptibility to storm water.

Highly Susceptible: A wetland is considered highly susceptible if:

- Forty percent or more of the wetland complex contains one or more highly susceptible wetland communities as shown in Table 7-1, below, and;
- Highly susceptible wetland plant communities have medium to exceptional floral diversity/integrity.

Moderate Susceptible: A wetland is considered moderately susceptible if:

- Forty percent or more of the wetland complex contains one or more moderately susceptible wetland communities as shown in Table 7-1, below, and;
- Moderately susceptible wetland plant communities have medium to exceptional floral diversity/integrity.

Table 7-1 Wetland Plant Communities - Susceptibility to Storm Water Impacts

Highly Susceptible Wetland Communities*		**Moderately Susceptible Wetland Communities***
Sedge Meadows	Low Prairies	Shrub-Carrs
Bogs	Coniferous Swamps	Alder Thickets
Coniferous Bogs	Hardwood Swamps	Fresh (wet) Meadows
Open Bogs	Seasonally Flooded Basins	Shallow Marshes
Calcareous Fens		Deep Marshes

* Wetland communities determined by using the key provided in MNRAM Version 2.0.

Slightly and Least Susceptible: Wetlands with low floral diversity, as determined by MNRAM, were considered to be least susceptible wetlands. Wetlands that had floral diversity that did not fall in the least susceptible category and were not high enough to be in the Moderate Susceptible category were given a slightly susceptible determination to provide appropriate storm water protection to preserve the remnant native plant community of these basins.

Water Quality

Water quality plays a significant role in the overall quality of a wetland. When the quality of the incoming water declines, the diversity of a wetland's plant community may be reduced to only those species that are tolerant of high nutrient and sediment loads. Once a wetland's plant community is changed, the wetland's character and ecosystem will change, often to a less valuable system in terms of biodiversity, habitat for wildlife, and aesthetic enjoyment. Pretreatment requirements for storm water have been developed to maintain or improve the pre-development character of the wetland. Pretreatment is most often achieved through the use of detention ponds located upstream of wetlands and vegetated buffer strips that surround the wetlands and provide filtering of sediments and nutrients. Examples of different detention pond types can be seen in Figure 6-1 of the 1999 SWMP. The phosphorus loading limitations into wetlands are presented in Table 7-2. These limitations were used in determining the maximum phosphorus discharge from ponds upstream of wetlands.

Table 7-2 Phosphorus Limitations into Wetlands

Wetland Management Category	Storm Water Phosphorus Pretreatment Requirement[1,2]
Highly Susceptible	150 ppb[3]
Moderately Susceptible	200 ppb
Slightly Susceptible	250 ppb
Least Susceptible	10 CY of dead sediment storage per acre drained[4]
Existing Streams as labeled on Map 3	10 CY of dead sediment storage per acre drained[4]

[1] ppb = parts per billion

[2] CY = cubic yards

[3] A multi-cell pond configuration with the lower cell as a constructed wetland or infiltration basin is recommended to achieve these levels of phosphorous removal.

[4] See Figure 6.1 of 1999 SWMP for design requirements. Dead sediment storage is the permanent pond volume below the outlet invert elevation.

Water Quantity

Generally speaking, storm water management plans have historically protected wetlands from the unacceptable influx of nutrients, but not from water fluctuations or extended inundation periods that can occur when land use changes to more impervious surfaces.

The NWTA addresses storm water quantity impacts to wetlands by providing protection strategies to maintain the bounce and inundation period of wetlands within acceptable levels from existing conditions. Acceptable levels of bounce and inundation are determined by a wetland susceptibility category. Wetlands have been put into the following categories: highly, moderately, slightly, and least susceptible to storm water impacts. The susceptibility categories for each wetland are shown on Map 1. The protection strategies in Table 7-3 set the acceptable bounce and inundation period requirements for wetlands based on their susceptibility category.

Table 7-3 Wetland Bounce and Inundation Period Requirements based on the Wetland Susceptibility^

Hydroperiod Standard	Highly Susceptible	Moderately Susceptible	Slightly Susceptible	Least Susceptible
Storm bounce 100-yr	Existing	Existing plus 0.5 ft	Existing plus 1.0 ft	No Limit
Discharge rate	Existing	Existing	Existing or less	Existing or less
Inundation period for 1 & 2 yr. Precipitation event	Existing	Existing plus 1 day	Existing plus 2 days	Existing plus 7 days
Inundation period for 10 yr. Precipitation event and greater	Existing	Existing plus 7 days	Existing plus 14 days	Existing plus 21 days
Outlet Invert Elevation	Note NWL* on Map	Note NWL* on Map	Note NWL* on Map (0 to 2.0 ft above existing run out)	Note NWL*on Map (0 to 4.0 ft above existing run out)

"Existing" in this chart means the existing hydrologic conditions.

^Source: MPCA 1997

*NWL = Normal Water Level. It is defined as the invert elevation of a defined outlet (culvert) or overflow elevation for a natural outlet.

7.2.4. Wetland Buffer Strip and Setback Protection

A wetland buffer is a vegetated area that surrounds a wetland and reduces negative impacts to wetlands from adjacent development. The needs identified for the establishment of wetland buffers are related to the functions that wetlands perform. Wetlands perform a variety of functions such as ground water recharge, storm water retention to improve water quality and reduce flooding, and wildlife habitat. Wetlands are often neighborhood amenities because they can provide screening from adjacent neighbors and wildlife viewing opportunities.

Wetland buffers can help mitigate potential development impacts to wetlands by reducing erosion by storm water; filtering suspended solids, nutrients, and harmful substances; and moderating water level fluctuations during storms. Buffers also provide essential wildlife habitat for feeding, roosting, breeding, and rearing of young, and cover for safety, movement, and thermal protection for many species of birds and animals.

Buffer Width Effectiveness for Wetland Protection

Buffer strips help mitigate the impacts of development adjacent to wetlands. Catch basins and storm sewers typically collect street and front yard drainage and direct the drainage to an appropriately sized pond for pre-treatment prior to discharge to a wetland or waterbody. Backyard drainage typically reaches wetlands or waterbodies without any pre-treatment, thereby allowing lawn and garden chemicals, sediments, pet wastes, fertilizer and other types of contaminants to directly impact the receiving waterbody.

Buffer strips can provide needed treatment of storm water drainage to protect wetlands from human impacts as areas develop. A secondary benefit is valuable habitat protection, especially near aquatic areas. Habitats adjacent to aquatic areas generally have a higher diversity of bird species than other habitats (Johnson, 1992). The reasons for this include: the proximity of habitat requirements (i.e., food, cover, and water), the increased number of niches (because of the wider diversity of plant species and structure), and the high edge-to-area ratio that results from the linear shape of most riparian zones (MPCA, 1997).

As the buffer width increases, the effectiveness of removing sediments, nutrients, and other pollutants from surface water increases. In addition, as buffer width increases, direct human impacts, such as dumped debris (i.e., garbage, lawn and garden cuttings, or fill) and trampled vegetation will decrease. A field study of wetland buffers in Seattle showed that 95 percent of buffers less than 50 feet wide suffered a direct human impact within the buffer, while only 35% of buffers wider then 50 feet suffered direct human impact (Schueler, 1995). An overview of scientific literature on wetland buffers suggests the following minimum buffer widths for protection of these buffer functions (MPCA, 1997):

Water Quality Protection: (Depends on vegetation, slope, density and type of adjacent land use and quality of receiving water)	25 feet or more
Protection from human encroachment:	50 – 150 feet or more
Bird habitat preservation:	50 feet or more
Protection of threatened, rare or endangered Species:	100 feet or more

Although these buffer widths are suggested by the MPCA, the Wetland Conservation Act may require a different minimum buffer width to obtain wetland credits. The most recent Wetland Conservation Act Rules should be reviewed to determine the minimum buffer width for credits.

Setbacks of 10 feet between structures and the edge of the buffer are recommended by the Minnesota Pollution Control Agency (MPCA, 1997) and have been incorporated as part of this plan to insure there is usable space between structures and buffers and to prevent encroachment of lawns into buffer areas. For purposes of this plan a structure is anything, which is built or constructed, an edifice or building of any kind, or any piece of work artificially built up or composed of parts jointed together in some definite manner.

Buffer strip features outlined in Table 7-4, below, are based on the wetland management classifications that are shown on Map 3. The purpose of these features is to mitigate the impacts (e.g., storm water, human encroachment, etc.) of development.

Table 7-4 Wetland Buffer Strip Features

Wetland Type	**Unique and Natural**	**Ecosystem Support**	**Ag/Urban Impacted**
Buffer Strip Average Width	50 feet from delineated wetland edge	25 feet from delineated wetland edge	16.5 feet
Buffer Strip Minimum Width	25 feet from delineated wetland edge	16.5 feet from delineated wetland edge	16.5 feet
Structural Setback Distance	10 feet – from upslope buffer edge to building or other structure	10 feet – from upslope buffer edge to building or other structure	0 feet
Native Vegetation in Buffer Strip	*Requirements below	*Requirements below	Optional**

*Buffer area vegetation shall be considered adequate when the buffer has a continuous, dense layer of perennial grasses, flowers, trees and/or shrubs. Vegetation shall be considered unacceptable if:

1. it is composed of noxious weeds (70% or more); or
2. topography or sparse vegetation tends to channelize the flow of surface water; or
3. for some other reason the vegetation is unlikely to retain nutrients and sediment.

**While native vegetation is not required as part of this plan, a buffer may not be acceptable for Public Value Credit under the Wetland Conservation Act if it does not contain native vegetation.

The buffer strip averages as stated above will be required for the Unique, Natural, Ecosystem Support, and the Ag/Urban Impacted Classifications. However, site-specific dimensions of the buffer strip may be adjusted with approval by the City to address the specific hydrologic and vegetative needs of the wetland, local topographic conditions, and specific site constraints. The guidance for establishing the buffer strip widths are demonstrated in Figure 7-2 and described below:

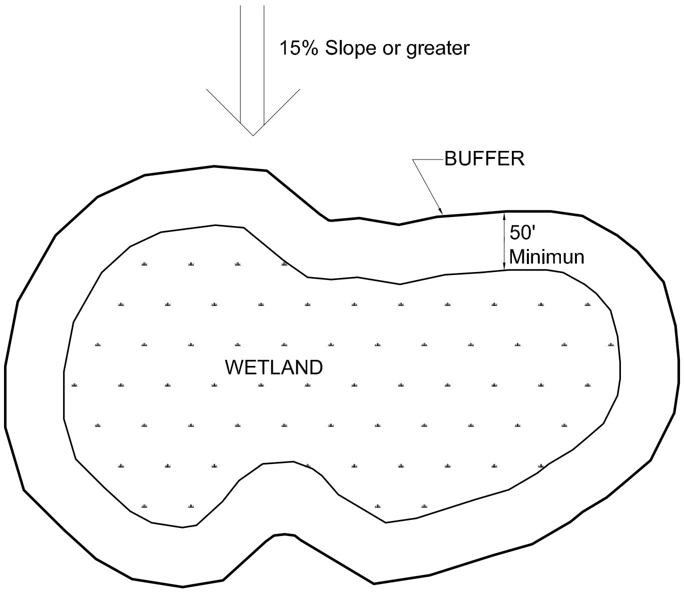
- Slopes greater than 15% will require the 50 foot average width around the entire wetland to get adequate treatment. No deviation to the minimum width will be allowed.
- Due to the importance of the recharge areas to side hill seep wetlands, buffers widths may be minimized down-gradient of the actual wetland if the buffer is expanded up-gradient to protect recharge areas. The overall average of the wetland will need to be met.
- Wetland buffer averaging may be utilized for protection of upland habitat such as woodland or prairie.
- Wetland buffer averaging may be utilized in cases where the natural wetland shape and ultimately buffer shape creates an unusual boundary for an individual property owner and inhibits use of the property.

Buffer strips should be maintained with a minimum of mowing and chemical weed control. The maintenance of adjacent manicured lawns should be compatible with the functions of the buffer strip and should not encroach into and decrease the required widths of the buffer strip. The City of Rochester's ordinance number 48 (Tall Grass and Weed Regulation, Internet accessible at www.ci.rochester.mn.us), especially section 48.04(b), should be consulted for proper maintenance of buffer vegetation.

7.2.5. Wetland Restoration/Enhancement

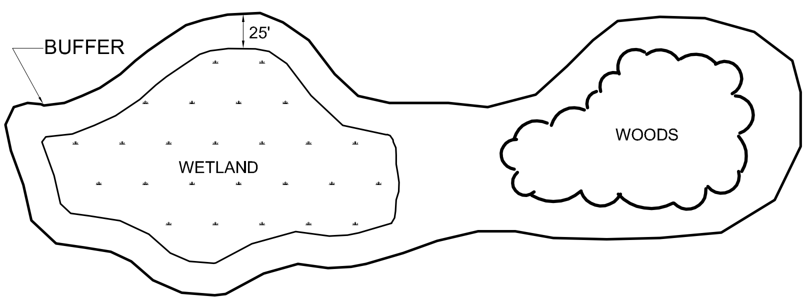
The Northwest Territory is the headwaters for what is referred to in this Addendum as the North Fork and South Fork stream corridor, both of which are part of the South Zumbro River watershed. In general, the landscape is moderately rolling with broad, shallow valleys. It lies at the intersection of the Blufflands and Rochester Plateau landscapes, as described in the MN DNR Ecological Classification System.

Currently, the vast majority of the Northwest Territory is farmed. The small amounts of land that are in permanent cover are mostly associated with unditched and untiled swales, as well as steeper slopes unsuitable for plowing. Historically, the study area would have hosted a mix of tallgrass prairie, oak/aspen lands, and wet meadow/wet prairie. The wet meadow/wet prairie



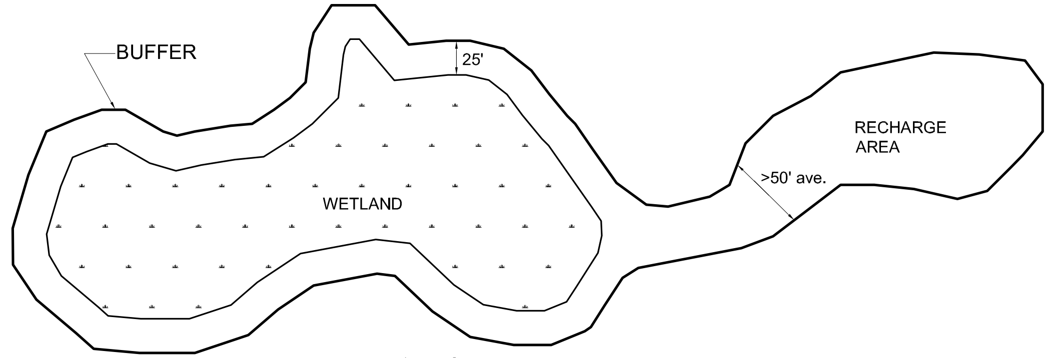
DETAIL 1

SLOPES



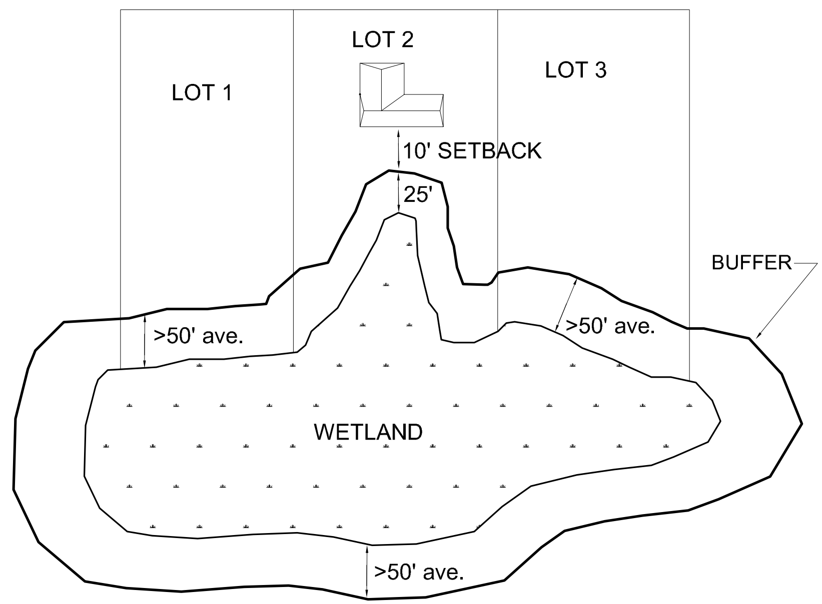
DETAIL 2

UPLAND HABITAT PROTECTION



DETAIL 3

SIDE HILL SEEPS with Recharge Area Protection



DETAIL 4

IRREGULAR WETLAND SHAPE

NOTE: >50' ave.: The overall buffer width around the entire wetland is required to meet the average width requirements without falling below the minimum width as presented in Table 7- 4. This allows for decreasing the width along portions of the wetland if other widths are expanded to meet the average.

GUIDANCE FOR BUFFER STRIP WIDTHS

CITY OF ROCHESTER

STORM WATER MANAGEMENT PLAN — NORTHWEST TERRITORY ADDENDUM

K:\363\36301128\Cad\Dwg\Plan buffer detail.dwg

FIGURE 7–2

NO SCALE

Bonestroo Rosene Anderlik & Associates

Engineers & Architects

363–01–128

would have historically occurred in side-slope swales, drainageways, and around seep areas. Since settlement, most of the swale wetlands have been converted to rowcrop agriculture through ditching and tiling. This has led to the development of channels, increased runoff, and degradation of the few wet meadows remaining. This section of the Addendum focuses on restoration opportunities within the Northwest Territory.

Potential Wetland Mitigation/Banking Sites

Wetland restoration within the sub-watershed is more desirable than creation or restoration outside the watershed. Developers or the City may receive wetland credits if the wetland restoration meets specific criteria. As part of the field inventory process, wetlands with hydrologic and vegetative restoration potential were identified and ranked for the ease of restoration. All the wetlands that are listed as restoration sites with a hydrologic ranking between high and low have the potential to be utilized as wetland mitigation and banking sites due to hydrology being altered. Wetlands ranked for vegetative restoration alone will likely not provide mitigation or banking credit.

Most of the hydrologic restoration sites are existing wetlands that can be expanded by restoration and thus provide new wetland credit within the expanded wetland area. If the wetlands are restored to the previous (prior to alteration) hydrologic regime they will also be allowed to receive Public Value Credit as allowed by the Wetland Conservation Act. The Wetland Conservation Act should be reviewed to determine applicable credit for any particular site prior to initiating wetland restoration activities.

Restoration rankings were provided based on the ease of restoration, with the easier restorations having a higher ranking. Details on how wetlands were ranked for restoration are presented in Table 7-5 on the following page. In the Northwest Territory, hydrologic rankings for restoration potential were most often applied to wetlands that were found to have ditches, tiles, or were actively being farmed. Described in more detail below and shown on Map 3 are wetlands with high restoration potential and thus are the most economically feasible to restore and serve as wetland mitigation/banking sites. Wetlands that represent medium to low ranking for hydrologic restoration are listed in Table 7-6 of this Addendum. These will also likely provide mitigation/banking credit, however, they would typically cost more to restore then the wetlands with a high hydrologic restoration potential. The “high” restoration opportunities described immediately below are not listed in priority order, but are rather given in order of their subwatershed.

Table 7-5 Hydrologic Restoration Ranking

Restoration Ranking	Description
NA	These wetlands have not had their hydrology altered through artificial drainage, extensive watershed alteration OR have been altered so significantly that restoration is not practical and they are best considered as their current type.
High	Minimal effort required to correct hydrologic alterations. E.g., blocking a small ditch, breaking one or a few tile lines, taking minor corrective actions within the watershed to restore historic quantity/quality of waters reaching wetland.
Medium	Moderate physical and financial efforts would be required to restore these communities. Substantial improvement in the short-term may require an intensive effort. E.g., creating small berm(s), plugging large ditches, installing control structures, and/or breaking several tile lines. Also includes moderate efforts within the watershed to restore historic quantity/quality of waters reaching wetland.
Low	These communities have often experienced significant hydrologic alteration through human activity. Improvement of these communities in the short-term requires substantial efforts. E.g., creating extensive berms, plugging large/multiple ditches, installing control structures, and/or breaking many tile lines. This category includes substantial efforts within the watershed to restore historic quantity/quality of waters reaching wetland. These wetlands may have had such significant alteration to their hydrology and the hydrology of the watershed that hydrologic restoration is unlikely within the next 100 years.

Wetlands with High Hydrologic and/or High Vegetation Restoration Potential

In the Northwest Territory study area, the wetlands given a High Restoration Potential are located within areas that are actively farmed. Described in more detail immediately below are wetlands with high restoration potential, and judged to be the most economically feasible to restore and serve as wetland mitigation/banking sites.

Wetlands with restoration potential within the Northwest Territory study area have been impacted by a wide variety of activities in the past. Some of these include grazing, tiling, ditching, colonization by trees and/or nonnative species, and plowing. The narrative below lists wetlands of high restoration potential. If the site is listed for vegetative restoration only, it will likely not qualify for wetland mitigation or banking credit under the Wetland Conservation Act.

Wetland: nw-w1. B
Hydrologic Restoration Potential: High
Vegetation Restoration Potential: Medium
Comments:

This wetland appears to be a good candidate for wetland mitigation and/or banking efforts. It is likely drained by tile, however, additional field investigation will be necessary to determine if a tile is responsible for the hydrologic alteration. Most of the wetland has been effectively drained to allow crop production. Restoration of the basin will likely require a small berm at the outlet and/or tile alteration. Due to its location within a stream corridor that links to the Douglas Trail, it also has the potential to be part of a valuable recreational corridor.

Wetland: nw-w2. A
Hydrologic Restoration Potential: High
Vegetation Restoration Potential: Medium
Comments:

This wetland is a broad, shallow swale that appears to have potential to be restored to a seasonally flooded basin or shallow marsh. Tiles have potentially altered the wetlands' hydrology, however, they were not observed during the site visit. Even with the apparent attempts to drain this wetland, it begun to reestablish native vegetation naturally in the absence of rowcropping and maintenance of the drainage. Upland prairie remnant on adjacent bedrock knob could be incorporated as a wetland buffer.

Wetland: nw-w2. C
Hydrologic Restoration Potential: High
Vegetation Restoration Potential: Low
Comments:

This wetland is located within a swale that flows across a crop field. The wetland appears to have been graded to reduce its size and allow additional land to be placed in crop production. If the wetland is restored it could provide valuable functions for floodwater retention and water quality due to it being located within an stream corridor and upstream of a proposed regional 3-Cell Filter Basin.

Wetland: nw-w2.D
Hydrologic Restoration Potential: High
Vegetation Restoration Potential: Medium
Comments:

This wetland has good potential for restoration. Manage the wet meadow with a buffer planting and periodic burning. Replant farmed swales and buffer with native species. Any restored hydrology should mimic pre-settlement conditions.

Wetland: nw-w2.M
Hydrologic Restoration Potential: High
Vegetation Restoration Potential: Medium
Comments:
This crop field was recently tiled. Restoration would involve breaking or altering tiles to restore the hydrology that appears to be from groundwater seeps in the waterway. During the spring of 2001, several areas in the field could not be worked by equipment, despite the fact that the field had been recently tiled. These unplowed areas had a good representation of native wetland plants at the time of the field visit in October 2001. Some of these plants included great blue lobelia, sedges, rushes, and other wildflowers. This wetland is immediately adjacent to a high knob with good quality prairie remnant. Consideration should be given to managing and protecting the wetland *and* adjacent prairie as one ecological unit.

Wetland: nw-w2.1
Hydrologic Restoration Potential: High
Vegetation Restoration Potential: Low
Comments:
This wetland is located in a swale that was recently regraded to improve agricultural drainage. It represents a good opportunity to create/restore a wetland that would have high functional values for floodwater storage. Native vegetation no longer exists in this basin because of extensive grading and row crop agriculture. Due to its location in the area of the 3-Cell Filter Basin it has the potential to be the third cell of a regional pond. With an appropriate design water quality goals could be met while providing valuable wildlife habitat and enhancing this portion of the stream corridor.

Wetland: nw-w2.6
Hydrologic Restoration Potential: High
Vegetation Restoration Potential: Medium
Comments:
This wetland has been tiled and deeply ditched in the last five years. The ditching and tiling have resulted in at least partial draining of most of a wet meadow and floodplain forest. In addition, a recently installed tile line is draining the field to the south. At the discharge of the tile line, severe down cutting has resulted in the formation of a drainage ditch that is effectively draining adjacent lands. Restoration should include alteration or breaking of the tile line and reestablishment of sheet flow in the wet meadow just north of the wooded area. Ditch blocks and filling of the artificially formed drainage ditch will help to promote sheet flow downstream. Wet meadow vegetation should also be managed to improve its quality, in conjunction with the hydrologic restoration.

Wetland: nw-w2.9
Hydrologic Restoration Potential: High
Vegetation Restoration Potential: High
Comments:
This long, linear swale is part of a stream corridor and has one of the more diverse plant communities for the Northwest Territory. The only hydrologic alteration may be from potential tile lines that may run parallel to the swale in the adjacent crop fields. If tile lines occur here, they effectively reduce the wetland size. This swale is spring-fed with many small seeps that daylight, flow across the surface, and then disappear. Prospects for complete restoration of this wetland are excellent if tiles are disrupted, adequate native vegetation buffers of grasses and flowers are planted, and the swale is maintained with periodic burning.

Wetland: nw-w1.2
Vegetation Restoration Potential: High
Hydrologic Restoration Potential: Not applicable
Comments:
This wetland was identified as having high vegetation restoration potential primarily because the landowner has already been working on plant community restoration. Likewise, the current landowner is interested in continuing this work. The best opportunities for restoration of vegetation in these wetlands is to periodic burning, additional seeding with native wetland species, and monitoring to see if management of problem species such as reed canary grass, stinging nettle and others is warranted.

Wetland: nw-w2.3
Vegetation Restoration Potential: High
Hydrologic Restoration Potential: Not applicable
Comments:
This is a very nice quality wet meadow surrounded by a former agricultural field enrolled in the Conservation Reserve Program. It has excellent potential to maintain/improve plant community quality by keeping the current buffer intact. Planting native grasses and flowers in the buffer would help to improve the habitat value and functionality of the buffer. It should be managed periodically by applying prescribed fire and other appropriate prairie ecosystem management tools. This is a very nice quality sedge/wet meadow that would respond favorably to active management.

Wetland: **nw-w2.B**
Vegetation Restoration Potential: High
Hydrologic Restoration Potential: Not applicable
Comments:
This wetland is in moderately good condition. It has some pockets of native, wet meadow vegetation, but approximately one half of the cover consists of non-native, cool season pasture grasses. The non-native reed canary grass, redtop, and to a lesser degree Kentucky bluegrass, may all pose management challenges for the vegetation in this wetland. In general, this wetland would benefit from vegetation management with tools such as mowing and periodic prescribed burning. This wetland is also a good candidate for vegetation management because it does not appear to have any hydrologic alteration.

Wetland: **nw-w3.A**
Vegetation Restoration Potential: High
Hydrologic Restoration Potential: Not Applicable
Comments:
This wetland is located in a very scenic retired pasture. This retired pasture, along with the three wetlands on this property (nw-w.3.C, nw-w3. B, nw-w4.8), provide excellent opportunities for prairie restoration and open space preservation since they have steep slopes with several wetlands dotted among them. These conditions make them poorly suited to development. The pastures in this area are excellent candidates for open space/park acquisition and management as a passive recreation prairie complex.

Wetland: **nw-w4.7**
Vegetation Restoration Potential: High
Hydrologic Restoration Potential: Not Applicable
Comments:
This is a small, but nice quality wet meadow that appears to have been pastured in the past. Currently, it is most impacted by runoff from surrounding row crop areas. The best opportunity for vegetation restoration lies in planting an adequate buffer of native prairie grasses and flowers, as well as prescribed burning, mowing, or periodic grazing (which can be consistent with prairie management). Hydrology appears to be intact.

Wetland: **nw-w4.8**
Vegetation Restoration Potential: High
Hydrologic Restoration Potential: Not Applicable
Comments:
This wetland represents a great opportunity for vegetation restoration since it is a good quality wet meadow with an intact upland buffer (similar to pastures to the south). Vegetation

restoration activities should include planting of the buffer area with prairie species, prescribed burning, managed haying and/or grazing, and perhaps periodic mowing. The hydrology of this wetland appears to be intact. This retired pasture, along with the two others on this property to the south, provide excellent opportunities for prairie restoration and open space preservation since they have steep slopes with several wetlands dotted among them. These conditions make them poorly suited to development. These pastures are excellent candidates for open space/park acquisition and management as a passive recreation prairie complex.

Wetlands with Medium Hydrologic and/or Medium Vegetation Restoration Potential

The wetlands listed in Table 7-6 on the next page are those with medium vegetation restoration potential and medium or below hydrologic restoration potential. While these wetlands did not receive a high ranking for hydrologic or vegetation restoration potential, they still offer valuable opportunities for potential wetland restoration.

Table 7-6 Medium Restoration Potential

Wetland	Vegetation Restoration Potential	Hydrologic Restoration Potential	Comments
nw-w1.5, nw-w1.6, nw-w1.7, nw-w1.9	Medium	Not Applicable	Best opportunity is for vegetative restoration. Landowner is working on some native plant community restoration and is interested in further managing his wetlands and conducting prescribed burning of his natural areas. The nonnative redtop, reed canary grass and Kentucky bluegrass are the greatest management issues. Hydrology appears intact at these wetlands. This site was photo-interpreted.
nw-w1.3	Medium	Not Applicable	This wetland would be difficult to restore, although some vegetative restoration would be rather easy to accomplish, particularly with the DNR trail present.
nw-w1.1	Low	Medium	This wetland is comprised of a low area adjacent to Douglas Trail, dominated by reed canary grass. It may be good hydrologic restoration/banking site. Topographic assessment of area necessary to determine feasibility.
nw-w1.A	Medium	Medium	This wetland is not on NWI map. Looks like it has potential as a wetland mitigation or banking site, although a topographic assessment of this area should be made to make sure that impounding the swale would not impact human structures.
nw-w1.E	Medium	Not Applicable	Hydrology appears to be intact, vegetation would benefit from management. Formerly grazed and would benefit from planting prairie in upland as buffer and maintaining as prairie community.

Table 7-6 Medium Restoration Potential (cont.)

Wetland	Vegetation Restoration Potential	Hydrologic Restoration Potential	Comments
nw-w2.J	Medium	Not Applicable	Viewed from a distance, this wetland appears to have potential for vegetation management, including planting of upland buffer. Management made easier due to being surrounded by cropland.
nw-w2.8	Medium	Medium	Wetland was aerial photo interpreted. Hydrologic restoration appears to be possible by blocking ditch. Vegetation management also appears to be enabled since the wetland has an upland buffer in many areas and occurs as a relatively continuous block of habitat.
nw-w2.2	Medium	Medium	The wet prairie is a rare community type for southeast MN and should be managed to improve its quality, including brush cutting and prescribed fire. Seeps in several locations on shallow slope and includes hardwood seepage swamp, shrub swamp, and wet-mesic prairie. Hydrology seems to disappear down slope indicating that the site may be tiled.
nw-w2.4	Medium	Medium	This is a wet swale where erosion has caused gulling around wetland and loss of hydrology for wetland. Regarding area and routing surface water through wetland again could restore hydrology. Vegetation restoration could include removal of box elder and planting of wet meadow/wet prairie species.
nw-w3.B	Medium	Not Applicable	This wetland is not on the NWI and is mostly in swale of crop field. It would take some effort to restore vegetation completely. Pasture that this wetland occurs in is very good candidate for open space preservation and restoration as prairie. It contains high vistas; steep slopes, contains a small prairie remnant, and is dotted with wetlands.
nw-w3.C	Medium	Not Applicable	This wetland is not on the NWI and is located in retired pasture just down slope from crop fields. This wetland and the surrounding grassland would benefit from active management and restoration as a prairie open space. Steep slopes, several wetlands, a small amount of remnant prairie, and scenic views make this a good candidate for a prairie preserve.
nw-w3.D	Medium	Not Applicable	Data sheet filled out from road. Difficult to tell if hydrology has been altered, but appears to be at least moderately intact. Vegetation restoration is possible, but is complicated by adjacent landscape plantings and homes.

Wetlands with Low Restoration Potential
Twenty-four of the 54 wetlands in the Northwest Territory are not good candidates for restoration. They are noted in Table 7-7 below by minor drainage District.

Table 7-7 Poor Candidates for Restoration

NW-1	NW-2	NW-3	NW-4
nw-w1.4	nw-w2.5	None	nw-w4.1
nw-w1.8	nw-w2.7		nw-w4.2
nw-w1.11	nw-w2.10		nw-w4.3
nw-w1.C	nw-w2.E		nw-w4.4
nw-w1.D	nw-w2.F		nw-w4.5
	nw-w2.G		nw-w4.6
	nw-w2.H		nw-w4.9
	nw-w2.I		nw-w4.A
	nw-w2.K		
	nw-w2.L		
	nw-w2.N		

Potential Partners for Wetland Restoration Projects

The entities listed below are potential partners for the wetland restoration sites:

- BWSR Banking for Road Construction Projects
- Department of Natural Resources, Conservation Grant
- Soil and Water Conservation District (CREP)
- Wildlife Organizations such as Ducks Unlimited

8. Storm Water Management Financing

8.1. Background

Prior to the 1999 SWMP, expanding the drainage system for future development was completed by individual developers. The design and construction of storm water detention/water quality facilities and trunk storm sewers were completed on a development-by-development basis with limited consideration for the effect of the overall drainage system.

The soils and geological characteristics of the NWTA study area would make the practice of allowing new development to discharge at predevelopment conditions highly complicated. The regional approach presented in this plan, enhanced by infiltration-friendly BMPs, is the best approach to minimize water quality impacts to Rochester's groundwater resulting from urbanization in the Northwest Territory.

The 1999 SWMP outlined a regional approach to improving the storm water drainage system and an area charge financing method. As with the 1999 Rochester SWMP, one of the objectives of the NWTA is to develop an area charge for financing the total cost of the storm water drainage system for the Northwest Territory area. This Section also discusses and provides estimations of likely costs for future infrastructure components.

8.2. Costs Associated with the Drainage System

8.2.1. Infrastructure Improvements

The infrastructure cost associated with new development focuses on the improvement of the drainage system to provide conveyance, rate control and water quality treatment as the system is expanded to serve additional areas for this NWTA. These infrastructure improvements include the proposed open channel drainage network, detention facilities (either water quality or water quantity ponds), and proposed outlets or improvements to existing culverts that are planned to serve as control structures.

For the open channel drainage network, hereinafter referred to as the trunk storm channel system, the infrastructure improvements include the acquisition of maintenance easements and environmental buffers, where appropriate, as well as stabilization and improvement components described in Section 5.4, such as step weirs or erosion control materials.

Consistent with the 1999 Rochester SWMP, a storm water area charge based on the area-wide cost of total improvements is utilized as the form of funding for capital investment for storm water management facilities.

The total cost of the proposed drainage system is summarized in Table 8.1, below. The total system cost has been separated into three subtotal costs: Water Quality, Water Quantity, and Trunk Storm Channels. Appendices F and G include construction cost estimates for all of the proposed trunk storm channels and the storm water basins, respectively. The drainage system costs are also summarized in greater detail by Minor District and Design Item in Appendix H.

Table 8-1 Drainage System Costs

		Subtotal Cost	Additional Cost	Total Cost
Ponds:				
Water Quality				
Land acquisition	(6%)	$530,896	$185,814	$716,710
Excavation	(10%)	$953,336	$333,668	$1,287,004
	(16%)		Water Quality Subtotal -	$2,003,714
Water Quantity				
Land acquisition	(23%)	$2,154,354	$754,024	$2,908,377
Excavation	(11%)	$1,033,334	$361,667	$1,395,000
Outlet cost	(3%)	$314,000	$109,900	$423,900
Trunk pipe cost	(5%)	$435,000	$152,250	$587,250
	(42%)		Water Quantity Subtotal -	$5,314,528
Pond Total	(58%)	$5,420,920	$1,897,322	$7,318,241
Trunk Channels:				
Erosion Protection	(5%)	$433,404	$151,691	$585,095
Excavation	(4%)	$398,825	$139,589	$538,414
Improvement Structure	(6%)	$574,614	$201,115	$775,729
Easement	(16%)	$1,470,612	$514,714	$1,985,326
Buffer	(12%)	$1,109,628	$388,370	$1,497,998
Trunk Channel Total	(42%)	$3,987,083	$1,395,479	$5,382,562
Grand Total:		**$9,408,002**	**$3,292,801**	**$12,700,803**

8.2.2. Operations, Maintenance, and Replacement

The following items were listed in the 1999 SWMP as items that were included in the City's annual budget estimate for the existing drainage system:

- Manhole and storm sewer cleaning
- Street Sweeping (5 times per year)
- Pond dredging of accumulated sediment
- Pond outlet inspection and cleaning program
- Energy dissipaters and erosion repair (rip-rap, channel lining, etc.)
- Ditch and drainage channel repair of erosion or bank stability
- Back yard drainage correction projects

Maintaining the drainage system will require the eventual replacement of some of the system components. Similar to the cost of maintenance, annual replacement costs will increase as the drainage system is expanded. Yet it will be important to consider the relative ease and advantage of routine inspections for preventing large system disruptions. The ability of the channels to convey runoff and the longevity of the ponds to store sediment are tied to the proper functioning of the channel system. When channel erosion or other debilitating symptoms occur it will be economically advantageous to address the cause of the problem as expediently as possible before symptoms worsen. The trunk storm channel system approach lends itself to easy inspection as no parts of the system are buried underground and visual checks can be performed from the channel's adjacent maintenance easement.

8.3. Financing Storm Water Improvements for New Development

An area charge approach is the method for financing the construction cost of the proposed regional facilities found in this plan. Any expansion and improvements to the City's future drainage system are generally financed through a storm sewer area charge (SSAC). In exchange for the area charge contribution, the City helps design and construct trunk storm sewers and storm water ponding areas under the recommended area charge finance system. In this regard, the City carries the financial responsibility of implementing the storm drainage system infrastructure elements that are captured on Map 2 while developers are responsible for all other elements.

For the NWTA study area, the storm water conveyance system utilizes a trunk storm channel network rather than storm sewer pipes. Regional pond facilities are constructed under the City's direction to serve drainage areas of approximately 75- to 200-acres. Ideally, regional basins are designed to treat as large an area as feasible to reduce the overall ponding area required, thus increasing the benefit to cost ratio. Ultimately, the area treated by the regional basins is influenced by the area's topography and local characteristics. Trunk storm channels are financed and constructed to serve upstream portions of the watershed under fully developed conditions. Developers may propose to the City Engineer the construction of trunk storm sewer pipe, in lieu of trunk storm channels. However, developers will then be responsible for the increased incremental costs to construct the trunk storm sewer, contingent on design approval by the City Engineer. Developer's proposal shall meet design criteria for runoff rate and quantity control as listed in Appendices B, while maintaining the functional integrity of the stream corridor for the 100-year storm.

A major portion of the effort in developing the NWTA was in the preliminary designation and layout of the trunk storm channels and storm water ponds. A summary of the construction cost estimates for all of the proposed trunk storm channels and the storm water basins are presented in Appendix F and Appendix G, respectively. The cost summaries include construction of the recommended facilities as well as estimated costs for land acquisition.

For the purpose of estimating costs, the storm water drainage system was considered to include all of the proposed facilities shown on Map 2 that are within the city's 25-year Urban Service Area. Generally, trunk storm channels were designated to begin at areas where modeled runoff under fully developed conditions (using existing contour data) warranted storm sewer pipes 30 inches in diameter or greater. Also, all open channels that convey flows from detention pond outlets are considered trunk facilities.

For the proposed storm water ponds, both quantity (flood attenuation) ponds and water quality ponds are considered part of the storm water drainage system. Excavation, outlet structures, and land acquisition costs associated with these ponds are included in the cost estimates.

8.4. Land Use Factors

Land use rates for the 1999 SWMP were calculated based on the specific contribution to the total cost of the system including trunk storm sewers, water detention facilities, and water quality facilities. Once the total cost of the system was established for these three factors, a percent contribution for the need for these facilities was calculated based on land use. However, the specific land use determinations within the NWTA study area are still in the planning process. Therefore, the land use factors that were developed for the 1999 SWMP are utilized for this NWTA. This was done based on the assumption that future development will resemble similar impervious characteristics as existing development in Rochester.

As described in Section 5.2.2, a uniform curve number value of 76 was applied for the entire study area. While intended to serve as an average of high and low impervious values, this curve number also happens to approximate the impervious value for medium density residential areas.

Appendix F tabulates the total estimated trunk storm channel system cost for the development of the drainage system within the 25-yr Urban Service Area as shown on Map 2. Appendix H tabulates the total estimated cost of the ponding facilities for water quality and quantity as proposed on Map 1. These costs contribute to the total cost of the system as follows.

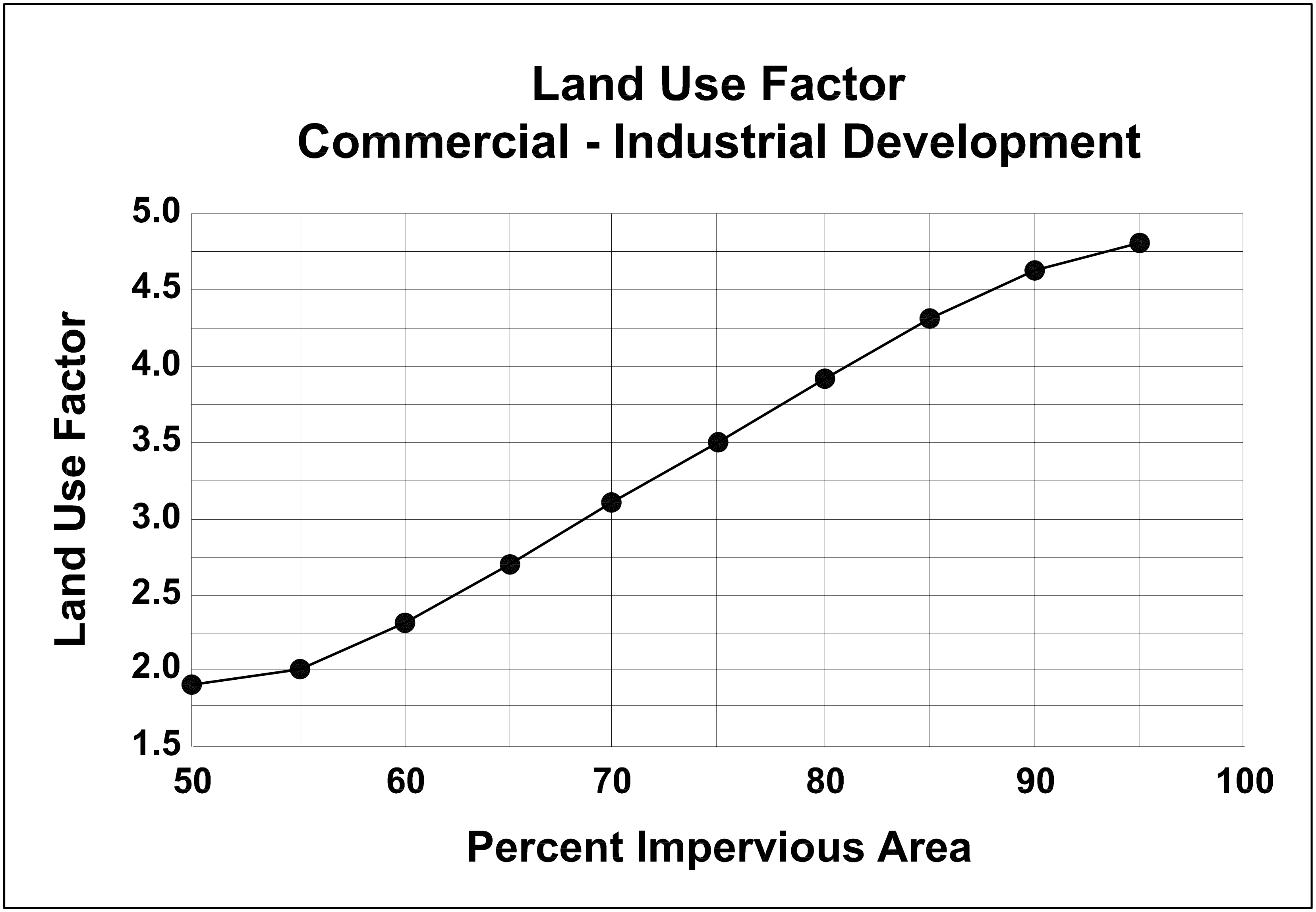
- Trunk Storm Channel - 42 percent
- Water Quantity and Quality Ponding Facilities - 58 percent

The actual land use factor is determined by first calculating the percentage of impervious surface for a site and then using the graph on Figure 8-1 to determine the land use factor. This method is consistent with the 1999 SWMP approach as an equitable solution to the possible wide variation in the percentage of impervious surface for various commercial /industrial sites. Section 8.5 of the 1999 SWMP provides significant detail on how the land use factors were determined.

8.5. Recommended Area Charge Rate

Table 8-2 presents the land use factors used to calculate the area rate charge for low, medium and high density residential development, as well as commercial and industrial development, along with their respective area charges. Additionally, this table summarizes the costs for various drainage system components. This table uses the total developable land that is estimated to develop for each land use within the 25-year Urban Service Area for the NWTA study area.

Constraint mapping using geographic information system software was used to determine the net developable land to arrive at the area charge cost. This is contrary to the earlier 1999 SWMP that assumed that 48 percent of the land would develop within the study area. This assumption was a direct incorporation of the City of Rochester’s Sanitary Sewer Master Plan, which created the original supposition that 48 percent of the land would develop and preceded the City’s ability to use more accurate, site-specific data.



LAND USE FACTOR

ROCHESTER, MINNESOTA

FIGURE 8–1

ROCHESTER STORM WATER MANAGEMENT PLAN – NORTHWEST TERRITORY ADDENDUM

Bonestroo Rosene Anderlik & Associates

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Table 8-2: Area Charge Rates for Future NWTA Drainage System

	Subtotal cost	Additional Cost	Total Cost
Ponds			
Land acquisition	$2,685,250	$939,838	$3,625,088
Excavation	$1,986,670	$695,334	$2,682,004
Outlet cost	$314,000	$109,900	$423,900
Trunk pipe cost	$435,000	$152,250	$587,250
	$5,420,920	$1,897,322	$7,318,241
Trunk Channels			
Erosion Protection	$433,404	$151,691	$585,095
Excavation	$398,825	$139,589	$538,414
Improvement Structure	$574,614	$201,115	$775,729
Easement	$1,470,612	$514,714	$1,985,326
Buffer	$1,109,628	$388,370	$1,497,998
	$3,987,083	$1,395,479	$5,382,562
Total	$9,408,002	$3,292,801	$12,700,803

Land Use	Land Use Factor	Area Charge
Low Density Residential	1.0	$2,243
Medium Density Residential	1.4	$3,141
High Density Residential	1.9	$4,262
Commercial*	3.4	$7,627
Industrial*	2.6	$5,833

*Land Use Factor shown represents average value. Specific Land Use Factor should be calculated using Figure 8-1.

Total Acres in Urban Service Area 5,140

Developable Acres 4,044

Area Charge ($/dev. acre) $3,141

Based on land use = Medium Density Residential

Note: Refer to Appendix H for more detail.

The following features were identified, classified as not developable, and subtracted from the gross acreage of the study area within the Urban Service Area to estimate the developable area:

- Any existing developments
- Platted parcels greater than 5 acres
- Railroads
- Slopes greater than or equal to 26%
- Roads (150 feet from centerline for Highway 52 and 33 feet from centerline for all other roads)
- Proposed channel widths and associated buffers
- Proposed storm water basins (area at high water level)
- Wetlands
- Any natural rivers or streams

In order to determine the area charge rate, the total cost estimate was divided by the amount of land available for development within the Urban Service Area for the Northwest Territory. As noted in Section 8.5, this generated an area charge rate for medium density residential development, which has a composite land use factor of 1.4. To determine the low density residential rate, the area charge was divided by the land use factor of 1.4, arriving at a value of $2,243 as shown in Table 8-2 on the previous page. Once the low density residential rate has been established, other land use rates are the product of the low density residential rate and the corresponding land use factor.

Rates for commercial, industrial, and high density residential areas are significantly higher than for low density residential areas. The higher rates are justified because these areas typically have a larger percentage of roofed and paved areas that increase the amount of runoff. The velocity of runoff on impervious surfaces is also greater, which results in lower times of concentration, higher peak runoff rates, and larger required storm sewer pipes and detention facilities. In addition, higher pollutant loads are generated from sites with greater impervious surfaces. These increased loads require larger water quality treatment volumes to preserve the quality of downstream waterbodies.

8.6. Funding for Operation and Maintenance and Infrastructure Replacement

Typically, an area charge rate is determined and assessed to recover upfront capital costs associated with implementing system improvements. However, a storm water drainage system must be maintained in good working order for it to function as anticipated. Usually, a storm water utility fee is determined and assessed to fund operation, maintenance and replacement of the storm water drainage system. An annual investment in the operations and maintenance of the drainage system can prevent costly problems due to flooding and long-term water quality impacts to surface waters.

A storm water utility is similar to other fees for services, such as water and sewer, which are provided to the City's businesses and residents. Many developing cities in Minnesota have elected to implement a storm water utility with single family residential rates ranging from $6 to $60 per year (Metropolitan Council, 2000). Storm water utility fees are generally based on the cost of providing storm water management and the amount of impervious surface present. Land uses that create higher levels of impervious surface require larger storm conveyance conduits (pipes or open channels) and larger storm water quality and quantity ponds to be maintained for the system.

The City of Rochester maintains a storm water management account that has separate funds to finance: 1) Storm Water Improvements, 2) Operations and Maintenance, and 3) System Replacement. This provides the city with a means of more accurately budgeting and tracking the annual cost of each aspect of the drainage system.

9. Erosion Control

Appropriate application of Best Management Practices (BMPs) in the existing agricultural landscape has prevented noticeable loss of soil resources to date. Continued implementation of pre- and post-construction BMPs is critical as development occurs and land uses change. Chapter 9 of the 1999 SWMP provides a detailed description of BMPs for erosion control. The reader is also referred to Section 5.4 of this Addendum, which describes the erosion control techniques that are recommended for the trunk channel system. Section 6.1.1 of this Addendum provides information on post-construction BMPs. The MPCA's Urban BMP Handbook is one resource that provides information on many more best management practices.

10. Groundwater

Groundwater resources occur on a regional scale. Because of the close proximity of the Northwest Territory to the 1999 SWMP study area (see Figure 1.1 in this Addendum), the regional groundwater data presented in the 1999 SWMP can be applied to the NWTA. Chapter 10 of the 1999 SWMP provides an overview of the groundwater resources within the Rochester region.

As noted in Section 4.2 of this NWTA, visual evidence of large runoff volumes was not observed. This was contrary to expectations that were based on the magnitude of drainage areas as well as the presence of numerous existing large road crossings. Infiltration processes appear to be significant in reducing the amount of storm water runoff that is generated under existing conditions. This assumption is generally supported by information from the Surficial Geology Plate of the Olmsted County Geologic Atlas that indicates the presence of large sand and gravel deposits across the study area that promote high rates of infiltration and percolation. Shallow depth-to-bedrock and fracture flow in the uppermost limestone bedrock also promotes rapid infiltration of surface water to the underlying aquifer.

Infiltration dynamics are of concern in this region because municipal and private drinking water supplies come from groundwater aquifers. Site-specific investigations of soil conditions, geologic features and infiltration capacity are recommended prior to any drainage system development or infrastructure improvements. The Olmsted County Geologic Atlas represents groundwater regions covered by District NW-3 and NW-4 as having high and high-moderate sensitivity to pollution that is due, in part, to infiltration and percolation dynamics.

Infiltration capacities under existing conditions for storm events of less than one inch are high, particularly at locations within the designated stream corridor in the lower half of the NWTA study area. The infiltration capacities are reduced during storm events of 3.5 inches and higher. The design of the regional system proposed in Map 1 is intended to minimize adverse infiltration impacts to the aquifer. Regional water quality ponds are designed to pre-treat concentrated runoff prior to infiltrating.

Chapter 10 of the 1999 SWMP addresses groundwater and infiltration issues for the broader Rochester region.

11. Operation and Maintenance

Guidelines and recommendations for the operation and maintenance of the storm water infrastructure (i.e., ponds, pipes, culverts, etc.) can be applied directly as outlined in Chapter 11 of the 1999 SWMP.

Proposed Channel System

Lined channels typically require little or no maintenance. Vegetated channels require periodic inspection and maintenance, as high flows can create erosion within the channel. Eroded channels will contribute to water quality problems in downstream waterbodies as the soil is continually transported downstream. If not maintained, the erosion of open channels will accelerate and the repair will become increasingly more costly.

When inspecting the proposed open channel system, the following items are considered undesirable, and will require maintenance:

- Downcutting, or gully formation, greater than or equal to 0.5 feet of vertical drop
- Significant siltation or accretion (usually a sign of upstream erosion)
- Insufficient vegetation present for slope stability, typically due to:
    - Excess shading
    - Presence of shallow-rooted invasive species (such as European buckthorn)
- Bank failure
- Channel obstructions, including excess vegetation and man-made intrusions

In areas where erosion greater than 0.5’ is observed, two maintenance options are available. Rip-rap can be placed at the point where the drop is observed to prevent upstream migration of the erosion. Or, the re-establishment of a stable channel reach can be accomplished via the replacement of proper vegetation or other effective channel stabilization methods.

To discourage the establishment of noxious weeds and undesirable vegetation, the open channels should be seeded with native species. Plantings should be selected that are appropriate to site specific conditions (e.g., full sun versus full shade, soil conditions appropriate for the planting). Periodic (annually or bi-annually) mowing and prescribed burning should be performed to maintain the integrity of the native plantings and maintain channel conveyance capacity. Trimming of the tree canopy should occur when the canopy coverage exceeds approximately 50% of the 100-year floodplain.

Rip-rap is recommended to be placed in areas where bank failure has occurred. Re-establishment of the original channel configuration and vegetation is not recommended in these areas. Site-specific hydraulic conditions will usually result in the reoccurrence of the bank failure if it is not properly protected.

Branches, large debris and other materials should be removed from the storm water conveyance system. Large debris resulting in the hindering of flows is of concern, as well as debris that redirects flow into the channel banks, thus promoting erosion. Cleaning of channel crossings is recommended annually following the spring thaw, or after large rainfall events (between three- to four-inch rainfall within 24 hours). At this time, channels can also be visually inspected for evidence of channel instability or failure.

- Visual characteristics: Investigate reaches for signs of channel stability. Channels that are stable under existing conditions may become unstable after development, due to increased flows. Thus, channels that are stable should receive channel stabilization efforts to prevent costly repairs due to a change in runoff regime. Channels that are unstable are candidates for improvement efforts. Signs of unstable channels include:
    - Erosion, downcutting or gully formation greater than 0.5 feet of vertical drop
    - Significant siltation or accretion of material are signs of upstream instability
    - Exposed soils and/or a lack of established ground cover
    - Shading of ground cover, especially by the noxious species European buckthorn which has a poor root structure and can weaken channel banks
    - Major obstacles in the channel that may cause diversion of flow (e.g. very large tree branches or tree trunks)

12. System Management Description

12.1. General

The NWTA was divided into four minor drainage Districts shown on Map 1. The minor drainage Districts were designated as shown in Table 12-1.

Table 12-1 NWTA Minor Drainage Districts

Minor Drainage District	Abbreviation	Acreage
West	NW-1	1,237
Central	NW-2	3,089
East	NW-3	1,504
Northeast	NW-4	1,710*

*547 acres of NW-4 are located within the 25-yr Urban Service Area

With the exception of District NW-1, each minor drainage District was further subdivided into Subdistricts. All Subdistricts are identified by the abbreviation of the minor drainage District in which it is located, followed by a number to differentiate it from other Subdistricts. The number system starts at the upstream end of each District and numerically increases in the downstream direction. Subdistrict acreages for minor Districts NW-2, NW-3, and NW-4 are presented in Appendix A. NW-1 was not split into Subdistricts because it is outside of the City's Urban Service Area. The boundaries of all the minor Districts and Subdistricts are shown on Maps 1, 2 and 3.

The NWTA proposes regional ponds that are located either at existing or future proposed road crossings, when possible. Additional ponds are included by berming when downstream conditions necessitate upstream peak flow attenuation. This approach reduces costs by situating most of the regional facilities at existing depressions and/or existing crossings, thus reducing extensive berming costs. The drainage areas are as large as feasible to minimize the number of ponds required, thus maximizing the amount of developable land. All of the ponds described within this Addendum have a maximum fluctuation of five feet or less. This maintains impoundment levels below what is considered for dam criteria as defined by the Minnesota Department of Natural Resources.

12.2. District NW-1

Drainage Area: 1,237 acres

Drainage District NW-1 was not divided into minor Subdistricts and analysis was completed only on a conceptual level to provide information relating to general water quantity rate control and water quality parameters. Detailed analysis was not warranted because future development of NW-1 was outside of Rochester's 25-year Urban Service Area.

Basic modeling of this area was required to produce the information upon which downstream watershed systems could be based. The NW-1 model design was predicated on an existing 48 inch corrugated metal pipe (CMP) road culvert at 60th Avenue NW, between 75th Street NW and 85th Street NW. Reasoning that this structure would serve to limit downstream flows, a hypothetical pond was modeled to retain peak discharges upstream of the 60th Avenue NW crossing. The modeling defines a maximum runoff rate and volume from District NW-1 that should be maintained in the future to ensure the proper performance of the proposed downstream storm water conveyance system.

12.3. District NW-2

Drainage Area: 3,089 acres
Number of storm water basins: 10
Major Reservoirs: NW-P2.5 (31.5 acres), NW-P2.10 (25.8 acres)
Major Streams: Upper Branch North Fork, Lower Branch North Fork

District NW-2 is the largest District within the Northwest Territory study area. A future extension of 50th Avenue NW is being considered. This road extension would link 65th Street NW and 85th Street NW. The road extension will affect the drainage routing and conveyance of storm water runoff. Development of a proposed interchange at Highway 52 and 75th Street NW will also affect storm water routing and proposed ponding locations. All flows from NW-2 are discharged downstream to areas NW-3 and NW-4.

NW-2.1

Flows out of this Subdistrict are currently conveyed by an existing 42-inch reinforced concrete pipe crossing at 75th Street NW. NW-P2.1 is proposed to be situated adjacent to this outflow point but the outlet is proposed to be reduced to an 18-inch reinforced concrete pipe (RCP). This will maximize storage and minimize the potential for downstream erosion that currently exists. The discharge from this pond flows into a short open channel that connects directly to pond NW-P2.2. Due to the rapid change in slope, a drop structure and energy dissipation would be required to prevent erosion at the downstream invert.

NW-2.2

NW-P2.2 receives storm water runoff from several upstream sources. As noted above, NW-P2.1 releases flows into this basin. There are two open channel systems in NW-2.2 that also deliver runoff to NW-P2.2. The location of NW-P2.2 is situated to take advantage of existing topography. It assumes the construction of an extension of 50th Avenue NW located between 65th Street NW and 85th Street NW with a 5'x 6' box culvert to convey flows from NW-P2.2 to downstream facilities.

NW-2.3

The delineation of this Subdistrict assumes that an extension of 50th Avenue NW located between 65th Street NW and 85th Street NW will be built and pond NW-P2.2 will be constructed. This allows the required area of NW-P2.3 to be reduced due to the reduction in direct drainage area and peak flow attenuation provided by the proposed upstream pond. NW-P2.3 is located at 75th Street NW, utilizing an existing 6-foot high by 8-foot wide box culvert. This regional pond is immediately upstream of the confluence of tributaries that forms the North Fork Lower Branch channel.

NW-2.4

NW-2.4P is located at 75th Street NW, utilizing an existing 4' x 6' box culvert. Similar to NW-P2.3, this regional pond is immediately upstream of the confluence of tributaries that forms the North Fork Lower Branch channel.

NW-2.5

This is the largest Subdistrict in the study area comprising approximately 537 acres. NW-P2.5 is a major system reservoir for District NW-2, providing rate control and water quality treatment for the entire drainage area. Wetland NW-W2.1, classified as ag/urban impacted, is located within the proposed ponding area. Appropriate steps for mitigation or replacement should be considered during pond design. Future considerations for this proposed pond include a new overpass design at the intersection Highway 52 and 85th Street NW. This regional basin utilizes an existing box culvert crossing (approximately 5' x 10') that runs diagonally across Highway 52 at the intersection with 85th Street NW, and discharges to a ditch located northeast of that intersection. This ditch runs along Highway 52 and collects flows from all four corners of the intersection, including areas: NW-2.5 (SW corner), NW-2.10 (NW corner), NW-4.1b (SE corner), and local flows from NW-4 (NE corner).

NW-2.8

The proposed location for NW-P2.8 is in the southwest corner of the intersection of 85th Street NW and the future extension of 50th Avenue NW located between 65th Street NW and 85th Street NW. An existing box culvert crossing (approximately 7' x 12') at 85th Street will serve as the basin's primary outlet. The potential future north-south road will connect 85th Street NW to 65th Street NW and will serve as the eastern impoundment for the pond. An equalizing structure underneath the proposed road would connect NW-P2.8 with NW-P2.9. This cost-effective design approach has the benefit of providing an outlet for NW-P2.9 without having to include a low-flow structure.

NW-2.9

NW-P2.9 is also located adjacent to the intersection of 85th Street NW and the future extension of 50th Avenue NW located between 65th Street NW and 85th Street NW. This pond is located so the future north-south road connecting 85th Street NW to 65th Street NW would serve as the impoundment for the pond. As described in the description for NW-P2.8, an equalizing structure would connect this basin with NW-P2.8.

NW-2.10

NW-P2.10 is a major system reservoir for District NW-2. NW-P2.10 utilizes the existing highway culvert crossing, consisting of dual 5' x 10' box structures crossing perpendicular to Highway 52 approximately 850 feet north of 85th Street NW. Flows from NW-P2.10 combine with flows from NW-P2.5 and NW-P4.1b and drain to the channel that runs adjacent to Highway 52 and the Oronoco Estates mobile home park.

NW-2.11a

NW-P2.11a was designed to reduce peak flows from this area prior to discharge into District NW-3. The basin is situated upstream of the existing highway crossing to avoid existing homes and wooded areas that result in the infeasibility of placing the basin directly adjacent to the highway. Due to the inability to utilize the existing road to detain water, a berm will be required to construct this pond. Discharge from NW-P2.11a will be from a new proposed 36-inch reinforced concrete pipe that will flow into an open channel conveying flows from the proposed pond to the existing Highway 52 crossing. This channel will receive some local overland runoff from Subdistrict NW-2.11b prior to being routed through the existing Highway 52 culvert crossing (dual 5’ x 7’ box culverts under the Highway 52 west frontage road connected to dual 62” x 102” arch pipes under Highway 52) located approximately 1,800 feet south of 75th Street NW.

NW-2.11b

No pond structures are proposed for this Subdistrict. All storm water runoff is expected to pass downstream to NW-3.2 via an existing crossing under Highway 52 (dual 5’ x 7’ box culverts under the Highway 52 west frontage road connected to dual 62” x 102” arch pipes under Highway 52) located approximately 1,800 feet south of 75th Street NW. Because of the small area in this Subdistrict, any water quantity or quality treatment will be managed downstream by NW-P3.2

NW-2.12

NW-P2.12 will provide water quality treatment for this relatively small Subdistrict and reduce existing localized erosion in the channel directly adjacent to Highway 52. Providing ponding immediately adjacent to the Highway was not feasible at this location due to existing topography. The small direct drainage area to the crossing under Highway 52 (6’ h x 4’ w modified breadbasket structure located approximately 4,200 feet south of 75th Street NW) is proposed to pass downstream where it is managed by regional pond NW-P3.2.

12.4. District NW-3

Drainage Area:1,504 acres
Number of storm water basins: 10
Major Reservoirs: NW-P3.3 (17.1 acres), NW-P3.6 (19.8 acres)
Major Streams: South Fork channel

All Subdistricts in NW-3 drain towards two outlets under 18th Avenue NW, north of 75th Street NW. A future north-south road has been proposed in coordination with the current Highway 52 reconstruction, and will provide additional areas that will be ideal for regional ponds. The proposed road will run parallel (1 mile west) to 18th Avenue NW, and will span from just south of 65th Street NW to 85th Street NW.

NW-3.1

A future north-south road provides an opportunity for ponding in this Subdistrict. It is assumed that a 36-inch culvert will be installed at 75th Street NW for an outlet. This regional pond mainly functions as a water quality improvement facility.

NW-3.2

The placement of NW-P3.2 takes advantage of an existing depression in topography. However, it relies on the construction of a future north-south road as its impoundment with a 48-inch reinforced concrete pipe to control flows. If the future north-south road is not constructed, upstream and downstream ponding facilities will have to be increased in size to accommodate for the lack of ponding proposed at this location. This basin receives some runoff from the west side of Highway 52 that flows unchecked through the existing Highway 52 culvert crossings described in NW-2.11a and NW-2.12 above, as well as an existing 36" culvert located approximately 3,500 feet south of 75th Street NW. NW-P3.2 also receives input from upstream regional basins NW-P2.11a and NW-P2.12.

NW-3.3

Although the drainage area for NW-3.3 is relatively small compared to other Subdistricts, the proposed basin requires a great deal of storage area to retain 100-year peak flows at a fluctuation level of 5 feet or less and reduce flows to NW-P3.6. NW-P3.3 is a major system reservoir, utilizing berming at a private drive that crosses the channel floodplain as its impoundment. Several outlet structures were modeled, though the existing dual 42-inch corrugated metal pipes were determined to adequately convey upstream flow and eliminated downstream flooding.

NW-3.4

An existing arch reinforced concrete pipe (3' rise, equivalent to a 48-inch round pipe) at 75th Street NW is proposed to be replaced by a 2' x 4' reinforced concrete box culvert in order to handle projected flows under developed conditions. This pond discharges directly into an open channel that conveys runoff to NW-P3.6. Energy dissipation may be required at the downstream invert to protect against erosion in the channel.

NW-3.5a

Existing development of a residential subdivision has increased runoff from this Subdistrict. The addition of a downstream residential road has also resulted in the rerouting of flows away from their natural flow path. These flows are routed through inadequately sized pipes, resulting in erosion of several driveways in the past. NW-P3.5a is proposed to be located upstream from the existing development to provide water quality treatment and peak flow attenuation.

NW-3.5b

This drainage area contains a series of low-density residential developments in the upper reaches where much of the study area's steep slopes are located. This area is well-forested. The regional pond proposed for this Subdistrict is primarily to provide downstream flood reduction at NW-P3.6. However, NW-P3.5b will also provide water quality treatment and peak flow attenuation for the existing developed area.

NW-3.6

This Subdistrict is bounded by two roads, 18th Avenue NW and 75th Street NW. There are a series of culverts along 18th Avenue NW at the upstream (i.e. southern) portion of this area. These crossings convey some storm water runoff out of the NWTA study area. However, for conservative planning purposes, the volume of runoff that is conveyed out of the District is considered negligible and thus the entire area of NW-3.6 is included in the analysis for a downstream regional pond.

NW-P3.6 is a major system reservoir. It is situated at 75th Street NW at a crossing where flows pass through dual arch culverts (5.3' rise, equivalent to at 84-inch round pipe). These pipes serve as the outflow controlling device for the regional pond. The modeling showed that NW-P3.6 is highly susceptible to water level fluctuations due to it's location in the downstream portion of the minor District. The 100-year high water level of NW-P3.6 is very sensitive to increased peak flows from upstream, thus it is very important to control upstream flows as proposed and provide additional detailed analysis of this pond as the watershed develops upstream.

NW-3.7

This drainage area is one of two locations where storm water runoff exits the study area from District NW-3. A regional pond is located at the intersection of 75th Street NW and 18th Avenue NW and utilizes an existing dual 6' x 8' box culvert. The primary intent of this basin is to provide water quality treatment, as much of the peak flow from upstream would be attenuated by the upstream ponding system.

NW-3.8

NW-P3.8 has been located in an upland area that is ideally suited for a regional pond. This pond is necessitated by the lack of sufficient land downstream to create a regional pond large enough to control 100-year peak flows under developed conditions. Pond NW-P3.8 is located at a property parcel line and will require berming and a proposed 48" reinforced concrete pipe outlet.

NW-3.9

This drainage area is the second of two locations where storm water runoff is proposed to exit the study area from District NW-3. Pond NW-P3.9 is situated at 18th Avenue NW and assumes a new 24-inch reinforced concrete pipe to be constructed to allow discharge out of the study area.

12.5. District NW-4

Drainage Area: 1,710 acres (547 of those acres are located within the 25-yr Urban Service Area)
Number of storm water basins: 3
Major Reservoirs: NW-P4.6 (10.9 acres)
Major Streams: North Fork channel (classified as DNR Protected Water-Tributary Stream)

As referenced in Section 2.4 of this Addendum, there are several notable features within District NW-4 that impact the storm water management system design. These features and factors were considered in the modeling of District NW-4. One feature affecting the system design is the Oronoco Estates mobile home park that is situated at the confluence of the Upper Branch's North Fork and South Fork corridors at top of the NW-4 watershed. Major system ponds NW-P2.5 and NW-P2.10 were proposed in order to limit discharge under fully developed conditions and ensure that channel capacities are designed to prevent flooding at this location, as well as downstream. Low-flow discharges from these two ponds are proposed to be routed to a future downstream detention and infiltration basin that would leverage existing excavations created by industrial activity. Possible locations for this future detention and infiltration basin are discussed below.

A sanitary treatment pond exists in District NW-4 to support the Oronoco Estates mobile home park. This treatment pond could be used for storm water ponding and potential wetland banking in the future, assuming that the mobile home park connects to City sewer. The modeling effort assumed that this area would indeed support a retention facility.

A major sand, gravel and rock excavation operation (Shamrock Enterprises) exists downstream of the Oronoco Estates mobile home park. Large areas have been mined to date and these excavations present opportunities for the creation of large regional detention facilities. The modeling effort assumed that a portion of this area would be redeveloped as a retention facility.

Also within District NW-4 is the Oronoco Sanitary Landfill (a municipal solid waste and demolition/construction debris landfill). This 52-acre landfill completed final closure in 1991, however, acceptance of municipal solid waste ended in March 1987 and acceptance of construction/demolition debris ended in October 1990. According to the MPCA, detections of landfill contamination in on-site ground water monitoring wells in 1983 led to the addition of the site to the State and Federal Superfund lists. Subsequent investigations resulted in the site being removed from both the State and Federal Superfund lists. The MPCA, as owner of the site under the Closed Landfill Program, continues to conduct quarterly ground water and gas migration monitoring.

A DNR managed Scientific and Natural Area (SNA) exists at the most downstream portion of District NW-4. This 80-acre parcel, named the Oronoco Prairie SNA, hosts five rare plant species making it a "top-quality prairie." A portion of this property lies in the drainageway for the channel that conveys runoff from upstream areas of District NW-4. The majority of the NWTA study area drains through the SNA site. This fact has greatly influenced the design of the regional ponding system, as the preservation of the SNA is of high importance. In addition to the protection of the SNA site, the channel that extends from T.H. 52 through District NW-4 and exits at 18th Avenue NW is classified as a DNR Protected Water. As such, appropriate coordination with the DNR will be required if and when adjacent development occurs.

Due to the existing features found in District NW-4, several possible strategies exist for managing this District to accommodate future storm water runoff within the Northwest Territory. For example, the North Fork channel could be diverted; a sand excavation operation could create a pond north of the Oronoco Estates mobile home park; the existing sewage treatment pond could be utilized for wetland banking, etc. These opportunities involve a range of cost impacts as well as human resource investment to attain the desired results. Any changes to the existing flows or drainage should be coordinated with the appropriate agencies, as the main channel for NW-4 is a DNR Protected Water and this flows through the Oronoco Prairie Scientific and Natural Area. The strategies outlined in the NWTA balance economics and feasibility with the overall goal of achieving sound storm water management.

The future strategy for managing water resources in District NW-4 should include regional storm water management facilities that provide water quantity and quality protection for downstream areas. This strategy is particularly relevant to any development that may occur south of 85th Street NW because of potential impacts to the downstream DNR Protected Water and SNA. Future development of parcels north of this boundary is not likely to occur in part because of existing active land use already occupying much of the area. Should any new development or redevelopment occur north of 85th Street NW, a regional pond system approach is strongly recommended. If this is not possible, any specific on-site storm water facilities must meet established requirements for runoff volume and any other criteria that may apply to sensitive downstream resources.

NW-4.1a

NW-P4.1a is proposed on the south side of 85th Street NW, utilizing an existing topographic depression and a proposed 42-inch reinforced concrete pipe for outlet control. The purpose of this pond is primarily for rate control. Flows from this area currently discharge through an existing 24-inch reinforced concrete pipe crossing 85th Street NW (located approximately 900 feet east of Highway 52) to the Oronoco Estates Mobile Home Park. That existing pipe is proposed to be plugged and abandoned with future flows proposed to be routed west, along the south side of 85th Street NW. This will route flows away from the inadequate mobile home park drainage system, to the Highway 52 ditch. Flows will then discharge north across 85th Street NW via the proposed 36" RCP for NW-4.1b, listed below. Those flows (from NW-4.1a and NW-4.1b) with then combine with flows from NW-2.5 and NW-2.10 in the east Highway 52 ditch located just north of the intersection with 85th Street NW.

NW-4.1b

This area is included to illustrate that the existing 24-inch reinforced concrete pipe running under 85th Street NW is proposed to be upgraded to a 36-inch reinforced concrete pipe. This is necessary in order to accommodate increased flows under future developed conditions. No other modifications to this area are proposed.

NW-4.3

The proposed ponding area is an existing ditch south of 85th Street NW and east of Highway 52. Only slight modifications to the existing depression are required, in combination with increasing the crossing size from a 24-inch reinforced concrete pipe to a 36-inch reinforced concrete pipe, to accommodate runoff under future developed conditions. The outflow discharges into an open channel that flows along the east border of the Oronoco Estates mobile home park.

NW-4.6

NW-P4.6 is proposed on the south side of 85th Street NW, utilizing an existing arch reinforced concrete pipe (2.4' rise, equivalent to a 36-inch round pipe) as a control structure. The purpose of this regional basin is primarily for rate control due to the relatively large size of this drainage area that it services. This proposed pond is considered a major system reservoir.

13. Conclusion

13.1. Summary

The 1999 SWMP provides a design guide with useful tools for managing the City of Rochester's water and land resources. The anticipated population growth and development within the Northwest Territory warrants this NWTA to appropriately plan and manage these resources in the Northwest Territory study area. The NWTA augments the data available to the City from the 1999 SWMP and maintains the integrity of the 1999 Plan's goals and policies.

The Northwest Territory will undergo a shift in land use away from predominantly agricultural patterns. This shift will increase the amount of impervious area and cause changes to the storm water regime that currently exists. The NWTA utilizes a regional approach to storm water management design while incorporating and enhancing the function of existing natural and constructed features in the proposed storm water drainage network.

The primary function of an urban storm drainage system is to minimize economic loss and inconvenience due to periodic flooding of streets and other low-lying areas. Properly designed storm drainage facilities provide flood control and minimize hazards and inconvenience associated with flooding. Although the specific land use patterns within the Northwest Territory have not been determined, by making projections for cumulative runoff values, the NWTA considers fully developed conditions within the entire study area. In the context of this Addendum, fully developed assumes a uniform curve number of 76 for all land cover within the study area.

The numerous natural channels found throughout the Northwest Territory have been incorporated into the NWTA conveyance network. The open channel conveyance system can allow for water quality benefits that are not possible with pipes, such as groundwater recharge and reduction of suspended solids. Other benefits of an open channel system include ease of inspection, enhancement of aesthetic appearance and an increased conveyance capacity versus a closed pipe (the open channel design can accommodate a 100-year event while storm sewer pipes are typically sized to accommodate a 10-year event). Topographic depressions and existing road crossings have been incorporated into this plan to determine the recommended locations for ponding areas. This regional approach minimizes construction costs and allows for a more effective use of existing culvert structures.

In addition to being a cost-effective storm water management approach to reduce flooding, the proposed integration of regional ponds with natural channels, as presented in this NWTA, provide the following functions:

1. Protect or improve water quality;

2. Recharge groundwater;

3. Increase natural resource amenities in neighborhoods by providing aesthetic, recreational and wildlife habitat improvements.

For the design of water quality ponds, the wet volume is the most critical factor that determines the pond's efficiency at removing suspended sediments and nutrients. The area and depth of ponds proposed in future developments may differ from the values presented here, but the wet volumes recommended in this NWTA should be maintained so that the prescribed phosphorus loading of the system is not exceeded. It can be assumed that water quality ponds will function in reducing pollutants if the design guidelines outlined in Chapter 6 are followed. The XP-SWMM model was selected for use in estimating pollutant and nutrient loads from the major drainage Districts. The XP-SWMM model predicts pollutant removal rates using event mean concentrations based on land use and pond removal efficiencies based on sediment settling removal.

The anticipated future development of the area will result in an increase in impervious area. This may alter or even prevent the natural occurrence of groundwater recharge as compared to undeveloped conditions. Although aquifers are regional in nature, the potential disruption of the infiltration processes from this local study area may have a strong affect on the groundwater resources because of the high rates of infiltration present in this area. By maintaining open channels in lieu of closed pipes as the storm water conveyance system, the opportunity for surface water treatment (via flow through vegetative filter strips and/or water quality treatment ponds) and groundwater infiltration capacity can be preserved to a greater extent.

Amenity aspects are maximized by careful planning in the initial development of any residential or industrial area and by integrating the regional pond/stream corridor approach presented here into the City's park and open space program wherever possible. While not necessarily precluding development, the identification and designation of stream corridors does help identify areas where conservation design principles and natural resources stewardship should be promoted. The wildlife opportunities and aspects of the storm water ponds should be maximized during a development's design stage. Channels within the proposed stream corridor will incorporate dedicated widths for the purpose of securing habitat and resources for wildlife. With proper planning, future improvements for local recreation such as pedestrian or bicycle trails can be successfully integrated into these dedicated widths. The proper location of the recreational trail system will allow good access to these areas for wildlife observation, will take advantage of scenic vistas, and will provide an aesthetic appearance to the trails.

The storm water system alignments shown in the NWTA are conceptual in nature. It is extremely important that each area be re-evaluated at the time of final design to confirm the criteria used in this study and to make any changes that a proposed development may dictate. Successful implementation of the management plan that is detailed in this Addendum will depend on the ability to secure and develop land for use as regional storm water facilities.

13.2. Recommendations

The following recommendations are based upon the data compiled in this Addendum:

1. Establish standard review procedures to ensure that all development activity within the Northwest Territory is in compliance with the general guidelines of this plan and the 1999 SWMP;

2. Implement strategies and practices described in Chapter 4 to guide development within the stream corridors;

3. Construct temporary sediment basins and regional storm water facilities during the initial phase of development within the watersheds addressed in the NWTA;

4. Require detailed hydrologic analysis during the final design and configuration of the drainage system for new developments based on the information contained in Appendices B and C and computer models developed for the NWTA;

5. Establish final high water levels to govern building elevations adjacent to storm water ponding areas and stream channels as development occurs or when drainage facilities are constructed as described in Chapter 5;

6. Incorporate emergency overflow routes into the final design of the drainage system and maintain them to provide relief during extreme storm conditions which exceed design conditions as described in Chapter 5;

7. Establish a storm water system maintenance program to ensure the successful operation of the system, including periodic inspection of storm sewers, channels and ponding areas as described in Chapter 11;

8. Provide erosion and sedimentation control guidelines for the effective design and implementation of erosion control practices;

9. Request the adoption of a storm water management facility area charge by the City Council to provide an equitable method of financing the expansion of the drainage system to serve future development;

10. Request the adoption of a storm water utility fee by the City Council to finance the operations, maintenance, and replacement of the drainage system;

11. Upon adoption of a storm water utility fee, budget funds for the acquisition of lands needed for storm water management not provided for by other means.

12. As part of a comprehensive land use plan update, identify natural resource features and apply other land use designations as needed to protect the integral components of the storm water management system. At that time, recommendations for ordinance changes to support the storm water management plans should be made. As an example, the wetland ordinance should be updated to incorporate by reference the buffer requirements outlined in the Wetland Conservation Act and the storm water management plans (and any subsequent addenda or updates thereto).

13. Consider the adoption of official maps to control the locations of buildings and storm water management facilities, such as drainageways and regional ponds.

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Appendix A

Drainage Areas by Subdistrict

Appendix A
Drainage Areas by Subdistrict

Area Designation	Area Acreage
NW-2.1	61.8
NW-2.2	441.9
NW-2.3	163.8
NW-2.4	275.5
NW-2.5	536.6
NW-2.6	40.9
NW-2.7	30.6
NW-2.8	501.2
NW-2.9	194.4
NW-2.10	458.1
NW-2.11a	208.8
NW-2.11b	58.2
NW-2.12	116.7
Subtotals -	3088.5

Area Designation	Area Acreage
NW-3.1	62.2
NW-3.2	233.6
NW-3.3	91.4
NW-3.4	161.4
NW-3.5a	107.3
NW-3.5b	227.7
NW-3.6	277.3
NW-3.7	170.5
NW-3.8	141.6
NW-3.9	31.2
	1504.2

Area Designation	Area Acreage
NW-4.1a	99.8
NW-4.1b	28.4
NW-4.3	31.9
NW-4.6	199.7
	359.8

Appendix B

Storm Water Basin Parameters

Appendix B
Storm Water Basin Parameters[1]

Watershed Pond ID#	Normal Water Level Elevation (NWL)	Basin Surface Area at NWL (Acres)	100-Year High Water Level (HWL) (feet)	100-Year Water Level Fluctuation (feet)	100-Year Detention Volume (Acre-feet)	100-Year Peak Discharge (cfs)	Water Quality Volume[2] (Acre-feet)	Basin Primary High Flow Outlet
NW-P1[3]	1054.0	30.0	1058.9	4.9	249.8	121.1	46.4	48" RCP
NW-P2.1	1098.0	1.5	1102.9	4.9	8.6	27.5	2.3	18" RCP
NW-P2.2	1070.0	11.5	1075.0	5.0	62.1	236.9	16.6	5'x6' Box
NW-P2.3	1050.0	3.0	1054.6	4.6	19.4	321.2	6.1	6'x8' Box
NW-P2.4	1052.0	6.5	1056.8	4.8	35.0	173.9	10.3	4'x5' Box
NW-P2.5	1010.4	28.0	1015.4	5.0	151.3	393.5	20.1	5'x10' Box
NW-P2.8	1028.0	16.0	1032.8	4.8	82.3	463.7	21.5	7'x12' Box
NW-P2.9	1028.5	5.0	1033.3	4.8	26.6	122.2	7.3	48" RCP
NW-P2.10	1010.0	20.0	1014.9	4.9	120.5	400.7	17.2	5'x10' Box
NW-P2.11a	1060.0	8.2	1064.5	4.5	50.3	76.0	7.8	36" RCP
NW-P2.12	1072.0	3.1	1076.7	4.7	16.0	75.5	4.4	36" RCP
NW-P3.1	1060.0	1.5	1065.0	5.0	8.6	34.6	2.3	24" RCP
NW-P3.2	1034.0	12.0	1039.0	5.0	67.0	161.4	10.9	54" RCP
NW-P3.3	1013.0	15.0	1017.9	4.9	81.3	126.3	3.4	48" RCP
NW-P3.4	1017.0	1.7	1021.8	4.8	22.2	121.2	6.1	42" RCP
NW-P3.5a	1044.0	2.7	1048.8	4.8	14.7	76.0	4.0	36" RCP
NW-P3.5b	1018.0	3.5	1023.0	5.0	40.6	130.9	8.5	48" RCP
NW-P3.6	998.0	18.0	1002.9	4.9	93.3	285.7	10.4	5'x8' Box
NW-P3.7	993.0	1.7	995.9	2.9	10.7	353.5	6.4	2 - 6'x8' Box
NW-P3.8	1024.0	4.0	1028.8	4.8	23.2	61.9	5.3	48" RCP
NW-P3.9	1002.0	0.8	1006.2	4.2	6.8	31.3	1.2	24" RCP
NW-P4.1a	1022.0	2.2	1025.8	3.8	14.0	83.9	3.7	42" RCP
NW-P4.3	1044.0	2.0	1047.6	3.6	8.7	27.2	1.2	24" RCP
NW-P4.6	1032.0	10.0	1035.6	3.6	37.6	62.0	7.5	36" RCP

1) Definitions:
- cfs = cubic feet per second
- RCP = reinforced concrete pipe
- Box = reinforced concrete box culvert

2) Water quality volume refers to the permanent storage below the normal water level (NWL).

3) Area NW-1 and pond NW-P1 were included for accurate modeling of the downstream areas.

Appendix C

Water Quality Modeling Results

Appendix C
Water Quality Modeling Results

Watershed Pond ID#	Suspended Solids		Total Phosphorus		Total Kjeldahl Nitrogen		Zinc		Lead	
	Annual Dis.Load (Lbs)	Annual Mean Conc. (mg/L)	Annual Dis.Load (Lbs)	Annual Mean Conc. (mg/L)	Annual Dis.Load (Lbs)	Annual Mean Conc. (mg/L)	Annual Dis.Load (Lbs)	Annual Mean Conc. (mg/L)	Annual Dis.Load (Lbs)	Annual Mean Conc. (mg/L)
NW-P1	44964	16.9	432	0.162	2162	0.813	285	0.107	127	0.048
NW-P2.1	2523	19.0	22	0.169	111	0.837	15	0.110	7	0.051
NW-P2.2	20526	18.9	183	0.169	908	0.838	120	0.111	55	0.051
NW-P2.3	26985	18.8	242	0.169	1202	0.837	159	0.110	73	0.051
NW-P2.4	11478	19.4	101	0.170	499	0.842	66	0.111	31	0.052
NW-P2.5	59085	18.5	535	0.168	2657	0.834	351	0.110	161	0.050
NW-P2.8	74380	17.2	705	0.163	3522	0.816	465	0.108	208	0.048
NW-P2.9	8336	19.9	72	0.172	355	0.848	47	0.112	22	0.053
NW-P2.10	147339	17.4	1393	0.164	6954	0.819	918	0.108	411	0.048
NW-P2.11a	8694	19.3	76	0.170	378	0.842	50	0.111	23	0.052
NW-P2.12	4955	19.7	43	0.171	212	0.845	28	0.111	13	0.052
NW-P3.1	2642	19.7	23	0.171	113	0.845	15	0.112	7	0.052
NW-P3.2	24969	18.8	224	0.169	1112	0.836	147	0.110	68	0.051
NW-P3.3	30844	18.6	279	0.168	1386	0.834	183	0.110	84	0.050
NW-P3.4	6962	20.0	60	0.172	295	0.849	39	0.112	18	0.053
NW-P3.5a	4586	19.9	40	0.171	195	0.847	26	0.112	12	0.053
NW-P3.5b	13596	18.9	122	0.169	604	0.837	80	0.110	37	0.051
NW-P3.6	62632	18.8	562	0.169	2785	0.838	367	0.111	169	0.051
NW-P3.7	69024	18.7	623	0.169	3089	0.837	408	0.110	187	0.051
NW-P3.8	6234	20.5	53	0.173	260	0.853	34	0.113	16	0.054
NW-P3.9	7100	19.1	63	0.170	313	0.841	41	0.111	19	0.051
NW-P4.1a	4369	20.3	37	0.173	183	0.851	24	0.112	11	0.053
NW-P4.3	1338	19.5	12	0.170	58	0.840	8	0.111	4	0.052
NW-P4.6	8343	19.4	73	0.170	362	0.843	48	0.111	22	0.052

Appendix D

Modified MNRAM Field Form

Area: Bear Creek Hadley Creek Northwest Basin #_________________________

Date_______________ Evaluator(s)_________

Access to Site ☐ Partial Access Only ☐ Full Access

Data has been entered into: ☐ Master ☐ Replica ☐ Laptop

N
Photo # and location:

___Agricultural plowed through; do not inventory

SCOPE AND LIMITATIONS:

1. Description of temporal factors of this assessment due to seasonal considerations and/or existing hydrologic and climatologic conditions (e.g., after heavy rains, snow or ice cover, frozen soil, during drought period, during spring flood, during bird migration). Circle those that apply and list any others.

HYDROLOGIC SETTING

1. Hydrogeomorphology
   ___Depressional
   ___Riverine (within the river/stream banks)
   ___Lacustrine Fringe (edge of deepwater areas)
   ___Extensive Peatland
   ___Slope
   ___Floodplain
   ___Other ___________________.

2. Primary hydrology source: Groundwater Surface Water Both Unknown

3. Additional Observations/Descriptions

4. Has the hydrology of (a.) the wetland, or (b.) the wetland's immediate watershed, been substantially altered by ditching, tiles, dams, culverts, pumping, diversion of surface flow, or changes to runoff within the immediate watershed (circle those that apply)?
   a.) Yes No If Yes; when and how?
   b.) Yes No If Yes; when and how?

5. Does the wetland have discernable inlets or outlets? Yes No If Yes, describe each.
   Inlets Outlets

6. Does the wetland have standing water? Yes No
   Maximum depth (if known)?_______
   Percent inundated________

7. What is the predominant hydroperiod (seasonal water level pattern) of the wetland(s)?

___Permanently Inundated (surface water present all year every year, except during droughts)
___Semi-Permanently Inundated (surface water present throughout growing season in most years)
___Seasonally Inundated (surface water present for extended periods in early growing season but absent by end of the growing season in most years)
___Temporarily Inundated (surface water present for brief periods during the growing season, water table usually below soil surface)
___Saturated (surface water seldom present but substrate saturated for extended periods during the growing season)
___Artificially Inundated (surface water controlled or induced by pumps/dikes/dames, etc.)

8. List any waters or wetlands in close proximity to the wetland. Note approximate distance from the wetland and if there is a surface water connection to other surface waters or wetlands.

VEGETATION **Functional Value (see guidance docs)** **Low** **Med** **High**

1. NWI/Cowardin Classification(s) (field observation) ________Circular 39 Classification(s)____

2. Wetland Type(s): (per Eggers and Reed) shallow open water deep marsh shallow marsh sedge meadow wet meadow low prairie calcareous fen open bog coniferous bog shrub-carr alder thicket hardwood swamp coniferous swamp floodplain forest seasonally flooded basin

3. Fill out the following information for each plant community within the wetland basin. Refer to the Guidance Documents to assess the Value.

Community A
Type______________________Percent of Site______________Value________
Dominant Species

Other Species

Community B
Type______________________Percent of Site______________Value______________

Dominant Species

Other Species

Community C
Type______________________Percent of Site______________Value______________

Dominant Species

Other Species

---

4. How much of the vegetation has been altered from a "pristine" state:_______% of area
5. Method of alteration: ditching filling dumping excavation mowing trails docks grazing tiling farming stormwater

6. Frequency/duration of occurrence frequent common occasional permanent
7. Invasive/Exotic species: _________% of area
8. List exotic species:

Floral Diversity and Integrity

1. Y N Is the wetland plant community scarce or rare within the wetland comparison domain?

2. Y N Is an additional plant survey necessary at another time? List reasons.

MAINTENANCE OF HYDROLOGIC REGIME **Functional Value (see guidance docs)**
Low Med High

1. Describe outlet characteristics

High	Lacks constructed outlet, or the watercourse/stream has not been channelized/ditched
Med. High	Constructed outlet is at or above temporary wetland zone or outlet is managed to duplicated natural conditions
Medium	Constricted or managed outlet; outlet lowered to significantly reduce temporary (7 days) and/or long term storage; evidence of ditched /channelized watercourse
Low	Excavated or enlarged outlet; outlet removes most/all long-term storage, no/little/some temporary storage remains, OR outlet changes wetland type (shallow to deep, or deep to shallow)

2. Describe the dominant land use and condition of the upland watershed that contributes to the wetland:

High	Watershed conditions essentially unaltered; e.g. land use development, minimal, idle lands, lands in hay or forests or low intensity grazing on gentle (<3%) to moderate (3 – 9%) slopes in good to excellent condition.
Medium	Watershed conditions somewhat modified; e.g. moderate grazing or recent logging on steep (>9%) slopes; conventional till with residue management on moderate slopes, no-till on steep slopes.
Low	Watershed conditions highly modified; e.g. intensive agriculture or grazing, no residue management on moderate or steep slopes, urban semi-pervious or impervious surface, intensive mining activities.

3. Describe the conditions of the wetland itself:

High	No evidence of recent tillage, temporary wetland zone intact; e.g. idle land, hayed or lightly to moderately grazed or logged. No compaction, rutting, or trampling damage to the wetland.
Medium	Temporary wetland zone tilled or heavily grazed most years. Zones wetter than temporary receive tillage occasionally. Some compaction, rutting, or trampling in wetland is evident.
Low	Wetland receives conventional tillage most (>75%) years; or otherwise significantly impacted e.g. filled, cleared. Sever compaction, rutting, or trampling damage to wetland.

4. For flow-through wetlands, describe the functional level of the wetland in retarding surface water flow in relation to primary wetland vegetation cover type.

High	Abundance, density, and interspersion very similar to Reference Standard Wetland
Medium	Abundance, density, and interspersion somewhat dissimilar to Reference Standard Wetland
Low	Abundance, density, and interspersion differs considerably from Reference Standard Wetland

Not a flow through wetland

WILDLIFE HABITAT **Functional Value (see guidance docs) Low Med High**

Rare/Unique Species and Specialized Habitat

Y N Is the wetland known to be used by locally rare species or species that are state or federally listed? If yes, wildlife habitat functional level rating =exceptional

Y N Is the wetland known to provide specialized habitat components for particular species or groups of species that are not generally available elsewhere (e.g. Colonial waterbird nesting colonies, significant amphibian breeding sites, deer wintering yards, etc.) If yes, wildlife habitat functional level rating = exceptional.

Y N Does the wetland provide seasonal or intermittent habitat components (e.g. amphibian breeding, resting/feeding by migratory waterfowl/shorebirds)?

Species seen/heard:

Habitat Structure

1. How does the plant species diversity of the evaluation wetland compare with an undisturbed reference standard wetland of the same type within the wetland comparison domain?

more diverse same somewhat less diverse much less diverse

2. Describe the dominant land use and condition of the immediate watershed that contributes to the wetland:
   - High Watershed conditions essentially unaltered, e.g. land use development minimal, idle lands, low intensity grazing or haying, forests
   - Med. Watershed conditions somewhat modified, e.g. moderate intensity grazing or haying; dispersed row crop agriculture; low density residential.
   - Low Watershed conditions highly modified, e.g. intensive rowcrop agriculture; urban semi-pervious or impervious surface, high-density residential, intensive mining activities

Aesthetics/Recreation/Education and Science Functional Value Low Med High

1. Y N Is the wetland visible from any of the following kinds of vantage points: roads, waterways, trails, public lands, houses, and/or businesses? (Circle all that apply.)

2. Y N Is the wetland in/near any population centers so as to generate aesthetic/recreation/educational use?

3. Y N Is any part of the wetland in public or conservation ownership?

4. Y N Does the public have direct access to the wetland from public roads or waterways?

5. Is the wetland itself relatively free of obvious human influences, such as:
   - a Y N Structures
   - b. Y N Trash/pollution
   - c. Y N Filling/dredging/draining

6. Is the area surrounding the wetland relatively free of obvious human influences, such as:
   - a Y N Building?
   - b Y N Roads?
   - c. Y N Other structures?

7. Y N Does the wetland provide a spatial buffer between developed areas?

8. Y N Is the wetland and immediately adjacent area currently being used for (or does it have the potential to be used for) the following recreational activities? (Check all that apply)

ACTIVITY	CURRENT	POTENTIAL USE
Education/scientific study		
Hiking/biking/skiing		
Hunting/fishing/trapping		
Boating/canoeing		
Food harvesting		
Wildlife observation		
Exploration/play/photography		
Others (list)		

SURROUNDING LAND USES

LAND-USE	Estimated % of Wetland's Immediate Watershed
Developed (Industrial/Commercial/Residential)	
Agricultural: cropland	
Agricultural: feedlots	
Agricultural: grazing	
Forested	
Grassed (without grazing)	
Recreation areas/parks	
Highways/Roads	
Mining (specify type)	
Water and wetlands	
Other (specify)	

RESTORATION POTENTIAL
(circle appropriate comments and make notes as needed)

HYDROLOGIC RESTORATION POTENTIAL

NA (not applicable) These wetlands have not had their hydrology altered through artificial drainage, extensive watershed alteration, or other, OR have been altered so significantly that restoration is not practical, and they are best considered as their current type

High Minimal effort required to correct hydrologic alterations. E.G.: blocking a small ditch, breaking one or a few tile lines, taking minor corrective actions within watershed to restore historic quantity/quality of waters reaching wetland.

Medium Some physical and financial efforts would be required to restore these communities. Substantial improvement in the short-term may require an intensive effort. E.G.: creating small berm(s), plugging large ditches, installing control structures, and/or breaking a several tile lines. Also includes moderate efforts within the watershed to restore historic quantity/quality of waters reaching wetland.

Low These communities have often experienced significant hydrologic alteration through human activity. Improvement of these communities in the short-term requires substantial efforts. E.g., creating extensive berms, plugging large/multiple ditches, installing control structures, and/or breaking many tile lines. This category includes substantial efforts within the watershed to restore historic quantity/quality of waters reaching wetland. These wetlands may have had such significant alteration to their hydrology and the hydrology of the watershed that hydrologic restoration is unlikely within the next 100 years.

Comments:

____
____
____

VEGETATION RESTORATION POTENTIAL

NA (not applicable) These wetlands currently have a good to excellent quality plant communities.

High Minimal effort required to restore composition, structure, and function for community type. Examples could include minor species/seed reintroduction, limited management via cutting, spot herbicide treatment, prescribed fire, and/or other practices, both within the wetland and in the surrounding upland. Limited exotic/invasive species infestations

Medium Some physical and financial efforts required to restore vegetation. Substantial improvement in the short-term might require intensive effort. E.g., reseeding portions of the wetland, and multi-year efforts that include a variety of management tools both within the wetland and in the adjacent upland buffer.

Wetland: includes crop field that can be seeded, hydrologically restored, and has potential to achieve moderate quality within 5 – 25 years, and existing wetland communities with low to moderate exotic/invasive species infestations.
Watershed: moderate efforts required to restore historic quantity/quality of waters reaching wetland.

Low These communities have often experienced significant alteration and may be dominated by nonnative species, or be in a cultivated field known to have problem species (onsite or in seedbank) that are likely to impair the success of the restoration. Improving these communities would require substantial efforts over 10 – 30 or more years. Examples might include reseeding of significant portions of wetland, multi-decade restoration efforts requiring a variety of management tools, both within the wetland and in the immediately surrounding upland buffer.

Wetland: crop field that can be seeded and hydrologically restored, but would require significant long-term maintenance in order to achieve at least moderate quality in 20 – 100+ years, or severe levels of exotic species (note potential seedbank). List problem species. __
Watershed: significant efforts to restore vegetation are necessary, or development is complete (or nearly so) and there are few opportunities for corrective action.

Comments: ____

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FEASIBILITY

(The intent of this section is gather additional information which may be useful in prioritizing/eliminating potential restoration sites.)

1. Yes No The site has multiple owners, which may complicate management/decision-making.

2. Current size of basin:____________ Potential size, if restored:____________

3. Connectivity. The wetland is part of a larger wetland complex, or is adjacent to upland that retains some native cover (eg. Woodland, prairie) Non-native cover such as abandoned fields may also be significant, as it can provide for wildlife cover, offer aesthetic contrast to the wetland, or itself be a candidate for management and restoration*.*

High Basin has good connectivity to extensive natural communities that appear to be in good condition, and thus both wildlife and aesthetic value of the area could be improved by enhancing wetland quality.

Moderate Basin is near or adjacent to smaller areas of woods, prairie, or old field, or is at one end of a corridor.

Low Basin is isolated within an intensely used landscape, such as agricultural field, urban, or development setting.

4. Other factors:

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General Comments on the adjacent upland: Cover type, quality, diversity, other items of note:

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____

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Appendix E

Summary of Wetland Data

Appendix E
Summary of Wetland Data

	MNRAM Functional Value Assessment[1]				Management Classification	
Wetland Identification	Infrared Review	Field Visit	Floral Integrity Value	Wildlife Value	Wetland Classification[2]	Storm Water Susceptibility[3]
nw-w1.1	No	Yes	Low	Medium	Ag/Urban Impacted	Least Susceptible
nw-w1.2	No	Yes	Medium	Medium/High	Natural	Moderately Susceptible
nw-w1.3	No	Yes	Medium/Low	Medium	Ecosystem Support	Slightly Susceptible
nw-w1.4	Yes	No	Medium/Low	Medium/Low	Ecosystem Support	Slightly Susceptible
nw-w1.5	Yes	No	Medium	Medium	Natural	Moderately Susceptible
nw-w1.6	Yes	No	Medium	Medium	Natural	Moderately Susceptible
nw-w1.7	Yes	No	Medium	Medium	Natural	Moderately Susceptible
nw-w1.8	Yes	No	Medium	Medium	Natural	Moderately Susceptible
nw-w1.9	Yes	No	Medium	Medium	Natural	Moderately Susceptible
nw-w1.11	Yes	No	Medium/Low	Medium	Ecosystem Support	Slightly Susceptible
nw-w1.A	No	Yes	Low	Medium	Ag/Urban Impacted	Least Susceptible
nw-w1.B	No	Yes	Low	Medium	Ag/Urban Impacted	Least Susceptible
nw-w1.C	No	Yes	Low	Low	Ag/Urban Impacted	Least Susceptible
nw-w1.D	No	Yes	Medium/Low	Medium/Low	Ecosystem Support	Slightly Susceptible
nw-w1.E	No	Yes	Medium/Low	Medium	Ecosystem Support	Slightly Susceptible
nw-w2.1	No	Yes	Low	Low	Ag/Urban Impacted	Least Susceptible
nw-w2.2	No	Yes	Medium	Medium/High	Unique	Highly Susceptible
nw-w2.3	No	Yes	High	High	Unique	Moderately Susceptible
nw-w2.4	No	Yes	Low	Medium/Low	Ag/Urban Impacted	Least Susceptible
nw-w2.5	No	Yes	Medium	Medium/Low	Ecosystem Support	Slightly Susceptible
nw-w2.6	No	Yes	Medium/Low	Medium/Low	Ecosystem Support	Moderately Susceptible
nw-w2.6.A	No	Yes	Medium/High	High	Natural	Highly Susceptible
nw-w2.7	Yes	No	Medium	Medium	Natural	Highly Susceptible
nw-w2.8	Yes	No	Medium/Low	Medium	Ecosystem Support	Moderately Susceptible
nw-w2.9	No	Yes	High	Medium/High	Unique	Moderately Susceptible
nw-w2.10	No	Yes	Medium/High	Medium	Natural	Moderately Susceptible
nw-w2.A	No	Yes	Low	Medium/Low	Ag/Urban Impacted	Least Susceptible
nw-w2.B	No	Yes	High	Medium/High	Unique	Moderately Susceptible
nw-w2.C	No	Yes	Medium/Low	Medium/Low	Ecosystem Support	Slightly Susceptible
nw-w2.D	No	Yes	Medium/High	Medium/High	Natural	Moderately Susceptible
nw-w2.E	No	Yes	Low	Medium/Low	Ag/Urban Impacted	Least Susceptible
nw-w2.F	No	Yes	Medium/Low	Medium	Ecosystem Support	Slightly Susceptible
nw-w2.G	No	Yes	Low	Low	Ag/Urban Impacted	Least Susceptible
nw-w2.H	No	Yes	High	Low	Unique	Slightly Susceptible
nw-w2.I	No	Yes	Low	Medium/Low	Ag/Urban Impacted	Least Susceptible
nw-w2.J	No	Yes	Medium/Low	Medium/Low	Ecosystem Support	Slightly Susceptible
nw-w2.K	No	Yes	Low	Medium/Low	Ag/Urban Impacted	Least Susceptible
nw-w2.L	No	Yes	Low	Low	Ag/Urban Impacted	Least Susceptible
nw-w2.M	No	Yes	Medium	Medium/Low	Ecosystem Support	Highly Susceptible
nw-w2.N	No	Yes	Medium	Medium/Low	Ecosystem Support	Highly Susceptible
nw-w3.A	No	Yes	Medium	Medium	Natural	Moderately Susceptible
nw-w3.B	No	Yes	Medium/Low	Medium	Ecosystem Support	Slightly Susceptible
nw-w3.C	No	Yes	Medium	Medium	Natural	Moderately Susceptible
nw-w3.D	No	Yes	Medium	Medium	Natural	Moderately Susceptible
nw-w4.1	Yes	No	Low	Low	Ag/Urban Impacted	Least Susceptible
nw-w4.2	Yes	No	Low	Low	Ag/Urban Impacted	Least Susceptible
nw-w4.3	Yes	No	Medium/Low	Medium	Ecosystem Support	Slightly Susceptible
nw-w4.4	Yes	No	Medium/Low	Medium/High	Ecosystem Support	Slightly Susceptible
nw-w4.5	Yes	No	Medium/Low	Medium	Ecosystem Support	Slightly Susceptible
nw-w4.6	Yes	Yes	Medium	Medium/High	Natural	Moderately Susceptible
nw-w4.7	No	Yes	High	Medium	Unique	Moderately Susceptible
nw-w4.8	No	Yes	High	Medium/High	Unique	Moderately Susceptible
nw-w4.9	Yes	No	Low	Medium/Low	Ag/Urban Impacted	Least Susceptible
nw-w4.A	No	Yes	Medium/Low	Medium/Low	Ag/Urban Impacted	Least Susceptible

[1]Refer to Section 7.1.3 for more information on MNRAM methodology
[2]Refer to Figure 7-1 and Section 7.2.2 for more information on wetland classification
[3]Refer to Table 7-1 and Section 7.2.3 for more information on storm water susceptibility

Appendix F

Proposed Trunk Channel System Data

Appendix F
Proposed Trunk Channel System Data

Designation			Within the	Pipe			Subtotal	Additional	Total
Flow From	Flow To	Channel Classification[1]	Stream Corridor?	Size (Feet)	Length (Feet)	Unit Cost[2,3,6] ($/ft)	Cost ($)	Cost[4] ($)	Cost ($)

Minor District NW-2

2.2.1	2.2.2	I - sta	Yes		1,040	43	44,992	15,747	60,739
2.2.2	2.2.5	II - sta	Yes		1,633	49	80,019	28,007	108,025
2.2.3	2.2.4	I - sta	Yes		625	43	27,038	9,463	36,502
2.2.4	2.2.5	II - sta	Yes		901	49	44,150	15,452	59,602
2.2.5	2.2.7	II - sta	Yes		1,064	49	52,137	18,248	70,385
2.2.6	2.2.7	I - sta	Yes		2,000	43	86,523	30,283	116,806
2.2.7	NW-P2.2	II - sta	Yes		476	49	23,324	8,164	31,488
2.2.8	2.2.9	I - imp	Yes		1,482	58	86,343	30,220	116,564
NW-P2.1	2.2.10			1.5	80	23	1,840	644	2,484
2.2.9	NW-P2.2	II - imp	Yes		590	61	35,991	12,597	48,587
2.2.10	NW-P2.2	I - imp	Yes		597	58	34,782	12,174	46,956
2.3.1	2.3.3	I - imp	Yes		2,515	58	146,528	51,285	197,812
2.3.2	2.3.3	I - imp	Yes		1,330	58	77,488	27,121	104,608
NW-P2.2	2.3.4			5x6	75	323	24,225	8,479	32,704
2.3.3	2.3.5	I - imp	Yes		510	58	29,713	10,400	40,113
2.3.4	2.3.5	II - imp	Yes		215	61	13,115	4,590	17,706
2.3.5	NW-P2.3	II - imp	Yes		1,069	61	65,210	22,824	88,034
2.4.1	2.4.2	I - imp	Yes		1,166	58	67,933	23,777	91,709
2.4.2	2.4.3	II - imp	Yes		1,102	61	67,223	23,528	90,751
2.4.3	NW-P2.4	II - sta	Yes		2,167	49	106,185	37,165	143,350
NW-P2.3	2.5.1			6x8	75	368	27,600	9,660	37,260
NW-P2.4	2.5.2			4x5	75	315	23,625	8,269	31,894
2.5.1	2.5.3	II - imp	Yes		1,167	61	71,188	24,916	96,104
2.5.2	2.5.3	II - imp	Yes		613	61	37,394	13,088	50,481
2.5.3	NW-P2.5	III - sta	Yes		3,112	57	177,413	62,094	239,507
NW-P2.5	4.11.1			5x10	200	436	87,200	30,520	117,720
2.8.1	2.8.2	I - sta	Yes		1,586	43	68,613	24,014	92,627
2.8.2	2.8.4	II - sta	Yes		591	49	28,960	10,136	39,095
2.8.3	2.8.4	I - sta	Yes		1,216	43	52,606	18,412	71,018
NW-P1	2.8.5			4	75	116	8,700	3,045	11,745
2.8.4	2.8.6	II - sta	Yes		1,866	49	91,436	32,003	123,438
2.8.5	2.8.6	I - sta	Yes		1,485	43	64,243	22,485	86,728
2.8.6	2.8.8	II - sta	Yes		449	49	22,001	7,701	29,702
2.8.7	2.8.8	I - imp	No		911	38	34,254	11,989	46,243
2.8.8	2.8.10	II - sta	Yes		789	49	38,662	13,532	52,193
2.8.9	2.8.10	I - sta	No		630	23	14,238	4,983	19,222
2.8.11	2.8.12	I - imp	No		1,140	38	42,864	15,003	57,867
2.8.10	2.8.13	II - sta	Yes		959	49	46,992	16,447	63,439
2.8.12	2.8.13	II - imp	No		1,667	40	67,247	23,536	90,783
2.8.13	NW-P2.8	II - sta	Yes		567	49	27,784	9,724	37,508
NW-P2.9	NW-P2.8			4	75	116	8,700	3,045	11,745

See last page for footnotes

Appendix F
Proposed Trunk Channel System Data

Designation		Channel	Within the	Pipe			Subtotal	Additional	Total
Flow From	Flow To	Classification[1]	Stream Corridor?	Size (Feet)	Length (Feet)	Unit Cost[2,3,6] ($/ft)	Cost ($)	Cost[4] ($)	Cost ($)
2.9.1	2.9.2	I - imp	Yes		621	58	36,180	12,663	48,843
2.9.2	NW-P2.9	II - imp	Yes		1,944	61	118,586	41,505	160,091
2.10.1	2.10.2	I - imp	No		383	38	14,401	5,040	19,441
2.10.2	2.10.5	II - imp	No		2,226	40	89,797	31,429	121,225
2.10.3	2.10.4	I - sta	No		608	23	13,741	4,809	18,550
2.10.4	2.10.5	II - sta	No		1,568	28	44,437	15,553	59,990
NW-P2.8	2.10.5			7x12	75	580	43,500	15,225	58,725
2.10.5	2.10.7	II - sta	Yes		1,641	49	80,411	28,144	108,554
2.10.6	2.10.7	I - imp	No		1,515	38	56,964	19,938	76,902
2.10.7	NW-P2.10	II - sta	Yes		1,556	49	76,246	26,686	102,932
2.10.8	2.10.9	I - imp	No		935	38	35,156	12,305	47,461
2.10.9	NW-P2.10	II - imp	No		1,078	40	43,486	15,220	58,707
2.10.10	2.10.11	I - imp	No		995	38	37,412	13,094	50,507
2.10.11	NW-P2.10	II - imp	No		126	40	5,083	1,779	6,862
NW-P2.10	4.11.2			5x10	135	436	58,860	20,601	79,461
2.11a.1	2.11a.2	I - sta	Yes		2,554	43	110,490	38,671	149,161
2.11a.2	NW-P2.11a	II - sta	Yes		1,433	49	70,218	24,576	94,795
NW-P2.11a	3.2.5			3	75	77	5,775	2,021	7,796
2.12.1	2.12.2	I - sta	Yes		995	43	43,045	15,066	58,111
2.12.2	NW-P2.12	II - sta	Yes		396	49	19,404	6,792	26,196
NW-P2.12	3.2.1			3	75	77	5,775	2,021	7,796
						Minor District NW-2 Subtotal	3,165,446	1,107,906	4,273,353

Minor District NW-3

3.1.1	NW-P3.1	I - sta	No		870	23	19,662	6,882	26,544
3.2.1	3.2.2	I - sta	Yes		432	43	18,689	6,541	25,230
3.2.2	3.2.4	II - sta	Yes		864	49	42,337	14,818	57,155
3.2.3	3.2.4	I - sta	No		656	23	14,826	5,189	20,015
3.2.4	NW-P3.2	II - sta	Yes		900	49	44,101	15,435	59,536
3.2.5	3.2.6	I - sta	Yes		297	43	12,849	4,497	17,346
3.2.6	NW-P3.2	II - sta	Yes		518	49	25,383	8,884	34,266
NW-P3.1	3.3.1			2	90	44	3,960	1,386	5,346
3.3.1	NW-P3.3	I - sta	No		1,418	23	32,047	11,217	43,264
NW-P3.2	3.3.2			4.5	75	139	10,425	3,649	14,074
3.3.2	NW-P3.3	II - sta	Yes		655	49	32,096	11,233	43,329
3.4.1	3.4.2	I - imp	No		682	38	25,643	8,975	34,619
3.4.2	NW-P3.4	II - imp	No		1,276	40	51,474	18,016	69,489
3.5a.1	3.5a.2	I - imp	No		1,042	38	39,180	13,713	52,892
3.5a.2	NW-P3.5a	II - imp	No		365	40	14,724	5,153	19,877
NW-P3.5a	3.5b.1			3	75	77	5,775	2,021	7,796
3.5b.1	NW-P3.5b	II - sta	No		1,990	28	56,396	19,739	76,135
3.5b.2	NW-P3.5b	I - imp	No		734	38	27,599	9,660	37,258
NW-P3.5b	3.6.5			4	75	116	8,700	3,045	11,745

See last page for footnotes

Appendix F
Proposed Trunk Channel System Data

Designation: Flow From	Designation: Flow To	Channel Classification[1]	Within the Stream Corridor?	Pipe Size (Feet)	Length (Feet)	Unit Cost[2,3,6] ($/ft)	Subtotal Cost ($)	Additional Cost[4] ($)	Total Cost ($)
3.6.1	3.6.2	I - imp	No		1,009	38	37,939	13,279	51,217
3.6.2	3.6.3	II - imp	No		2,682	40	108,192	37,867	146,059
NW-P3.3	3.6.3			4	60	116	6,960	2,436	9,396
3.6.3	NW-P3.6	II - imp	Yes		269	61	16,409	5,743	22,153
NW-P3.4	3.6.4			3.5	90	101	9,090	3,182	12,272
3.6.4	NW-P3.6	I - imp	Yes		110	58	6,409	2,243	8,652
3.6.5	NW-P3.6	II - sta	No		468	28	13,263	4,642	17,905
NW-P3.6	NW-P3.7			5x8	72	355	25,560	8,946	34,506
3.7.1	3.7.2	I - imp	No		1,134	38	42,639	14,924	57,562
3.7.2	NW-P3.7	II - imp	No		1,763	40	71,119	24,892	96,011
NW-P3.7	OUT[5]			6x8 (2)	85	368	31,280	10,948	42,228
3.8.1	NW-P3.8	I - imp	Yes		822	58	47,891	16,762	64,653
NW-P3.8	3.9.1			4	75	116	8,700	3,045	11,745
3.9.1	NW-P3.9	I - sta	Yes		822	43	35,561	12,446	48,007
NW-P3.9	OUT[5]			2	100	44	4,400	1,540	5,940
						Minor District NW-3 Subtotal	951,276	332,946	1,284,222

Minor District NW-4

Flow From	Flow To	Channel Classification	Within the Stream Corridor?	Pipe Size (Feet)	Length (Feet)	Unit Cost ($/ft)	Subtotal Cost ($)	Additional Cost ($)	Total Cost ($)
4.1a.1	NW-P4.1a	I - imp	No		2,355	38	88,549	30,992	119,541
NW-P4.1a	4.1b.1			3.5	75	101	7,575	2,651	10,226
4.1b.1	4.1b.2	I - imp	No		555	38	20,868	7,304	28,172
4.1b.2	4.11.1			3	100	77	7,700	2,695	10,395
NW-P4.3	4.4.1			2	75	44	3,300	1,155	4,455
4.6.1	4.6.2	I - sta	No		883	23	19,956	6,985	26,941
4.6.2	NW-P4.6	II - sta	No		1,016	28	28,793	10,078	38,871
NW-P4.6	4.7.1			3	75	77	5,775	2,021	7,796
4.4.1	OUT[5]	I - imp	No		586	38	22,034	7,712	29,746
4.7.1	OUT[5]	I - sta	Yes		528	43	22,842	7,995	30,837
4.11.1	4.11.2	II - sta	Yes		810	49	39,691	13,892	53,583
4.11.2	OUT[5]	I - imp	Yes		657	58	38,278	13,397	51,675
						Minor District NW-4 Subtotal	305,361	106,876	412,237

1) "Sta" is an abbreviation for channel stabilization measures. "Imp" is an abbreviation for channel improvement measures. "I" and "II" reflects the channel conveyance capacity. Refer to Section 5.4 for more information.
2) Unit cost includes erosion protection, excavation, weir structures, and purchase of maintenance easement (including freeboard). For channels within the environmental corridor, unit cost also includes purchase of buffer strip. Land acquisition for maintenance and/or buffer area is assumed to be $15,000 per acre.
3) Unit costs were derived by summing the total costs of channel improvements and dividing by the length of each channel type. Costs within the environmental corridor were summed and allocated separate from costs outside of the corridor.
4) Additional cost reflects an estimation of an additional 35% of subtotal cost for enginnering, administration, interest and contigency.
5) Flows exit the study area.
6) Costs correspond to April 2002.

Appendix G

Basin Cost Estimate

Appendix G
Basin Cost Estimate

Pond Designation	Pond Exacavation (Ac-Ft)	Excavation Cost[1,4] ($3.20/CY)	Land Acquisition (Ac)	Land Acquisition Cost[2,4] ($11,500/Ac)	Outlet Cost[4] ($)	Subtotal Cost ($)	Additional Cost[3] ($)	Total Cost ($)
Minor District NW-2								
NW-P2.1	4.03	20,822	2.0	23,000	7,500	51,322	17,963	69,285
NW-P2.2	28.99	149,676	13.5	155,250	16,000	320,926	112,324	433,250
NW-P2.3	10.02	51,743	5.3	60,950	20,000	132,693	46,442	179,135
NW-P2.4	17.33	89,471	7.9	90,850	16,000	196,321	68,712	265,033
NW-P2.5	50.38	260,110	33.0	379,500	20,000	659,610	230,864	890,474
NW-P2.8	37.94	195,852	17.9	205,850	20,000	421,702	147,596	569,298
NW-P2.9	12.61	65,093	6.0	69,000	12,000	146,093	51,133	197,226
NW-P2.10	41.28	213,109	30.0	345,000	20,000	578,109	202,338	780,447
NW-P2.11a	17.89	92,359	11.1	127,650	12,000	232,009	81,203	313,212
NW-P2.12	7.58	39,112	3.6	41,400	12,000	92,512	32,379	124,891
					Minor District NW-2 Subtotal	2,831,297	990,954	3,822,251
Minor District NW-3								
NW-P3.1	4.05	20,926	2.0	23,000	7,500	51,426	17,999	69,425
NW-P3.2	24.34	125,672	15.0	172,500	16,000	314,172	109,960	424,132
NW-P3.3	19.69	101,649	18.0	207,000	12,000	320,649	112,227	432,876
NW-P3.4	10.49	54,175	5.3	60,950	12,000	127,125	44,494	171,618
NW-P3.5a	6.97	35,960	3.2	36,800	12,000	84,760	29,666	114,426
NW-P3.5b	16.66	86,003	12.3	141,450	12,000	239,453	83,808	323,261
NW-P3.6	29.06	150,026	19.6	225,400	16,000	391,426	136,999	528,425
NW-P3.7	8.53	44,061	3.6	41,400	20,000	105,461	36,911	142,373
NW-P3.8	9.95	51,364	5.7	65,550	12,000	128,914	45,120	174,034
NW-P3.9	2.53	13,069	1.7	19,550	7,500	40,119	14,042	54,161
					Minor District NW-3 Subtotal	1,803,505	631,227	2,434,732
Minor District NW-4								
NW-P4.1a	6.54	33,778	3.7	42,550	12,000	88,328	30,915	119,242
NW-P4.3	2.94	15,158	2.4	27,600	7,500	50,258	17,590	67,848
NW-P4.6	15.01	77,482	10.7	123,050	12,000	212,532	74,386	286,919
					Minor District NW-4 Subtotal	351,118	122,891	474,009

1) Assumes that material is of good quality and reused on site.

2) Land acquisition costs were a weighted average of "H/F" soils (hydric, floodplain and hydric/floodplain soils together) and "upland" (all other) soils.
"H/F" soils were assumed to cost $5,000 per acre and upland soils were assumed to cost $15,000 per acre
By GIS, 37% of HWL encompassed "H/F" and 63% encompassed "upland", giving a rounded weighted cost of $11,500.

3) Additional cost reflects an estimation of an additional 35% of subtotal cost for enginnering, administration, interest and contigency.

4) Costs correspond to April 2004.

Appendix H

Cost Summaries by Minor District and Design Item

Appendix H
Cost Summaries by Minor District and Design Item

Cost Summary by Minor District

		Subtotal Cost	Additional Cost	Total Cost
Minor District NW-2				
Water Quality	(9.7%)	$913,361	$319,676	$1,233,038
Water Quantity	(23.5%)	$2,213,736	$774,807	$2,988,543
Trunk Channels	(30.5%)	$2,869,646	$1,004,376	$3,874,023
	(63.7%)	Minor District NW-2 Subtotal -		$8,095,603
Minor District NW-3				
Water Quality	(5.0%)	$470,988	$164,846	$635,834
Water Quantity	(15.4%)	$1,447,367	$506,579	$1,953,946
Trunk Channels	(8.9%)	$836,426	$292,749	$1,129,175
	(29.3%)	Minor District NW-2 Subtotal -		$3,718,954
Minor District NW-4				
Water Quality	(1.1%)	$99,883	$34,959	$134,842
Water Quantity	(2.9%)	$275,585	$96,455	$372,039
Trunk Channels	(3.0%)	$281,011	$98,354	$379,364
	(7.0%)	Minor District NW-2 Subtotal -		$886,246
Grand Total		$9,408,002	$3,292,801	$12,700,803

Note: Costs correspond to April 2002.

Appendix H
Cost Summaries by Minor District and Design Item

Cost Summary by Design Item

		Subtotal Cost	Additional Cost	Total Cost
Ponds:				
Water Quality				
Minor District NW-2				
Land acquisition	(3.5%)	$326,701	$114,345	$441,046
Excavation	(6.2%)	$586,660	$205,331	$791,991
Minor District NW-3				
Land acquisition	(1.8%)	$168,468	$58,964	$227,432
Excavation	(3.2%)	$302,520	$105,882	$408,402
Minor District NW-4				
Land acquisition	(0.4%)	$35,727	$12,505	$48,232
Excavation	(0.7%)	$64,156	$22,455	$86,610
	(15.8%)		Water Quality Subtotal -	$2,003,714
Water Quantity				
Minor District NW-2				
Land acquisition	(12.5%)	$1,171,749	$410,112	$1,581,861
Excavation	(6.3%)	$590,687	$206,740	$797,427
Outlet cost	(1.7%)	$155,500	$54,425	$209,925
Trunk pipe cost	(3.1%)	$295,800	$103,530	$399,330
Minor District NW-3				
Land acquisition	(8.8%)	$825,132	$288,796	$1,113,928
Excavation	(4.0%)	$380,385	$133,135	$513,520
Outlet cost	(1.3%)	$127,000	$44,450	$171,450
Trunk pipe cost	(1.2%)	$114,850	$40,198	$155,048
Minor District NW-4				
Land acquisition	(1.7%)	$157,473	$55,115	$212,588
Excavation	(0.7%)	$62,262	$21,792	$84,053
Outlet cost	(0.3%)	$31,500	$11,025	$42,525
Trunk pipe cost	(0.3%)	$24,350	$8,523	$32,873
	(41.8%)		Water Quantity Subtotal -	$5,314,528
Pond Total	(57.6%)	$5,420,920	$1,897,322	$7,318,241
Trunk Channels:				
Minor District NW-2				
Erosion Protection	(3.2%)	$296,711	$103,849	$400,559
Excavation	(3.0%)	$280,508	$98,178	$378,686
Improvement Structure	(3.8%)	$353,064	$123,572	$476,636
Easement	(10.5%)	$988,496	$345,974	$1,334,469
Buffer	(10.1%)	$950,868	$332,804	$1,283,671
Minor District NW-3				
Erosion Protection	(1.1%)	$104,963	$36,737	$141,700
Excavation	(1.0%)	$94,699	$33,145	$127,844
Improvement Structure	(1.7%)	$159,255	$55,739	$214,994
Easement	(3.8%)	$359,967	$125,988	$485,955
Buffer	(1.2%)	$117,541	$41,139	$158,681
Minor District NW-4				
Erosion Protection	(0.3%)	$31,730	$11,105	$42,835
Excavation	(0.3%)	$23,618	$8,266	$31,884
Improvement Structure	(0.7%)	$62,295	$21,803	$84,098
Easement	(1.3%)	$122,149	$42,752	$164,901
Buffer	(0.4%)	$41,219	$14,427	$55,646
Trunk Channel Total	(42.4%)	$3,987,083	$1,395,479	$5,382,562
Grand Total:		$9,408,002	$3,292,801	$12,700,803

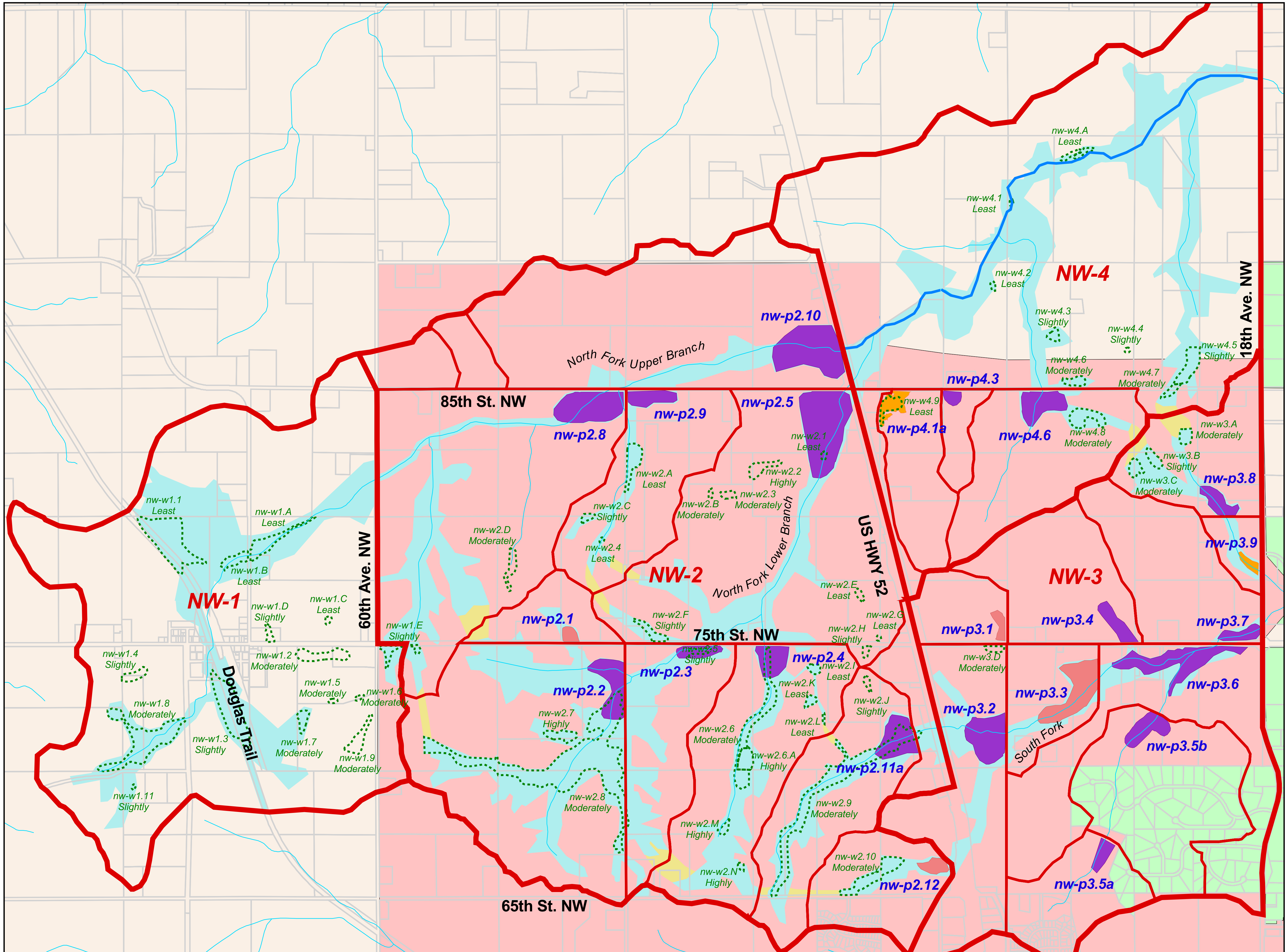
Note: Costs correspond to April 2002.

City of Rochester

STORM DRAINAGE

Rochester Storm Water Management Plan - Northwest Territory Addendum

Map 1



Legend

Proposed Ponds
- Sediment Basin
- Nutrient Removal Basin
- 3-Cell Filter Basin

- Minor Drainage Districts
- Subdistricts

- Wetlands:
  - nw-w4.4: Wetland ID
  - Slightly: Storm Water Susceptibility
- DNR Protected Water
- Other Watercourses
- Stream Corridor
- Potential Upland Corridor Connection
- Parcels

- 25 Yr. Urban Service Area
- Suburban Development Area
- Resource Protection Area

N W E S

March 2004

2000 0 2000
Feet

ROCHESTER MINNESOTA

Bonestroo Rosene Anderlik & Associates
Engineers & Architects

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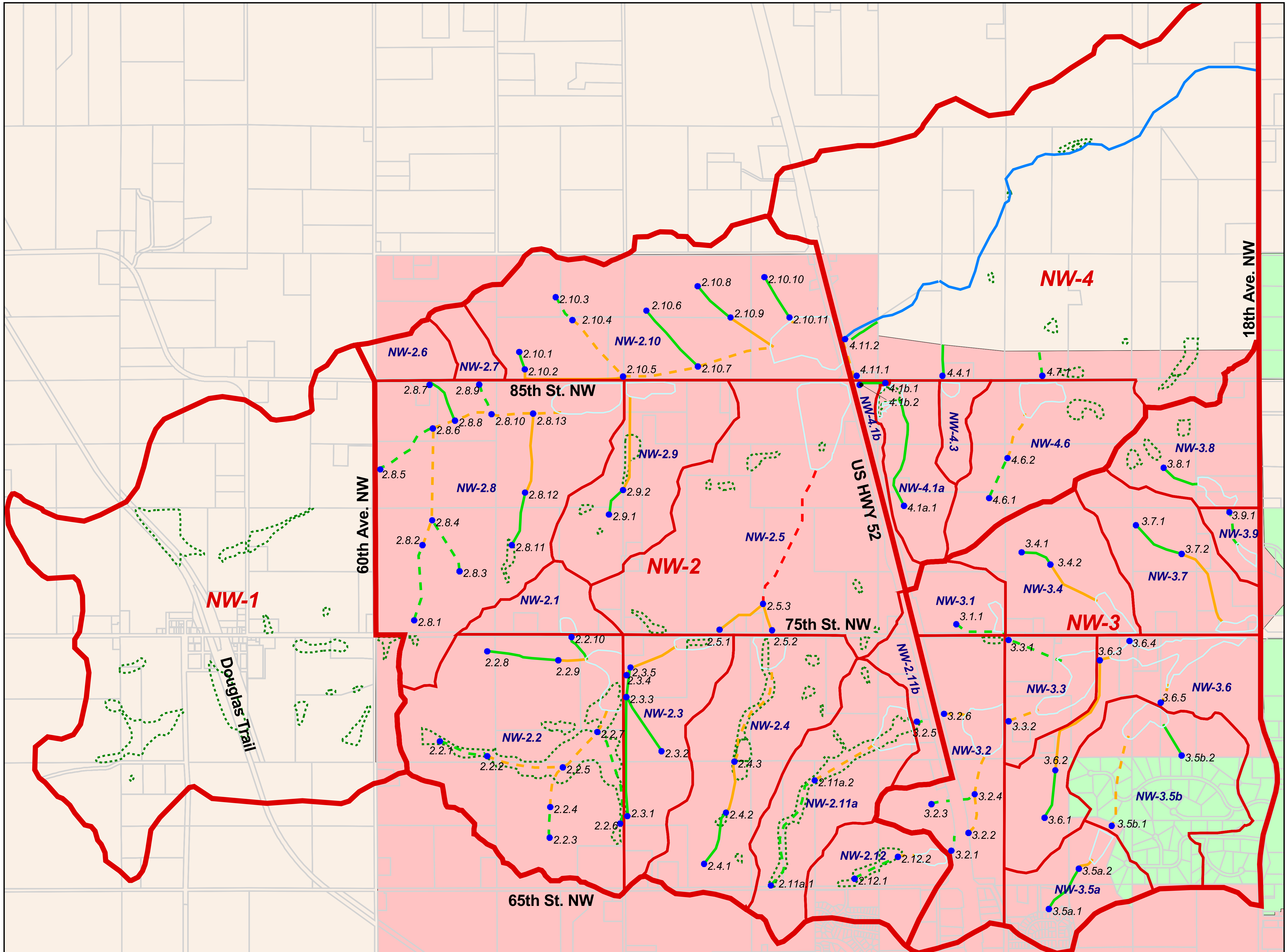
1) Data in map are in Olmsted County Coordinate System.
2) Olmsted County Land Use Approved 6-25-02.



City of Rochester

TRUNK STORM CHANNEL

Rochester Storm Water Management Plan - Northwest Territory Addendum

Map 2

Legend

Open Channels & Proposed Improvements
- Type I - Improve
- Type I - Stabilize
- Type II - Improve
- Type II - Stabilize
- Type III - Stabilize

- Channel node with ID
- Minor Drainage Districts
- Subdistricts
- Proposed Ponds
- Parcels
- 25-Year Urban Service Area
- Suburban Development Area
- Resource Protection Area
- Wetlands
- DNR Protected Water

N E S W

March 2004

2000 0 2000

Feet

ROCHESTER MINNESOTA

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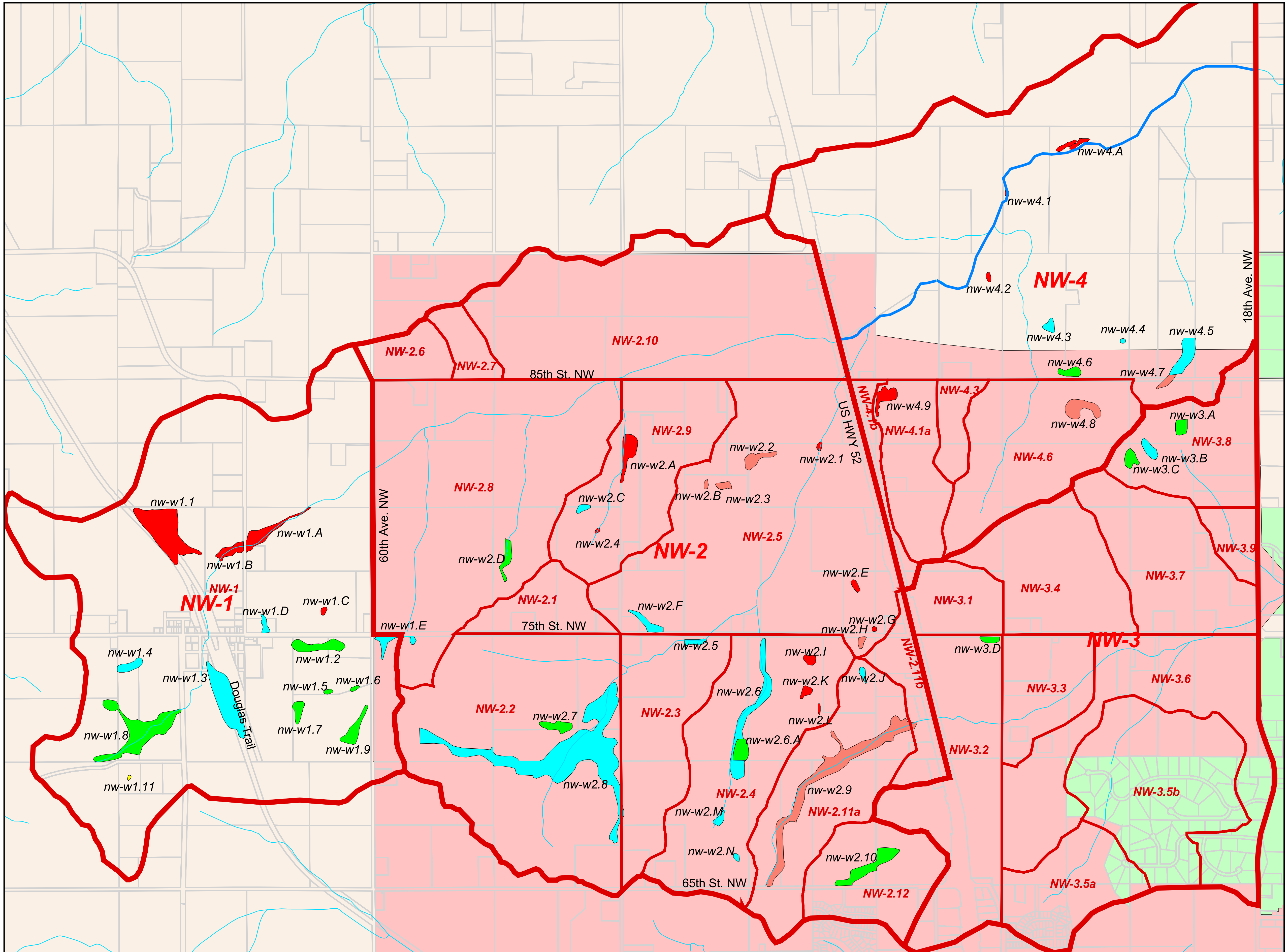

City of Rochester

WETLANDS

Rochester Storm Water Management Plan - Northwest Territory Addendum

Map 3

Legend

Wetland Classification
- Unique
- Natural
- Ecosystem Support
- Ag/Urban Impacted
- Minor Drainage Districts
- Parcels
- 25 Yr. Urban Service Area
- Suburban Development Area
- Resource Protection Area
- DNR Protected Water
- Other Watercourses

N W E S

March 2004

2000 0 2000
Feet

ROCHESTER MINNESOTA

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