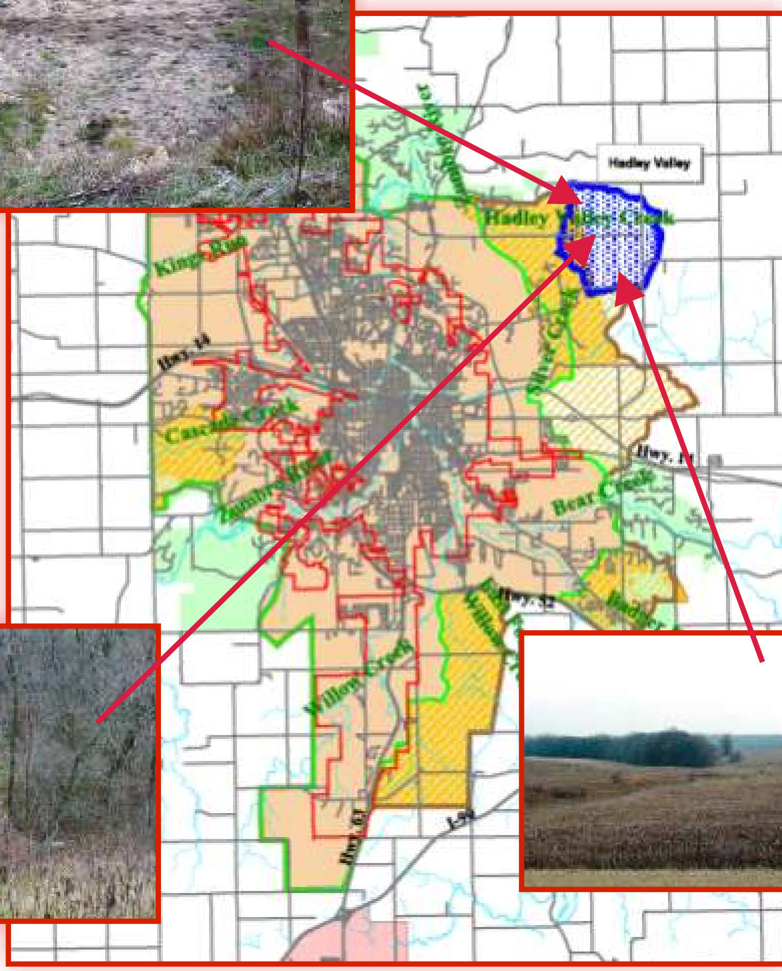
Rochester

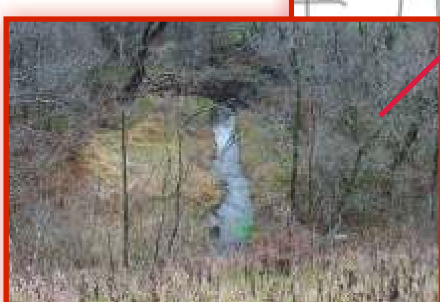
Storm Water Management Plan

Hadley Valley Addendum

March 2004



Bonestroo
Rosene
Anderlik &
Associates
Engineers & Architects



Rochester Storm Water Management Plan
Hadley Valley Addendum

TABLE OF CONTENTS **i**

Appendices

Tables

Figures

Maps

1. Introduction

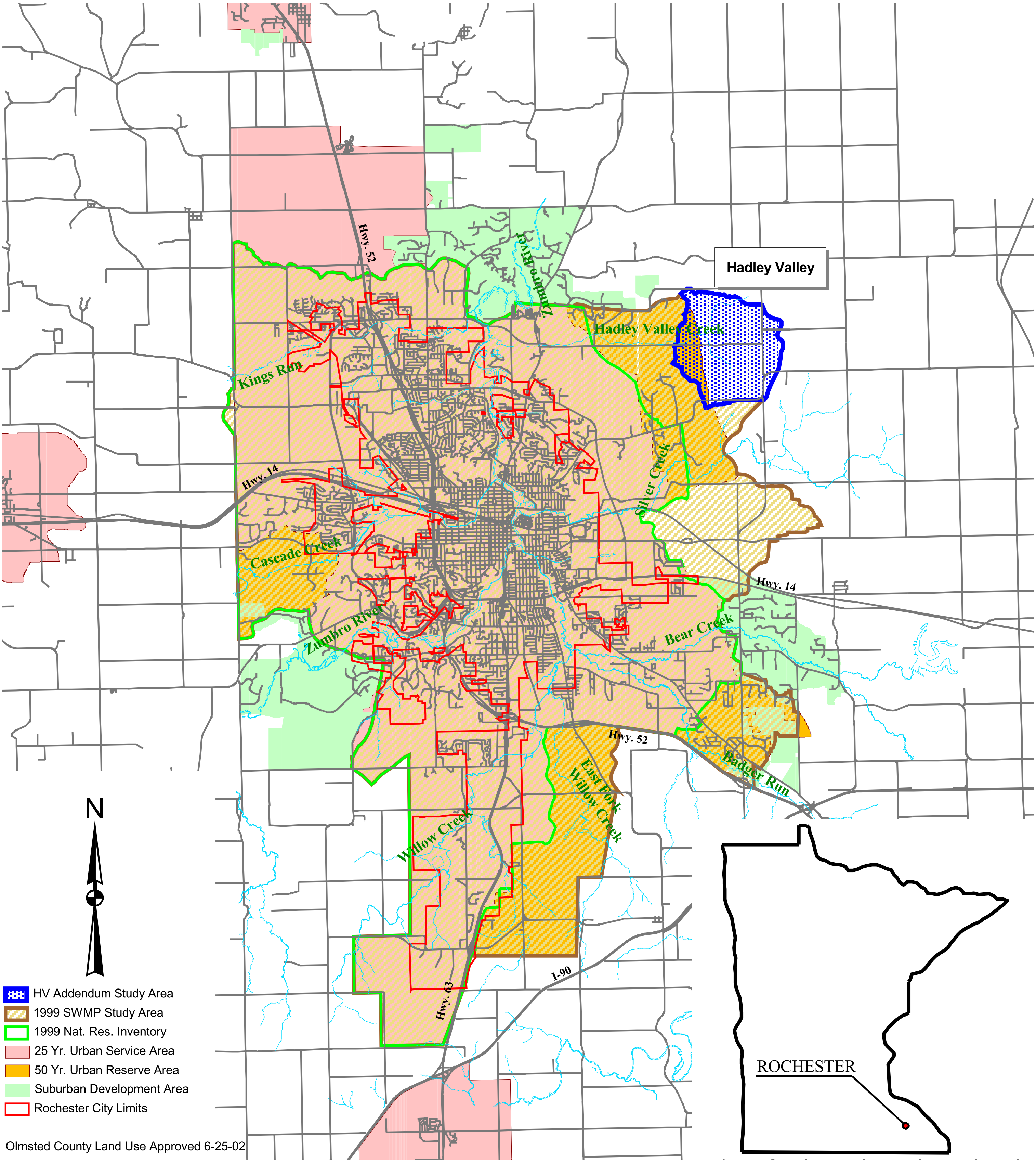
In response to rapid population growth, the City of Rochester undertook a storm water planning effort in 1995. A Steering Committee was formed to guide the development of Rochester's Storm Water Management Plan (SWMP), which was published in 1997 and updated in 1999. This report, the "Hadley Valley Addendum" (HVA), was prepared as an Addendum to the 1999 SWMP to provide a detailed assessment the headwaters of the Hadley Valley Creek watershed.

Although the downstream portion of the Hadley Valley Creek major drainage District was included in the 1999 SWMP, the upstream portion of the Hadley Valley Creek major drainage District was analyzed only on a broad basis because it was outside of the 2045 Urban Service Area. The upstream areas are now receiving detailed storm water planning due to anticipated land use changes and downstream impacts in this sensitive area. Figure 1-1 illustrates the study area for the original SWMP and the HVA study area.

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 potential extension of storm water management facilities into this area.



LOCATION MAP - HADLEY VALLEY

ROCHESTER, MINNESOTA

FIGURE 1-1

ROCHESTER STORM WATER MANAGEMENT PLAN - HADLEY VALLEY ADDENDUM

Bonestroo Rosene Anderlik & Associates
Engineers & Architects

\363\36301129\CAD\GIS\AVPROJECT\HV_PROJLOC.APR 1/18/02

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:

- 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 HVA study area, 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 HVA. However, the 1999 SWMP addressed NPDES recommendations and requirements, and has been replaced by the topic of wetlands in the HVA. The reader is encouraged to refer to the 1999 plan for details on the NPDES program and requirements.

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 Hadley Valley and the resources contained within Hadley Valley. 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 HVA study area of 1,849 acres is comprised of four minor drainage Districts. This differs from the 1999 SWMP, which identified only two minor drainage Districts (labeled as HV-A1.1 and HV-A1.2 in the 1999 SWMP). The HVA study area is formed by a combination of existing roadways as well as topographic high points. The HVA study area is roughly bounded on the south by Viola Road NE (County Road 2) and by Hadley Valley Road NE (County Road 124) on the north. The east boundary of the study area is immediately east of 55th Avenue NE. The west boundary is situated upstream of existing residential developments, very roughly referenced as the north-south line dividing Sections 16 and 17 of Township 107N and Range 13W. Figure 1-1 shows the location of the study area with respect to the Urban Reserve Area boundaries.

The general location and corresponding acreage of the four minor drainage Districts within the HVA study area are summarized in the following table.

Table 1-1 HVA Minor Drainage Districts

Minor Drainage District	Abbreviation	Acreage
Southeast	HV-1	968
Northeast	HV-2	413
Northwest	HV-3	305
Southwest	HV-4	163
Total		1,849

1.2. General Description

The Hadley Valley watershed is one of nine major drainage Districts which impact the City of Rochester and its constituents. The HVA study area is a landscape that is currently experiencing high levels of erosion due to soil types, slopes and land use practices. The Hadley Valley Creek, which drains this study area and the overall major drainage District, has become degraded from activities such as low-flow diversion, surrounding agriculture practices, sedimentation and deposition of eroded material. Sound water resource planning is required to address the sensitive condition of the landscape and protect downstream resources. Downstream impacts resulting from erosion and sediment deposition catalyzed a previous study of the major drainage District. A report published in October, 2000 by the United States Department of Agriculture Natural

Resource Conservation Service (USDA-NRCS) provides suggestions to address degradation from upstream erosion, and the general sensitive nature of the landscape. The USDA-NRCS report is discussed further in Section 9.

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 Hadley Valley 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. 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 will form the framework of the City's storm water management strategies of the City, including the Hadley Valley 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 HVA study area is an area with significant elevation changes. Figure 3-1 illustrates 10-foot contour data for the study area. The elevation ranges from a high of approximately 1280 feet in the east to a low of about 1060 feet above mean sea level in the west. Relatively flat plateaus of upland areas transition abruptly into steep valleys and ravines. The steep valleys form numerous channels that feed into Hadley Valley Creek, which drains this study area from east to west.

Some small ponds exist within the study area that have been created by constructing berms and low-hazard dams within valley areas. There are several locations within the study area where the groundwater discharges to the ground surface above the Decorah Shale contact creating side-hill seep wetlands. Chapter 7 provides a detailed overview of wetlands within the study area.

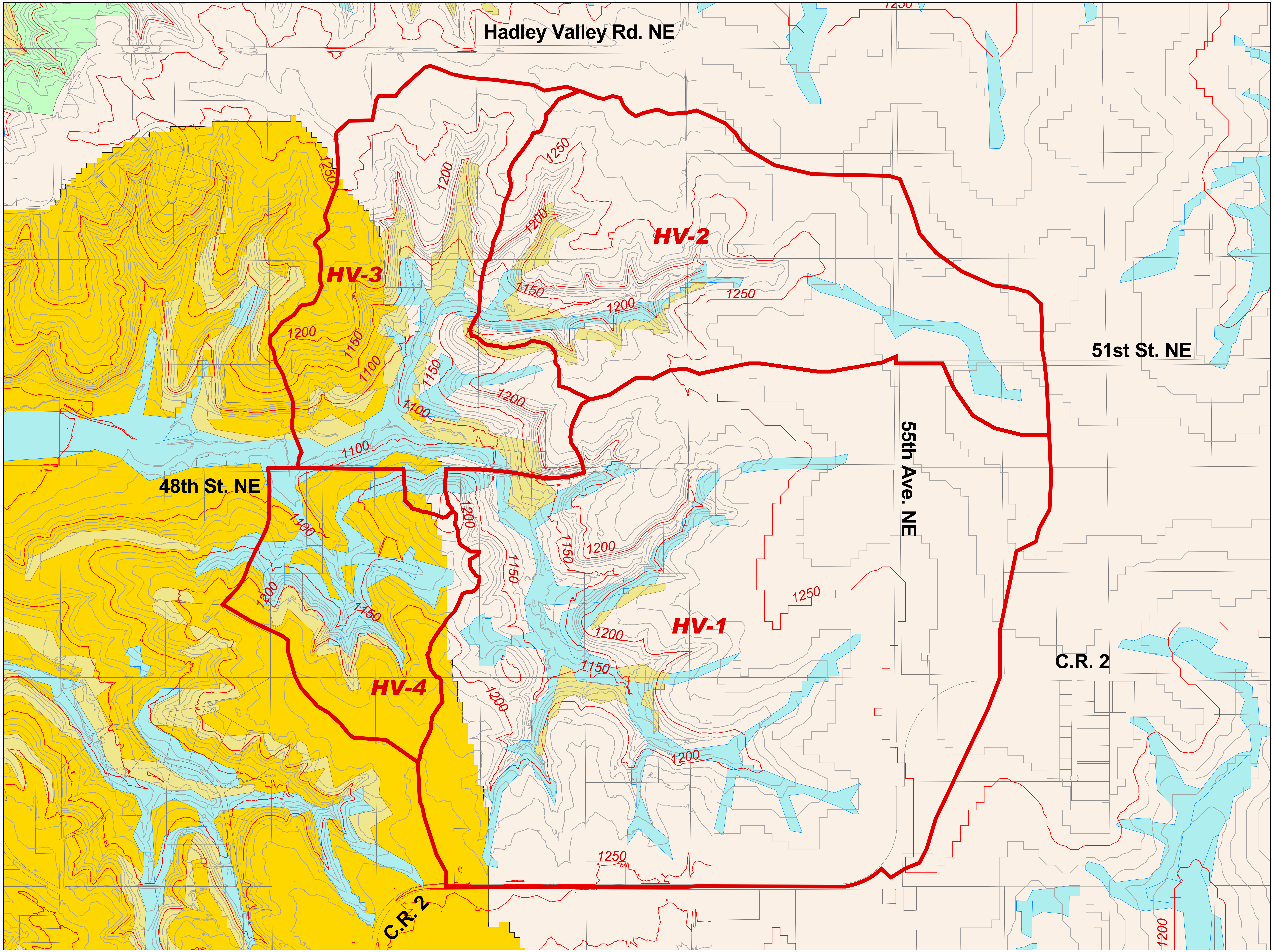
DNR Public Waters and FEMA Floodplain information has been examined within the limits of the HVA study area. No protected waters or floodplain restrictions were found in the HVA study area.

3.1.1. District HV-1

This area is characterized by smooth knolls that are dissected by sharp ravines. Small swales are present upstream of the valley heads and also along the sides of valleys and ravines. The drainage principally flows towards the northwest; however, the tributary ravines and creeks in District HV-1 flow in several directions (southwest, north, and northeast) before joining with the main valley. Wooded cover predominates along ravines, while upland areas are predominantly agricultural areas.

3.1.2. District HV-2

The topography and land cover of District HV-2 is nearly identical to District HV-1. In contrast, the direction of drainage is from east to west. The main valley in District HV-2 has the least developed dendritic drainage compared to the rest of the study area. The drainage area is long and narrow in comparison to the others, resulting in fewer, less defined, tributary ravines.



City of Rochester

CONSTRAINTS TO DEVELOPMENT

DUE TO SOIL TYPE

Rochester Storm Water Management Plan - Hadley Valley 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"
- 50 Yr. Urban Reserve Area
- Resource Protection Area
- Minor Contour (10' interval)
- Major Contour (50' interval)

N W E S

1200 0 1200
Feet

March 2004

Bonestroo Rosene Anderlik & Associates
Engineers & Architects

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.

k:\363\36301129\cad\gis\avproject\erosivesoils.apr

Towards the downstream (west) end of District HV-2, the topography gets steeper, tributary areas become more defined, and several areas with steep slopes (greater than 18%) can be found.

3.1.3. District HV-3

Continuing from the downstream end of District HV-2, several areas of steep slopes (greater than 18%) exist in District HV-3. These areas are situated at the upstream formation of ravines. The topography at the downstream area of this drainage District is gentle with relatively flat and wide terrain. This is a result of the convergence of the two main branches of the Hadley Valley Creek and the formation of a large floodplain.

3.1.4. District HV-4

Drainage and topography in District HV-4 is similar to that found in District HV-1. Flows are toward the northwest. Relatively flat plateaus and smooth knolls are dissected by sharp ravines.

3.2. Soils

3.2.1. Associations

Two 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 soil group in the HVA study area is the Rockton-Channahon-Atkinson association (Soil Group #3). This soil group, which almost completely covers the study area, has been formed both in a loamy mantle and in the underlying clayey residuum over bedrock. Soil Group #3 consists of nearly level to steeply sloping, well-drained loamy soils on uplands.

The Mt. Carroll-Otter-Joy association (Soil Group #4) is found in a small amount in the northeast corner of the study area. This soil group was formed in loess. It consists of nearly level to moderately steep, silty soils found on uplands and in upland drainageways that can either be well drained, very poorly drained, or somewhat poorly drained depending on the location relative to drainageways. Typically, Mt. Carroll series soils are located on summits and are well drained.

Joy series soils are typically located in the floodplain of drainageways, and are considered to be somewhat poorly drained. While Otter series soils are located within drainageways and are very poorly drained.

The Surficial Geology Plate of the Olmsted County Geologic Atlas indicates that the majority of the study area consists of thinly covered bedrock and colluvial slopes. The bedrock is generally within five feet of the surface, and covered by either glacial till or loess. The shallow depth to bedrock typically results in high infiltration capacity and high potential for groundwater pollution. These characteristics of the study area are further explained in Sections 5.3, 5.5, 6.3, and Chapter 10. The colluvial slopes generally dissect bedrock, with exposure of the bedrock being common. The colluvial slopes offer little resistance to groundwater exfiltration (springs) that can lead to the creation of side hill seep wetlands, some of which are shown on Map 3 in the Appendix and discussed in Chapter 7.

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 that Section, 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 in this document illustrates and identifies these hydric soil conditions within the HVA 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 HVA study area.

The nature and prevalence of these highly erodible soils contributes to the sensitive characteristics of the HVA study area. The soil conditions also significantly impact the quality of the downstream resources. Proper management of land use activities and storm water planning will be paramount to maintaining the integrity of the resources, both terrestrial and aquatic, within the HVA study area. More discussion on erosion control can be found in Section 9.

3.3. Wetlands

Within the HVA study area, 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, these sites 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.

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

Land Use

Land use in the Hadley Valley area is a mix of row crop fields located in level to moderately sloped areas on hilltops and some valley bottoms. Pasture and woodland are found on steeper slopes and stream floodplains. Areas in permanent vegetative cover are generally those that are least accessible by agricultural machinery, prone to flooding, or have some other characteristic that makes them poorly suited to cultivation. Wetlands in Hadley Valley are generally associated with hillside seep areas, drainage swales and, to a lesser extent, natural depressions and ponds that have been created to minimize sediment movement from crop areas and flooding. The transportation infrastructure has been minimally developed in the HVA study area. This is primarily due to the lack of residential developments within the HVA study area at the time of this Addendum, as well as unsuitable terrain.

4. Stream Corridors

4.1. Introduction

The extensive existing network of stream channels within the HVA study area conveys storm water runoff, typically from east to west. 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 stream channel drainageways. Under fully developed urban conditions, the proposed open channels will support a higher base flow than existing conditions due to increased amounts of storm water runoff.

The natural, open space along existing channel areas provides 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 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 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, and provide green space and connectivity between the area's natural resources allowing 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 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 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 20 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 300 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. Due to the topography in the area, it is difficult to route a sufficient amount of drainage area to ponds located outside of the existing channels, which also resulted in an in-line system. 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.

Section 12.6 of the 1999 SWMP provides a general description of the condition of Hadley Valley Creek, as observed in the field. The description notes channel instability and degradation in areas of the Hadley Valley Creek major drainage District. Similar conditions of instability and degradation were observed in the field in several of the stream corridors for the HVA study area.

However, there were also a few instances of stable channel morphology and robust wooded vegetation in the stream corridor. These observations are all described in detail in Section 12 of this HVA. Based on field observations, storm water and natural resource management in upstream areas will be critical to maintaining the integrity of the stream corridor.

4.3. Description of Stream Corridors

Continued use of the numerous existing natural channels for storm water management is being proposed in the Hadley Valley study area rather than constructing a trunk storm sewer system and filling existing channels. Many of the natural channels are encompassed by the stream corridor created by the criteria listed in Section 4.1. In addition to natural channels, the stream corridor is also comprised of some agricultural land that is currently in production, wetlands, and some forested land cover, as well as non-wooded upland.

4.3.1. North Fork

The North Fork stream corridor begins in HV-2 east of 55th Avenue NE at a proposed regional storm water pond (HV-P2.1). The corridor continues overland on the west side of 55th Avenue NE through relatively flat agricultural land. An in-line regional pond facility (HV-P2.4) is proposed at the transition of agriculture landscape into the valley landscape. The stream corridor and channel flows descend into the established wooded valley. Within the valley, several side-hill seep wetlands are integrated in the stream corridor.

The North Fork stream corridor enters District HV-3 upstream from two tributary channels. These channels are also integrated into the stream corridor. The stream discharge turns south and then west to exit the study area. The corridor widens as the terrain becomes flatter and less wooded, due to the confluence with the South Fork of Hadley Valley Creek and widening of the floodplain.

4.3.2. South Fork

The South Fork originates in District HV-1. However, due to the highly dendritic nature of the South Fork corridor, there are several upstream sources for the South Fork corridor within District HV-1. Similar to the North Fork corridor, the main spine of the stream corridor begins east of 55th Avenue NE at a proposed regional storm water pond (HV-P1.5). The upper reaches of the valley are somewhat sparsely wooded. As the flows continue to the northwest, the valley deepens and the tree cover becomes more dominant. The stream corridor exits District NW-1 under 48th Street NE. Immediately downstream of 48th Street NE, the corridor turns west and merges with the North Fork stream corridor before exiting the study area.

4.3.3. West Fork

A separate stream corridor, labeled the West Fork, is established in District HV-4. While the topography and drainage in District HV-4 is similar to District HV-1, the stream corridor encompasses more area relative to the size of the District. This is primarily due to a high amount of wetland indicator soils present in the area. The West Fork corridor crosses under 48th Street where it exits the study area. Just north of 48th Street NE, outflows from District HV-4 (the West Fork) and District HV-3 combine and flow west.

4.4. Stream Corridor Management

As previously mentioned, agricultural best management practices within the study area have preserved the integrity of many of the 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 HVA study area is proposed to utilize the existing open channels and ravines. 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 HVA 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 includes the hydrologic factors of runoff coefficient (C), runoff curve number (CN) and time of concentration (Tc). Future development conditions for the HVA study area have not been specifically identified in Rochester Land Use Plan and Zoning Map amendments at the time of this Addendum. Low-density residential development was assumed as the future land use, with a large percentage of the ravine areas considered undevelopable. Thus, storm water runoff for the HVA study area was analyzed assuming a curve number (CN) value of 70 for the large-lot residential areas, and 62 for the undevelopable areas (primarily steep wooded ravines).

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 that the majority of the study area is comprised of bedrock thinly covered by glacial till and loess. The depth to bedrock is approximately five feet, offering little resistance to surface water infiltration. The modeling of the proposed storm water system is conservative in that it does not include the likely infiltration due to the shallow bedrock in the 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, colluvial slopes that are present in the HVA study area can allow for the discharge of subsurface water to the ground surface. At the time of development, a detailed model should be created to account for the potential impact of groundwater release.

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 that plan, pipe capacity was determined based on the Manning's equation.

The approach used in this HVA 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 trunk storm drainage system. The designated locations are for planning purposes only. The final location and size of the pipes and channels will be determined at the time these areas develop.

Three types of channels are proposed for the HVA 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 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.

Table 5.1 illustrates the classification and criteria of the three channel types for the HVA.

Table 5.1 Channel Classifications

Channel Classification	Typical Slope	100-yr Design Conveyance Capacity[1]	Maximum Design Conveyance Capacity[1, 2]
Type HV-I	4.75%	0-100 cfs	125 cfs
Type HV-II	2.75%	101-500 cfs	625 cfs
Type HV-III	1.25%	501-1100 cfs	1375 cfs

[1] cfs = cubic feet per second

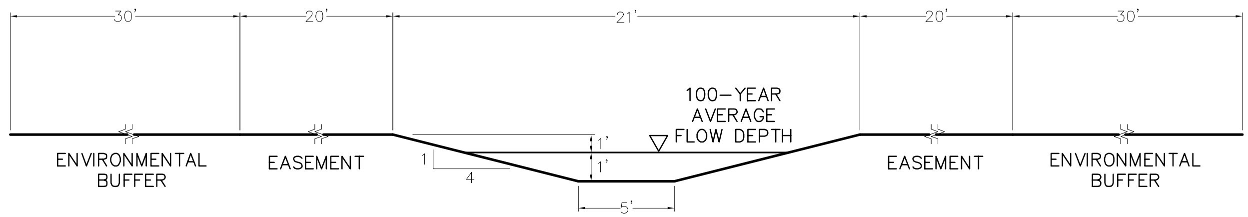
[2] The Maximum Design Conveyance Capacity is 25% above the highest discharge value for the 100-yr Design Conveyance Capacity.

Proposed capital improvement investments to the three channel classifications are considered under one of two approaches:

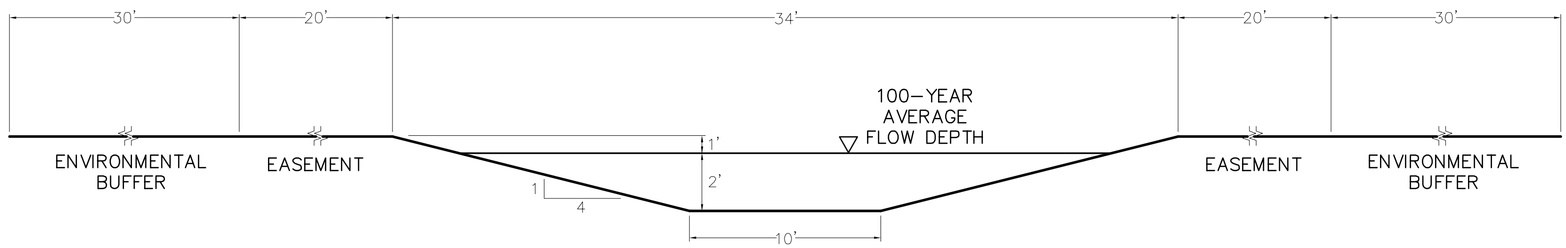
- Stream stabilization – This includes incorporating materials and components that will protect the stream channel from degrading or eroding as a result of receiving increased volumes under developed conditions. Stabilization techniques include minor shaping, seeding (MN/DOT 26B "ditch mix" is recommended),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

  For planning and cost estimation purposes, stabilization efforts are included in this HVA 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.)

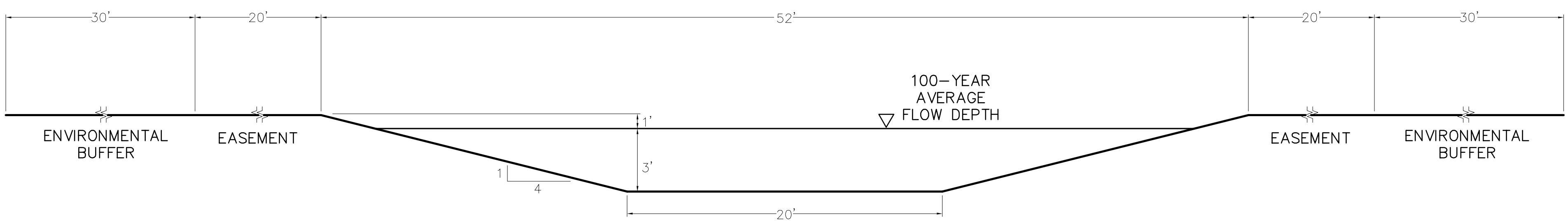
TYPE 1



TYPE 2



TYPE 3



NOTE: SEE FIGURE 5-2 FOR TYPICAL CROSS SECTIONS

MINIMUM CHANNEL WIDTH & BUFFER REQUIREMENTS

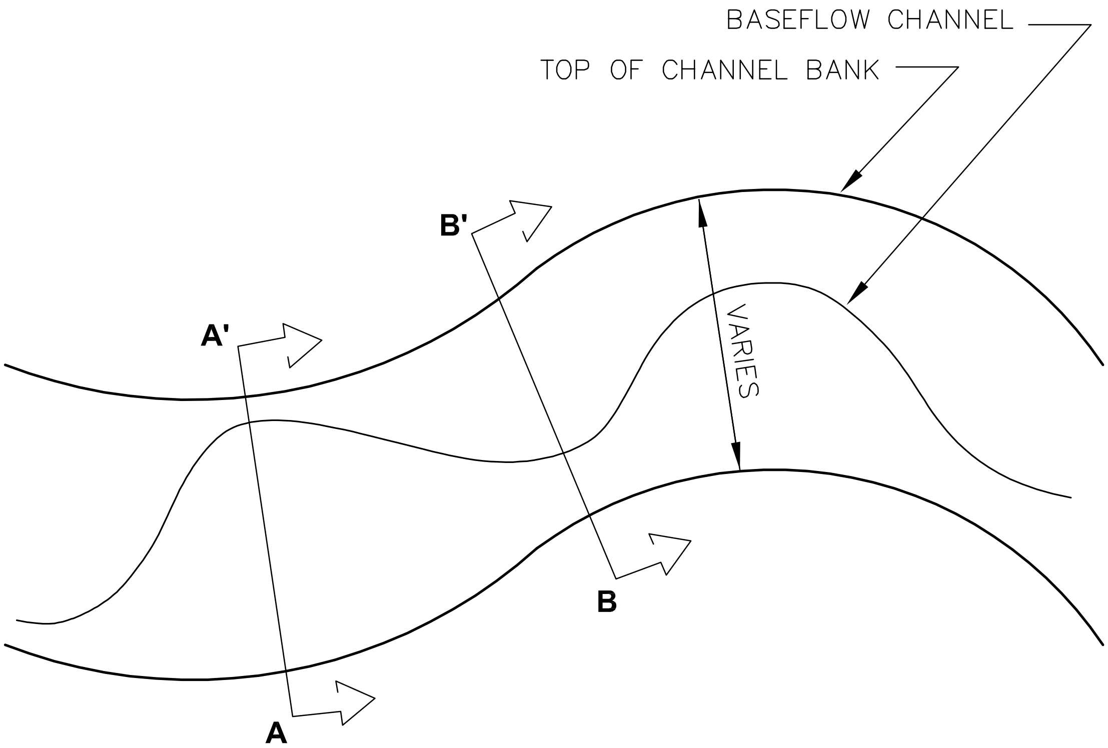
Bonestroo Rosene Anderlik & Associates
Engineers & Architects

ROCHESTER, MINNESOTA

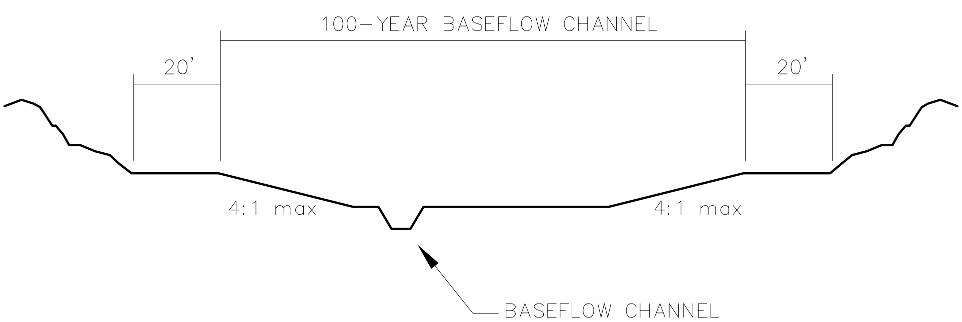
FIGURE 5-1

ROCHESTER STORM WATER MANAGEMENT PLAN - HADLEY VALLEY ADDENDUM

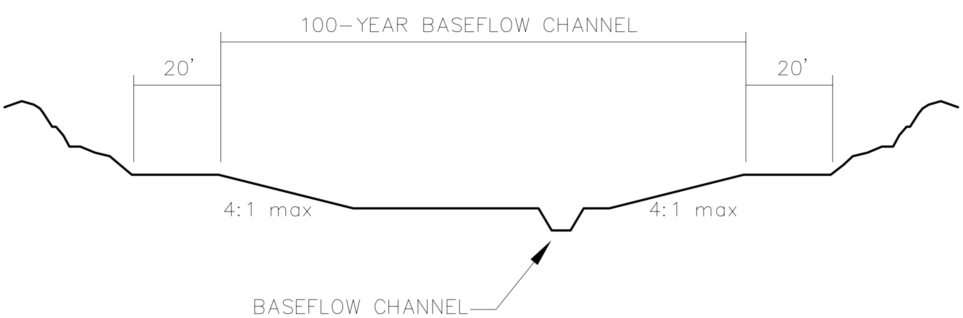
BUFF_REQ.DWG 5-15-02 COMM. 363-01-129



PLAN VIEW



SECTION A-A'



SECTION B-B'

TYPICAL CHANNEL CROSS SECTIONS

CITY OF ROCHESTER FIGURE 5-2

ROCHESTER SWMP - HADLEY VALLEY ADDENDUM

Bonestroo Rosene Anderlik & Associates

TYP_X-SECTIONS.DWG 3-21-02 COMM. 36301129

- 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 HVA at all proposed reaches where substantial slope or channel deepening or widening is anticipated. Improvement activities will include significant channel excavation and re-grading, installation of step weirs every 250 feet for Type HV-I channels, every 400 feet for Type HV-II channels, and every 600 feet for Type HV-III, 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 HVA 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, with outlet pipes operating under pressurized conditions. Any pond discharge between 6 and 20 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 high sensitivity to groundwater pollution, 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 City of Rochester Zoning Ordinance and Land Development Manual Ordinance No. 2785, 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 HVA discusses the recommended practices for implementing construction and post-construction best management practices (BMPs) in Hadley Valley 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 is typically 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 are 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 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 HVA uses a regional storm water pond approach by locating storm water facilities to serve approximately 15- to 750-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. The size of the drainage areas served by ponds in the HVA study area vary greatly in magnitude due to the necessity to control as much drainage area as possible upstream of the ravines (even if the area is smaller than typically desired), and the lack of desirable locations for ponds within the ravines (which results in one large pond in the wide downstream floodplain to serve a large area).

Map 1 shows effective locations for storm water basins, most 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 as shown.

6.2. Storm Water Management Basin Types

This HVA 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 HVA 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. Due to the high sensitivity to groundwater pollution in the study area, storm water ponding may not provide a sufficient level of treatment required to protect the groundwater. As stated in Section 5.5, site-specific investigations should precede the approval of proposed storm water facilities.

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 HVA 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 HVA 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 HVA. 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 SWMP. Wetland identification numbers used for the wetland inventory are based on the minor drainage Districts defined in the Hadley Valley Addendum. 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.

Ten wetlands within the Hadley Valley Addendum area were visited by trained personnel who used MNRAM to assess wetland functions for Floral Diversity/Integrity and Wildlife Habitat. All property owners that had wetlands within their property were contacted for access. There were four wetlands that access was not granted or access from the property owner was not confirmed during the inventory effort so the assessment was completed viewing the wetland from an adjacent property. 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. The summary of the wetland functions assigned to each wetland assessed and the viewing location is 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 not inventoried as part of the Hadley Valley Addendum shall be assessed at the time that a project is proposed. A wetland professional hired by the applicant or the City shall apply the MNRAM assessment. 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. The City using the information contained within the completed MNRAM and applying the criteria outlined in Section 7.2.1 will determine final classification of the wetlands.

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 HVA 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.

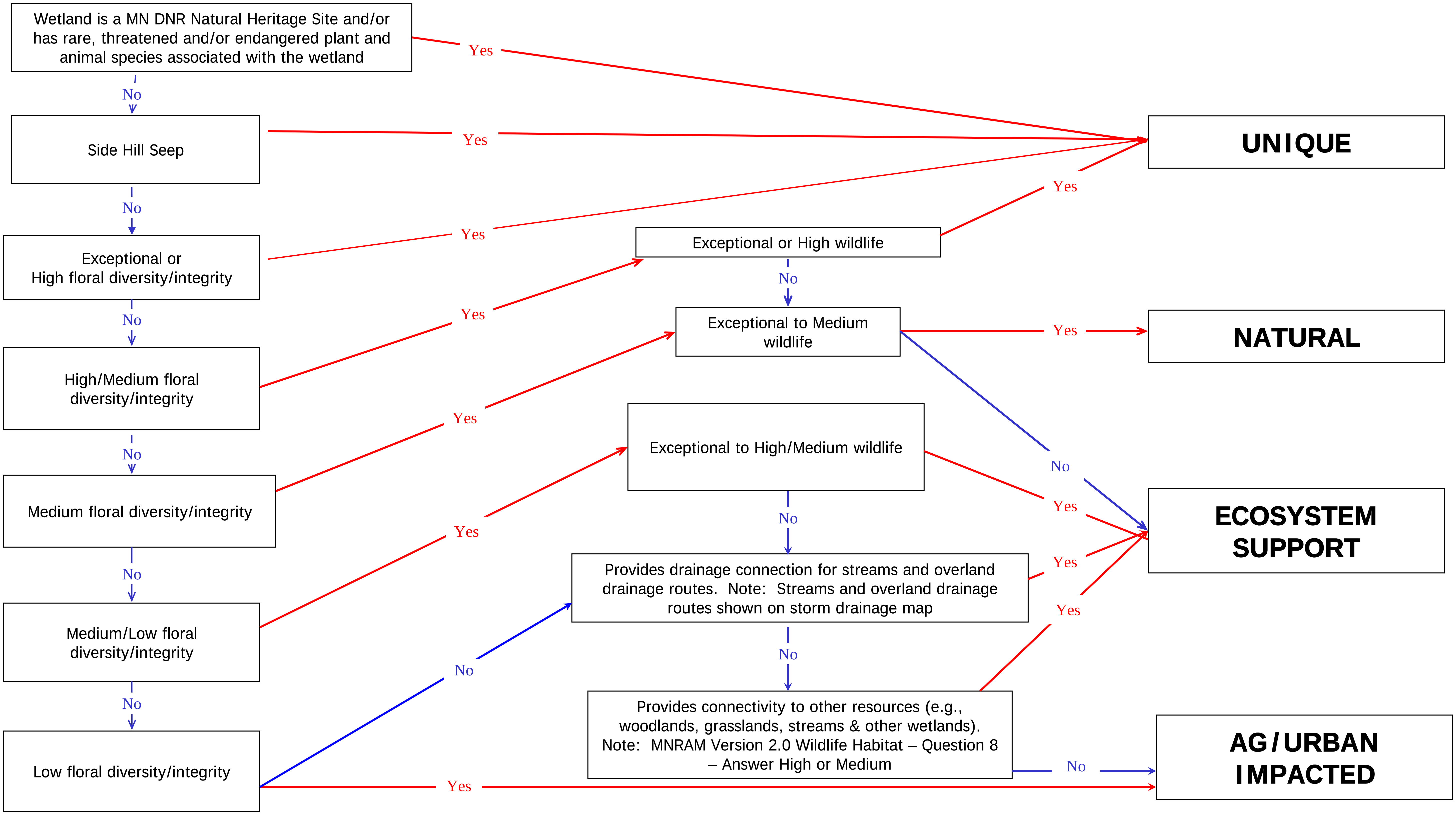
Other criteria were also considered in refining the management classifications and goals. For example, wetlands may be classified as *"Ecosystem Support"* based on the value of their physical connection and/or drainage to other systems, though they may have low floral diversity and moderate wildlife 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. A table that lists the classification for each wetland in the Hadley Valley study area is included in Appendix E.

7.2.2. Wetland Classification Summary

Unique Wetlands: The classification "unique" is used for wetlands that exist in a largely unaltered state or have hydro geomorphology 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. Infrastructure 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 – Hadley Valley Addendum

363-01-129/draft report/fig. 7-1

Bonestroo Rosene Anderlik & Associates
Engineers & Architects

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 their 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 Hadley Valley 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(-ities) and an assessment of Floral Diversity using the key provide 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 7.2.1, 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 low 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 strip that surround the wetland 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]
Creeks and Streams as labeled on Map	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 HVA 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, and slightly and least susceptible. The susceptibility categories for each wetland are shown on Map 1. The protection strategies in Table 7-3 on the following page 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 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 (Castelle, et. al. 1992). 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:

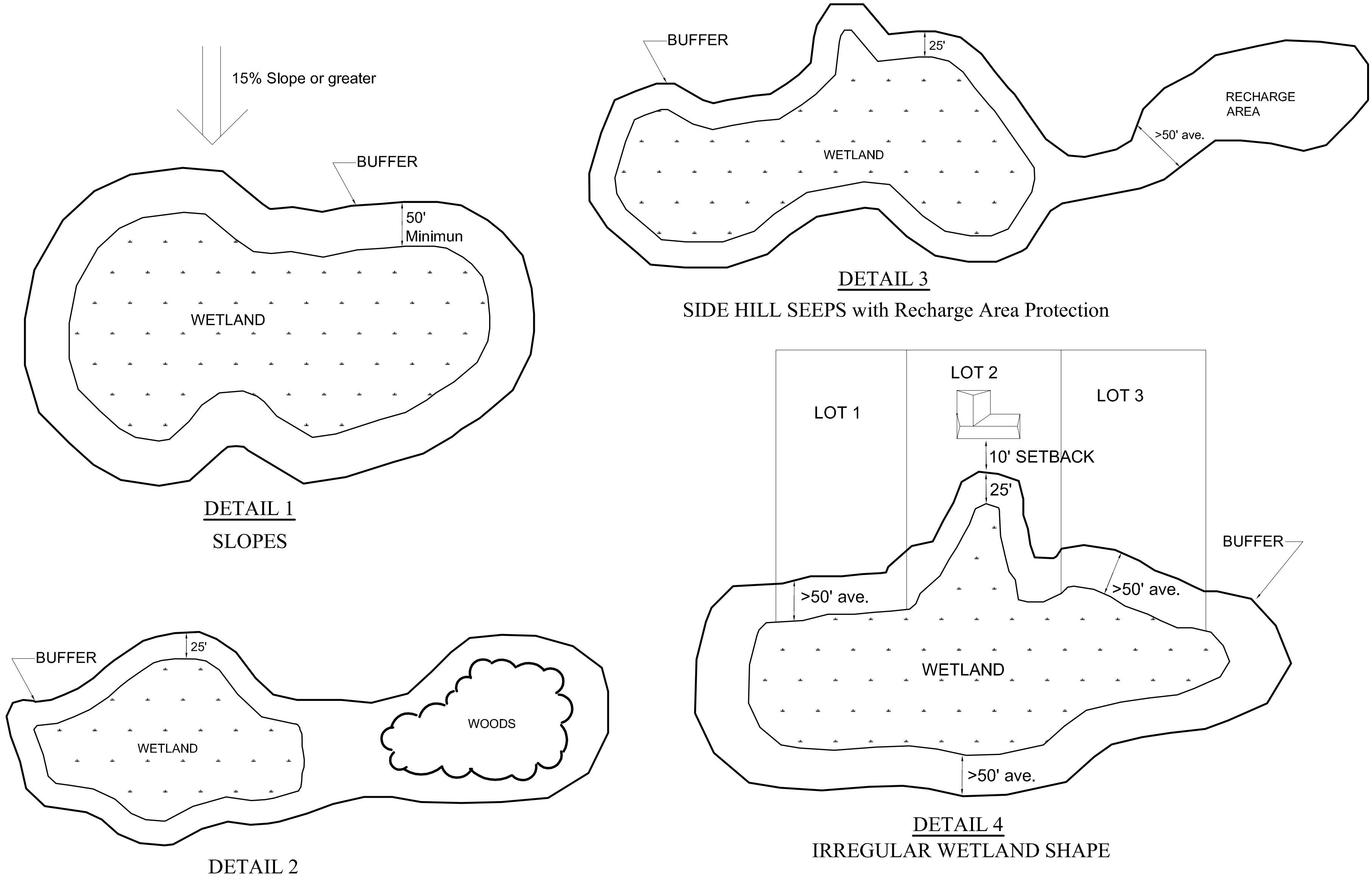
- Slopes greater than 15% will require the 50 foot average width around the entire wetland to get adequate treatment. No deviation to the minimum width will be allowed.
- Due to the importance of the recharge areas to side hill seep wetlands, buffers widths may be minimized down-gradient of the actual 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 Hadley Valley area is oriented in a generally east to west direction. From the eastern end of the watershed to the South Fork of the Zumbro River, the valley is approximately six miles in length. In general, the landscape is moderately rolling along the hilltops and in the eastern reaches of drainage. The majority of the area can be characterized as steeply rolling to more highly dissected in the middle reaches of the valley. It lies at the intersection of the Blufflands (Hadley Valley itself) and Rochester Plateau (more gently rolling areas on the east side). The Rochester Plateau and Blufflands are Subsection landscapes of the MN DNR Ecological Classification System.

Land use in the Hadley Valley area is a mix of row crop fields in level to moderately sloped areas on hilltops and some valley bottoms. Pasture, woodland, and forest are found on steeper slopes and stream bottoms. Areas in permanent vegetative cover are generally those that are least accessible by agricultural machinery, prone to flooding, or have some other characteristic



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 – HADLEY VALLEY ADDENDUM

K:\363\36301129\Cad\Dwg\Plan buffer detail.dwg

MARCH 2002

FIGURE 7–2

NO SCALE

Bonestroo
Rosene
Anderlik &
Associates

Engineers & Architects

363–01–129

that makes them poorly suited to cultivation. Wetlands in Hadley Valley are generally associated with hillside seep areas, drainage swales, and to a lesser extend natural depressions and ponds that have already been created to minimize sediment movement from crop areas and flooding.

At the time of Euro-American settlement, the Hadley Valley area hosted a mix of oak openings and barrens, brush prairie, and tall grass prairie. Oak openings and barrens are thought to be savanna-like settings with scattered trees and prairie grasses and flowers. Brush prairie, as recorded by land surveyors of the Government Land Office in the mid-1800's, is thought to be transitional between the treeless tall grass prairie and savannas, which typically have full-grown trees. Since settlement, most of the prairie has been plowed. Pioneers typically converted savannas and brush prairie to pastures. Most of the remaining examples of savanna-like settings are current or former pastures that are now dominated by nonnative grasses.

Since settlement, most of the prairie has been plowed, or only rarely still exists as pastures that are now typically dominated by nonnative grasses. Similarly many of the depressional wetlands that would have been associated with the Rochester plateau have been drained. Conversely, many of the side hill seep wetlands in Hadley Valley still retain their hydrology and representative vegetation. Despite this most of the side hill seeps have been impacted by inappropriate levels of grazing or attempts at drainage.

The drainage of depressional wetlands in the Hadley Valley area has led to the development of channels, increased runoff, and degradation of natural community composition, structure, and function. These effects are often profound due to the steeper slopes and lighter soils found here compared to many other small watersheds in the Rochester area. Since many of these altered areas still have the ability to recover, this section of the Addendum focuses on restoration opportunities within Hadley Valley.

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. The wetlands in this study area were rated as to the potential for restoration. During the course of this study, approximately one half of the wetlands within the study area were not visited due to access limitations. Therefore, the list of wetlands with restoration potential given below only includes wetlands that were visited or wetlands that had obvious hydrologic alterations visible on the infrared aerial photographs. As future planning occurs in this area, a concerted effort should be made to collect field data on unvisited wetlands in areas that may be influenced by changes in land use to capture opportunities for restoration and protection.

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 are not likely to provide mitigation or banking credit.

Most of the hydrologic restoration sites are existing wetlands that can be expanded through restoration, which can provide new wetland credit for 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 Hadley Valley, 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 than 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 minor District.

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 Hadley Valley 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 Hadley Valley 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: HV-W3.1
Vegetation Restoration Potential: High
Hydrologic Restoration Potential: High
Comments: Viewed from across fence since access denied. Reduce grazing pressure and manage with fire periodically. This appears to be a very nice quality wetland. This wetland should be looked at closer by a qualified ecologist when access can be gained to the property since it has some fen-like qualities. Farm operators could improve natural community quality by fencing seepage wet meadows to exclude cattle, and increase income by instituting rotational grazing plan with warm season grass paddocks used in conjunction with nonnative cool season grasses.

Wetland: HV-W1.1
Vegetation Restoration Potential: High
Hydrologic Restoration Potential: NA
Comments: Viewed from across fence since access denied. Reduced grazing pressure and management with prescribed burning would improve vegetative diversity. This appears to be a very nice quality wetland. This wetland should be looked at closer by a qualified ecologist when access can be gained to the property since it has some fen-like qualities. Farm operators could improve natural community quality by fencing seepage wet meadows to exclude cattle, and increase income by instituting rotational grazing plan with warm season grass paddocks used in conjunction with nonnative cool season grasses.

Wetland: HV-W1.A
Vegetation Restoration Potential: High
Hydrologic Restoration Potential: **-**
Comments: Viewed from road, since access denied; Wetland is near other side hill seep areas and has a variety of grasses including prairie cord grass and sedge species. Due to the existing quality of the plant community it has the potential to be enhanced further will little effort.

Wetland: HV-W2.A
Vegetation Restoration Potential: High
Hydrologic Restoration Potential: Medium
Comments: This wetland is found along a valley bottom that has had some downcutting of a stream channel due to excess runoff from farm fields on the surrounding hilltops. The wet meadow that lies along its course is fed by springs and is, to some degree being drained by the downcutting. Impoundments above the wetland are helping to reduce the overall impact

of excessive runoff, but significant runoff/erosion is still occurring due to farming practices used in crop fields. Terracing and or no-till systems would help to offset this, but the steep erodible soils in the fields would protect the wetland better if they were in permanent native grass/forb cover. Wetland extends upslope and includes at least two or three discharge areas at different elevations along a slope with Oak Woodland-Brushland and Dry Prairie. Down cutting would need to be repaired to improve hydrology.

Wetlands with Medium Hydrologic and/or Medium Vegetation Restoration Potential

The wetlands listed in the table below are those with medium hydrologic and/or medium vegetation 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 mitigation and enhancement sites.

Table 7-6 – Medium Restoration Potential

Wetland ID	Vegetation Restoration	Hydrologic Restoration	General Memo
hv-w2.3	Low	Medium	This former wetland has been recently drained and re-graded as a waterway and is now incorporated into an agricultural field. The hydrologic restoration potential depends on the presence of tile and how easy it would be to break/disrupt it.
hv-w1.C	Medium	-	This is an interesting wetland that is at the confluence of an east-west and a northeast-southwest trending waterway. Includes several areas of springs as well as what appears to be perennial streams from the two valleys. Best opportunity for restoration lies in maintaining current hydrology in surrounding area to prevent disturbance of the plant community that is currently recovering from former grazing of moderate to severe intensity.

Wetlands with Low Restoration Potential

Eight of the 14 wetlands in the Hadley Valley Drainage area 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

HV-1	HV-2	HV-3	HV-4
hv-w1.2	hv-w2.1	hv-w3.2	hv-w4.A
hv-w1.3	hv-w2.2	hv-w3.A	
hv-w1.B			

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
- MN Waterfowl Association
- 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 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 HVA is to develop an area charge for financing the total cost of the storm water drainage system for the Hadley Valley 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 Addendum. 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 and 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	(4%)	$109,231	$38,231	$147,462
Excavation	(6%)	$187,194	$65,518	$252,712
	(10%)		Water Quality Subtotal -	$400,174
Water Quantity				
Land acquisition	(17%)	$539,059	$188,671	$727,730
Excavation	(7%)	$236,156	$82,655	$318,811
Outlet cost	(8%)	$246,000	$86,100	$332,100
Trunk pipe cost	(3%)	$78,475	$27,466	$105,941
	(35%)		Water Quantity Subtotal -	$1,484,582
Pond Total	(45%)	$1,396,115	$488,640	$1,884,756
Trunk Channels:				
Erosion Protection	(4%)	$123,349	$43,172	$166,521
Excavation	(0%)	$9,789	$3,426	$13,215
Improvement Structure	(29%)	$926,500	$324,275	$1,250,775
Easement	(21%)	$650,511	$227,679	$878,190
Buffer	(1%)	$25,248	$8,837	$34,085
Trunk Channel Total	(55%)	$1,735,396	$607,389	$2,342,785
Grand Total:		**$3,131,512**	**$1,096,029**	**$4,227,541**

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 HVA 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 15- to 750-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 HVA 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. 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 for 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 HVA study area are still in the planning process. Therefore the land use factors that were developed for the 1999 SWMP are utilized for this HVA. 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 curve number of 70 was applied to the large-lot residential areas, and a curve number of 62 was applied to the remaining undevelopable areas (primarily steep wooded ravines).

Appendix F tabulates the total estimated trunk storm channel system cost for the development of the drainage system, 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.

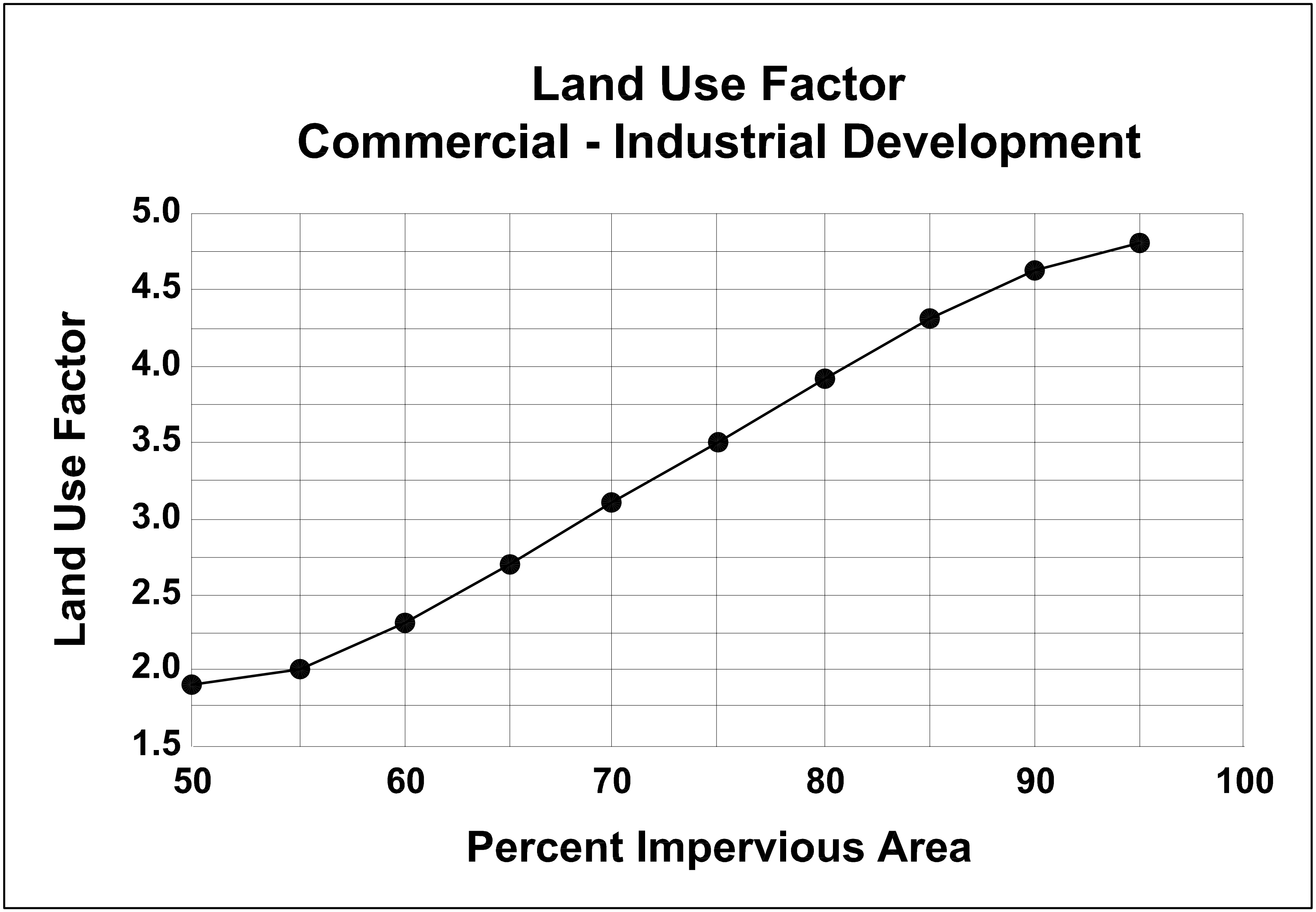
- Trunk Storm Channel 55 percent
- Water Quantity and Quality 45 percent

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 HVA 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 — HADLEY VALLEY ADDENDUM

Bonestroo Rosene Anderlik & Associates

\363\36301129\cad\dwg\landuse_factor.dwg 3-27-02

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

		Subtotal cost	Additional Cost	Total Cost
Pond				
	Land acquisition	$648,290	$226,902	$875,192
	Excavation	$423,350	$148,173	$571,523
	Outlet cost	$246,000	$86,100	$332,100
	Trunk cost	$78,475	$27,466	$105,941
		$1,396,115	$488,640	$1,884,756
Channel				
	Erosion Protection	$123,349	$43,172	$166,521
	Excavation	$9,789	$3,426	$13,215
	Improvement Structure	$926,500	$324,275	$1,250,775
	Easement	$650,511	$227,679	$878,190
	Buffer	$25,248	$8,837	$34,085
		$1,735,396	$607,389	$2,342,785
Total		$3,131,512	$1,096,029	$4,227,541

Land Use	Land Use Factor	Area Charge
Low Density Residential	1.0	$2,631
Medium Density Residential	1.4	$3,683
High Density Residential	1.9	$4,998
Commercial*	3.4	$8,944
Industrial*	2.3	$6,051

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

Total Acres in HVA Study Area	1,849
Developable Acres	1,607
Area Charge ($/dev. acre)	**$2,631**
Based on land use = Low 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 to estimate the developable area:

- Any existing developments
- Platted parcels greater than 5 acres
- Railroads
- Slopes greater than or equal to 26%
- 33 feet from centerline of 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 HVA study area, arriving at a value of $2,631, as shown in Table 8-2. 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 water conveyance 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. However, the most likely land development for the majority of the study area is low density residential.

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

Erosion and downstream sedimentation are major factors in the Hadley Valley watershed. This is a result of a combination of soil conditions, slopes and land use practices. Erosion control and management has been the focus of past study efforts for this area. The most recent characterization of erosion issues in the Hadley Valley watershed was produced by the United States Department of Agriculture Natural Resource Conservation Service (USDA-NRCS). This watershed report was prepared at the request of the City of Rochester, Department of Parks and Recreation and published in October, 2000. Other historical studies and erosion control efforts for the Hadley Valley watershed are summarized in the USDA-NRCS report.

Field observations for this Addendum supported the concern for erosion and downstream sedimentation. Some farming Best Management Practices were observed such as contour planting and low-till methods. The agricultural BMPs are beneficial to the control of erosion. Implementation of pre- and post-construction BMPs is critical as future 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 the HVA study area was included in 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 this Addendum. Chapter 10 of the 1999 SWMP provides an overview of the groundwater resources within the Rochester region.

Some geologic features specific to the HVA study area are highly relevant to the groundwater resources in the HVA study area. Infiltration dynamics are of strong concern in this region because domestic water supply is from groundwater aquifers. As discussed in Section 5.5 of this Addendum, the Surficial Geology Plate of the Olmsted County Geologic Atlas indicates that the depth to bedrock is less than five feet in many areas of the HVA study area. This geologic condition is found in most areas that would be considered developable, that is, above the steep ravines. The upland areas also contain soils that are typically well-drained, as discussed in Chapter 3 of this Addendum. In conjunction with this, these areas are ranked by the Olmsted County Geologic Atlas as having very high sensitivity to groundwater contamination.

For the above reasons, site-specific investigations of soil conditions, geologic features, and infiltration capacity are recommended prior to any development or infrastructure improvements. 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 HVA study area was divided into four minor drainage Districts. The minor drainage Districts were designated as shown in Table 12-1.

Table 12-1 HVA Minor Drainage Districts

Minor Drainage District	Abbreviation	Acreage
Southeast	HV-1	968
Northeast	HV-2	413
Northwest	HV-3	305
Southwest	HV-4	163
Total		1,849

With the exception of District HV-3, 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. The acreages of each Subdistrict are presented in Appendix A and their boundaries are shown on Maps 1, 2 and 3.

The HVA proposes regional ponds that are located either at upstream areas where ravines begin, or at downstream areas where larger drainage Subdistricts can be managed. Regional ponds are proposed at existing road crossings in the HVA study area whenever feasible. Additional ponds are included by berming or damming 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 and damming costs. The drainage areas are as large as feasible to minimize the number of ponds required, thus maximizing the amount of developable land. Some of the ponds described within this Addendum have a maximum fluctuation of more than five feet, which necessitates large berms for impoundments, which is considered a low hazard dam structure as defined by the Minnesota

Department of Natural Resources. Proper permits should be acquired during the design of ponding facilities determined to require a bounce in excess of 5 feet.

As a result of previous studies in this area, good farming practices, and the necessity for access to farm land, several storm water ponding areas presently exist in the HVA study area. All of these ponding areas are located within existing ravines and have been created by the construction of berms, low-hazard dams, and field access roads. Three of these ponds (HV-P1.11, HV-P2.4, and HV-P4.1) clearly show a permanent pool for the treatment of storm water runoff. The remaining ponding areas (approximately 4, all located in District HV-1) provide "live" storage to aid in peak flow attenuation during storm events, which serves to protect downstream areas from excessive high water levels and erosion. Most of these ponding areas are proposed to be utilized as regional basins in this plan as shown on Map 1. At the time of development, the ponding area's existing outlets and storage volumes should be verified and adjusted as necessary to provide adequate water quality treatment, flood storage volume, and peak flow attenuation.

12.2. District HV-1

Drainage Area: 968 acres
Number of storm water basins: 13
Major Streams: South Fork

District HV-1 is the largest minor District in the HVA study area, and contains the highest number of proposed ponding areas. Two proposed ponding locations have been situated to utilize 55th Avenue NE as an embankment. Generally, the majority of the ponds located in District HV-1 are situated in uplands just upstream of ravines. The ponds situated in upland locations are proposed in areas where the largest drainage areas possible could be controlled to reduce downstream erosion as much as feasible. Typically, it is difficult to situate ponds within the ravines due to bounce, slope, and monetary infeasibility. However, three ponds in District HV-1 are proposed to be located within existing ravines because of the need to control upstream flows at those proposed locations. All flows generated in District HV-1 eventually reach the ultimate outlet from this District, a 9'x 10' box culvert crossing north under 48th Street NE and discharging to District HV-3.

HV-P1.1, HV-P1.2, and HV-P1.4 are all regional ponds that are proposed to be located in the upstream sections of ravines, were sufficient drainage area could be routed to them for treatment of storm water runoff and peak flow attenuation. The drainage areas draining to these ponds are typically smaller than desired for a regional pond design, though the highly erodible nature of the ravines in the HVA study area warrants the protection of the ravines via peak flow attenuation and stabilization as necessary and feasible.

HV-P1.3, HV-P1.6, and HV-P1.9 are all existing rate control ponds that were created by berming, damming, or field access roads. These ponds currently serve to protect the downstream ravines by providing peak flow attenuation, but provide little or no water quality benefit at this time. These areas are proposed to be utilized for water quality and quantity in this HVA. Storage volumes for both water quality and quantity should be verified at the time of development and adjusted as necessary. The outlet should also be verified and modified or replaced as necessary.

HV-P1.5 and HV-P1.8 are proposed to utilize 55th Ave. NE as a ponding embankment. These ponding areas were assumed to have a 4' bounce during a 100-yr storm due to the elevation of the existing ground relative to the elevation of the roadway. When the pond is upgraded to meet the recommendations of this Addendum, the amount of bounce available in these ponding areas should be verified, and the pond designs should be adjusted accordingly. If, at the time of development, it is determined that a 5' bounce could be provided for these ponds (the maximum bounce allowable prior to the necessity of acquiring a damming permit from the MNDNR), the required water quantity ponding volume could be provided with a smaller footprint, thus increasing developable area and decreasing the required size for the drainage easement.

HV-P1.7 and HV-P1.10 are proposed to be located within an existing ravine. The construction of these ponds will likely require permitting from the DNR for the construction of low-hazard dams. Ideally, damming is not desirable, though additional peak flow attenuation for runoff from the upstream drainage areas draining to these ponds was required to maintain acceptable 100-yr high water levels at 48th St. NE crossing location (HV-P1.13).

HV-P1.11 is an existing pond that provides water quality treatment of runoff from farmland in addition to peak flow attenuation. This pond was constructed by berming in a deep ravine just north of 48th St. NE. Due to the large elevation drop from this pond's existing normal water level and the elevation in the ravine where the pond's outlet pipe discharges, erosion within the ravine has been observed. Modification of the pond's outlet to reduce outflows and the inclusion of proper energy dissipation at the discharge point should be addressed at the time of development in the area, if not sooner. From the point of discharge from this pond, flows travel approximately 50’ to a crossing under 48th St. NE. This crossing was observed to be in poor condition.

HV-P1.12 is an existing ditch that currently discharges to a 36” pipe crossing diagonally under 48th St. NE. When water level in the ditch exceeds approximately 2’ of depth, flows will also discharge west, in the ditch adjacent to 48th St. NE. The flows in the ditch are proposed to be eliminated with the addition of a ditch block, and minimal additional storage within the existing ditch. This will result in the routing of all storm water flows generated in drainage District HV-1.12 to be routed through the existing 36” pipe to regional basin HV-P1.13 for additional peak flow attenuation. This basin is not proposed to provide water quality treatment but is primarily included in this plan to ensure that flows from this area are routed to HV-P1.13 for additional peak flow attenuation. Runoff generated in this area will ultimately flow to HV-P3 where it will be treated for water quality purposes.

HV-P1.13 is the final outlet point for District HV-1, discharging north under 48th St. NE to District HV-3. The existing storage and 9’x 10’ box culvert outlet are proposed to be maintained in the future ponding system. Several alternatives were analyzed to utilize this area for additional peak flow attenuation. Due to the steep topography in the vicinity of the outlet pipe, little benefit in peak flow attenuation was realized in comparison to large increases to existing high water levels. To illustrate the minimal storage capacity at this location, Map 1 displays the footprint of retained water at the calculated 100-yr HWL. The area is 1.4 acres, corresponding to more than 8 feet of bounce; a much smaller area than would be expected for the large volume of water that concentrates at that location during storm events. When modeling the alternatives for this location, not only were little benefits observed immediately at HV-P1.13, but also large detriments to the system were observed downstream. By increasing the retention at HV-P1.13, the model was showing that peak flows in the North and South Branches were more closely coinciding, resulting in higher peak outflows and HWLs calculated at HV-P3 for the alternatives. The timing of peak flows in the North and South Branches will be an issue as the HVA study area develops, and should be analyzed in detail at that time.

12.3. District HV-2

Drainage Area: 413 acres
Number of storm water basins: 5
Major Streams: North Fork

HV-P2.1 is proposed to utilize 55th Ave. NE as a ponding embankment. Similar to proposed regional basins HV-P1.5 and HV-P1.8, this ponding area was assumed to have a 4' bounce during a 100-yr storm due to the elevation of the existing ground relative to the elevation of the roadway. When the pond is upgraded to meet the recommendations of this Addendum, the amount of bounce available for this ponding area should be verified, and the pond design should be adjusted accordingly. If, at the time of development, it is determined that a 5' bounce could be provided for these ponds (the maximum bounce allowable prior to the necessity to acquire a damming permit from the MNDNR), the required water quantity ponding volume could be provided with a smaller footprint, thus increasing developable area and decreasing the required size for the drainage easement.

HV-P2.2 and HV-P2.3 are proposed to be located in the upstream sections of ravines, were sufficient drainage area could be routed to them for treatment of storm water runoff and peak flow attenuation. Initially, HV-P2.4 was proposed for treatment and attenuation of runoff generated from these areas. After additional modeling, HV-P2.2 and HV-P2.3 were necessitated when modeling showed that HV-P2.4 was insufficiently sized to accommodate flows from the entire drainage area, and also appeared to be unexpandable. Should better contour information show that HV-P2.4 is expandable when this area develops, the removal of HV-P2.2 and HV-P2.3 from the proposed ponding system would be a viable option.

HV-P2.4 is an existing pond that provides water quality treatment of runoff from farmland in addition to peak flow attenuation. When analyzing recent aerial photographs and 10' contour data, it is believed that this pond will be difficult to expand due to steep topography in the area. HV-P2.2 and HV-P2.3 were added upstream from HV-P2.4 to aid in peak flow attenuation and storm water treatment. When this area develops, if HV-P2.4 is found to be easily expandable, construction of HV-P2.2 and HV-P2.3 may not be required.

HV-P2.5 is proposed to be constructed by incorporating a combination of a low-hazard dam construction and excavation. Due to the steep topography in the area, an adequate "live" storage volume would be difficult and costly to provide without allowing a pond bounce greater than the desired 5 feet. HV-P2.5 has been modeled to bounce nearly 7 feet, reducing the amount of excavation required to provide the "live" storage volume desired to attenuate peak outflows from this area. This ponding area is proposed to perform as a three-cell basin with a large portion of the area dedicated to wetland restoration and banking for replacement credits.

12.4. District HV-3

Drainage Area: 305 acres
Number of storm water basins: 1
Major Reservoirs: HV-P3 (12.5 acres)
Major Streams: North Fork, South Fork

HV-P3 is the sole regional pond proposed in District HV-3, and the most essential pond proposed to meet water quality and quantity goals in the HVA study area. Many of the existing ravines in the HVA study area are too steep and narrow to locate adequate, cost-effective, storm water basins. Storm water runoff is proposed to flow unrestricted through those areas until a feasible downstream ponding area is reached, HV-P3. Nearly half of the entire HVA study area is treated at this ponding location. HV-P3 also serves to attenuate peak flows that, to some extent, have been "passed down" from HV-P1.13 where additional ponding was determined to be infeasible. A large portion of the area within District HV-P3 contains the large ravines produced at the downstream end of the North and South Branches, and their confluence at proposed pond HV-P3. The topography in the upstream reaches of the tributary ravines does not allow for the routing of sufficient drainage area to basins that would be proposed in those upstream locations. This type of upland topography limits the number of feasible ponding locations in the District, and results in larger downstream ponding areas. HV-P3 serves to treat runoff generated in the direct drainage area, HV-3, as well upstream areas HV-1.12 and HV-1.13 where providing permanent storage volumes was infeasible. Due to the high flows required to discharge from this pond, a weir outlet structure has been proposed rather than the piped outlets proposed for the remaining ponds in the study area. The weir outlet is a practical outlet for controlling high flows while keeping costs low, and should prove to be easily constructible in the area that it has been proposed. This ponding area is proposed to perform as a three-cell basin with a large portion of the area dedicated to wetland restoration and banking for replacement credits.

12.5. District HV-4

Drainage Area: 163 acres
Number of storm water basins: 2
Major Streams: West Fork

HV-P4.1 is an existing pond that provides water quality treatment of runoff from farmland in addition to peak flow attenuation. This pond may have been constructed as a result of previous study efforts in the Hadley Valley area. This pond's existing storage volume and outlet should be verified at the time of development of this area to determine compatibility with water quality and quantity requirements.

HV-P4.2 is proposed for water quality treatment and storm water runoff storage for the majority of District HV-4. During the field visit to this area, an excessive amount of upstream erosion and downstream sediment deposition was observed immediately up- and downstream of 48th St. NE. Upon further inspection, it was determined that the crossing under the roadway was recently increased from a 24" crossing to a 54" crossing. To provide sufficient cover over the pipe, the invert had to be placed much lower than the invert of the previous 24" pipe was likely located. The lowering of this invert, in addition to the large increase in capacity and steep pipe slope, resulted in high velocities localized at the 54" pipe. These high velocities promoted the erosion of the upstream area, and presumably will continue upstream until a new, stable, equilibrium condition is reached. Sediment from this erosion was transported immediately downstream where slower velocities allowed the sediment to drop from suspension. In a situation where a pipe is replaced in this fashion, upstream erosion and downstream sediment deposition are to be expected. The observed conditions in this location were far worse than typical due to the highly erodible nature of the soils found in the HVA study area. This proposed ponding area is shown to utilize 48th St. NE as a ponding embankment, though the utilization of 48th St. NE may be infeasible due to the elevation of the existing ground relative to the elevation of the roadway. A berm may need to be constructed upstream from the roadway to create a ponding location and minimize the amount of required excavation. Due to the limited amount of bounce available in this area, this pond was modeled to provide, approximately, a 4-foot bounce. If, at the time of development, it is determined that a 5-foot bounce could be provided for this pond (the maximum bounce allowable prior to the necessity to acquire a damming permit from the MNDNR), the required water quantity ponding volume could be provided with a smaller footprint, thus increasing developable area and decreasing the required size for the drainage easement.

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 Hadley Valley study area warrants this HVA to appropriately plan and manage these resources in the Hadley Valley study area. The HVA augments the data available to the City from the 1999 SWMP and maintains the integrity of the 1999 Plan's goals and policies.

The Hadley Valley study area may undergo a shift in land use away from predominantly agricultural patterns. This shift would increase the amount of impervious area and cause changes to the storm water regime that currently exists. The HVA 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, homes, 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 Hadley Valley study area have not been determined, by making projections for cumulative runoff values, the HVA considers fully developed conditions within the entire study area. In the context of this Addendum, fully developed assumes a curve number of 70 for all developable land cover within the study area, and a curve number of 62 for undevelopable areas (assumed to be steep and wooded).

The numerous natural channels found throughout the Hadley Valley study area have been incorporated into the HVA 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 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 HVA, 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 HVA 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 minor 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 from undeveloped infiltration processes. 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 water to follow pathways to the groundwater will 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 HVA are conceptual in nature. It is extremely important that each area be reevaluated 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 Hadley Valley 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 HVA;

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 HVA;

5. Require 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.

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

References

Bonestroo & Associates. 1999. *Storm Water Management Plan*. City of Rochester, Minnesota.

Federal Emergency Management Agency. 1995. *Flood Insurance Study, Olmsted County, Minnesota and Incorporated Areas*. Washington, D.C.

Henderson, Carrol L. 1987. *Landscaping for Wildlife*. Minnesota Department of Natural Resources Nongame Wildlife Program, Minnesota Bookstore.

Johnson, Alan W., Rela, Dianne M. 1992. *A Literature Review of Recommended Buffer Widths to Maintain Various Functions of Stream Riparian Areas*. King County Surface Water Management Division, King County, Washington.

Metropolitan Council 2000. *Storm Water Utility Use in the Twin Cities Metropolitan Area*. St. Paul, Minnesota.

Minnesota Department of Transportation 2000, *Standard Specifications for Construction*. Office of Technical Support.

Minnesota Geological Survey 1988. *Geological Atlas of Olmsted County Minnesota*. University of Minnesota, St. Paul, Minnesota. County Atlas Series, Atlas C-3.

Minnesota Pollution Control Agency 1997. *Storm Water and Wetlands: Planning and Evaluation for Addressing Potential Impacts of Urban Storm-Water and Snow-melt Runoff on Wetlands.*

Minnesota Pollution Control Agency 2000. *Protecting Water Quality in Urban Areas – Best Management Practices for Dealing with Storm Water Runoff from Urban, Suburban and Developing Areas in Minnesota.* Division of Water Quality.

Rochester-Olmsted Planning Department 2002. *Zoning Ordinance and Land Development Manual of the City of Rochester*. Rochester, Minnesota.

Schueler, Thomas R. 1994, 1995. *Watershed Protection Techniques*. Volumes 1 and 2, Center for Watershed Protection, Herndon, Virginia.

U.S. Department of Agriculture 1994. *Conservation Choices, Your Guide to 30 Conservation and Environmental Farming Practices*. Soil Conservation Service, St. Paul, Minnesota.

U.S. Department of Agriculture Soil Conservation Service 1980. *Soil Survey of Olmsted County Minnesota*. Soil Conservation Service, Minnesota.

XP Software Inc. 1993-2003. *Storm Water Management Model with XP Graphical Interface*. XP Software, Tampa, Florida.

Appendix A

Drainage Areas by Subdistrict

Appendix A
Drainage Areas by Subdistrict

Area Designation	Area Acreage
HV-1.1	16.1
HV-1.2	13.7
HV-1.3	25.4
HV-1.4	25.2
HV-1.5	36.4
HV-1.6	36.9
HV-1.7	47.7
HV-1.8	124.3
HV-1.9	68.6
HV-1.10	41.7
HV-1.11	64.8
HV-1.12	32.5
HV-1.13	434.3
Subtotals -	967.6

Area Designation	Area Acreage
HV-2.1	73.9
HV-2.2	24.2
HV-2.3	23.4
HV-2.4	50.9
HV-2.5	240.3
	412.7

Area Designation	Area Acreage
HV-3	304.7
	304.7

Area Designation	Area Acreage
HV-4.1	30.1
HV-4.2	133.4
	163.5

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
HV-P1.1	1224.0	0.3	1228.6	4.6	1.8	6.7	0.4	12" RCP
HV-P1.2	1226.0	0.3	1230.3	4.3	1.7	4.2	0.3	10" Orifice
HV-P1.3	1210.0	0.5	1214.8	4.8	3.3	6.9	0.6	12" RCP
HV-P1.4	1232.0	0.5	1236.6	4.6	3.2	6.8	0.6	12" RCP
HV-P1.5	1246.0	1.0	1250.1	4.1	5.3	6.3	0.8	12" RCP
HV-P1.6	1232.0	1.0	1236.4	4.4	5.7	11.1	0.9	15" RCP
HV-P1.7	1188.0	0.3	1192.9	4.9	3.9	77.3	1.0	36" RCP
HV-P1.8	1246.0	5.3	1250.1	4.1	24.1	6.3	2.9	12" RCP
HV-P1.9	1227.0	0.4	1231.9	4.9	10.6	43.7	1.6	27" RCP
HV-P1.10	1204.0	0.3	1208.7	4.7	3.9	75.0	0.9	36" RCP
HV-P1.11	1225.0	1.5	1229.9	4.9	8.8	12.0	1.5	12" RCP
HV-P1.12	1180.0	0.1	1183.2	3.2	1.4	80.5	0.0	36" RCP
HV-P1.13	1100.0	0.0	1108.2	8.2	5.0	1138.3	0.0	9' x 10' Box
HV-P2.1	1268.0	2.8	1271.9	3.9	12.8	6.3	1.7	12" RCP
HV-P2.2	1250.0	0.6	1254.8	4.8	3.8	2.6	0.6	8" Orifice
HV-P2.3	1250.0	0.6	1254.7	4.7	3.7	2.5	0.5	8" Orifice
HV-P2.4	1225.0	1.1	1229.3	4.3	6.0	49.4	1.0	30" RCP
HV-P2.5	1120.0	3.4	1126.9	6.9	28.7	169.3	4.5	48" RCP
HV-P3	1066.0	12.5	1071.0	5.0	77.8	955.6	13.6	30' Weir
HV-P4.1	1146.0	0.6	1149.2	3.2	3.4	5.7	0.5	12" RCP
HV-P4.2	1080.0	2.8	1084.2	4.2	13.8	48.9	2.3	30" RCP

1) Definitions:
- cfs = cubic feet per second
- RCP = reinforced concrete pipe
- Box = reinforced concrete box culvert
- Orifice = modeled as an orifice and assumed to discharge to a pipe

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

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)
HV-P1.1	282	13.8	3	0.151	16	0.802	2	0.086	0	0.004
HV-P1.2	226	12.8	3	0.147	14	0.788	1	0.084	0	0.004
HV-P1.3	542	16.8	5	0.161	27	0.842	3	0.090	0	0.005
HV-P1.4	511	15.9	5	0.159	27	0.832	3	0.089	0	0.005
HV-P1.5	781	16.9	8	0.162	39	0.846	4	0.090	0	0.005
HV-P1.6	1502	16.1	15	0.160	78	0.836	8	0.089	0	0.005
HV-P1.7	2686	17.0	26	0.163	134	0.849	14	0.091	1	0.005
HV-P1.8	1451	17.6	14	0.165	71	0.857	8	0.091	0	0.005
HV-P2.1	1576	16.8	15	0.162	80	0.846	8	0.090	0	0.005
HV-P2.2	448	14.5	5	0.154	25	0.814	3	0.087	0	0.005
HV-P2.3	426	14.3	5	0.153	24	0.810	3	0.086	0	0.005
HV-P2.4	3787	17.3	36	0.163	187	0.851	20	0.091	1	0.005
HV-P2.5	11032	21.0	92	0.176	472	0.899	50	0.096	3	0.006
HV-P3	56042	25.2	428	0.192	2143	0.963	229	0.103	15	0.007
HV-P4.1	644	16.8	6	0.162	32	0.843	3	0.090	0	0.005
HV-P4.2	4439	21.4	37	0.177	188	0.902	20	0.096	1	0.006

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: ____

____

____

____

____

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:

____

____

____

____

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

____

____

____

____

Appendix E

Summary of Wetland Data

Appendix E
Summary of Wetland Data

Wetland Identification	MNRAM Functional Value Assessment[1]				Management Classification	
	Infrared Review	Field Visit	Floral Integrity Value	Wildlife Value	Wetland Classification[2]	Storm Water Susceptibility[3]
hv-w1.1	No	Yes	Medium/Low	Medium/Low	Ecosystem Support	Slightly Susceptible
hv-w1.2	No	Yes	Low	Medium	Ag/Urban Impacted	Least Susceptible
hv-w1.3	No	Yes	Low	Medium/Low	Ag/Urban Impacted	Least Susceptible
hv-w1.A	No	Yes	Medium	High	Natural	Highly Susceptible
hv-w1.B	No	Yes	Low	Medium	Ag/Urban Impacted	Least Susceptible
hv-w1.C	No	Yes	Medium	Medium/High	Natural	Moderately Susceptible
hv-w2.1	No	Yes	Low	Medium/Low	Ag/Urban Impacted	Least Susceptible
hv-w2.2	No	Yes	Low	Medium/Low	Ag/Urban Impacted	Least Susceptible
hv-w2.3	No	Yes	Low	Low	Ag/Urban Impacted	Least Susceptible
hv-w2.A	No	Yes	High	High	Unique	Moderately Susceptible
hv-w3.1	Yes	No	High	Medium	Unique	Moderately Susceptible
hv-w3.2	Yes	No	Medium/High	Medium/High	Unique	Moderately Susceptible
hv-w3.A	Yes	No	Medium	Medium/High	Natural	Moderately Susceptible
hv-w4.A	Yes	No	Medium/Low	Medium	Ecosystem Support	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	Pipe			Subtotal	Additional	Total
Flow From	Flow To	Channel Classification[1]	Stream Corr.?	Size (Feet)	Length (Feet)	Unit Cost[2, 3, 6] ($/ft)	Cost ($)	Cost[4] ($)	Cost ($)
HV-P1.1	1.13.1			1	75	19	1,425	499	1,924
HV-P1.2	1.13.2			1	75	19	1,425	499	1,924
HV-P1.3	1.13.4			1	75	19	1,425	499	1,924
HV-P1.4	1.7.1			1	75	19	1,425	499	1,924
1.5.1	HV-P1.5	I - sta	No		617	44	26,957	9,435	36,392
HV-P1.5	1.6.1			1	75	19	1,425	499	1,924
1.6.1	HV-P1.6	I - imp	No		471	45	21,304	7,456	28,760
HV-P1.6	1.7.2			1.25	75	27	2,025	709	2,734
1.7.1	1.7.3	I - sta	No		562	44	24,554	8,594	33,148
1.7.2	1.7.3	I - sta	No		661	44	28,879	10,108	38,987
1.7.3	HV-P1.7	I - sta	No		244	44	10,660	3,731	14,392
HV-P1.7	1.13.5			3	75	77	5,775	2,021	7,796
1.8.1	HV-P1.8	I - sta	No		2,061	44	90,046	31,516	121,562
1.8.2	1.8.3	I - imp	No		611	45	27,636	9,673	37,309
1.8.3	HV-P1.8	II - imp	No		699	48	33,465	11,713	45,177
HV-P1.8	1.9.1			1	100	19	1,900	665	2,565
1.9.1	1.9.2	I - imp	No		514	45	23,249	8,137	31,386
1.9.2	HV-P1.9	II - sta	No		449	44	19,740	6,909	26,649
HV-P1.9	1.10.1			2.25	75	50	3,750	1,313	5,063
1.10.1	1.10.2	I - sta	No		328	44	14,330	5,016	19,346
1.10.2	HV-P1.10	II - sta	No		284	44	12,486	4,370	16,856
HV-P1.10	1.13.6			3	100	77	7,700	2,695	10,395
1.11.1	1.11.2	I - imp	No		384	45	17,369	6,079	23,448
1.11.2	HV-P1.11	II - imp	No		413	48	19,772	6,920	26,693
HV-P1.11	1.13.10			1	100	19	1,900	665	2,565
HV-P1.12	1.13.14			3	150	0	0	0	0
1.13.1	1.13.3	I - sta	No		1180	44	51,555	18,044	69,599
1.13.2	1.13.3	I - sta	No		1208	44	52,778	18,472	71,250
1.13.3	1.13.9	II - sta	No		1369	44	60,187	21,065	81,252
1.13.4	1.13.8	I - sta	No		613	44	26,782	9,374	36,156
1.13.5	1.13.7	I - sta	No		209	44	9,131	3,196	12,327
1.13.6	1.13.7	I - sta	No		372	44	16,253	5,688	21,941
1.13.7	1.13.8	II - sta	No		938	44	41,238	14,433	55,672
1.13.8	1.13.9	II - sta	No		1749	44	76,893	26,913	103,805
1.13.9	1.13.13	III - sta	No		839	39	32,973	11,540	44,513
1.13.10	1.13.12	I - sta	No		833	44	36,394	12,738	49,132
1.13.11	1.13.12	I - sta	No		736	44	32,156	11,255	43,411
1.13.12	1.13.13	II - sta	No		2316	44	101,820	35,637	137,458
1.13.13	1.13.15	III - sta	No		801	39	31,479	11,018	42,497
1.13.14	1.13.15	I - sta	No		976	44	42,642	14,925	57,566
1.13.15	HV-P1.13	III - sta	No		130	39	5,109	1,788	6,897
HV-P1.13	3.1			9 x 10	140	0	0	0	0
						Minor District HV-1 Subtotal	1,018,012	356,304	1,374,316

See last page for footnotes

Appendix F
Proposed Trunk Channel System Data

Designation		Channel	Within	Pipe			Subtotal	Additional	Total
Flow From	Flow To	Channel Classification[1]	Within Stream Corr.?	Pipe Size (Feet)	Length (Feet)	Unit Cost[2, 3, 6] ($/ft)	Subtotal Cost ($)	Additional Cost[4] ($)	Total Cost ($)
Minor District HV-2									
2.1.1	2.1.2	I - imp	No		667	45	30,169	10,559	40,728
2.1.2	HV-P2.1	II - imp	No		348	48	16,661	5,831	22,492
HV-P2.1	2.4.1			1	75	19	1,425	499	1,924
HV-P2.2	2.4.2			1	75	19	1,425	499	1,924
HV-P2.3	2.4.4			1	75	19	1,425	499	1,924
2.4.1	2.4.3	I - sta	No		1612	44	70,429	24,650	95,079
2.4.2	2.4.3	I - sta	No		516	44	22,544	7,890	30,435
2.4.3	HV-P2.4	I - sta	No		50	44	2,185	765	2,949
2.4.4	HV-P2.4	I - sta	No		232	44	10,136	3,548	13,684
HV-P2.4	2.5.1			2.5	75	56	4,200	1,470	5,670
2.5.1	2.5.4	I - sta	No		554	44	24,204	8,472	32,676
2.5.2	2.5.3	I - sta	No		151	44	6,597	2,309	8,906
2.5.3	2.5.4	II - sta	No		777	44	34,160	11,956	46,116
2.5.4	HV-P2.5	II - sta	No		1764	44	77,552	27,143	104,696
2.5.5	HV-P2.5	II - sta	No		1000	44	43,964	15,387	59,351
HV-P2.5	3.2			4	75	116	8,700	3,045	11,745
					Minor District HV-2 Subtotal		355,776	124,522	480,298
Minor District HV-3									
3.1	HV-P3	III - sta	Yes		1222	60	73,272	25,645	98,918
3.2	3.4	II - sta	No		468	44	20,575	7,201	27,776
3.3	3.4	II - sta	No		1643	44	72,233	25,281	97,514
3.4	3.6	II - sta	No		231	44	10,156	3,554	13,710
3.5	3.6	II - sta	No		975	44	42,865	15,003	57,868
3.6	3.7	II - sta	No		878	44	38,600	13,510	52,110
3.7	HV-P3	III - sta	No		419	39	16,467	5,763	22,230
HV-P3	out[5]			Weir	30	850	25,500	8,925	34,425
					Minor District HV-3 Subtotal		299,668	104,884	404,551
Minor District HV-4									
HV-P4.1	4.2.3			1	75	19	1,425	499	1,924
4.2.1	4.2.2	I - sta	No		1243	44	54,307	19,007	73,315
4.2.2	4.2.4	II - sta	No		852	44	37,457	13,110	50,567
4.2.3	4.2.4	I - sta	No		694	44	30,321	10,612	40,933
4.2.4	HV-P4.2	II - sta	No		289	44	12,706	4,447	17,153
HV-P4.2	out[5]			2.5	75	56	4,200	1,470	5,670
					Minor District HV-4 Subtotal		140,416	49,146	189,562

1) "Sta" is an abbreviation for channel stabilization measures. "Imp" is an abbreviation for channel improvement measures. "I", "II", and "III" 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] ($12,050/Ac)	Outlet Cost[4] ($)	Subtotal Cost ($)	Additional Cost[3] ($)	Total Cost ($)
Minor District HV-1								
HV-P1.1	0.7	3,796	0.5	6,025	12,000	21,821	7,637	29,458
HV-P1.2	0.7	3,400	0.5	6,025	7,500	16,925	5,924	22,849
HV-P1.3	1.3	6,513	0.9	10,845	12,000	29,358	10,275	39,633
HV-P1.4	1.2	6,334	0.9	10,845	12,000	29,179	10,213	39,391
HV-P1.5	1.9	9,835	1.5	18,075	12,000	39,910	13,969	53,879
HV-P1.6	2.0	10,350	1.6	19,280	12,000	41,630	14,571	56,201
HV-P1.7	1.7	8,926	0.9	10,845	20,000	39,771	13,920	53,690
HV-P1.8	7.7	39,851	6.5	78,325	12,000	130,176	45,561	175,737
HV-P1.9	3.7	19,241	3.4	40,970	20,000	80,211	28,074	108,284
HV-P1.10	1.7	8,679	1.4	16,870	20,000	45,549	15,942	61,492
HV-P1.11	3.3	16,907	2.1	25,305	12,000	54,212	18,974	73,187
HV-P1.12	0.3	1,423	0.4	4,820	0	6,243	2,185	8,428
HV-P1.13	1.0	5,143	1.4	16,870	0	22,013	7,705	29,717
				Minor District HV-1 Subtotal		556,997	194,949	751,946
Minor District HV-2								
HV-P2.1	4.3	22,075	3.7	44,585	12,000	78,660	27,531	106,192
HV-P2.2	1.3	6,863	1.0	12,050	7,500	26,413	9,244	35,657
HV-P2.3	1.3	6,645	1.0	12,050	7,500	26,195	9,168	35,364
HV-P2.4	2.2	11,473	1.7	20,485	20,000	51,958	18,185	70,143
HV-P2.5	10.2	52,888	4.9	59,045	20,000	131,933	46,176	178,109
				Minor District HV-2 Subtotal		315,159	110,306	425,465
Minor District HV-3								
HV-P3	29.1	150,444	14.5	174,725	0	325,169	113,809	438,978
				Minor District HV-3 Subtotal		325,169	113,809	438,978
Minor District HV-4								
HV-P4.1	1.2	6,233	1.2	14,460	7,500	28,193	9,868	38,061
HV-P4.2	5.1	26,332	3.8	45,790	20,000	92,122	32,243	124,365
				Minor District HV-4 Subtotal		120,315	42,110	162,426

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, approximately 30% of HWL encompassed "H/F" and 70% encompassed "upland", giving a rounded weighted cost of $12,050.

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

4) Costs correspond to April 2002.

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 HV-1				
Water Quality	(3.0%)	$93,662	$32,782	$126,443
Water Quantity	(15.8%)	$493,510	$172,729	$666,239
Trunk Channels	(31.5%)	$987,837	$345,743	$1,333,579
	(50.3%)	Minor District NW-2 Subtotal -		$2,126,261
Minor District HV-2				
Water Quality	(2.2%)	$68,333	$23,917	$92,250
Water Quantity	(8.4%)	$264,001	$92,400	$356,402
Trunk Channels	(11.6%)	$363,849	$127,347	$491,197
	(22.2%)	Minor District NW-2 Subtotal -		$939,848
Minor District HV-3				
Water Quality	(3.6%)	$111,039	$38,864	$149,903
Water Quantity	(7.7%)	$239,630	$83,870	$323,500
Trunk Channels	(7.9%)	$248,920	$87,122	$336,042
	(19.2%)	Minor District NW-2 Subtotal -		$809,445
Minor District HV-4				
Water Quality	(0.7%)	$23,391	$8,187	$31,578
Water Quantity	(3.3%)	$102,549	$35,892	$138,441
Trunk Channels	(4.3%)	$134,791	$47,177	$181,968
	(8.3%)	Minor District NW-2 Subtotal -		$351,987
Grand Total		$3,131,512	$1,096,029	$4,227,541

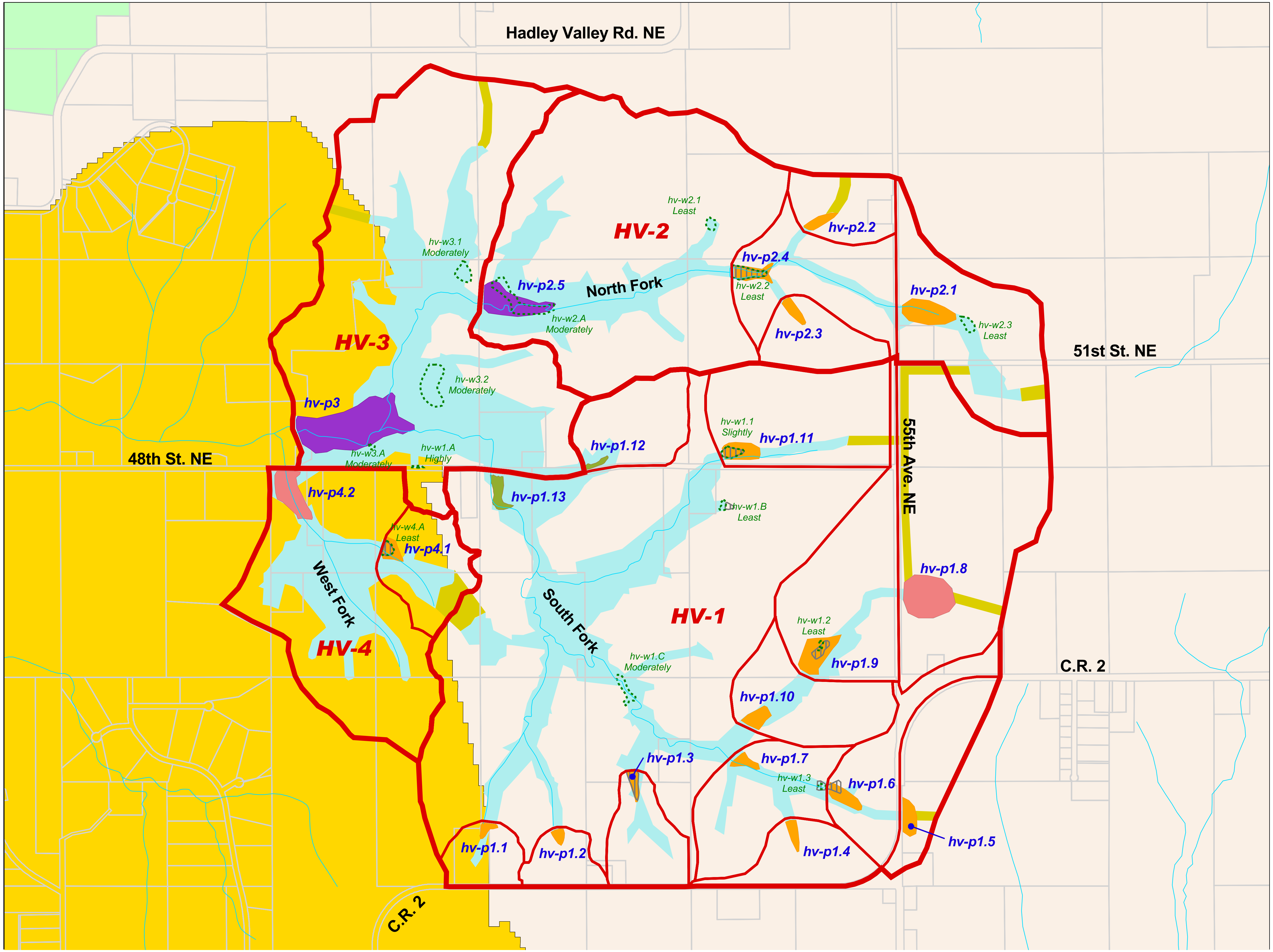
Note: Costs correspond to April 2002.

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 HV-1				
Land acquisition	(1.1%)	$34,514	$12,080	$46,594
Excavation	(1.9%)	$59,148	$20,702	$79,850
Minor District HV-2				
Land acquisition	(0.8%)	$25,180	$8,813	$33,993
Excavation	(1.4%)	$43,153	$15,103	$58,256
Minor District HV-3				
Land acquisition	(1.3%)	$40,917	$14,321	$55,238
Excavation	(2.2%)	$70,122	$24,543	$94,665
Minor District HV-4				
Land acquisition	(0.3%)	$8,620	$3,017	$11,636
Excavation	(0.5%)	$14,772	$5,170	$19,942
	(9.5%)		Water Quality Subtotal -	$400,174
Water Quantity				
Minor District HV-1				
Land acquisition	(7.4%)	$230,586	$80,705	$311,291
Excavation	(2.6%)	$81,249	$28,437	$109,686
Outlet cost	(4.8%)	$151,500	$53,025	$204,525
Trunk pipe cost	(1.0%)	$30,175	$10,561	$40,736
Minor District HV-2				
Land acquisition	(3.9%)	$123,035	$43,062	$166,097
Excavation	(1.8%)	$56,791	$19,877	$76,669
Outlet cost	(2.1%)	$67,000	$23,450	$90,450
Trunk pipe cost	(0.5%)	$17,175	$6,011	$23,186
Minor District HV-3				
Land acquisition	(4.3%)	$133,808	$46,833	$180,640
Excavation	(2.6%)	$80,322	$28,113	$108,435
Outlet cost	(0.0%)	$0	$0	$0
Trunk pipe cost	(0.8%)	$25,500	$8,925	$34,425
Minor District HV-4				
Land acquisition	(1.6%)	$51,630	$18,071	$69,701
Excavation	(0.6%)	$17,794	$6,228	$24,022
Outlet cost	(0.9%)	$27,500	$9,625	$37,125
Trunk pipe cost	(0.2%)	$5,625	$1,969	$7,594
	(35.1%)		Water Quantity Subtotal -	$1,484,582
Pond Total	(44.6%)	$1,293,566	$452,748	$1,884,756
Trunk Channels:				
Minor District HV-1				
Erosion Protection	(2.2%)	$70,207	$24,572	$94,779
Excavation	(0.2%)	$7,400	$2,590	$9,990
Improvement Structure	(17.1%)	$535,279	$187,348	$722,627
Easement	(12.0%)	$374,951	$131,233	$506,184
Buffer	(0.0%)	$0	$0	$0
Minor District HV-2				
Erosion Protection	(0.8%)	$23,657	$8,280	$31,938
Excavation	(0.1%)	$2,389	$836	$3,225
Improvement Structure	(5.9%)	$185,101	$64,785	$249,887
Easement	(4.1%)	$127,454	$44,609	$172,063
Buffer	(0.8%)	$25,248	$8,837	$34,085
Minor District HV-3				
Erosion Protection	(0.6%)	$20,150	$7,052	$27,202
Excavation	(0.0%)	$0	$0	$0
Improvement Structure	(4.2%)	$131,805	$46,132	$177,936
Easement	(3.1%)	$96,965	$33,938	$130,903
Buffer	(0.0%)	$0	$0	$0
Minor District HV-4				
Erosion Protection	(0.3%)	$9,335	$3,267	$12,602
Excavation	(0.0%)	$0	$0	$0
Improvement Structure	(2.4%)	$74,315	$26,010	$100,325
Easement	(1.6%)	$51,141	$17,899	$69,040
Buffer	(0.0%)	$0	$0	$0
Trunk Channel Total	(55.4%)		$560,212	$2,342,785
Grand Total:			$1,012,960	$4,227,541

Note: Costs correspond to April 2002.



City of Rochester

STORM DRAINAGE

Rochester Storm Water Management Plan - Hadley Valley Addendum

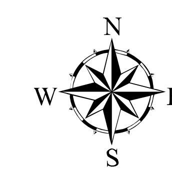
Map 1

Legend

Proposed Ponds
- Rate Control Pond
- Sediment Basin
- Nutrient Removal Basin
- 3-Cell Filter Basin

- Minor Drainage Districts
- Subdistricts

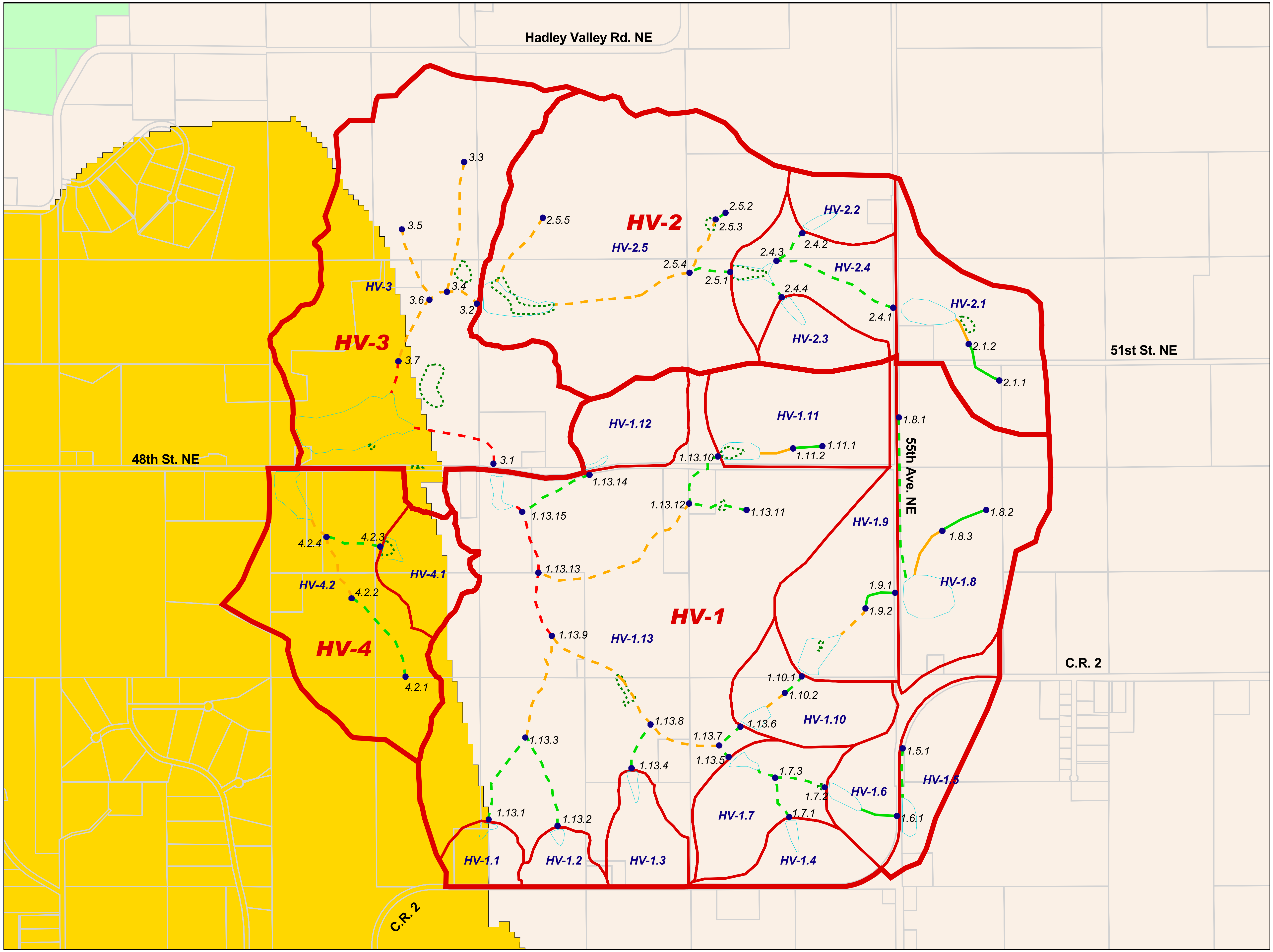
- Wetlands
  - hv-w2.3: Wetland ID
  - Least: Storm Water Susceptibility
- Existing Ponds
- Watercourses
- Stream Corridor
- Potential Upland Corridor Connection
- Parcels
- 50 Yr. Urban Reserve Area
- Resource Protection Area



March 2004

k:\363\36301129\cad\gis\avprojects\hv_maps.apr

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 - Hadley Valley 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
- 50 Yr. Urban Reserve Area
- Resource Protection Area
- Wetlands

N S W E

March 2004

1200 0 1200

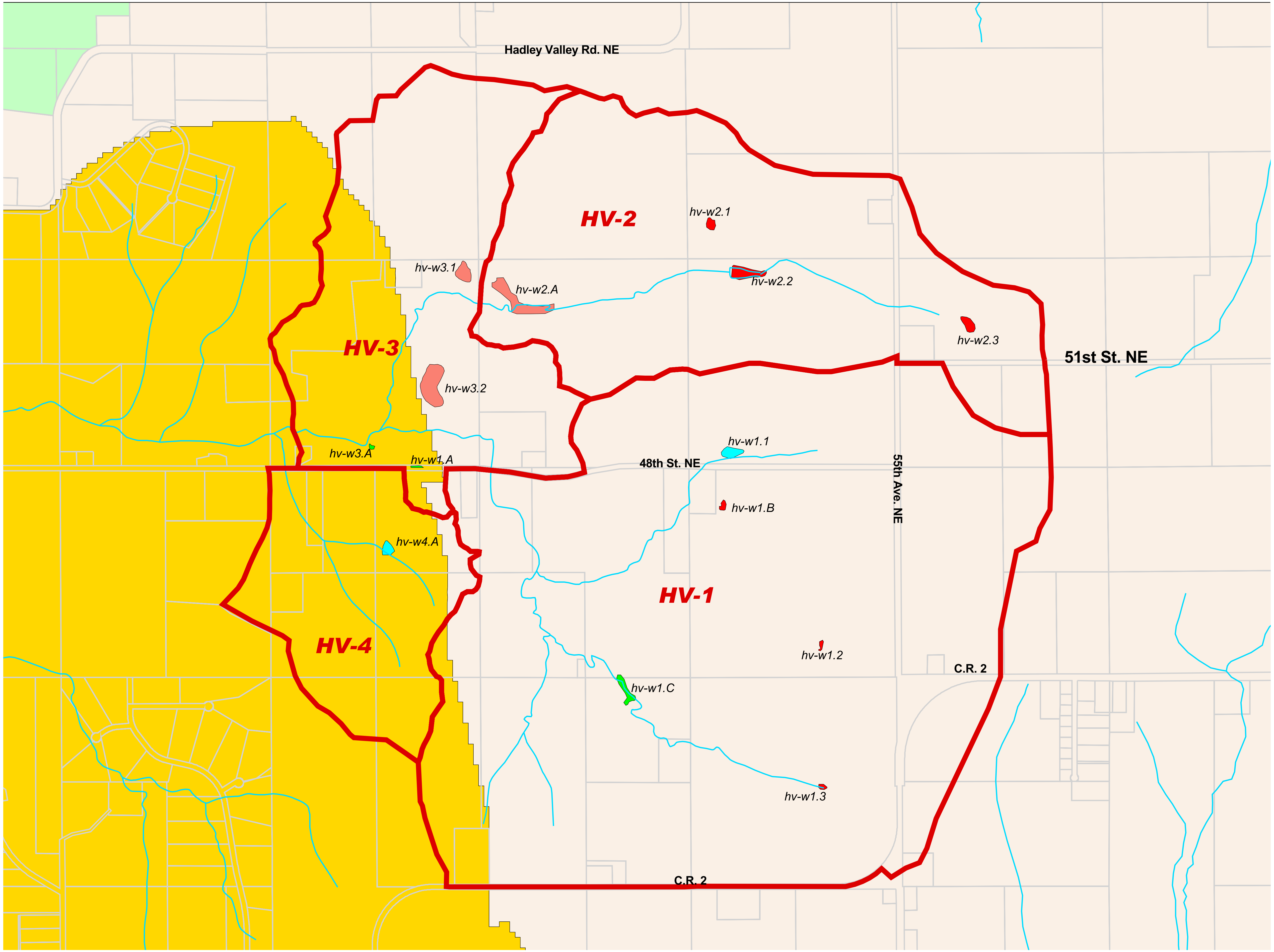
Feet

ROCHESTER MINNESOTA

Bonestroo Rosene Anderlik & Associates Engineers & Architects

k:\363\36301129\cad\gis\avprojects\hv_maps.apr

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



City of Rochester

WETLANDS

Rochester Storm Water Management Plan - Hadley Valley Addendum

Map 3

Legend

Wetland Classification

- Unique
- Natural
- Ecosystem Support
- Ag/Urban Impacted

- Minor Drainage Districts
- Parcels
- 50 Yr. Urban Reserve Area
- Resource Protection Area
- Watercourses

N W E S

March 2004

1200 0 1200

Feet

ROCHESTER MINNESOTA

Bonestroo Rosene Anderlik & Associates
Engineers & Architects

k:\363\36301129\cad\gis\avprojects\hv_maps.apr

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