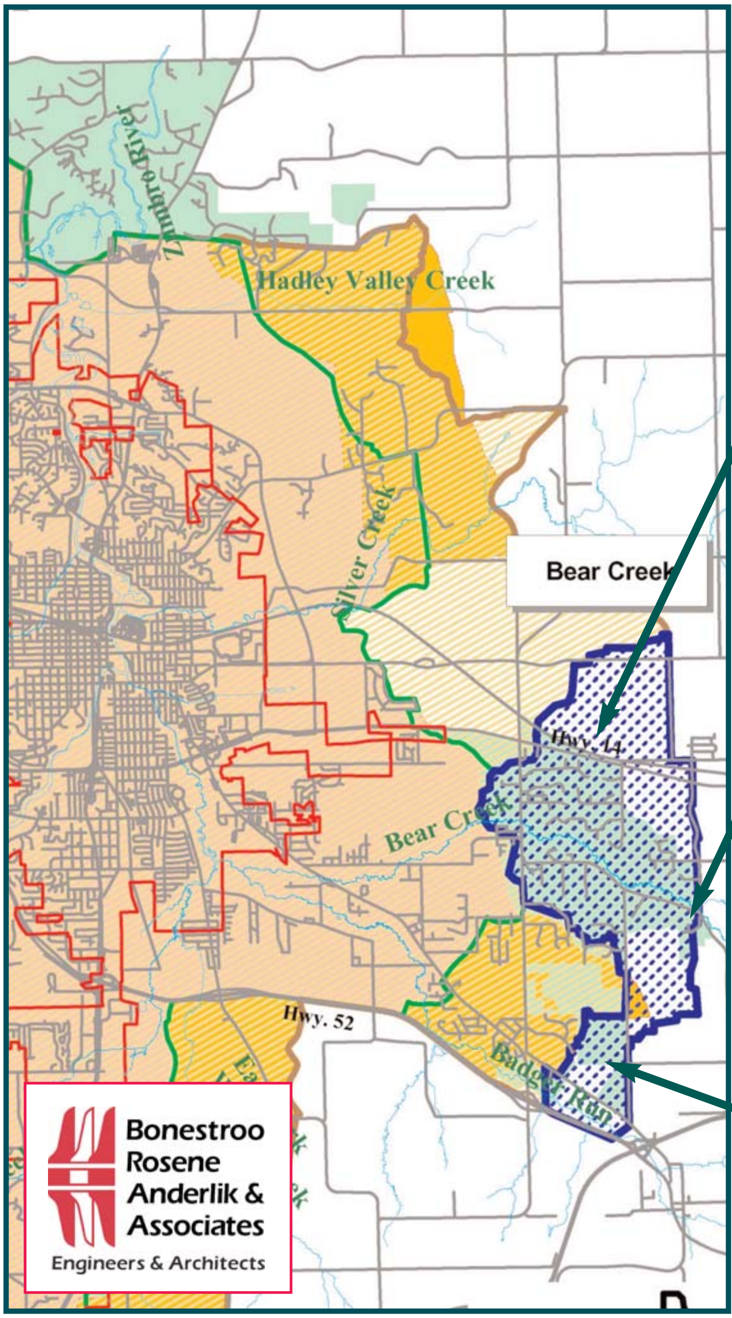
Rochester

Storm Water Management Plan

Bear Creek Addendum

March 2004



Bonestroo
Rosene
Anderlik &
Associates
Engineers & Architects

Rochester Storm Water Management Plan
Bear Creek Addendum

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1. Introduction

In response to rapid population growth, the City of Rochester undertook a storm water planning effort in 1995. A Steering Committee was formed to guide the development of Rochester's Storm Water Management Plan (SWMP), which was published in 1997 and updated in 1999. In 2001 the City's efforts continued with three addenda: Northwest Territory, Bear Creek, and Hadley Valley. This report, the "Bear Creek Addendum" (BCA), was prepared as an addendum to the 1999 SWMP to assess in more detail parts of the Bear Creek Watershed. This region includes rural, suburban and urban uses, with agricultural and some commercial and industrial land uses. Figure 1-1 illustrates the study area for the original SWMP, as well as the location and boundary of this Addendum.

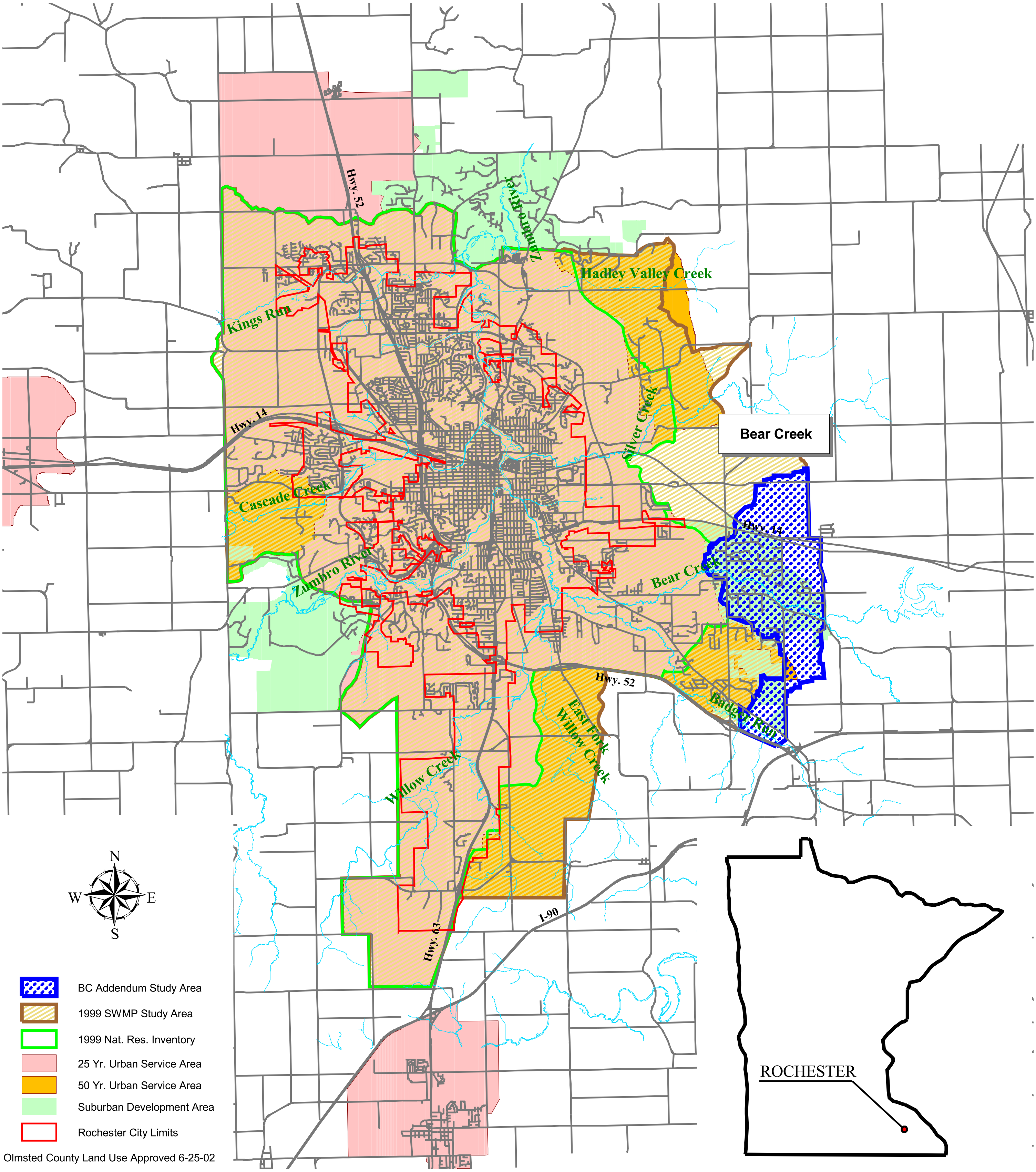
The following excerpt from the 1999 SWMP summarizes the main intent of the SWMP and this Addendum.

"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 runoff 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.

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.



LOCATION MAP - BEAR CREEK

FIGURE 1-1

ROCHESTER, MINNESOTA

ROCHESTER STORM WATER MANAGEMENT PLAN - BEAR CREEK ADDENDUM

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- 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 Bear Creek Addendum 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 BCA. However,the 1999 SWMP addressed NPDES recommendations and requirements in Chapter 7, while Chapter 7 in this BCA covers the topic of wetlands. The reader is encouraged to refer to the 1999 plan for details on the NPDES program and requirements.

The contents of this Addendum serve to create a framework for storm water management 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.

Since this Addendum complements the original 1999 SWMP to assess the study area in more detail, the BCA shall take precedence as the planning document for the portion of the Bear Creek watershed that it addresses.

The 1999 SWMP described the City of Rochester as been located within eight Major Drainage Districts. The Northwest Territory Addendum added a ninth district. These nine Major Drainage Districts are listed in Table 1-1, where Badger Run is included in the Bear Creek District.

Table 1-1 Major Drainage Districts

Major Drainage District	Abbreviation	Area (Acres)
Willow Creek	WC	16,500
Bear Creek	BC	30,473
Mayo Run	MR	2,200
Silver Creek	SC	12,260
Hadley Valley Creek	HV	6,300
Kings Run	KR	9,675
Cascade Creek	CC	24,500
South Fork Zumbro River	ZR	99,700
Northwest Territories	NW	7,540

1.1. Study Area

Figure 1-1 illustrates the Bear Creek Addendum (BCA) study area and the current Urban Service and Urban Reserve Area boundaries. The BCA study area is mostly east of 50th Avenue SE, west of Chester Road, south of College View Road, and north of Highway 52.

The Bear Creek Addendum (BCA) analyzes in more detail approximately 3,739 acres, not included in the 1999 SWMP. These 3,739 acres are located in the following *Minor Drainage Districts* in the BCA (Table 1-2):

Table 1-2 Bear Creek Addendum Minor Drainage Districts

Minor Drainage District	Abbreviation	Area (Acres)
Bear Creek North	BC-a2.5	1,354
Bear Creek Center	BC-a2.4	1,569
Badger Run	BC-a1.5	611
Bear Creek West	BC-a2.9	205
Total		3,739

Note: These Minor Drainage Districts had been referred to as *subdistricts* in the 1999 SWMP. In the BCA, *Subdistricts* are smaller divisions of the *Minor Drainage Districts*.

This Addendum analyzes only 38% of Minor Drainage District BC-a2.5 and 100% of the other three Minor Drainage Districts. These four Minor Drainage Districts were further subdivided into *Subdistricts* wherever storm water management opportunities existed for the undeveloped areas. These subdistricts are listed with their size in acres in Appendix A and are covered in detail in Chapter 12 of this Addendum.

1.2. General Description

The Bear Creek Addendum study area is mixed with rural, suburban and urban uses. Using the Olmsted County Future Land Use Map (updated March 21, 2000), the BCA study area includes approximately 12 acres in the 25-Year Urban Service Area; 102 acres in the 50-Year Urban Reserve Area; 1,856 acres in Suburban Development Area; and 1,769 acres in Resource Protection Area.

The major east-to-west roads in the study area are College View Road (County Road 9); Highway 14; 20th Street SE (County Road 143); Marion Road (County Road 123); and Highway 52. The major north-to-south roads are 50th and 60th Avenue SE; and 65th Avenue SE (County Road 119), continued to the south by Chester Road (County Road 19). All these roads are paved, except for the southern portion of 60th Avenue SE. The minor roads are mainly for local access to properties and are mostly paved with rural section.

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 Bear Creek 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 the current 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 Chapter 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 Bear Creek 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 water bodies 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

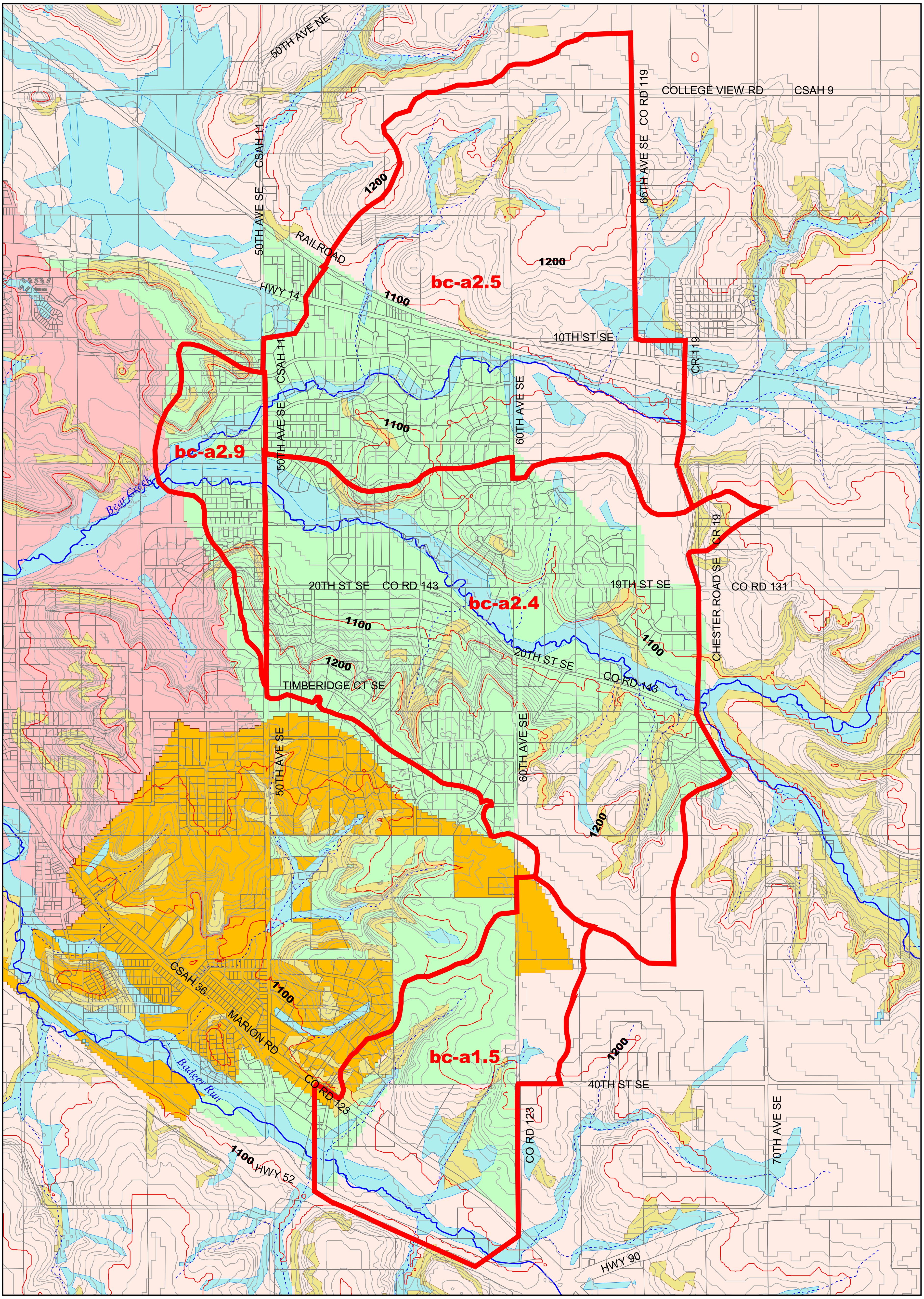
3.1 Topography and Drainage

The Bear Creek watershed is part of the gently to moderately rolling landscape that characterizes the Rochester area. Numerous streams and creeks drain the uplands, dissecting the terrain in a dendritic (tree-like) drainage pattern. Wetlands are mostly located in the stream corridors, localized depressions, and groundwater seepage areas. Land surface elevations vary from a low of 1040 feet (leaving Minor Drainage District BC-a2.9) to a high of 1300 feet above mean sea level north of College View Road (County Road 9). A ridge at an elevation about 1240 feet above mean sea level creates the watershed divide between Bear Creek on the north and Badger Run on the south of the BCA study area (see Figure 3-1 for contour data). Natural slopes generally range from 2 to 5 percent in upland areas, 5 to more than 30 percent in stream valleys, and less than 1 percent along flood plain areas.

The Bear Creek watershed covers approximately 75 square miles southeast of downtown Rochester and is drained by two major streams: Bear Creek and Badger Run. Badger Run begins near the Town of Marion and flows west along a flat, meandering course to Bear Creek. Bear Creek flows from an area approximately one mile southwest of the City of Eyota west toward the confluence of Willow Creek and Badger Run. After this confluence, Bear Creek continues north to Bear Creek Park (South of Trunk Highway 14), where the Army Corps of Engineers (USACE) has reconstructed the channel cross section. Bear Creek eventually discharges to the South Fork Zumbro River in Rochester just north of 4th Street SE, which then bisects the City as it flows north to Lake Zumbro and hence to the Mississippi River.

As part of the flood control project, the USACE built a dam in the upper reaches of the Bear Creek, in Chester Woods County Park. This dam regulates the flows on the Bear Creek, resulting in reduced peak flows and more stable base flows.

The BCA study area Minor Drainage District BC-a2.5 is drained by the, here named, Bear Creek North Branch. This stream joins the Bear Creek main stem at the western limit of this study area. The Bear Creek main stem drains Minor Drainage District BC-2.4, while Badger Run drains Minor



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"

Land Use Designation
ROPD - June, 2002
- Resource Protection Area
- Suburban Development Area
- 25 Year Urban Service Area
- 50 Year Urban Reserve Area

Contours
- 100 ft Contours
- 10 ft Contours
- DNR Protected Watercourse
- Other Watercourses

1) All Data in Map are in Olmsted County Coordinate System.
2) Soils information display slightly distorted due to the process of original map digitation. Acquired from LMIC in 2003 - last update (conversion to shapefiles) in 2001.

City of Rochester

CONSTRAINTS TO DEVELOPMENT
DUE TO SOIL TYPE

Rochester Storm Water Management Plan
Bear Creek Addendum

Figure 3-1

2000 0 2000 Feet

N W E S

March 2004

ROCHESTER MINNESOTA

Bonestroo Rosene Anderlik & Associates
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Drainage District BC-a1.5 on the south. These three streams have very mild slopes, generally less than 0.5%, while their tributary creeks have average slopes of 4 to 8% and are highly susceptible to erosion. Erosion-deposition of sediments is observed to have a significant impact on the stream morphology of Bear Creek and its North Branch.

3.1.1. Minor Drainage District BC-a2.5

The northern portion of this Minor Drainage District drains south to the Bear Creek North Branch, which flows southwesterly. This Branch has three major road crossings: County Road 19 (Chester Road) entering this Minor Drainage District; 60th Avenue SE; and 50th Avenue SE leaving this Minor Drainage District.

Land slopes are mostly between 2 and 12% north of the railroad, with milder slopes south of the railroad. Generally milder slopes and depressions are found upstream, adjacent to the railroad, which has promoted wetland development in these areas. Drainageways are relatively stable and are moderately susceptible to erosion, even though this North Branch by Chester Road is severely degraded.

3.1.2. Minor Drainage Districts BC-a2.4 and BC-a2.9

Areas from the milder slopes in the north and steeper slopes in the south drain to Bear Creek, which flows northwesterly. Bear Creek enters Minor Drainage District BC-a2.4 through a crossing with three box culverts (12-feet wide by 6-feet high) under Chester Road. It leaves Minor Drainage District BC-a2.4, flowing into BC-a2.9 at the 50th Avenue SE crossing.

Land slopes are mild along the Bear Creek floodplain. Away from the floodplain, slopes range from mild to moderate on its north side (1 to 12%, with some areas steeper than 25%) and mild to very steep on its south side (1 to 12%, with many areas greater than 25%). Drainageways are relatively stable and are moderately susceptible to erosion. Steeper slopes of greater than 4% are highly susceptible to bank erosion.

3.1.3. Minor Drainage District BC-a1.5

Most of this Minor Drainage District drains southwesterly to Badger Run, which flows northwesterly. Two branches of Badger Run join before entering this Minor Drainage District: one from areas north of Highway 90, while the other mostly from the south. About 1,000 feet after leaving this Minor Drainage District, Badger Run crosses 50th Avenue SE (County Road 11).

Land slopes are mild to moderate (1 to 12%, with only about 5% of the area being steeper than 12%). Drainageways are moderately susceptible to erosion, with steeper slopes of greater than 4% being highly susceptible to bank erosion.

3.2. Soils

3.2.1. Associations

Four major soil associations are present in the Bear Creek watershed. These associations are characterized by certain drainage, relief, erosion, particle size, and other soil parameters. Several minor soil types can be found within a general soil type, depending on soil spatial variability. 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-Natural Resources Conservation Service, formerly Soil Conservation Service).

The Bear Creek Addendum study area includes about 68 minor soil types within four major associations. The soil associations are described below in order of dominance by aerial extent.

The Rockton-Channahon-Atkinson association (Soil Group #3) is the most prevalent group within the BCA study area. This soil group consists of nearly level to steeply sloping, well-drained loamy soils on uplands. These areas are dominated by soils formed in a loamy mantle and in the underlying clayey residuum over bedrock. This association is generally on broad uplands that have slopes of 0 to more than 12 percent, dissected by deep drainageways.

The Dickinson-Plainfield-Kalmarville (Soil Group #8) association consists of soils that are nearly level to very steep, well-drained to poorly drained soils that are loamy and sandy on outwashed terraces and silty on flood plains. This association has the most recent soil deposits and is found on terraces, foot slopes and flood plains in stream valleys. Slopes range from 0 to 30 percent. Areas covered by this association are stream corridors of Bear Creek and Badger Run.

The Racine-Floyd-Maxfield association (Soil Group #2) consists of silty soils on uplands and in upland drainageways. Local relief between drainageways and summits is about 20 to 50 feet, with slopes ranging from 0 to 18 percent. This association is located in the northern portions of Bear Creek along the railroad and Highway 14.

The Mt. Carroll-Otter-Joy association (Soil Group #4) is in areas dominated by silty soils formed in loess. These soils are typically found on uplands with slopes ranging from nearly level to moderately steep. The well-drained Mt. Carroll soils are on summits and side slopes, while other very poorly to somewhat poorly drained soils are found in drainageways. These soils cover the uplands north of the railroad.

Up to 40% of the Bear Creek Addendum study area can have bedrock within five feet of the ground surface (Olmsted County Geologic Atlas Surficial Geology Plate). Hence, local geologic and soil characteristics need to be considered during the feasibility and design of storm water facilities. During the design of these facilities subsurface water flows that may affect the system also need to be considered, since dissected soil or geologic layers allow exfiltration to surface waters. For more details on soil types and characteristics, refer to the Soil Survey of Olmsted County (USDA-SCS, March 1980). The Surficial Geology Plate also illustrates other features, such as the highly permeable terrace deposits.

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 soils 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 Addendum illustrates and identifies these hydric soil conditions within the BCA 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 BCA study area.

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

3.3 Wetlands

The National Wetlands Inventory (NWI) identified several wetlands within the Bear Creek Addendum study area. Infra-red aerial photographs were reviewed to locate other potential wetlands. Where property access was granted, 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. Some of the wetlands have been drained in order to sustain farming practices.

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

3.4 Land Use

The Bear Creek area was predominately prairie, wetland/floodplain and hardwood forest prior to settlement. Land clearing for farming after the mid 1800s and more recent residential and commercial developments have altered the landscape.

The area north of the railroad in Minor Drainage District BC-a2.5 is mostly agricultural, with a few residential lots along the roads, such as 10th Street SE. Practically all the area west of 60th Avenue SE and south of the railroad in Minor Drainage Districts BC-a2.4 and BC-a2.5 has developed with suburban housing in 2 to 5 acre lots. The area east of 60th Avenue SE and north of 19th Street SE is mostly agricultural, but is under high development pressure. The southern uplands of BC-a2.4 east of 60th Avenue SE are mostly undeveloped, but are also rapidly developing.

Minor Drainage District BC-a1.5 has remained mostly agricultural, with scattered housing. However, its northwest perimeter is starting to develop, particularly in areas designated by the Rochester-Olmsted Planning Department Future Land Use Plan (June 2002) to be within the 50-Year Urban Reserve Area and the Suburban Development Area.

Even though agricultural soil conservation practices are in common usage, land degradation can be observed, such as in the barren area south of Highway 14 and west of Chester Road. Overall, disturbances to land cover have increased soil erosion and sediment transport to streams, particularly Bear Creek. While some erosion is attributed to development construction, agriculture was also observed to contribute sheet and rill erosion in areas with slopes greater than 2%.

Suburban land use is characterized by mowed lawns, which promotes fertilizer use and adversely affects water quality and aquatic ecosystems.

Areas that remain forested are generally in very fragile lands, with steep slopes and highly erodible soils. These are extremely important to maintain soil stability, as well as to promote groundwater recharge. The floodplain soils of the Bear Creek have high infiltration capacity and facilitate the percolation of water flowing from the uplands through the small creeks into milder sloped areas. Best management practices that promote infiltration also reduce the potential for erosion of stream banks. These practices are desirable especially when runoff increases, caused by changes in land use, occur.

Within this study ares, Badger Run and both branches of Bear Creek are classified as DNR Protected Waters, as illustrated in Maps 1, 2 and 3. Floodplain information is published by the Federal Emergency Management Agency (FEMA) as part of the Flood Insurance Studies. Map Panels 169, 188, 307, and 326 contain the Flood Insurance Rate Maps (FIRM) for the BCA study area.

4. Stream Corridors

4.1. Introduction

The existing network of intermittent stream channels within the Bear Creek area conveys storm water runoff, typically from east to west. These watercourses are shown in Map 1, located at the end of this Addendum. The natural channels are situated in areas where soil types and conditions (i.e., hydric, floodplain and flood prone) inhibit urban/suburban development. The proposed storm drainage network utilizes these existing drainageways. Under fully developed urban conditions, the proposed open channels will support a higher base flow than existing conditions due to increased amounts of surface runoff.

The natural, open space 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 and developed.

These features and functions lend themselves to designation as, for planning purposes, multi-functional "stream corridors" that extend beyond the banks of the channels. The stream corridors preserve the natural drainageways, provide buffers between the channels and developed areas, allow for the future development of bicycle and 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 soils as classified by the Soil Survey of Olmsted County (see Section 3.2.2 for details)
- Wetlands (both National Wetland Inventory and infra-red aerial photograph interpreted wetlands were used for this Addendum)
- Forested land identified by Minnesota Land Cover Classification System
- 100-yr high water levels for detention basins
- 50 feet from the top of bank of channels within the defined stream corridor (on both sides of the channel)

The location and extent of the stream corridors designated using these criteria is shown on Map 1 at the back of this Addendum. A minimum stream corridor width of 50 feet from the edge of each channel bank was established. However, using the criteria noted above resulted in large stream corridor areas in Bear Creek, due to the predominance of steep slopes and forested areas.

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. In some cases, residents and business owners adjacent to stream corridors were interviewed for historic accounts of peak water levels observed within or extending beyond existing channels. These residents and site inspections of existing stream channels and roadside ditches confirmed that infiltration is high along the Bear Creek floodplains and along other drainageways where steeper slopes transition to milder slopes.

While some stream corridors are relatively stable, others experience moderate to severe degradation. While some of the degradation is due to suburban development, the impact of agricultural land use is also evident, such as in the North Branch of the Bear Creek by Highway 14 and Chester Road SE.

4.3. Description of Stream Corridors

In the 1999 SWMP, the segments of the Bear Creek Corridor were described. Two of these segments continue in the BCA study area: Bear Creek - Upper Reach and Badger Run. Both extend from County Road 11 upstream to the eastern boundary. The following description from the 1999 SWMP is applicable to the segments within the BCA study area.

4.3.1. Bear Creek - Upper Reach

General Description

The Upper Reach of Bear Creek meanders through a narrow forested floodplain. Adjacent to the floodplain, upland forest and agricultural land uses are dominant. The Bear Creek channel is generally about 30 feet wide and less than one foot deep. In many places, severely eroded streambanks are scoured out by the current and slump down into the creek, redepositing fine sediments into Bear Creek. Just downstream from County Road 11, an unnamed tributary joins Bear Creek from the north. This tributary contained substantial flow and was approximately 15 feet in width and six inches deep. A narrow strip of floodplain forest runs along this tributary for much of its length, making it a significant component of the Bear Creek Corridor.

Natural Communities

The original vegetation of the Upper Reach of Bear Creek consisted mostly of forest and woodland natural communities. Near Bear Creek, floodplain and lowland hardwood forest was present. Farther back from the creek, on higher ground, oak forest, oak woodland-brushland and oak savanna were found. On ridge tops, above the creek valley, scattered patches of prairie were present.

Today lowland hardwood forest, floodplain forest and oak woodland-brushland are the dominant natural communities in the Upper Reach of the Bear Creek Corridor. The quality of lowland hardwood forest in the Bear Creek Corridor is generally much higher than other portions of the City. Along the Upper Reach of Bear Creek, groundwater seepage seems to be the primary source of water, not inundation from the nearby creek. Dominant tree species include green ash, eastern cottonwood, bur oak, American elm, silver maple and boxelder. Native shrubs such as American hazel, speckled alder and chokecherry were present in this lowland hardwood forest. Ground cover species were not surveyed.

Upland forest communities in the Upper Reach of the Bear Creek Corridor are generally mesic oak forest on north and east facing slopes and oak woodland - brushland on dry, well-drained areas adjacent to the creek floodplain. Within mesic oak forest natural communities, red oak, bur oak, basswood, black cherry and green ash are the common tree species. In oak woodland-brushland areas bur oak, pin oak, black oak, quaking/trembling aspen and black cherry are the dominant tree species. In general, the shrub layer is dominated by such species as buckthorn, prickly gooseberry, black current, prickly ash and raspberry. The overall forest quality as measured by species diversity and impacts from human disturbances (logging and grazing) is moderate to high in these upland forested natural communities.

Several significant wetlands occur in this reach. One of the better quality wetlands is bisected by County Road 11, just north of the creek. This wetland is a seepage meadow with old creek oxbows bisecting it in several places. Small areas of emergent marsh occur in these oxbows. The wet meadow seepage areas are dominated by sedges and wool grass; the emergent areas by river bullrush, cattail, wild mint and reed canary grass. Although exotic species such as reed canary grass are present, and grazing continues to occur in this wetland, the overall quality of this wetland is good. The species composition of this wetland is representative of other wetlands in the Upper Reach of the Bear Creek Corridor.

Wildlife

Due to the high quality and good diversity of natural communities and the connectivity of these natural communities to Bear Creek, wildlife habitat values in the Upper Reach are high.

Fisheries

The Upper Reach of Bear Creek is classified by the DNR as a rough fish-forage fishery. Some of the more common fishes include white sucker, creek chub, fathead minnow, black redhorse and golden redhorse. The DNR maintained a marginal fishery for brown, rainbow and brook trout through stocking up until 1975. Stocking was discontinued after it was determined that suitable habitat for trout in Bear Creek is very limited for two primary reasons: fine sand substrates and warm water temperatures. In some portions of Bear Creek where springs provide cold-water sources, the potential for future trout establishment exists. Reestablishment of trout in Bear Creek, however, does not appear to be a high priority of the DNR. The main fisheries in Bear Creek will likely be for suckers and chubs.

Rare/Endangered Plants Animals and Natural Communities

A number of rare and endangered animals are documented for the Upper Reach of Bear Creek. Two records of Blanding's turtle (threatened) and two records of blue racer snakes (special concern) are shown for this area. The black redhorse is a special concern fish species found only in a few drainage areas of southeast Minnesota. This species has been documented during fishery surveys of Bear Creek.

4.3.2. Badger Run

General Description

The upper portion of Badger Run, just downstream from County Road 11, flows through or adjacent to a series of wet meadow/sedge meadow wetlands. The wetlands and the slightly higher land adjacent to them are presently used for pasture. The lower portion of Badger Run flows through pastured areas of hobby farms and residential areas. Much of the riparian fringe in this reach of Badger Run is affected by debris and fill dumped into the floodplain. Runoff from residential septic systems (e.g., outlet pipes from drain fields) and livestock is evident in places along this reach. This section of the Bear Creek Corridor would have good potential as a high quality stream corridor if proper clean up efforts were undertaken.

Natural Communities

At the time of European settlement, the vegetation of Badger Run was dominated by oak savanna and oak woodland-brushland. Along the creek itself, wet prairie and wet meadow wetlands would have also been present.

The upper portion of Badger Run just below County Road 11 contains numerous wet meadow wetlands. Because of drainage and cattle grazing, most of these wetlands are degraded and are dominated by reed canary grass with scattered pockets of hummock sedge and blue vervain. The surrounding pastures are grazed heavily and generally contain a mixture of brome and blue grass. The lower portion of Badger Run (downstream from 30th Avenue SE) is characterized by a narrow riparian fringe of low-quality floodplain forest dominated by boxelder and eastern cottonwood or shrub swamp dominated by willow, dogwood and reed canary grass. Along Pinewood Road, several tracts of oak forest and oak woodland-brushland are present. The moister, mesic forested natural communities occur on north facing slopes and are dominated by bur oak, basswood, red oak, white oak and American elm.

Wildlife
Wildlife habitat quality is moderate within Badger Run. The quality of wildlife habitat is reduced due to the poor overall quality of natural communities in this corridor and the lack of a connection between Badger Run and upland wildlife habitat.

Fisheries
No fisheries surveys have been conducted in Badger Run. It is likely that many of the fish species present in the lower portions of Bear Creek are present in, or would migrate into, Badger Run. Beaver dams (which were present in several locations) and low water levels may act as a barrier to upstream fish migration during some years.

Rare/Endangered Plants Animals and Natural Communities
One record of a Blanding's turtle (threatened) is shown for the upper portion of this reach. The occurrence of Blanding's turtles is possible along much of Badger Run due to the number of wetlands along the creek. Within the lower portions of Badger Run, the occurrence of the black redhorse (a fish species of special concern) is likely due to the presence of this species within Bear Creek.

4.4 Stream Corridor Management

The stream corridor areas are very fragile and their future stability and biological diversity depend on appropriate future management. 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 be needed during future development to help maintain water quality, reserve necessary stream capacity, and protect native habitat. Special attention should be given to stabilizing and improving creeks that drain the uplands and that are already being affected by erosion.

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 Chapter 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 Chapter 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 Bear Creek study area is proposed to maximize the use of existing open channels. The study area contains an extensive system of well-defined channels that are considered an amenity to the area. These channels 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 location of open channels within the Study Area is shown on Map 2, located at the end of this Addendum.

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 BCA 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 capture the hydrologic factors of runoff coefficient (C), runoff curve number (CN) and time of concentration (T_c). Future development conditions for the BCA study area have not been specifically identified in Land Use Plan and Zoning Map amendments at the time of this Addendum. Storm water runoff for BCA study area was analyzed assuming a uniform curve number (CN) value of 68. This value represents the suburban land density typical in the area.

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 the proposed ponds, with their locations illustrated in Map 1.

All developable areas were modeled considering the expected land use density and the available conveyance capacities of the drainageways. The proposed storm water facilities were sized to control and treat flows resulting from new developments while maintaining existing conveyance capacities for the flows from existing developed areas. It was assumed that existing urban/suburban developments will not redevelop. If any redevelopment occurs in the future, appropriate storm water facilities will be needed to control and treat the additional runoff.

The Olmsted County Geologic Atlas (Surficial Geology Plate) shows broad regions of glacial terrace deposits in the BCA study area, chiefly sand and gravel, which offer little resistance to surface water infiltration. Additionally, upland areas are mapped in the Surficial Geology Plate as bedrock, generally within five feet of the surface. Two main types of bedrock are present at or near the surface, such as highly permeable limestone and impermeable shale. As a result, infiltration is variable across the study area. Therefore, the modeling of the proposed storm water system is conservative in that it does not include the suspected infiltration in the watershed area. Over time, the suspected high infiltration rates could be diminished due to the sedimentation of fine particles washed downstream during construction and from developed areas. Unless the pond and channel system is maintained as infiltration basins and infiltration swales, the system will eventually lose the existing infiltration capacity. Thus, the proposed system was designed to account for the total anticipated volume of runoff, neglecting the likely infiltration within the pond and channel system.

The modeling of the proposed storm water system also does not account for the potential effect of groundwater exfiltration. As stated in Section 3.2.1, the soils and subsurface geologic conditions that are present in the BCA study area can allow for the discharge of subsurface water to the ground surface. At the time an area affected by groundwater flows is considering development, a site-specific hydrologic investigation is warranted.

5.4. Storm Water Conveyance Requirements

The 1999 Rochester SWMP outlines storm water conveyance requirements, which are 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 BCA 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. Steeper slopes may be appropriate in natural channels based on stability criteria. 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 generalized for planning purposes only. The final location and size of the pipes and channels will be determined at the time these areas develop.

Although several man-made channel types may be used for storm water conveyance, the design conveyance capacities needed indicate that only one type of channel is appropriate for planning purposes for the BCA study area. A typical cross-section for these channels is shown in Figures 5-1 and 5-2. The channel includes a 20-foot maintenance buffer adjacent to each bank. The City of Rochester's Tall Grass and Weed Regulation, especially section 48.04 (b), should be consulted for proper maintenance of buffer vegetation. All channels include a one-foot freeboard above the 100-year average flow depth. The required freeboard was derived by estimating the flow depth of a discharge that is 25% greater than the maximum level of the design capacity.

For planning purposes the BCA contains only Type BC-I channels, where the typical slope is representative of lower channel reaches. However, as development occurs site, specific channel design will need to consider local channel slopes, ultimate runoff flows, and other characteristics including stream stability criteria. Table 5-1 illustrates the classification and criteria for the channel types.

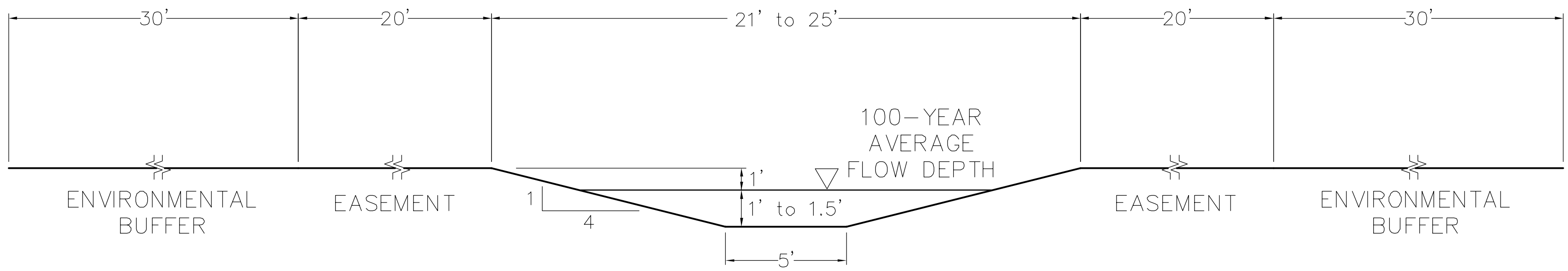
Table 5-1 Channel Classification

Channel Classification	Typical Slope	100-yr Design Conveyance Capacity[1]	Maximum Design Conveyance Capacity[1,2]
Type BC-I	1.5%	0-150 cfs	188 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.

TYPE BC-I



NOTE: SEE FIGURE 5-2 FOR TYPICAL CROSS SECTIONS

MINIMUM CHANNEL WIDTH & BUFFER REQUIREMENTS

ROCHESTER, MINNESOTA

FIGURE 5-1

ROCHESTER STORM WATER MANAGEMENT PLAN – BEAR CREEK ADDENDUM

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Associates
Engineers & Architects

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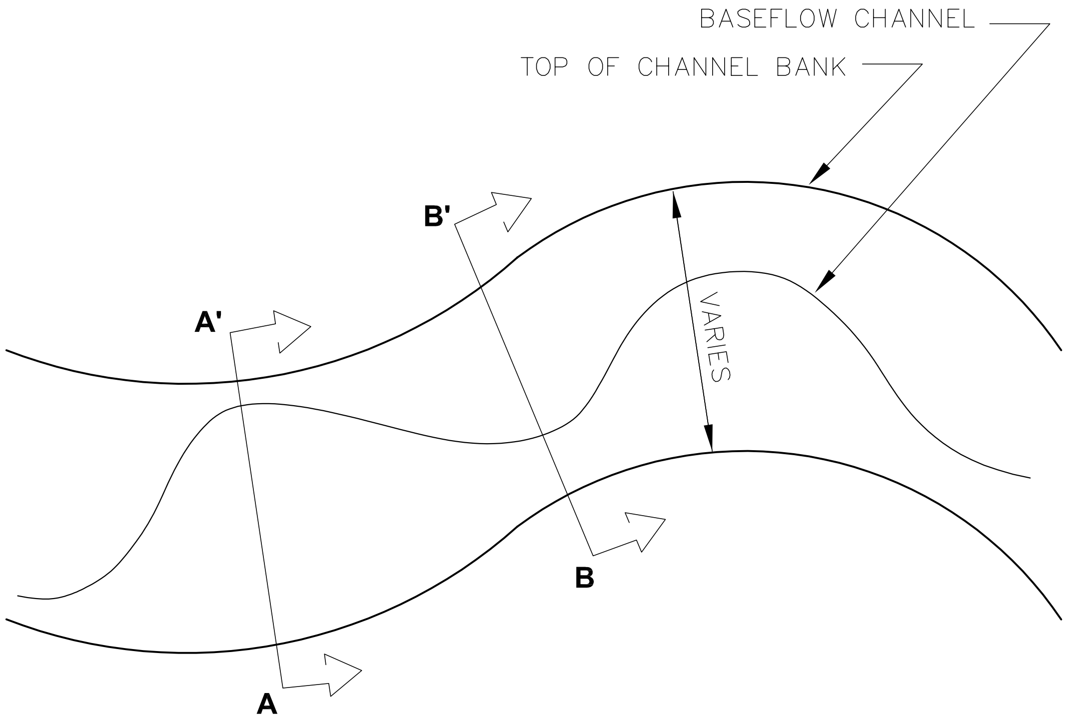
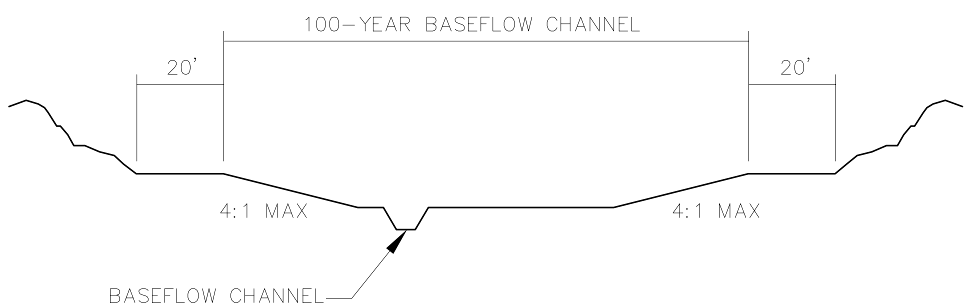
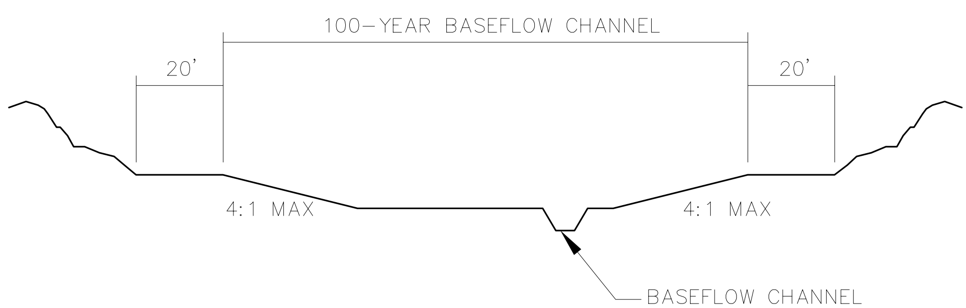


PLAN VIEW



SECTION A-A'



SECTION B-B'

TYPICAL CHANNEL CROSS SECTIONS

CITY OF ROCHESTER FIGURE 5-2

ROCHESTER SWMP – BEAR CREEK ADDENDUM

TYP_CHAN_XSEC.DWG March 2004 COMM. 363-01-130

Bonestroo Rosene Anderlik & Associates

Proposed capital improvement investments to channels 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 BCA 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. Other site specific erosion/stabilization issues may also need to be addressed during these phases to implement appropriate stream stabilization measures. (Map 2 shows a schematic layout of the conveyance system and potential channel classifications.)

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

  For planning and cost estimation purposes, stream improvements are included in this BCA 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 about every 300 feet for Type BC-I channels, as well as activities noted in stream stabilization, to improve the stability and capacity of the stream. The design criteria of each specific reach should be defined during the design and implementation phases of the storm water system. (Map 2 shows a schematic layout of the conveyance system and potential channel classifications.)

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

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

- Grade/slope – In reaches where sufficient conveyance capacities exist, longitudinal slopes up to 2% should not require improvement measures. Reaches with longitudinal slopes from 2-4% will likely require step weirs and selective placement of rip-rap, or other appropriate measures. Reaches with slopes greater than 4% are typically highly unstable and should be designed considering measures such as channel-lining and pipes.

- 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, selective placement of rip-rap, and other appropriate measures should be considered.

5.5. Storm Water Detention Basin Requirements

Incorporating ponding areas as recommended in this BCA 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 insure 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 20cubic feet per second (cfs) will have a two-stage outlet while any discharge above 20 cfs will have a three-stage outlet.

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

6. Storm Water Quality

6.1. Background

The main purpose of the storm water quality portion of the 1999 SWMP is to provide guidelines for protecting and improving the water quality of Rochester's lakes, streams, wetlands and ground water. This Chapter of the BCA discusses the recommended practices for implementing construction and post-construction best management practices (BMPs) in the Bear Creek area as required by the NPDES Phase II rules to meet the intent of the 1999 plan. 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 (2000) is one resource that provides information on many best management practices that are available.

Table 6-1 Construction Best Management Practices (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 gravel should be placed in the driveway location to provide a stable access to the site.

It is important that an inspection program and enforcement procedures be developed for erosion control on construction sites. The Minnesota Pollution Control Agency reviews and enforces erosion control for construction sites disturbing one or more acres through the NPDES program. However, a limited number of MPCA staff 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 BCA uses a regional storm water pond approach by locating storm water facilities to serve approximately 3- to 160-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, land acquisition, and construction expenditures. However, additional ponds are required in some of the uplands before runoff is discharged into existing streams or creeks, to reduce erosion and promote their stability.

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. They will need to be evaluated in detail once development characteristics are known.

6.2. Storm Water Management Basin Types

This BCA incorporates medium-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 BCA serve the combined functions of rate control, sediment removal and nutrient removal. Section 6.2 and Figure 6-1 of the 1999 SWMP provide more detail about the types of storm water management basins, their characteristics, and their respective benefits.

6.3. Design Criteria for Water Quality

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

The design criteria for wet detention basins outlined in Section 6.3 of the 1999 SWMP are to be used for the design of ponds proposed within the BCA study area. The area and depth of ponds proposed in future developments may differ from the values presented here, but the minimum wet volumes recommended in this BCA 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 and P8) and approach was utilized for the BCA. Section 6.4 of the 1999 SWMP provides an overview of the water quality modeling process. Appendix C lists the results of the water quality modeling process.

7. Wetlands

7.1. Background

7.1.1. Wetland Inventory and Assessment Method

The wetland inventory was organized within the context of the 1999 SWMP and this Bear Creek Addendum (BCA). Wetland identification numbers used in this Addendum are based on the Minor Drainage District ID 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 Maps 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
- Obtain permission from property owners to access wetland(s)
- 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

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 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.

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

Thirty-one of the 39 mapped wetlands within the Bear Creek Drainage area were visited by trained personnel and assessed for Floral Diversity/Integrity and Wildlife Habitat wetland functions. All property owners that had wetlands within their property were contacted for access. There were 8 wetlands that access was not granted or access from the property owner was not confirmed during the inventory effort. Each wetland was assessed and assigned a rank that reflected the value of the functions it provides. Wetlands were ranked as Exceptional, High, Medium/High, Medium, Medium/Low, Low or Not Applicable for each function assessed. Summaries of the wetland functions assigned to each wetland assessed, infrared review and field visits completed are presented in Appendix E.

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

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

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

7.2. Wetland Management and Protection

7.2.1. Wetland Management Classification Methodology

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

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

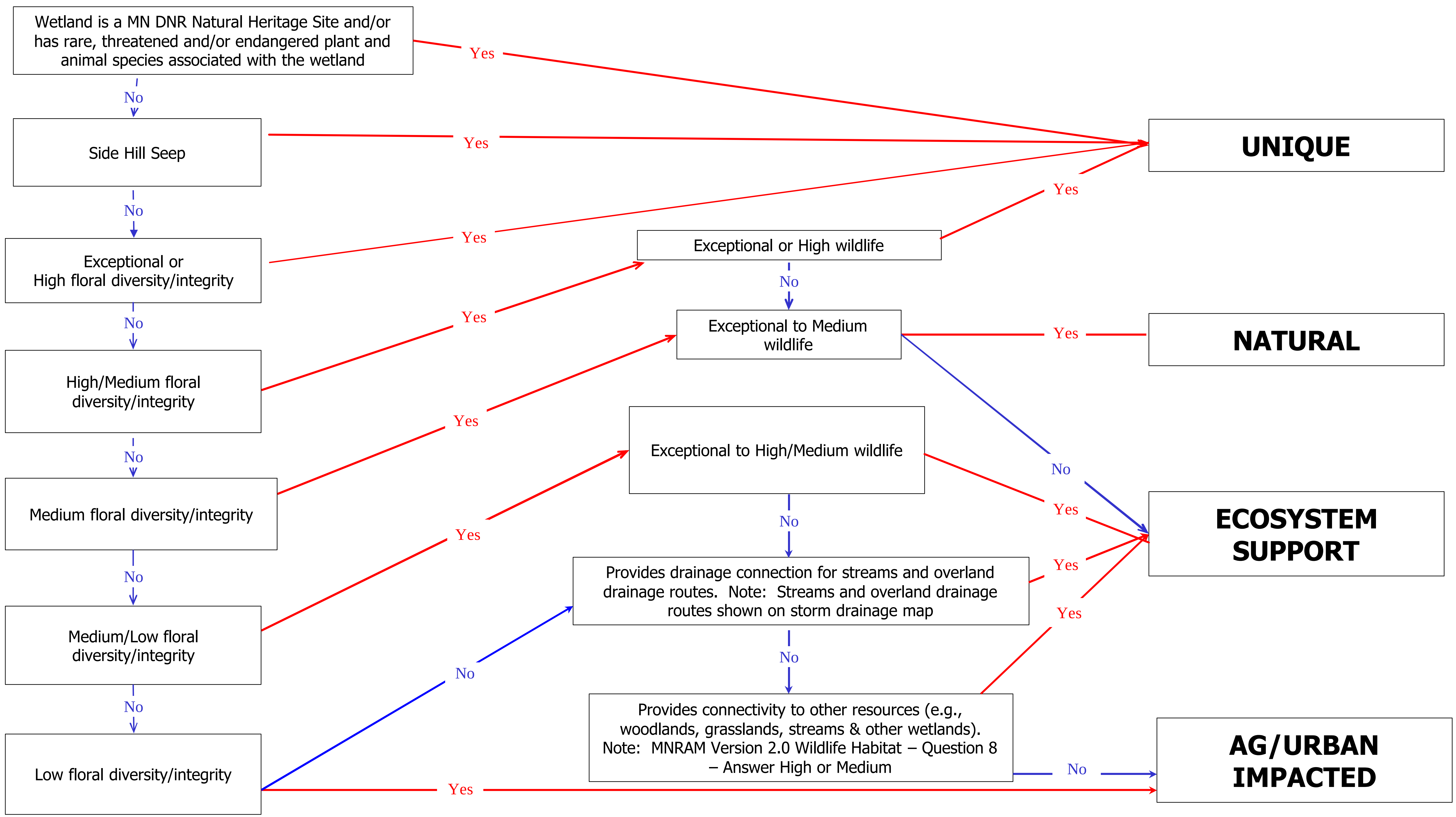
Other criteria were also considered in refining the management classifications and goals. For example, wetlands may be classified as *"Ecosystem Support"* based on the value of the upland ecosystems that surround them or their physical connection and/or drainage to other systems, though they may have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

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

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

7.2.2. Wetland Classification Summary

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



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

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

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

Ag/Urban Impacted Wetland: This classification is for wetlands in urban or agricultural areas that are significantly altered or highly degraded from past land use practices. It does not infer that all wetlands located in agricultural or urban land use areas are highly degraded. On the contrary, as can be seen on Map 3, several high quality Unique and Natural wetlands are present in the agricultural areas of the Bear Creek 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 hydrologic regime and vegetative composition. The wetland's sensitivity to storm water input is dependent on the wetland community type and the quality of its plant community. Some wetlands (e.g., sedge meadows with *Carex* species) are sensitive to disturbance and will show signs of degradation unless water quality, water level fluctuation (i.e., "bounce"), and the inundation period of water are maintained to pre-development conditions. On the other hand, there are other wetlands (e.g., floodplain forests) which are better adapted to handle the fluctuating water levels and influx of sediment often associated with storm water.

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

Highly Susceptible: A wetland is considered highly susceptible if:

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

Moderate Susceptible: A wetland is considered moderately susceptible if:

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

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

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

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

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

Water Quality

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

Table 7-2 Phosphorus Limitations into Wetlands

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

[1] ppb = parts per billion
[2] CY = cubic yards
[3] A multi-cell pond configuration with the lower cell as a constructed wetland or infiltration basin is recommended to achieve these levels of phosphorous removal.
[4] See Figure 6.1 of 1999 SWMP for design requirements. Dead sediment storage is the permanent pond volume below the outlet invert elevation.

Water Quantity

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

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

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

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

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

^Source: MPCA 1997

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

7.2.4. Wetland Buffer Strip and Setback Protection

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

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

Buffer Width Effectiveness for Wetland Protection

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

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

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

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

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

Setbacks of 10 feet between structures and the edge of the buffer are recommended by the Minnesota Pollution Control Agency (MPCA, 1997) and have been incorporated as part of this Addendum to insure there is usable space between structures and buffers and to prevent encroachment of lawns into buffer areas. For purposes of this Addendum 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 Addendum, 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:

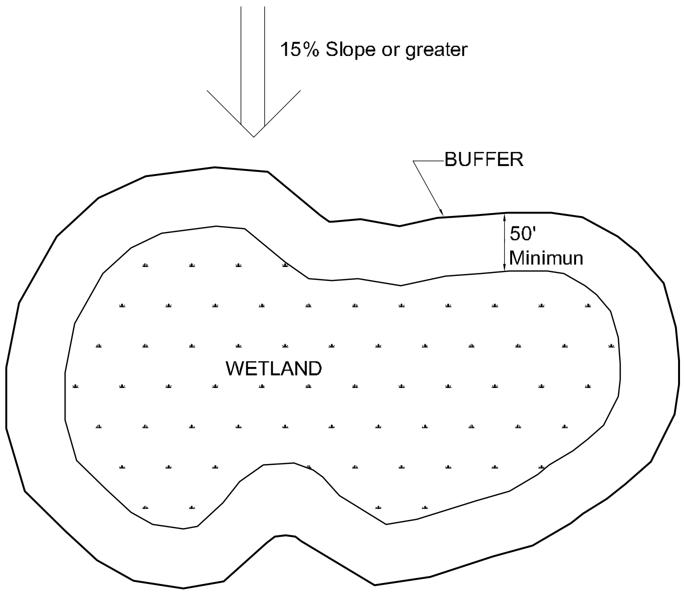
- Slopes greater than 15% will require the 50-foot average width around the entire wetland to get adequate treatment. No deviation to the minimum width will be allowed.
- Due to the importance of the recharge areas to side hill seep wetlands, buffers widths may be minimized down-gradient of the actual 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

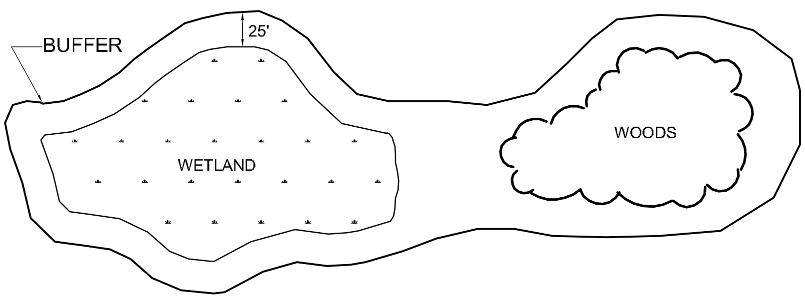
The Bear Creek study area is roughly bounded on the south by the intersection of Highway 52 and Interstate 90, College View Road on the north, Chester Road SE on the east side, and County Road 11 on the west. The study area lies within the Rochester Plateau landscape Subsection of the MN DNR Ecological Classification System.

Land use in the Bear Creek area is a mix of rural residential and commercial properties, forested areas, pastures, and rowcrop fields. The topography is mostly moderately rolling, with the least relief being associated with the Bear Creek and Badger Run floodplains. In addition, there are areas of steeper slopes in the north and central portions of the study area. With the exception of steeper slopes and forested parcels, most arable land is currently farmed, or has been at some point in the past. Wetlands in the Bear Creek study area are generally associated with hillside seep areas, floodplain, drainage swales, and to a lesser degree ponds that have already been



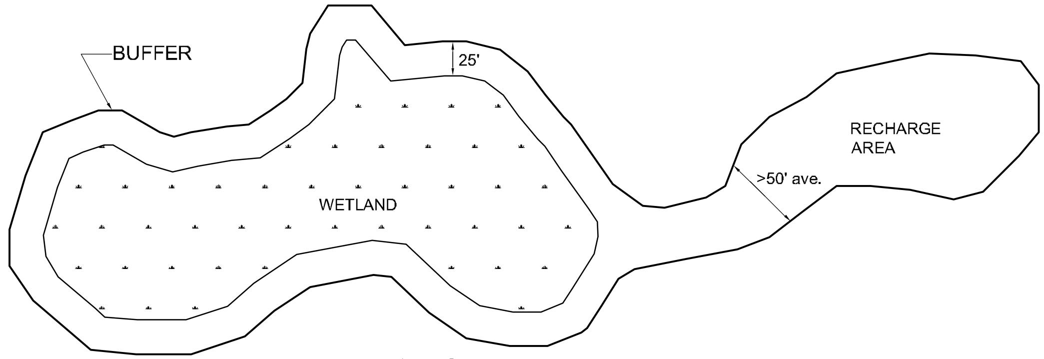
DETAIL 1

SLOPES



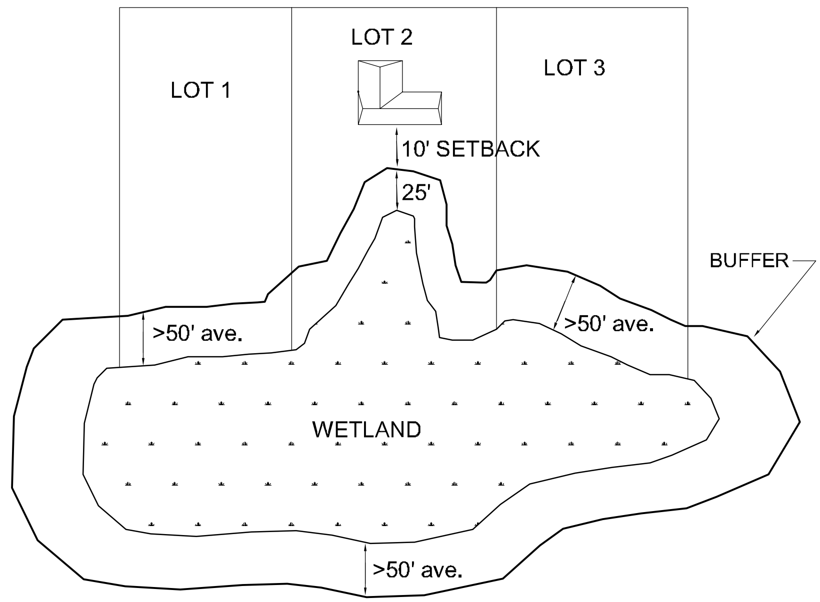
DETAIL 2

UPLAND HABITAT PROTECTION



DETAIL 3

SIDE HILL SEEPS with Recharge Area Protection



DETAIL 4

IRREGULAR WETLAND SHAPE

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

GUIDANCE FOR BUFFER STRIP WIDTHS

CITY OF ROCHESTER

STORM WATER MANAGEMENT PLAN – BEAR CREEK ADDENDUM

FIGURE 7–2

NO SCALE

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created to minimize erosion and excessive offsite sediment transport.

At the time of Euro-American settlement, the Bear Creek study area hosted a mix of oak openings and barrens, brush prairie, and tallgrass prairie. Oak openings and barrens are thought to be savanna-like settings with a mix of trees and prairie with some shade tolerant grasses and flowers under trees. Brush prairie, as recorded by land surveyors of the Government Land Office in the mid-1800s, is thought to be transitional between the treeless tallgrass prairie and savannas (which typically have full-grown trees). Since settlement, most of the prairie has been plowed. Savannas and brush prairie was typically converted to pastures. Most of the remaining examples of savanna-like settings are current or former pastures that are now dominated by nonnative grasses.

Many of the sidehill seep wetlands still retain their hydrology, although the vegetation and soils of most seep areas have been impacted by inappropriate levels of grazing or attempts at active drainage. Similarly, the most depressional wetlands that would have historically occurred in the study area have been drained. This drainage effort has led to the development of channels, increased runoff, and degradation of natural community composition, structure, and function. Since many of these altered areas still have the ability to recover, this section of the Addendum focuses on vegetation and hydrologic restoration opportunities within the Bear Creek study area. Access to a small number of wetlands was not possible during this study. These wetlands should be considered for field review on an as-needed basis in the future to determine their quality and restoration potential.

Potential Wetland Mitigation/Banking Sites

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

Most of the sites with hydrologic restoration potential are existing wetlands that can be expanded by restoration and thus provide new wetland credit within the expanded wetland area. If the wetlands are restored to the previous (prior to alteration) hydrologic regime they will also 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 below in Table 7-5.

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 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; eg. 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 effort 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. This category 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 instances within a wetlands watershed where substantial efforts are required to restore historic quantity/quality of waters reaching wetland. These wetlands may have had significant enough alteration to the hydrology and the hydraulics 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 Bear Creek 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 Bear Creek 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: bc-w1.5.3
Hydrologic Restoration Potential: High
Vegetation Restoration Potential: Medium
Comments: Small seep basin surrounded by old field and many other seep areas. Partial restoration has already taken place by the elimination of cultivation for crops. Although reed canary grass comprises the majority of the basins' vegetation, native wet meadow species have readily established. Placing a berm on the down slope side may provide for more water retention and prevent soil erosion from high flows events.

Wetland: bc-w1.5.6
Hydrologic Restoration Potential: High
Vegetation Restoration Potential: High
Comments: The original hydrology and vegetation of this pastured wetland would be relatively easy to restore by filling in the small ditch that was created on the slope, perhaps over 50 years ago. Also, reducing grazing pressure and managing with fire (and other tools) would aid in restoration of this wetland. Hydrologic restoration of this basin would be relatively easy. However, it would not provide a substantial increase in wetland area.

Wetland: bc-w1.5a
Hydrologic Restoration Potential: High
Vegetation Restoration Potential: High
Comments: Wet meadow in an abandoned cornfield in location of Haverhill Soils. Partial restoration has taken place by eliminating cultivation. Reed canary and rice cut grass dominate the vegetation, but a good diversity of natives has also become established. Erosion is noticeable on the down slope side and could be controlled with a berm.

Wetland: bc-w2.4.1
Hydrologic Restoration Potential: NA
Vegetation Restoration Potential: High
Comments: Floodplain community adjacent to stream. Vegetation community is in good to very good condition. Several wetlands distributed along length of stream corridor/floodplain bordered

on west by County Road 11, which may hinder hydrologic connection to bc2.9.1

Wetland: bc-w2.4.18
Hydrologic Restoration Potential: High
Vegetation Restoration Potential: Medium
Comments: Base of hill wetland with northern portion reed canary grass, southern open water/mud flat. Overflows to northwest and forms a floodplain forest environment. This wetland contains little to no ground or shrub layer and would benefit by selective thinning of trees. Blocking or raising the outlet to the north near the road could restore hydrology.

Wetland: bc-w2.5.9
Vegetation Restoration Potential: High
Hydrologic Restoration Potential: High
Comments: The landowner has tiled this wetland, apparently in the last year or two. This wetland is a good quality, small wet meadow but will probably decline quickly in quality if the hydrology is not restored. Also, mowing on west side of the wetland during dry periods should be ceased or at least reduced in frequency to prevent additional damage to native species composition.

Wetland: bc-w2.5.2
Vegetation Restoration Potential: High
Hydrologic Restoration Potential: Medium
Comments: Vegetation condition in this series of interconnected seep-driven wet meadows is good to excellent. The wetland would benefit from planting adjacent upland areas to prairie vegetation. Hydrology appears to be nearly intact, although there may be some drainage to the east along private lane ditch. Merits further investigation. West side of this wetland has dugout pond, presumably for cattle watering that would benefit from reshaping to original contours.

Wetland: bc-w2.5.8
Vegetation Restoration Potential: High
Hydrologic Restoration Potential: **NA**
Comments: Despite occurring in a development, this wetland provides a good opportunity for native vegetation restoration. The wetland occurs in the floodplain of a nearby stream and is surrounded by lawn. The wetland would benefit by not having the edges mowed so frequently, as well as periodic burning during fall or spring.

Wetland: bc-w2.9.1

Vegetation Restoration Potential: High

Hydrologic Restoration Potential: **NA**

Comments: Riparian wetland, vegetation in very good condition, but would benefit from grazing used with other management techniques

Wetlands with Medium Hydrologic and/or Medium Vegetation Restoration Potential

Wetlands that have a medium rank for hydrologic and/or vegetative restoration are listed in Table 7-6 in watershed identification order. These medium potential wetlands will also likely provide mitigation/banking credit; however they would typically cost more to restore than the wetlands with a high Hydrologic Restoration Potential. While these wetlands did not receive a high ranking for hydrologic or vegetation restoration potential, they still offer valuable opportunities for potential wetland restoration.

Table 7-6 Wetlands with Medium Restoration Potential

Wetland	Vegetation Restoration Potential	Hydrologic Restoration Potential	Comments
bc-w1.5.2	Medium	Medium	Very large complex of sloping seep areas and wet meadow in abandoned field. Basin starts at top of hill in forested area at edge of pasture to the north. High diversity of species has already established. Basin outlets at roadside ditch at base of hill. Groundwater hydrology source should be protected for entire basin. Ditch seems to have little influence on draining basin.
bc-w1.5.4	Low	Medium	Reed canary grass, box elder, and sand bar willow are dominant in this wetland basin. Old field to east and west. Hydrology restoration by blocking ditch outlet to culvert under road on south end.
bc-w1.5.5	Medium	Medium	Sloping drainageway, flows from wood, through pasture, and into old cultivated field. Outlet is a ditch under road to south. Grazing has effected vegetation in upper portion. Native vegetation has re-established since cultivation has stopped.
bc-w1.5b	Low	Medium	High source of weed seeds due to being in the center of a soybean field. The wetland is a

Wetland	Vegetation Restoration Potential	Hydrologic Restoration Potential	Comments
			sloping drainageway. Blocking ditched outlet located at ravine to the west could restore hydrology.
bc-w2.4.20	Medium	Medium	Blocked portion of ravine controlled by pipe above normal water level. Upland has good woods and old field components. Ravine usually probably only receives water from runoff during storms and spring melt. Mostly mudflat could benefit from seeding or planting marsh and meadow species. Hydrology fluctuates greatly due to raised outlet.
bc-w2.5.4	Low	Medium	Currently, this wetland does not hold water throughout the growing season in most years. It may represent a good banking opportunity, particularly if it is determined there is a tile line running through the wetland. Additionally, there is a quality prairie remnant immediately to the west that should be considered for protection and restoration. Restoring the vegetation of the wetland itself would be difficult without controlling the reed canary grass through inundation, spraying, and/or removing soil.
bc-w2.5.7	Medium	Low	Wetland has been partially filled to build a structure for a storage business. The majority of the wetland appears to have perhaps been formerly grazed, if not plowed. Since being retired from agriculture, the vegetation is recovering nicely and would benefit from some management. Potential management activities could include mowing of weeds and planting of non-wetland areas with native prairie grasses and forb species to enhance buffering ability for creek and to increase wildlife habitat value. The northwest corner of this wetland that is managed differently than the old field is very heavily impacted by grazing, which had caused near total loss of vegetation in 2001.

Wetlands with Low Restoration Potential

Fifteen of the 39 wetlands in the Bear Creek Drainage area are not good candidates for restoration; see Table 7-7.

Table 7-7 Wetlands with Low Restoration Potential

BC-1.5	**BC-2.4**	**BC-2.5**
bc-w1.5.1	bc-w2.4.2	bc-2.5.1
bc-w1.5.7	bc-w2.4.3	bc-2.5.6
	bc-w2.4.4	bc-w2.5.3
	bc-w2.4.13	bc-w2.5a
	bc-w2.4.14	
	bc-w2.4.15	
	bc-w2.4.16	
	bc-w2.4.17	
	bc-w2.4.19	

Potential Partners for Wetland Restoration Projects

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

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

8. Storm Water Management Financing

8.1. Background

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

The 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 this BCA is to develop an area charge for financing the total cost of the trunk storm water drainage system for the Bear Creek area. This Chapter also discusses and provides estimations of likely costs for future infrastructure components.

In the BCA study area, only a portion is likely to be available for development under the jurisdiction of the City of Rochester. In addition to the area charge for all the facilities within the whole BCA study area, an area charge was estimated for the facilities proposed within the AUAR portion of the BCA study area (see Section 8.5.). A portion of this BCA study area was previously included in an Alternative Urban Area Review (AUAR) study (Earth Tech, May 2002).

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 this study area. These infrastructure improvements include the proposed open channel drainage network, detention facilities (either water quality or water quantity ponds), and proposed outlets or improvements to existing culverts that are planned to serve as control structures.

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

Consistent with the 1999 Rochester SWMP, a storm water area charge based on the area-wide cost of total improvements is utilized as the method 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 Drainage District and Design Item in Appendix H.

Table 8-1 Drainage System Costs

		Subtotal Cost	Additional Cost[1]	Total Cost
Ponds:				
Water Quality				
Land acquisition	(3.2%)	$118,575	$41,501	$160,076
Excavation	(5.6%)	$204,054	$71,419	$275,473
	(8.8%)		Water Quality Subtotal -	$435,550
Water Quantity				
Land acquisition	(23.3%)	$856,193	$299,668	$1,155,861
Excavation	(6.4%)	$236,387	$82,736	$319,123
Outlet cost	(7.0%)	$256,500	$89,775	$346,275
	(36.7%)		Water Quantity Subtotal -	$1,821,259
Pond Total	(45.5%)	$1,671,710	$585,098	$2,256,808
Trunk Channels:				
Trunk Channel Total	(54.5%)	$2,004,423	$701,548	$2,705,971
Grand Total:	**(100.0%)**	**$3,676,133**	**$1,286,647**	**$4,962,779**

[1] Additional Cost estimates a 35% of subtotal cost for engineering, administration, interest and contingency.

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 dissipators 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 Addendum. Any expansion and improvements to the City's future drainage system are generally financed through a storm sewer area charge (SSAC). The area charge contribution will help the design and construction of trunk storm sewers and storm water ponds recommended in this Addendum. In this regard, the City carries the financial responsibility of implementing the storm drainage system infrastructure elements that are shown on Map 2, while developers are responsible for all other elements.

For the BCA study area, the storm water conveyance system utilizes a trunk storm channel network, rather than trunk storm sewer pipes. Regional pond facilities are constructed under the City's direction to serve drainage areas of approximately 3 to 160 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 the watershed under fully developed conditions. Dvelopers 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 Appendix B, while maintaining the functional integrity of the stream corridor for the 100-year storm.

A major portion of the effort in developing the BCA 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. However, this study does not consider additional storm water system capacities or costs that would be required if redevelopment of existing developed land occurs in the future.

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 are conveying 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 factors 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 BCA study area are still in the planning process. Therefore the land use factors that were developed for the 1999 SWMP are utilized for this BCA. This was done based on the assumption that future development will resemble similar impervious characteristics as existing development in Rochester. As described in Section 5.2.2, a uniform curve number value of 68 was applied for the entire BCA study area, representing suburban development.

Appendix F tabulates the total estimated trunk storm channel system cost for the development of the drainage system as shown on Map 2. Appendix G 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 (from Table 8-1).

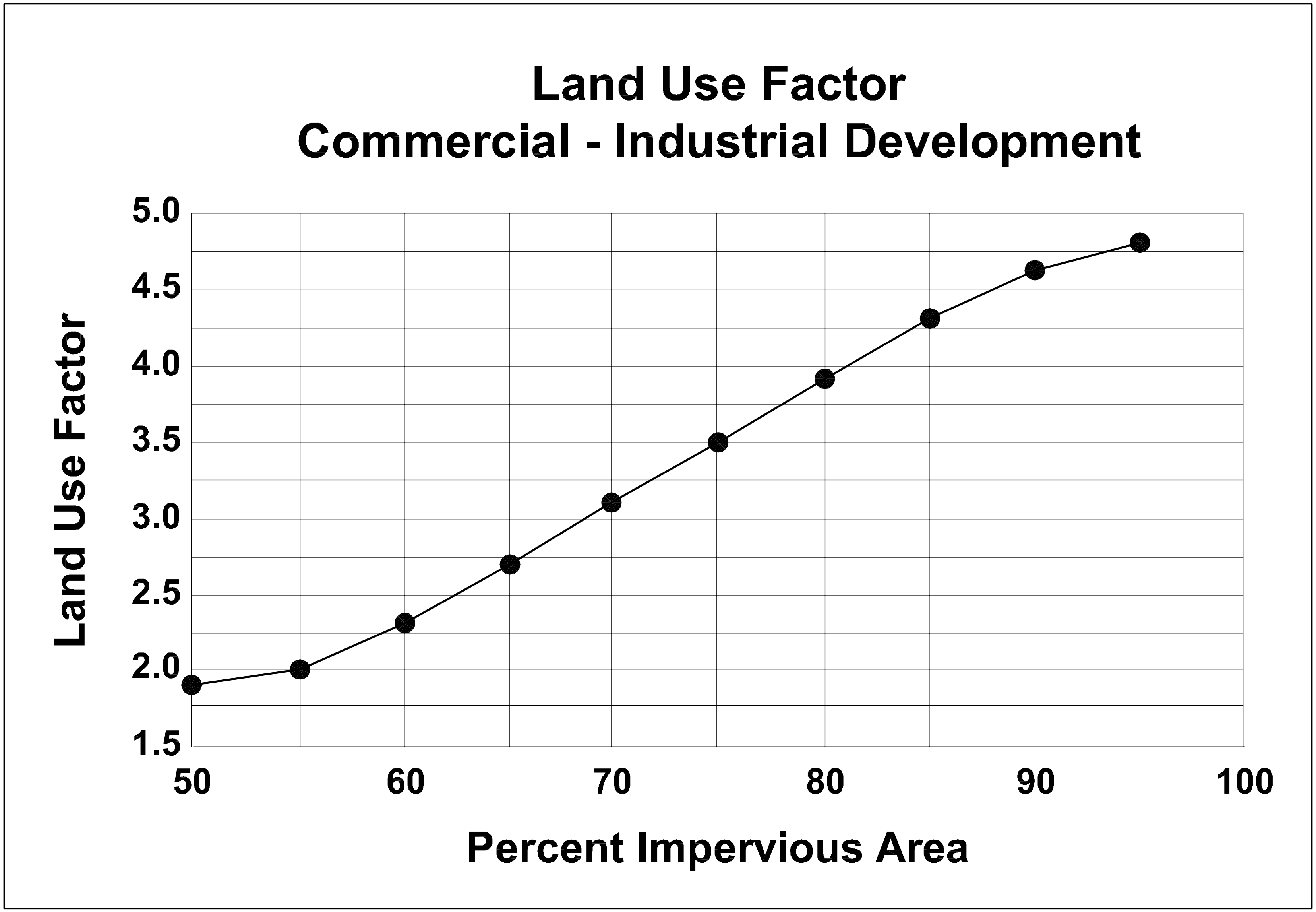
- Trunk Storm Channel 55 percent
- Water Quantity and Quality 45 percent

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 charge rate 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 (i) the total developable land within the BCA study area; and (ii) the developable land within the AUAR portion of the BCA 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 – BEAR CREEK ADDENDUM

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Bonestroo Rosene Anderlik & Associates

Table 8-2 Area Charge Rates for Future Drainage System – Bear Creek Addendum

	Subtotal cost	Additional Cost	Total Cost
Pond			
Land acquisition	$974,768	$341,169	$1,315,937
Excavation	$440,442	$154,155	$594,596
Outlet cost	$256,500	$89,775	$346,275
	$1,671,710	$585,098	$2,256,808
Trunk cost	$2,004,423	$701,548	$2,705,971
Total	$3,676,133	$1,286,647	$4,962,779

Land Use	Land Use Factor	Area Charge
Low Density Residential	1.0	$3,173
Medium Density Residential	1.4	$4,442
High Density Residential	1.9	$6,029
Commercial*	3.4	$10,789
Industrial*	2.3	$7,298

*Land Use Factor shown represents average value. Specific Land

Use Factor should be calculated using Figure 8-1.

Estimated Developable Area (acres)	1,564
Area Charge for BCA study area ($/developable acre)	**$3,173**
Within AUAR portion of BCA study area:	
Estimated total cost ($)	$936,364
Estimated Developable Area (acres)	277
Area Charge ($/developable acre)	**$3,380**

Based on land use = Suburban 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
- Roads (150 feet from centerline for Highway 52)
- 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 sum of all cost estimates plus a contingency factor of 35% was divided by the amount of land available for development within the BCA study area. This generated an area charge rate for suburban density residential development, which can be considered similar to the low density residential rate. As shown in Table 8-2, this area charge is estimated at $3,173 per developable acre for the entire BCA study area. The rate for the AUAR portion of the study area is $3,380 per developable acre. Once the low density residential rate has been established, other land use rates are the product of the low density residential rate and the corresponding land use factor.

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

8.6. Funding for Operation and Maintenance and Infrastructure Replacement

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

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

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

9. Erosion Control

As a result of a combination of soil conditions, slopes and land use practices, the Bear Creek watershed has a high erosion potential when the soil cover is disturbed. Some farming Best Management Practices were observed such as contour planting and reduced-tillage 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 BMPs.

10. Groundwater

Groundwater resources occur on a regional scale. Because the BCA 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.

The BCA study area has soil and geologic conditions that result in a moderate to very high sensitivity to groundwater contamination (illustrated in the Olmsted County Geologic Atlas). Shallow bedrock, fractured limestone, glacial till, the Decorah Shale, and highly permeable soils (such as terrace deposits) are features that affect water infiltration and groundwater flow dynamics. Sink holes were observed in the BCA study area, which also increase the potential for groundwater contamination. Hence, these areas are very sensitive to pollution, which could contaminate groundwater aquifers used for domestic water supply.

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 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. Inspection and cleaning, if needed, of channel crossings are 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

The BCA study area consists of four *Minor Drainage Districts* covering 3,739 acres as shown in Table 12-1.

Table 12-1 Bear Creek Addendum Minor Drainage Districts

Minor Drainage District	Abbreviation	Area (Acres)
Bear Creek North	BC-a2.5	1,354
Bear Creek Center	BC-a2.4	1,569
Badger Run	BC-a1.5	611
Bear Creek West	BC-a2.9	205
Total		3,739

Note: These Minor Drainage Districts had been referred to as *Subdistricts* in the 1999 SWMP. In the BCA, *Subdistricts* are smaller divisions of the *Minor Drainage Districts*.

The area of Minor Drainage District BC-a2.5 analyzed in this Addendum covers about 38% of its total area as identified in the 1999 SWMP. The other three Minor Drainage Districts are analyzed in their entirety in this BCA.

The Minor Drainage Districts of this BCA used the same numbering system used in the 1999 SWMP. Each Minor Drainage District was subdivided in the BCA into *subdistricts* by adding another number (e.g., BC-a2.5.2); a zero was generally used for areas already developed (e.g., BC-a2.5.0). Areas that required further subdivision were distinguished by letters; for example, BC-a2.5.1a and BC-a2.5.1b drain to the same watercourse. The acreages of each *Subdistrict* are presented in Appendix A and their boundaries are shown on Maps 1, 2 and 3.

The proposed storm water facilities are aimed at maximizing treatment of direct runoff from areas to be developed in the future within the study area. As a result, facilities were not considered for the lands already developed, which will need to be done if these lots subdivide as part of re-development. Hence, runoff from developed areas or areas upstream of the expansion study are not being treated by facilities considered in this document.

Storm water facilities located in the upper reaches (or hilltop areas) are designed to maintain/improve the natural stream stability by capturing the maximum runoff to reduce the "flashy," short-duration, high-flow runoff peaks. As these areas develop, the number and characteristics of the facilities could be modified during the design stage (considering grading and development layout, internal roads, geology, ponding feasibility and dam criteria of the Minnesota Department of Natural Resources, and other factors) to effectively achieve the stream stability and water quality goals. Additional facilities will also be required for areas that re-develop, since facilities are not proposed in this Addendum for existing development.

For reference, the Bear Creek Major Drainage District documentation from the 1999 SWMP is presented in this Addendum as Section 12.0. The four Minor Drainage Districts of this BCA are covered in detail in Sections 12.1 to 12.4.

12.0 Bear Creek Major Drainage District

Drainage Area: 30,473 acres
Number of Storm Water Facilities: 24
Major Reservoirs: BR-1 (118.4 acres)
Major Streams: Bear Creek, Badger Run

The Bear Creek Major Drainage District includes the drainage area located southeast of Rochester and extends northwesterly to the confluence with the South Fork Zumbro River. Flood control reservoir BR-1 was constructed approximately three miles west of Eyota (in Chester Woods County Park) to control stream flows in Bear Creek from the 8,280 acres of upstream drainage. Bear Creek continues west from this reservoir to the confluence with Badger Run at Bear Creek Park. Badger Run begins east of the Town of Marion and flows parallel to Highway 52 to Bear Creek. Suburban development has occurred along both Bear Creek and Badger Run. Storm water facilities were designed to control runoff rates and treat storm water in locations along both streams where development has not yet occurred.

Bear Creek and Badger Run have similar characteristics within the Urban Service and Urban Reserve Areas, in that they are both low gradient streams with wide, flat floodplains in most areas.

Protecting the floodplain areas of both streams is essential to maintain conveyance capacity and flood storage volumes.

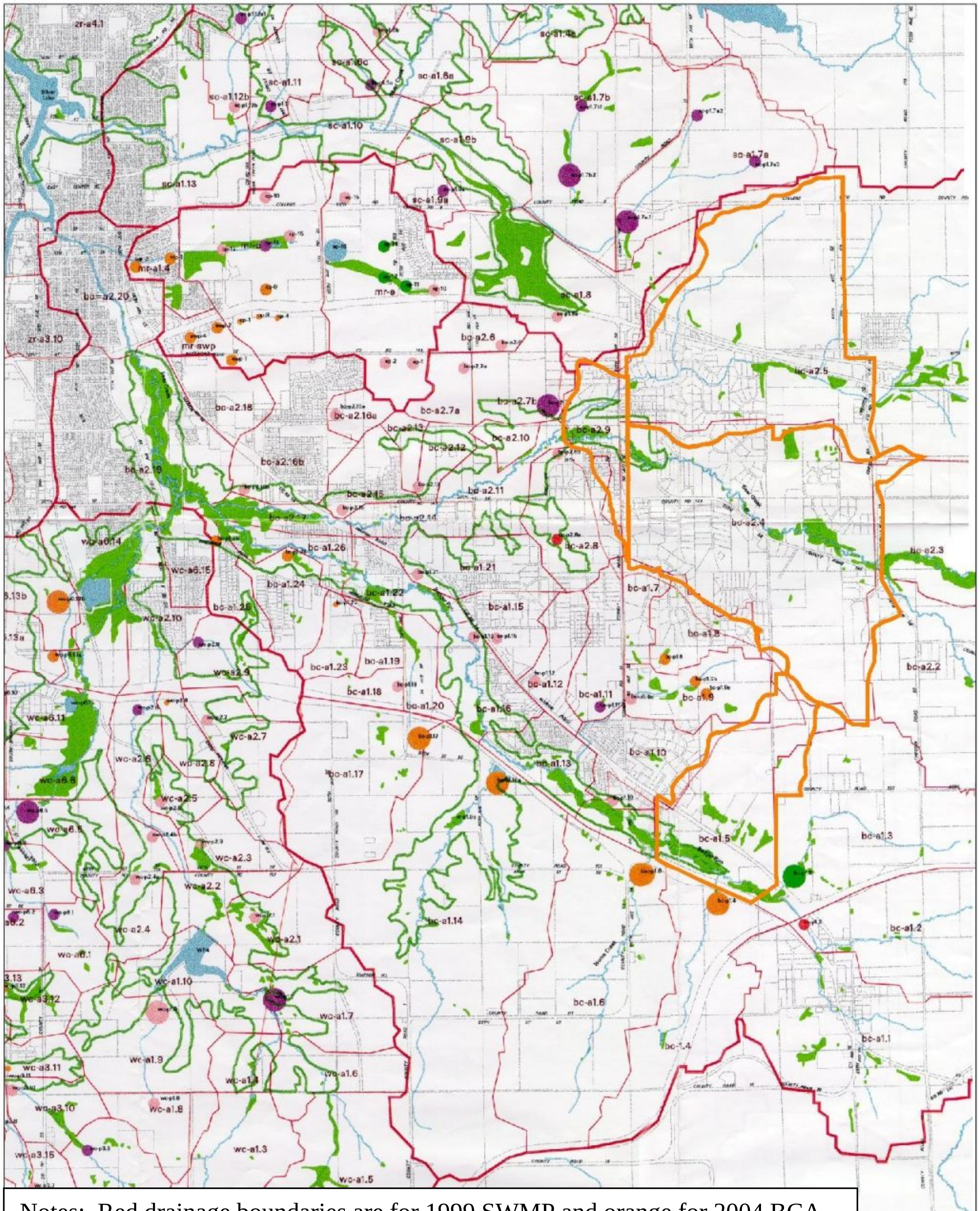
A summary of the special concerns identified in the 1999 SWMP for this Major Drainage District is given below. The basins and trunk systems described below are illustrated in Maps 1 and 2 of the 1999 SWMP. Figure 12-1 illustrates a reduced view of the Bear Creek area with all its Minor Drainage Districts (red) and the portions of these districts studied in this Addendum (orange).

Basins BC-P1.3, BC-P1.4, BC-P1.6, BC-P1.14 and BC-P1.17 are all located outside of the 2045 service area (identified in the 1999 SWMP). These basins receive runoff from 4,955 acres of primarily agricultural land draining to Badger Run. This area constitutes approximately 47 percent of the total drainage area to Badger Run. Significant rate reductions and water quality improvements cannot be achieved without controlling runoff from these areas. These basins were designed to take advantage of existing terrain to reduce peak flows and remove high levels of suspended solids associated with agricultural runoff. The construction of these basins will require berms and weir outlet control devices at the existing road crossings for each basin.

Minor Drainage Districts BC-A1.7, BC-A1.8 and BC-A1.9 all drain to the existing box culvert at 55th Street SE (total drainage area of 507 acres). The proposed basin BC-P1.9 is intended to reduce the peak flow rate from this area through construction of a control structure and excavation to provide detention volume for a 100-year discharge rate of 246 cfs. The basin's final design must include an analysis of the current and ultimate downstream capacity through the residential subdivision north of Marion Road. The channel currently flows through subdivided lots that have not been developed (existing homes are more than 10 years old). If future development requires this channel to be diverted, flows from BC-P1.9 should be channeled to BC-P1.11. A detailed hydraulic analysis will be required for BC-P1.11 to compensate for increased volumes and required outlet capacity. BC-P1.8 is an existing basin within BC-A1.8 and currently does not have a stabilized outlet. Appendix A-2 of the 1999 SWMP provides the proposed discharge characteristics for this basin.

BC-P1.11 is located within an existing gravel mining site. Runoff from Minor Drainage Districts BC-A1.7, BC-A1.8, and BC-A1.9 must be directed to this basin by constructing a channel between the existing crossing at 55th Avenue SE and the proposed pond. Future gravel mining in this area should be oriented toward developing this basin and channel excavation.

Figure 12-1 Bear Creek Minor Drainage Districts and Areas Studied to Date



Notes: Red drainage boundaries are for 1999 SWMP and orange for 2004 BCA.
Not to scale. For details see Map 1 of the 1999 SWMP.

BC-P1.15 is planned as a two-cell pond split by Marion Road (see Map 1 of the 1999 SWMP). The pond was designed to operate as one pond under large storm events. The second cell west of Marion Road acts as the control for water levels in both cells. This will require an equalizer pipe between the two ponds, assumed as a 48-inch pipe for the model. Depending on specific future development of the area, both cells may be shifted to one side of Marion Road if site conditions are adequate.

BC-P1.21 is located between Marion Road and Badger Run (see Map 1 of the 1999 SWMP). Final basin design must insure that the tail water effect from the 100-year high water level of Badger Run does not cause this basin to exceed the 100-year high water level.

BC-P1.23 is indicated as a two-cell pond split by 30th Avenue SE due to existing land constraints in the lower portion of the drainage area. Optimum final pond design would shift both cells to one side of the road if sufficient land can be acquired at the time of construction. The stream bank and floodplain along the south side of Badger Run in this area would benefit greatly from the combined effects of stream bank restoration and pond construction.

BC-P2.8 has been located north of 19th Street SE based on the current level of suburban development in the area. An alternative location for this basin, depending on future development, would shift BC-P2.8 west to the north of 20th Street SE. The trunk storm sewers indicated on Map 2 of the 1999 SWMP would then be realigned to direct flows from 19th Street to this basin.

BC-P2.15 was designed to control runoff from Minor Drainage District BC-A2.15. Future development north of 20th Street SE should include grading the ditch along 20th Street, and channel construction to direct flows to this basin. This basin was located based on existing forested areas south of 20th Street. Future reconstruction of 20th Street should include the construction of trunk storm sewer as indicated in Map 2 of the 1999 SWMP.

Minor Drainage Districts BC-A2.16 A and B include 405 acres of land zoned for low-density residential and commercial development. Approximately 60 percent of the area in the lower portion of the watershed has been developed. A storm water facility to control runoff rates has not been constructed at this time. Basin BC-P2.16a is proposed to decrease the discharge rate to downstream storm sewers to prevent surcharging. Future development within Minor Drainage District BC-A2.16A that produces runnoff that cannot be directed to this basin must include provisions to insure that the downstream storm sewers have adequate capacities to handle it.

12.1 Bear Creek North —Minor Drainage District BC-a2.5

Drainage Area: 13,054 acres within the BCA area
Number of Storm Water Facilities: 15
Major Streams: Bear Creek North Branch

Minor Drainage District BC-a2.5 is drained by a stream heretofore called the Bear Creek North Branch (North Branch). This North Branch joins Bear Creek west of 50th Avenue SE, just downstream of Minor Drainage District BC-a2.9. It then parallels the south side of Highway 14 up to the eastern limit of this study area.

The area north of the railroad has agricultural land use and is practically undeveloped—with only a few farmsteads and houses. The area drains through four natural waterways that cross the railroad and Highway 14 to reach Bear Creek's North Branch. Five Subdistricts drain to this waterway: BC-a2.5.0, BC-a2.5.1, BC-a2.5.2, BC-2.5.3, and BC-2.5.4 (west to east). The distribution of water-flows between these Subdistricts will be development dependent and will need to be analyzed in the design phase.

Subdistrict BC-a2.5.0
This Subdistrict identifies areas containing existing development. Hence, no storm water facilities are proposed at this time. Storm water facilities will need to be considered for any re-development in the area.

Subdistrict BC-a2.5.1
It includes Subdistricts BC-a2.5.1a, BC-a2.5.1b, BC-a2.5.1c, BC-a2.5.1d, BC-a2.5.1e, and BC-a2.5.1.f. They drain southwestwardly down to the railroad crossing. From this point the water flows south through a stable channel to Bear Creak's North Branch, after crossing under Highway 14 in two 5-ft rise by 10-ft span concrete box culverts, and under Logan Street SE in two 48-inch rise by 54-inch span arch corrugated metal pipes.

The major regional basin in this Subdistrict is BC-p2.5.1a, while other basins are planned to control sediment and to prevent stream bank erosion. Ponds BC-p2.5.1c and BC-p2.5.1f are located upstream of the crossings under College View Road (County Road 9). Ponds BC-p2.5.1b, BC-p2.5.1d, and BC-p2.5.1e are located to capture the maximum runoff in sediment basins that control flows before water goes down the steeper creek reaches.

Subdistricts BC-a2.5.2 and BC-a2.5.3

Ponds BC-p2.5.2 and BC-p2.5.3a are regional basins, while BC-p2.5.3b is designed to control upstream flows, mostly towards BC-a2.5.3a. These three ponds will need to be evaluated together in detail, as they are development dependent. Subdistrict BC-a2.5.2 offers more favorable conditions for a larger regional basin than BC-a2.5.3a.

Subdistrict BC-a2.5.4

Four ponds serve Subdistricts BC-a2.5.4a, BC-a2.5.4b, BC-a2.5.4c, BC-a2.5.4d, and BC-a2.5.4e (downstream to upstream). A pond is not proposed for BC-a2.5.4c due to topographic and existing development constraints, but this area should use best management practices to reduce direct runoff and enhance water quality. When this Subdistrict develops, the storm water facilities need to be located and designed to maximize the drainage area they serve, to enhance water quality treatment, and reduce adverse impacts to drainageways.

BC-p2.5.4a is the major regional basin in this Subdistrict. It is not sized to treat runoff from approximately 300 acres outside the BCA area, lying east of 65th Avenue SE (County Road 119). Most of the 300-acre area drains through a small farm pond (used for recreation), and enters area BC-a2.5.4a through two 48-inch reinforced concrete pipes that cross underneath 65th Avenue SE.

Flows from BC-a2.5.4 pass under 10th Street SE through a 6-ft rise by 10-ft span arch reinforced concrete pipe, and under Highway 14 through a 6-ft rise by 10-ft span box concrete culvert, before reaching the North Branch.

Subdistrict BC-a2.5.5

This Subdistrict includes the largest, mostly undeveloped, area of land south of the Bear Creek North Branch. Pond BC-p2.5.5 is located just south of the creek and east of 60th Avenue SE. It is designed mainly as a water quality basin to treat directly contributing areas, and to release 100-year flows from developed conditions at the estimated 10-year runoff for existing conditions. That is, it is not designed to control high flows from the North Branch upstream areas.

Subdistrict BC-a2.5.6

Pond BC-p2.5.6 serves a small area west of Chester Road SE (County Road 19) and south of Highway 14. If re-development occurs in this area, this facility could be moved downstream, to treat the additional area flows before they reach the Bear Creek North Branch.

12.2 Bear Creek Center —Minor Drainage District BC-a2.4

Drainage Area: 1,569 acres within the BCA study area
Number of Storm Water Facilities: 6
Major Reservoirs: BR-1 (118.4 acres) – upstream of the BCA study area
Major Streams: Bear Creek

Bear Creek drains Minor Drainage District BC-a2.4, entering through three 6-ft rise by 12-ft span concrete box culverts. Although it has the largest area of the four Minor Drainage Districts considered in this Addendum, it has the smallest amount of undeveloped area. This limits additional storm water facilities to the six proposed. If some areas re-develop, additional facilities should be considered, particularly if forest areas are cleared and/or if areas with high infiltration capacity and depression storage are affected.

Subdistrict BC-a2.4.0

Subdistricts BC-a2.4.0a to BC-a2.4.0l include areas that are considered as existing development. Hence, no storm water facilities are proposed. Storm water facilities should be considered for any re-development in the area.

Subdistrict BC-a2.4.1

Pond BC-p2.4.1 is the largest facility within BC-a2.4. It is proposed mainly for water quality treatment and to meet existing capacities downstream. It would be constructed north of 19th Street SE and west of Chester Road SE (County Road 19) to maximize the area to be treated.

Subdistrict BC-a2.4.2

Located north of 20th Street SE and east of 50th Avenue SE, this is the only undeveloped area in the western part of the study area. A new access road is planned here, which will bisect BC-a2.4.2a on the south and BC-a2.4.2b on the north. Pond BC-p2.4.2a is currently envisioned on the south side of this new road, but is development dependent, and could be placed on the north side in order to maximize the treatment area. This area is highly permeable, and other storm water best management practices could also be considered to achieve water quantity and quality goals.

Subdistricts BC-a2.4.3a, BC-a2.4.3b, BC-a2.4.3c, and BC-a2.4.3d
These four Subdistricts were established to maximize the drainage from undeveloped areas and to control flows from the upper hills, before they flow into their natural drainageways. The main objective is to control runoff peaks and reduce streambank erosion. Hence, these could be designed and implemented as more than four storm water facilities, depending on development or re-development, and considering detailed physical characteristics such as geology.

12.3 Badger Run —Minor Drainage District BC-a1.5

Direct drainage Area: 611 acres
Number of Storm Water Facilities: 12
Major Streams: Badger Run

Minor Drainage District BC-a1.5 is drained by Badger Run, which joins Bear Creek at Bear Creek Park. Approximately 3,470 acres of Badger Run drain into Minor Drainage District BC-a1.5 (from Subdistricts BC-a1.1, BC-a1.2 and BC-a1.3, BC-a1.4; illustrated in the 1999 SWMP). Adding the 611 acres of BC-a1.5 gives 4,081 acres that drain out of BC-a1.5.

Badger Run flows northwest through the southern part of BC-a1.5. Here stream slopes are flatter than 0.3%, resulting in a wider floodplain that includes wetlands. Badger Run is located between Highway 52 on the south and Marion Road on the north, just northwest of the junction of Highways 52 and 90.

Subdistrict BC-a1.5.0
This Subdistrict is made up of areas that are either already developed or are located within undevelopable floodplain and wetland areas. Hence, no storm water facilities are proposed. Storm water facilities will need to be considered for any future re-development in the area.

Subdistrict BC-a1.5.1
It drains about 280 acres and includes Subdistricts BC-a1.5.1a, BC-a1.5.1b, BC-a1.5.1c, BC-a1.5.1d, BC-a1.5.1e, BC-a1.5.1f, and BC-a1.5.1g. It was subdivided to maximize ponding in the upstream areas to reduce erosion of existing drainageways. In addition, the existing infrastructure limits the size of the facility adjacent to Marion Road.

Flows from BC-a1.5.1 cross Marion Road before reaching Badger Run, as the stream is about to leave Minor Drainage District BC-a1.5 (western limit).

Subdistrict BC-a1.5.2

It drains about 132 acres and includes Subdistricts BC-a1.5.2a and BC-a1.5.2b. Pond BC-p1.5.2b is to control flows before the 60th Avenue SE crossing. Pond BC-p1.5.2a is envisioned adjacent to Marion Road and is designed to treat the remaining area, possibly requiring some stair-casing to reduce costs. Flows from BC-a1.5.2 cross Marion Road and join those of BC-a1.5.3 before reaching Badger Run.

Subdistrict BC-a1.5.3

This Subdistrict drains about 36 acres. Pond BC-p1.5.3 is envisioned upstream of the creek crossing at Marion Road. Flows from BC-a1.5.3 cross Marion Road and join those of BC-a1.5.2 before reaching Badger Run.

Subdistricts BC-a1.5.4a and BC-a1.5.4b

Ponds BC-p1.5.4a and BC-p1.5.4b are envisioned primarily to maximize water quality treatment, before discharging to Badger Run and its associated wetlands. Hence, they should be designed to capture and treat the runoff from any change in land use.

The storm water facility BC-p1.5.4b should be designed considering the facilities in Subdistricts BC-a1.5.2 and BC-a1.5.3, so as to maximize water quality treatment opportunities.

12.4 Bear Creek West —Minor Drainage District BC-a2.9

Drainage Area: 205 acres within the BCA study area
Number of Storm Water Facilities: 0
Major Reservoirs: BR-1 (118.4 acres) – upstream of the BCA study area
Major Streams: Bear Creek and Bear Creek North Branch

Both the Bear Creek and its North Branch drain Minor Drainage District BC-a2.9. These two streams join at its western boundary. No facility was proposed for BC-a2.9 since it is nearly fully developed. Appropriate facilities will need to be considered if re-development occurs.

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. This Bear Creek Addendum (BCA) complements it, analyzing in detail the storm water management opportunities in developable areas of Minor Drainage Districts BC-a2.5, BC-a2.4, BC-a1.5 and BC-a2.9.

The BCA study area has mostly suburban land use in the central section, while the northern and southern portions are predominantly agricultural. The developed lots average two to five acres, which led to the use of an average runoff curve number of 68, as characteristic of these suburban development areas. Road ditches tend to have medium to high infiltration, particularly in the flood prone areas. Forests protect steep slopes and highly erodible soils. Uplands are drained by steep creeks. Both the creeks and the uplands are highly vulnerable to erosion. Hence, any changes in land use that increase runoff peaks and volumes can cause severe environmental degradation if best management practices are not implemented.

The BCA utilizes a regional approach to storm water management design, incorporating and enhancing existing natural drainageways in an effort to improve water quality and reduce costs. However, this approach is limited in areas that have already partially developed. Also, storm water facilities needed to regulate flows of new development in upland areas are planned in order to maintain or enhance the stability of steep ravines and to reduce erosion.

The primary function of an urban storm drainage system is to minimize economic loss and inconvenience due to periodic flooding of streets and other low-lying areas, as well as to maintain or improve water quality, by reducing contamination by sediments, nutrients, or other pollutants. Properly designed storm drainage facilities enhance water quality, provide flood control, and minimize hazards and inconvenience associated with flooding.

Storm sewers represent a sizable investment for the community and this investment can be reduced and more economically addressed by utilizing and improving the existing channels and drainageways. 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 storm while storm sewer pipes are typically sized to accommodate a 10-year storm). Topographic depressions and existing road crossings have been considered in this Addendum 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 BCA, provides the following functions:

1. Protect or improve water quality
2. Recharge ground water
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 important consideration. The ultimate area and depth of the ponds may differ from the values presented here, depending on actual development specifics, but the wet volumes recommended in this BCA 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 drainage districts. The 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 increased impervious area. This may alter or even prevent the existing natural occurrence of groundwater recharge from 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 surface water to follow pathways to the groundwater will be preserved. In Bear Creek, this infiltration occurs in areas where steep creeks reach milder slopes and/or highly permeable soils, such as those of the floodplain areas within the Bear Creek stream corridor.

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 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 implemented. The proper location of the recreational trail system will allow good access to these areas for wildlife observation, such as in the existing trail along Bear Creek in its lower reaches. The design and location of the recreational trail system will take advantage of scenic vistas and provide an aesthetic appearance to the trails. The existing Bear Creek trail system could even reach Chester Woods County Park to provide a high quality recreational and nature-exposure trail for residents and visitors.

The storm water system alignments shown in the BCA are conceptual. It is extremely important that each area be reevaluated at the time of final design to adjust to the proposed development characteristics and requirements, as well as to confirm the criteria used in this Addendum, and study the pertinent geological and soil characteristics. Successful implementation of the management plan 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 all development activity within the Bear Creek Addendum area is in compliance with the general guidelines of this Addendum 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 BCA.

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 BCA.

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 may 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 operation, maintenance, and replacement of the drainage system.

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

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

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

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Appendix A

Drainage Areas by Subdistrict

Appendix A
Drainage Areas by Subdistrict

Area Designation	Area (Acres)
Bear Creek North: Area A (District bc-a2.5)	
bc-a2.5.0	550.3
bc-a2.5.1a	155.7
bc-a2.5.1b	41.0
bc-a2.5.1c	3.5
bc-a2.5.1d	23.3
bc-a2.5.1e	93.5
bc-a2.5.1f	31.4
bc-a2.5.2	84.1
bc-a2.5.3a	60.2
bc-a2.5.3b	42.7
bc-a2.5.4a	64.2
bc-a2.5.4b	14.8
bc-a2.5.4c	28.6
bc-a2.5.4d	35.7
bc-a2.5.4e	28.1
bc-a2.5.5	74.6
bc-a2.5.6	22.4
Subtotal	1354.1

Area Designation	Area (Acres)
Bear Creek Center: Area B (District bc-a2.4)	
bc-a2.4.0a	395.5
bc-a2.4.0b	62.9
bc-a2.4.0c	97.7
bc-a2.4.0d	160.9
bc-a2.4.0e	187.2
bc-a2.4.0f	18.6
bc-a2.4.0g	28.9
bc-a2.4.0h	47.8
bc-a2.4.0i	96.1
bc-a2.4.0j	38.0
bc-a2.4.0k	92.0
bc-a2.4.0l	25.7
bc-a2.4.1	147.8
bc-a2.4.2a	25.2
bc-a2.4.2b	9.4
bc-a2.4.3a	15.6
bc-a2.4.3b	55.5
bc-a2.4.3c	44.2
bc-a2.4.3d	20.0
Subtotal	1569.0

Area Designation	Area (Acres)
Bear Creek West: Area D (District bc-a2.9)	
bc-a2.9	204.9

Area Designation	Area (Acres)
Badger Run: Area C (District bc-a1.5)	
bc-a1.5.0	130.1
bc-a1.5.1a	47.4
bc-a1.5.1b	37.0
bc-a1.5.1c	63.1
bc-a1.5.1d	38.7
bc-a1.5.1e	43.7
bc-a1.5.1f	17.9
bc-a1.5.1g	29.1
bc-a1.5.2a	93.7
bc-a1.5.2b	30.4
bc-a1.5.3	34.4
bc-a1.5.4a	20.6
bc-a1.5.4b	24.5
Subtotal	610.6

Appendix B

Stormwater Basin Parameters

Appendix B
Stormwater Basin Parameters[1]

Watershed Pond ID#	Normal Water Level Elevation (NWL) (feet)	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
Bear Creek: Area A (District bc-a2.5)								
bc-p2.5.1a	1090	5.5	1093.8	3.8	22.3	23.9	3.1	24" RCP
bc-p2.5.1b	1170	1.2	1173.6	3.6	4.8	6.4	0.8	12" RCP
bc-p2.5.1c	1240	0.1	1242.1	2.1	0.3	1.0	0.06	6" RCP
bc-p2.5.1d	1180	0.6	1183.7	3.7	2.8	6.4	0.5	12" RCP
bc-p2.5.1e	1150	3.6	1153.1	3.1	12.0	15.6	2.0	18" RCP
bc-p2.5.1f	1240	0.9	1243.7	3.7	3.8	7.2	0.7	12" RCP
bc-p2.5.2	1090	2.3	1094.0	4.0	10.0	17.3	1.7	18" RCP
bc-p2.5.3a	1110	1.7	1113.7	3.7	7.2	12.0	1.2	15" RCP
bc-p2.5.3b	1200	1.2	1204.2	4.2	5.7	6.5	0.9	12" RCP
bc-p2.5.4a	1120	1.9	1123.9	3.9	8.2	11.6	1.3	15" RCP
bc-p2.5.4b	1175	0.2	1178.6	3.6	1.0	10.9	0.3	15" RCP
bc-p2.5.4d	1225	0.8	1228.8	3.8	3.6	7.6	0.6	12" RCP
bc-p2.5.4e	1260	0.6	1263.8	3.8	2.8	7.1	0.5	12" RCP
bc-p2.5.5	1085	1.7	1087.6	2.6	4.7	75.8	1.5	6 ft wide X 5 ft high Box RCP
bc-p2.5.6	1115	0.6	1118.2	3.2	2.3	6.4	0.4	12" RCP
Bear Creek: Area B (District bc-a2.4)								
bc-p2.4.1	1100	4.6	1103.5	3.5	17.3	28.4	3.0	24" RCP
bc-p2.4.2a	1060	0.5	1062.3	2.3	1.2	39.9	0.5	54" RCP
bc-p2.4.3a	1210	0.5	1215.6	5.6	3.0	25.0	0.3	10" RCP
bc-p2.4.3b	1220	1.4	1227.2	7.2	8.0	39.2	1.2	12" RCP
bc-p2.4.3c	1180	1.0	1186.0	6.0	6.0	33.8	0.7	10" RCP
bc-p2.4.3d	1200	0.6	1204.1	4.1	3.1	4.4	0.5	10" RCP
Badger Run: Area C (District bc-a1.5)								
bc-p1.5.1a	1095	1.2	1097.1	2.1	2.7	64.0	1.0	6 ft wide X 5 ft high Box RCP
bc-p1.5.1b	1110	1.2	1114.0	4.0	5.4	32.5	0.8	24" RCP
bc-p1.5.1c	1178	1.5	1182.4	4.4	7.4	11.0	1.2	15" RCP
bc-p1.5.1d	1226	1.0	1229.9	3.9	4.5	7.5	0.8	12" RCP
bc-p1.5.1e	1216	1.2	1219.9	3.9	5.3	7.6	0.9	12" RCP
bc-p1.5.1f	1180	0.5	1183.4	3.4	2.2	5.1	0.4	12" RCP
bc-p1.5.1g	1188	0.6	1191.2	3.2	2.3	6.2	0.4	12" RCP
bc-p1.5.2a	1105	3.6	1108.2	3.2	12.4	16.2	2.0	18" RCP
bc-p1.5.2b	1195	1.0	1199.0	4.0	4.7	7.9	0.6	12" RCP
bc-p1.5.3	1105	1.0	1108.8	3.8	4.4	5.9	0.7	12" RCP
bc-p1.5.4a	1075	0.3	1077.1	2.1	0.8	37.1	0.4	42" RCP
bc-p1.5.4b	1085	0.5	1087.3	2.3	1.2	40.9	0.5	54" 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)
Bear Creek: Area A (District bc-a2.5)										
bc-p2.5.1a	3168	17.6	30	0.165	154	0.856	16	0.091	0.93	0.005
bc-p2.5.1b	762	17.1	7	0.162	38	0.847	4	0.090	0.23	0.005
bc-p2.5.1c	44	12.8	1	0.147	3	0.788	0	0.084	0.01	0.004
bc-p2.5.1d	508	17.5	5	0.164	25	0.852	3	0.091	0.15	0.005
bc-p2.5.1e	1928	17.2	18	0.163	95	0.850	10	0.091	0.57	0.005
bc-p2.5.1f	666	17.2	6	0.163	33	0.848	4	0.090	0.20	0.005
bc-p2.5.2	1765	17.9	16	0.165	85	0.859	9	0.092	0.51	0.005
bc-p2.5.3a	1234	17.8	11	0.165	59	0.858	6	0.091	0.36	0.005
bc-p2.5.3b	864	17.0	8	0.162	43	0.846	5	0.090	0.26	0.005
bc-p2.5.4a	1318	17.6	12	0.164	64	0.854	7	0.091	0.39	0.005
bc-p2.5.4b	273	17.8	3	0.164	13	0.852	1	0.091	0.08	0.005
bc-p2.5.4d	649	17.8	6	0.165	31	0.856	3	0.091	0.19	0.005
bc-p2.5.4e	537	17.8	5	0.165	26	0.857	3	0.091	0.16	0.005
bc-p2.5.5	1479	17.5	14	0.164	72	0.854	8	0.091	0.44	0.005
bc-p2.5.6	440	17.9	4	0.165	21	0.857	2	0.091	0.13	0.005
Bear Creek: Area B (District bc-a2.4)										
bc-p2.4.1	3050	17.9	28	0.165	146	0.859	16	0.092	0.89	0.005
bc-p2.4.2a	485	17.3	5	0.163	24	0.849	3	0.091	0.14	0.005
bc-p2.4.3a	347	17.9	3	0.165	17	0.858	2	0.092	0.10	0.005
bc-p2.4.3b	1134	16.9	11	0.162	57	0.846	6	0.090	0.34	0.005
bc-p2.4.3c	725	17.0	7	0.162	36	0.847	4	0.090	0.22	0.005
bc-p2.4.3d	487	16.9	5	0.162	24	0.844	3	0.090	0.15	0.005
Badger Run: Area C (District bc-a1.5)										
bc-p1.5.1a	1053	18.4	10	0.167	49	0.864	5	0.092	0.30	0.005
bc-p1.5.1b	913	19.0	8	0.168	42	0.871	4	0.093	0.26	0.005
bc-p1.5.1c	1246	17.7	12	0.165	60	0.856	6	0.091	0.37	0.005
bc-p1.5.1d	753	17.0	7	0.162	37	0.846	4	0.090	0.22	0.005
bc-p1.5.1e	865	16.9	8	0.162	43	0.846	5	0.090	0.26	0.005
bc-p1.5.1f	375	17.0	4	0.162	19	0.845	2	0.090	0.11	0.005
bc-p1.5.1g	447	17.9	4	0.165	21	0.858	2	0.091	0.13	0.005
bc-p1.5.2a	2028	17.5	19	0.164	99	0.855	11	0.091	0.60	0.005
bc-p1.5.2b	627	17.5	6	0.164	31	0.853	3	0.091	0.18	0.005
bc-p1.5.3	715	17.4	7	0.164	35	0.852	4	0.091	0.21	0.005
bc-p1.5.4a	400	17.7	4	0.164	19	0.854	2	0.091	0.12	0.005
bc-p1.5.4b	502	17.5	5	0.164	24	0.852	3	0.091	0.15	0.005

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]
bc-w1.5.1	Yes	Yes	Medium/Low	Medium/Low	Ecosystem Support*	Slightly Susceptible
bc-w1.5.2	Yes	Yes	Medium/High	Medium/High	Unique	Moderately Susceptible
bc-w1.5.3	Yes	Yes	Medium/Low	Medium/Low	Unique	Slightly Susceptible
bc-w1.5.4	Yes	Yes	Medium	Medium	Natural	Highly Susceptible
bc-w1.5.5	Yes	Yes	Medium/High	Medium/High	Unique	Moderately Susceptible
bc-w1.5.6	Yes	Yes	Medium/Low	Medium	Ecosystem Support	Moderately Susceptible
bc-w1.5.7	Yes	Yes	Medium/Low	Medium/High	Ecosystem Support	Moderately Susceptible
bc-w1.5a	Yes	Yes	Medium	Medium	Unique	Moderately Susceptible
bc-w1.5b	Yes	Yes	Medium/Low	Low	Ecosystem Support*	Slightly Susceptible
bc-w2.4.1	Yes	Yes	Medium/High	High	Unique	Moderately Susceptible
bc-w2.4.2	Yes	Yes	Medium/Low	Medium	Ecosystem Support	Slightly Susceptible
bc-w2.4.3	Yes	Yes	High	High	Unique	Highly Susceptible
bc-w2.4.4	Yes	Yes	High	High	Unique	Moderately Susceptible
bc-w2.4.5	No	No	No Access		No Access	
bc-w2.4.6	No	No	No Access		No Access	
bc-w2.4.7	No	No	No Access		No Access	
bc-w2.4.8	No	No	No Access		No Access	
bc-w2.4.9	No	No	No Access		No Access	
bc-w2.4.10	No	No	No Access		No Access	
bc-w2.4.11	No	No	No Access		No Access	
bc-w2.4.12	No	No	No Access		No Access	
bc-w2.4.13	Yes	Yes	Medium	High	Natural	Slightly Susceptible
bc-w2.4.14	Yes	Yes	High	High	Unique	Slightly Susceptible
bc-w2.4.15	Yes	Yes	Medium	Medium/High	Natural	Slightly Susceptible
bc-w2.4.16	Yes	Yes	Medium	Medium/High	Natural	Slightly Susceptible
bc-w2.4.17	Yes	Yes	Medium	High	Natural	Slightly Susceptible
bc-w2.4.18	Yes	Yes	Low	Medium	Ag/Urban Impacted	Slightly Susceptible
bc-w2.4.19	Yes	Yes	Medium/Low	Medium	Ecosystem Support	Slightly Susceptible
bc-w2.4.20	Yes	Yes	Low	Medium/High	Ag/Urban Impacted	Slightly Susceptible
bc-w2.5.1	Yes	Yes	Medium/Low	Medium/High	Ecosystem Support	Slightly Susceptible
bc-w2.5.2	Yes	Yes	Medium/High	High	Unique	Moderately Susceptible
bc-w2.5.3	Yes	Yes	Medium/Low	Medium	Ecosystem Support	Slightly Susceptible
bc-w2.5.4	Yes	Yes	Low	Medium	Ag/Urban Impacted	Least Susceptible
bc-w2.5.6	Yes	Yes	Medium	Medium/High	Natural	Slightly Susceptible
bc-w2.5.7	Yes	Yes	Medium	Medium/High	Natural	Moderately Susceptible
bc-w2.5.8	Yes	Yes	Medium/Low	Medium	Ecosystem Support	Slightly Susceptible
bc-w2.5.9	Yes	Yes	Medium/High	Medium/High	Unique	Moderately Susceptible
bc-w2.5a	Yes	Yes	Low	Medium	Unique	Least Susceptible
bc-w2.9.1	Yes	Yes	High	High	Unique	Moderately 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			Pipe			Subtotal	Additional	Total
Flow From	Flow To	Channel Classification[1]	Size (Feet)	Length (Feet)	Unit Cost[2,3,5] ($/ft)	Cost ($)	Cost[4] ($)	Cost ($)
Bear Creek: Area A (District bc-a2.5)						841,312	294,459	1,135,771
2.5.1	2.5.2	BC-I - stabilization	na[6]	2,492	41	102,172	35,760	137,932
2.5.2	2.5.5	BC-I - stabilization	na	1,450	41	59,450	20,808	80,258
2.5.3	2.5.4a	BC-I - stabilization	na	1,074	41	44,034	15,412	59,446
2.5.4	2.5.4a	BC-I - stabilization	na	611	41	25,051	8,768	33,819
2.5.4a	2.5.5	BC-I - stabilization	na	913	41	37,433	13,102	50,535
2.5.5	2.5.6	BC-I - stabilization	na	2,043	41	83,763	29,317	113,080
2.5.7	2.5.8	BC-I - improvement	na	2,380	56	133,280	46,648	179,928
2.5.8	2.5.9	BC-I - stabilization	na	1,113	41	45,633	15,972	61,605
2.5.10	2.5.11	BC-I - stabilization	na	560	41	22,960	8,036	30,996
2.5.12	2.5.13	BC-I - improvement	na	1,204	56	67,424	23,598	91,022
2.5.13	2.5.14	BC-I - stabilization	na	2,011	41	82,451	28,858	111,309
2.5.15	2.5.16	BC-I - stabilization	na	1,465	41	60,065	21,023	81,088
2.5.17	2.5.18	BC-I - improvement	na	264	56	14,784	5,174	19,958
2.5.19	2.5.20	BC-I - stabilization	na	1,532	41	62,812	21,984	84,796
Bear Creek: Area B (District bc-a2.4)						497,564	174,147	671,711
2.4.1	2.4.2	BC-I - improvement	na	1,016	56	56,896	19,914	76,810
2.4.3	2.4.5	BC-I - stabilization	na	1,894	41	77,654	27,179	104,833
2.4.4	2.4.5	BC-I - stabilization	na	1,506	41	61,746	21,611	83,357
2.4.5	2.4.6	BC-I - stabilization	na	1,962	41	80,442	28,155	108,597
2.4.7	2.4.9	BC-I - stabilization	na	2,001	41	82,041	28,714	110,755
2.4.8	2.4.9	BC-I - stabilization	na	771	41	31,611	11,064	42,675
2.4.9	2.4.10	BC-I - stabilization	na	2,614	41	107,174	37,511	144,685
Badger Run: Area C (District bc-a1.5)						665,547	232,941	898,488
1.5.1	1.5.3	BC-I - improvement	na	1,798	56	100,688	35,241	135,929
1.5.2	1.5.3	BC-I - improvement	na	1,220	56	68,320	23,912	92,232
1.5.3	1.5.6	BC-I - stabilization	na	1,250	41	51,250	17,938	69,188
1.5.4	1.5.6	BC-I - stabilization	na	608	41	24,928	8,725	33,653
1.5.5	1.5.6	BC-I - stabilization	na	305	41	12,505	4,377	16,882
1.5.6	1.5.7	BC-I - stabilization	na	1,000	41	41,000	14,350	55,350
1.5.7	1.5.8	BC-I - stabilization	na	1,032	41	42,312	14,809	57,121
1.5.8	1.5.9	BC-I - stabilization	na	1,387	41	56,867	19,903	76,770
1.5.10	1.5.11	BC-I - stabilization	na	394	41	16,154	5,654	21,808
1.5.12	1.5.13	BC-I - stabilization	na	2,731	41	111,971	39,190	151,161
1.5.13	1.5.15	BC-I - improvement	na	1,053	56	58,968	20,639	79,607
1.5.14	1.5.15	BC-I - improvement	na	1,064	56	59,584	20,854	80,438
1.5.15	1.5.16	BC-I - improvement	na	375	56	21,000	7,350	28,350
GRAND TOTAL FOR POND TRUNK COSTS						2,004,423	701,548	2,705,971

[1] "Stabilization" is an abbreviation for channel stabilization measures. "Improvement" is 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.

[4] Additional Cost estimates a 35% of subtotal cost for engineering, administration, interest and contingency.

[5] Costs correspond to April 2002.

[6] na = not applicable; note that the cost of pond outlet pipes were assumed to be part of outlet cost in this Addendum (see Appendix G).

Appendix G

Basin Cost Estimate

Appendix G
Basin Cost Estimates

Pond ID#	Pond Excavation (acre-feet)	Excavation Cost[1,4] ($)	Land Acquisition (acres)	Land Acquisition Cost[2,4] ($)	Outlet Cost[4,5] ($)	Subtotal Cost ($)	Additional Cost[3] ($)	Total Cost ($)
Bear Creek: Area A (District bc-a2.5)		218,528	34	504,952	117,000	840,480	294,168	1,134,648
bc-p2.5.1a	7.6	49,050	7.5	112,517	7,500	169,068	59,174	228,242
bc-p2.5.1b	1.7	11,226	1.8	26,661	7,500	45,387	15,885	61,272
bc-p2.5.1c	0.1	755	0.2	3,204	7,500	11,460	4,011	15,471
bc-p2.5.1d	1.1	6,862	1.1	15,993	7,500	30,355	10,624	40,980
bc-p2.5.1e	4.4	28,133	4.9	73,683	7,500	109,317	38,261	147,577
bc-p2.5.1f	1.4	9,320	1.4	21,375	7,500	38,195	13,368	51,563
bc-p2.5.2	3.7	24,043	3.3	49,809	7,500	81,352	28,473	109,826
bc-p2.5.3a	2.6	17,047	2.6	38,508	7,500	63,055	22,069	85,124
bc-p2.5.3b	2.0	13,045	1.9	28,004	7,500	48,549	16,992	65,541
bc-p2.5.4a	2.9	19,024	2.8	42,367	7,500	68,891	24,112	93,003
bc-p2.5.4b	0.5	2,970	0.4	6,710	7,500	17,179	6,013	23,192
bc-p2.5.4d	1.3	8,707	1.3	19,668	7,500	35,875	12,556	48,432
bc-p2.5.4e	1.1	7,006	1.1	16,025	7,500	30,532	10,686	41,218
bc-p2.5.5	2.4	15,586	2.3	35,172	12,000	62,758	21,965	84,724
bc-p2.5.6	0.9	5,752	1.0	15,255	7,500	28,507	9,978	38,485
Bear Creek: Area B (District bc-a2.4)		89,975	11	165,020	45,000	299,995	104,998	404,993
bc-p2.4.1	6.4	41,542	6.2	92,915	7,500	141,957	49,685	191,642
bc-p2.4.2a	0.7	4,751	0.8	11,501	7,500	23,752	8,313	32,065
bc-p2.4.3a	0.9	6,035	0.7	11,114	7,500	24,649	8,627	33,276
bc-p2.4.3b	2.8	17,836	1.0	15,264	7,500	40,600	14,210	54,810
bc-p2.4.3c	1.9	12,522	1.2	18,104	7,500	38,126	13,344	51,470
bc-p2.4.3d	1.1	7,289	1.1	16,122	7,500	30,911	10,819	41,730
Badger Run: Area C (District bc-a1.5)		131,939	20	304,797	94,500	531,235	185,932	717,168
bc-p1.5.1a	1.5	9,885	1.6	24,554	12,000	46,438	16,253	62,692
bc-p1.5.1b	1.9	12,338	1.8	27,194	7,500	47,032	16,461	63,493
bc-p1.5.1c	2.7	17,484	2.2	33,252	7,500	58,236	20,383	78,619
bc-p1.5.1d	1.7	10,732	1.6	23,447	7,500	41,678	14,587	56,266
bc-p1.5.1e	2.0	12,658	1.8	27,173	7,500	47,331	16,566	63,896
bc-p1.5.1f	0.8	5,258	0.9	13,734	7,500	26,492	9,272	35,764
bc-p1.5.1g	0.9	5,782	1.0	15,244	7,500	28,526	9,984	38,510
bc-p1.5.2a	4.5	29,054	4.9	73,976	7,500	110,530	38,686	149,216
bc-p1.5.2b	1.6	10,044	1.6	23,655	7,500	41,199	14,420	55,618
bc-p1.5.3	1.6	10,329	1.6	23,413	7,500	41,241	14,434	55,676
bc-p1.5.4a	0.5	3,540	0.5	7,636	7,500	18,676	6,537	25,213
bc-p1.5.4b	0.7	4,836	0.8	11,520	7,500	23,856	8,350	32,205
TOTAL COST FOR ALL		440,442		974,768	256,500	1,671,710	585,098	2,256,808

[1] A $4/cubic yard is used assuming that material is of good quality and reused on site.

[2] Land acquisition costs were assumed at $15,000/acre.

[3] Additional Cost estimates a 35% of subtotal cost for engineering, administration, interest and contingency.

[4] Costs correspond to April 2002.

[5] Outlet Cost was assumed to include the cost of the pond outlet pipe in this Addendum.

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[1]	Total Cost
Bear Creek: Area A (District bc-a2.5)				
Water Quality	(4.3%)	$159,090	$55,682	$214,772
Water Quantity	(18.5%)	$681,389	$238,486	$919,876
Trunk Channels	(22.9%)	$841,312	$294,459	$1,135,771
	(45.7%)		Subtotal -	$2,270,419
Bear Creek: Area B (District bc-a2.4)				
Water Quality	(1.7%)	$63,485	$22,220	$85,705
Water Quantity	(6.4%)	$236,510	$82,778	$319,288
Trunk Channels	(13.5%)	$497,564	$174,147	$671,711
	(21.7%)		Subtotal -	$1,076,704
Badger Run: Area C (District bc-a1.5)				
Water Quality	(2.7%)	$100,054	$35,019	$135,073
Water Quantity	(11.7%)	$431,181	$150,913	$582,095
Trunk Channels	(18.1%)	$665,547	$232,941	$898,488
	(32.6%)		Subtotal -	$1,615,656
Grand Total		**$3,676,133**	**$1,286,647**	**$4,962,779**

[1] Additional Cost estimates a 35% of subtotal cost for engineering, administration, interest and contingency.

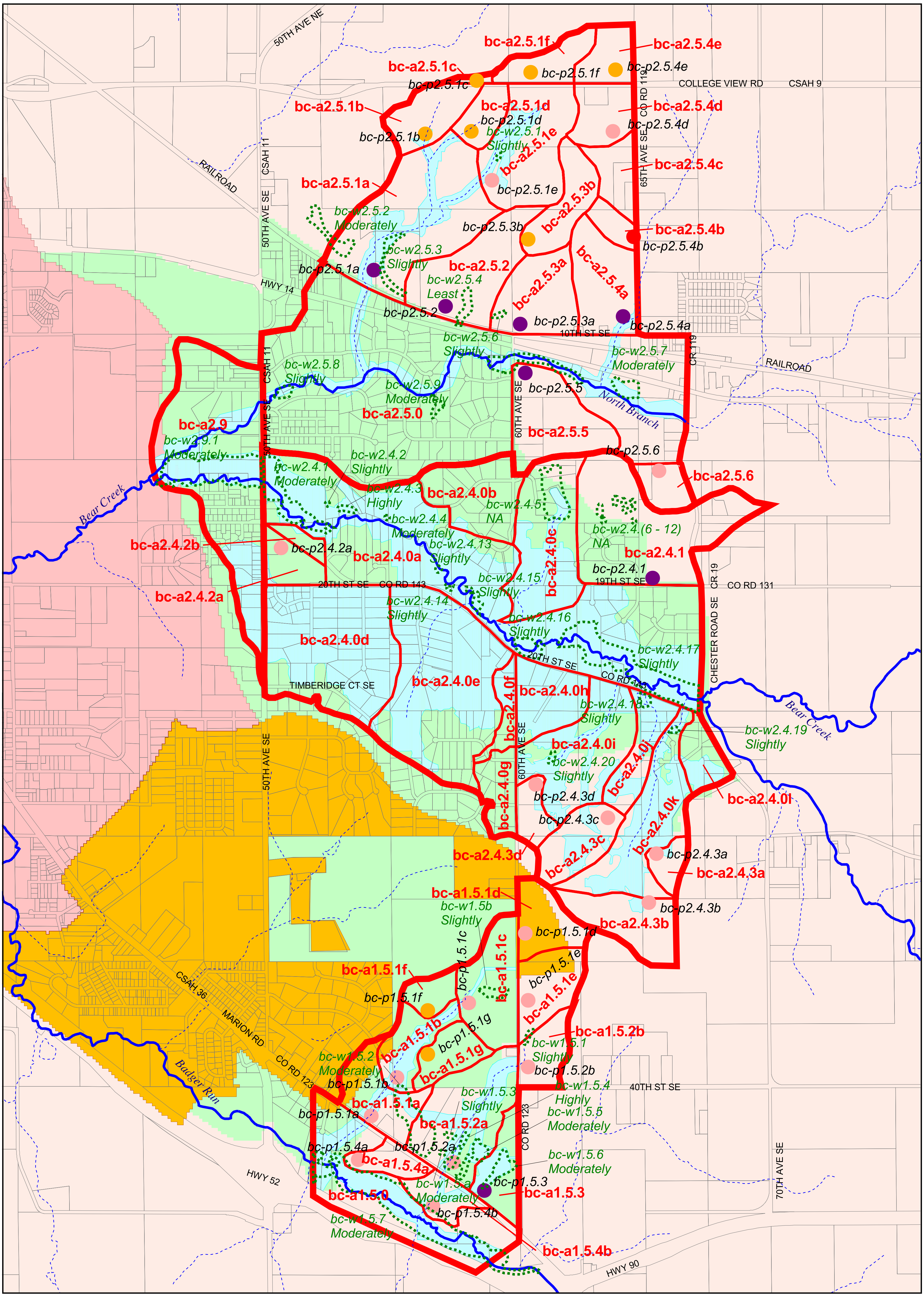
Note: Costs correspond to April 2002.

Cost Summary by Design Item

		Subtotal Cost	Additional Cost[1]	Total Cost
Ponds:				
Water Quality				
Bear Creek: Area A (District bc-a2.5)				
Land acquisition	(1.6%)	$58,470	$20,465	$78,935
Excavation	(2.7%)	$100,620	$35,217	$135,838
Bear Creek: Area B (District bc-a2.4)				
Land acquisition	(0.6%)	$23,333	$8,166	$31,499
Excavation	(1.1%)	$40,153	$14,053	$54,206
Badger Run: Area C (District bc-a1.5)				
Land acquisition	(1.0%)	$36,773	$12,870	$49,643
Excavation	(1.7%)	$63,281	$22,148	$85,430
	(8.8%)		Water Quality Subtotal -	$435,550
Water Quantity				
Bear Creek: Area A (District bc-a2.5)				
Land acquisition	(12.1%)	$446,482	$156,269	$602,750
Excavation	(3.2%)	$117,908	$41,268	$159,175
Outlet cost	(3.2%)	$117,000	$40,950	$157,950
Trunk pipe cost	(0.0%)	$0	$0	$0
Bear Creek: Area B (District bc-a2.4)				
Land acquisition	(3.9%)	$141,687	$49,591	$191,278
Excavation	(1.4%)	$49,822	$17,438	$67,260
Outlet cost	(1.2%)	$45,000	$15,750	$60,750
Trunk pipe cost	(0.0%)	$0	$0	$0
Badger Run: Area C (District bc-a1.5)				
Land acquisition	(7.3%)	$268,024	$93,808	$361,833
Excavation	(1.9%)	$68,657	$24,030	$92,687
Outlet cost	(2.6%)	$94,500	$33,075	$127,575
Trunk pipe cost	(0.0%)	$0	$0	$0
	(36.7%)		Water Quantity Subtotal -	$1,821,259
Pond Total	(45.5%)	$1,671,710	$585,098	$2,256,808
Trunk Channels:				
Bear Creek: Area A (District bc-a2.5)				
	(22.9%)	$841,312	$294,459	$1,135,771
Bear Creek: Area B (District bc-a2.4)				
	(13.5%)	$497,564	$174,147	$671,711
Badger Run: Area C (District bc-a1.5)				
	(18.1%)	$665,547	$232,941	$898,488
Trunk Channel Total	(54.5%)		$701,548	$2,705,971
Grand Total:			**$1,286,647**	**$4,962,779**

[1] Additional Cost estimates a 35% of subtotal cost for engineering, administration, interest and contingency.

Note: Costs correspond to April 2002.



LEGEND

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

- Minor Drainage Districts
- Drainage Subdistricts
- Stream Corridor
- Parcels

Land Use Designation
ROPD - June, 2002
- Resource Protection Area
- Suburban Development Area
- 25 Year Urban Service Area
- 50 Year Urban Reserve Area

Wetlands:
bc-w2.4.1: Wetland ID
Moderately: Storm Water Susceptibility
NA: No Access/Not Inventoried

- DNR Protected Watercourse
- Other Watercourses

City of Rochester

STORM DRAINAGE

Rochester Storm Water Management Plan
Bear Creek Addendum

Map 1

2000 0 2000 4000 Feet

N W E S

March 2004

Bonestroo Rosene Anderlik & Associates
Engineers & Architects

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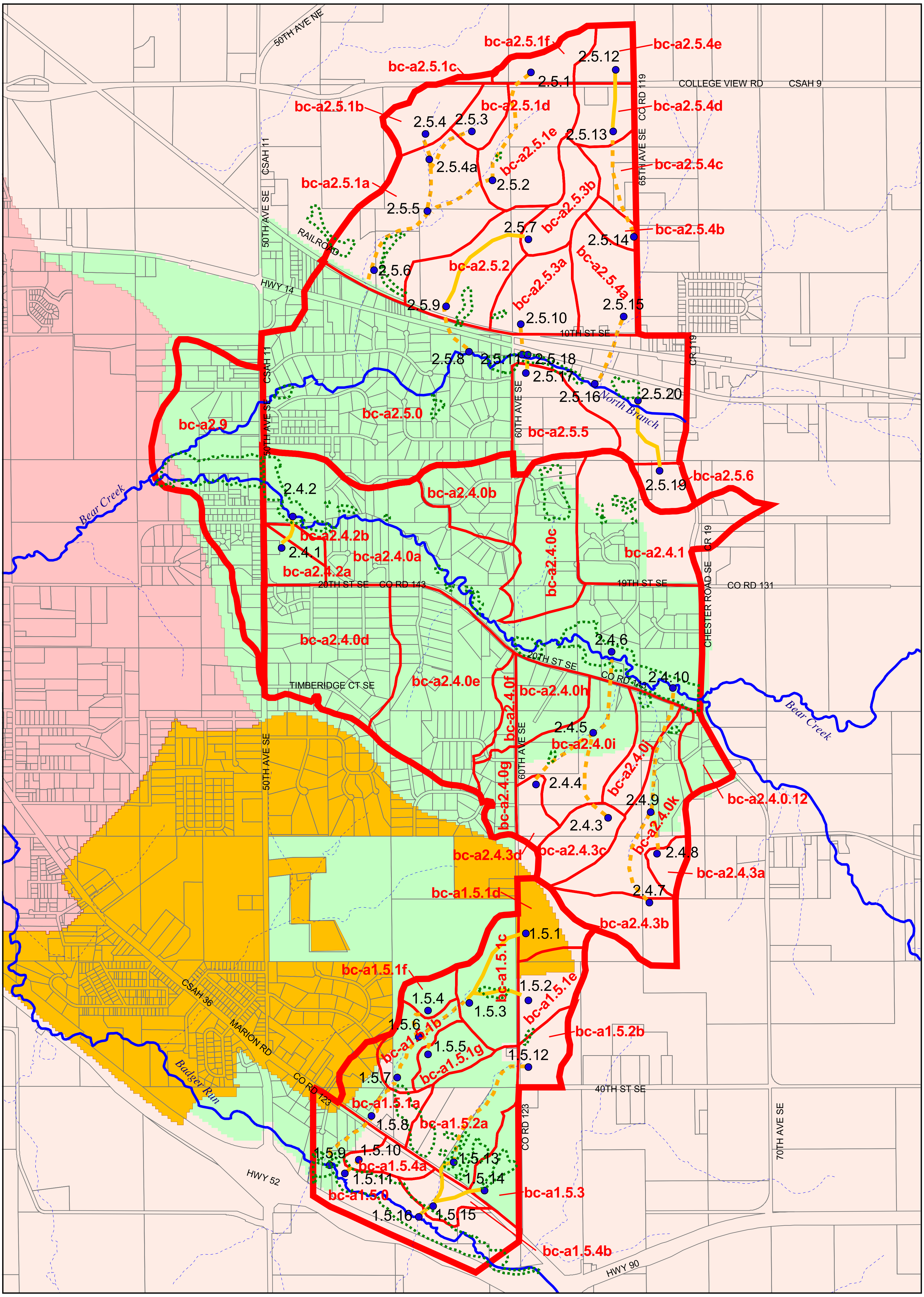
1) Data in Map are in Olmsted County Coordinate System.



LEGEND

Open Channels & Proposed Improvements
- Type BC-I Improve
- Type BC-I Stabilize
- Channel Node with ID
- Minor Drainage Districts
- Drainage Subdistricts
- Parcels

Land Use Designation ROPD - June, 2002
- Resource Protection Area
- Suburban Development Area
- 25 Year Urban Service Area
- 50 Year Urban Reserve Area
- Wetlands
- DNR Protected Watercourse
- Other Watercourses

2000 0 2000 4000 Feet

City of Rochester

TRUNK STORM CHANNEL

Rochester Storm Water Management Plan
Bear Creek Addendum

Map 2

N W E S

March 2004

ROCHESTER MINNESOTA

Bonestroo Rosene Anderlik & Associates
Engineers & Architects

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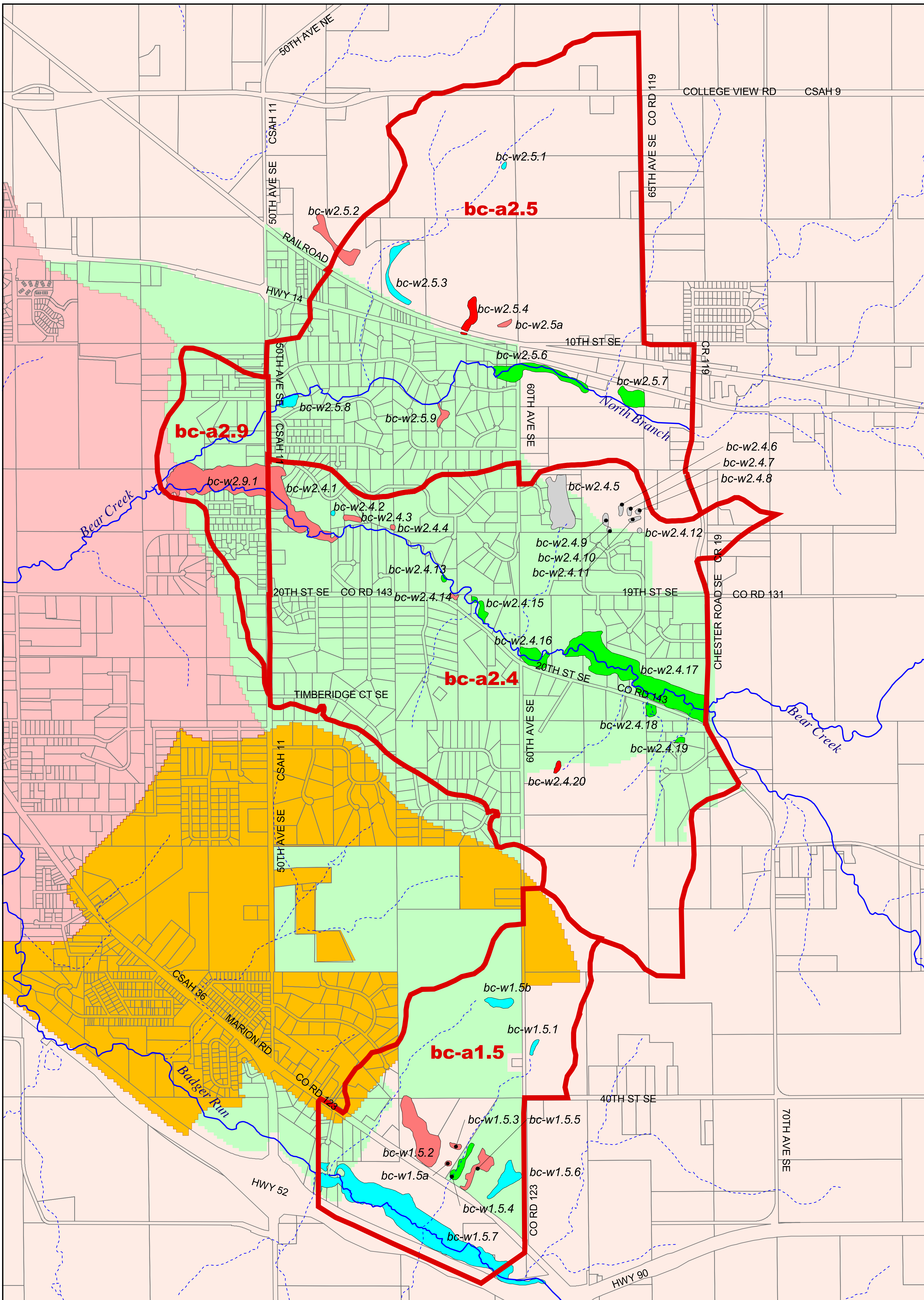
1) Data in Map are in Olmsted County Coordinate System.



Legend

Wetland Classification
- Unique
- Natural
- Ecosystem Support
- Ag/Urban Impacted
- No Access/Not Inventoried

Land Use Designation
ROPD - June, 2002
- Resource Protection Area
- Suburban Development Area
- 25 Year Urban Service Area
- 50 Year Urban Reserve Area

- Minor Drainage Districts
- Parcels
- DNR Protected Watercourse
- Other Watercourses

City of Rochester

WETLANDS

Rochester Storm Water Management Plan - Bear Creek Addendum

Map 3

2000 0 2000
Feet

N S W E

March 2004

ROCHESTER MINNESOTA

Bonestroo Rosene Anderlik & Associates
Engineers & Architects

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1) All Data in Map are in Olmsted County Coordinate System.