Loading Assessment and Nondegradation Report

For Selected Municipal Separate Storm Sewer Systems (Selected MS4s)

City of Burnsville, Minnesota

SEH No. A-BURNS0705.00

DRAFT - September 12, 2007

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EXECUTIVE SUMMARY

The revised National Pollutant Discharge Elimination System (NPDES) Permit No. MNR040000 for Small Municipal Separate Storm Sewer Systems (MS4s) defines the conditions for discharging storm water from municipal sources in Minnesota. The primary requirement of the permit, which has been in place since 2003, is to develop and implement a Storm Water Pollution Prevention Program (SWPPP) that addresses each of the six minimum control measures. A new provision in the reissued 2006 permit requires 30 Minnesota municipalities to complete a nondegradation assessment and report. These 30 municipalities are referred to as Selected MS4s.

Based on the findings of the assessment, Selected MS4s are required to submit additional information to the Minnesota Pollution Control Agency (MPCA) Commissioner and to determine whether additional control measures, beyond those already identified in their SWPPP, can be reasonably taken to minimize the impacts of new or expanded discharges. Burnsville is one of the 30 Selected MS4s and, therefore, the City has completed a loading analysis and has prepared this report to comply with the requirements of the permit. The nondegradation assessment consists of determining the change in loading of annual runoff volume, total suspended sediment (TSS), and total phosphorus (TP) between 1988 and current conditions (2005) and between current conditions and projected future conditions (2020).

A detailed analysis of 30 years of recorded daily precipitation data was completed to determine the annual average precipitation and runoff volume for the Burnsville area. The annual runoff volume for a given area is a function of the relative amount of impervious and pervious areas as well as the runoff curve number for each portion. On an annual basis, the impervious portions of Burnsville contribute nearly 95 percent of the runoff volume. The impervious fraction for year 2005 for individual watersheds ranges from 4 percent to 85 percent, while the corresponding average annual runoff depth for the 156 drainage areas evaluated varies from 1.8 inches to 16.4 inches. The overall annual runoff volume from 1988 to 2005 has increased roughly 12 percent.

In order to evaluate the effects of the City's infiltration/filtration standard for new development in the future, annual runoff volume estimates for the 2005 to 2020 time period considered the effects of capturing a 1-inch runoff volume for projected areas of future development. Based on this analysis, the estimated annual runoff volume will decrease between 2005 and 2020 by about three percent. The annual runoff volume in 2020 is still estimated to be higher than levels in 1988. The overall increase in annual runoff volume relative to 1988 conditions is not considered significant when evaluating the potential effects on channel erosion and stream

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morphology. The City is not aware of any channel erosion or stability issues that are directly attributable to an increased runoff volume.

Results of the loading analysis for TSS and TP for the 1988 to 2005 time period on a City-wide basis show a decrease in the TSS loading of approximately 245 tons and a small increase in the TP loading of 60 pounds. When assessing the distribution of these loading changes on a subwatershed basis, the results vary from essentially no change in TP loading in the Lac Lavon subwatershed to an increase in TP loading in the Sunset Pond subwatershed of an estimated 170 pounds on an annual basis. Similar variations are apparent in the more detailed data for each of the 156 individual drainage areas. A summary of the loading analysis results is provided in the following table.

Summary of Loading Assessment Results

Year	Imp. surface (acres)	Imp. %	Runoff Volume (ac-ft)	Annual TSS (tons)	Annual TP (lbs)	Comments
1988	5,723	33.1%	10,145	1,379	9,104	Assuming No Storm Water Treatment
2005	6,563	38.0%	11,409	1,134	9,162	Assuming Storm Water Treatment by Ponds Only - Based on Ponds Created between 1988 and 2005
2020	7,748	44.9%	11,061	1,021	8,783	Runoff volume, TSS, and TP loads are assumed for the new impervious areas. Revised development and redevelopment standards considered.
1988 to 2005 relative changes	+840	+14.7%	+12.4%	-17.7%	0.65%	Increase in Runoff Volume, Reduction in TSS and minor increase in TP loading
2005 to 2020 relative changes	+1,185	+18.1%	-3.1%	-10.0%	-4.1%	Decrease in Runoff Volume, TSS and TP levels. TP and TSS reductions below 1988 levels and volume below 2005 levels.

Based on projected changes in land use, the overall increase in impervious surface between 2005 and 2020 is estimated to be approximately 1,185 acres. This increase represents an impervious percentage increase city-wide from 38.0 percent to 44.9 percent. Even with this increase in the impervious surface coverage projected by 2020, the net increase in annual runoff volume will be substantially reduced due to implementation of storm water treatment practices focusing on infiltration and filtration. Implementation of the City's proposed standards for new development and redevelopment between 2005 and 2020 will result in a net reduction in TSS loading of 113 tons and a reduction in TP loading of an estimated 381 pounds annually by the year 2020.

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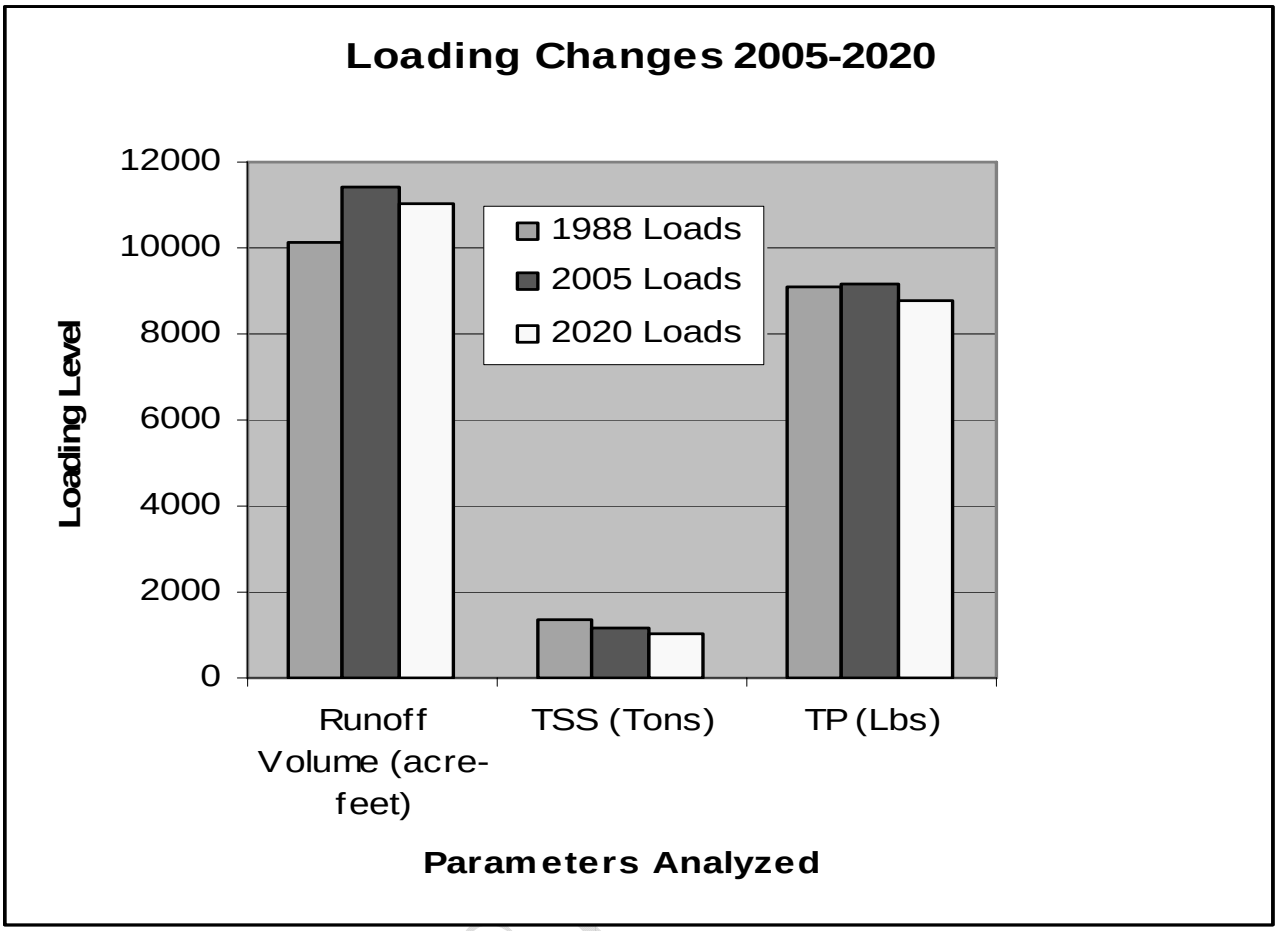

The City is in the process of updating its 2002 Water Resources Management Plan. One of the main components of the update is in the revision to storm water management standards for new development and redevelopment projects. While some of the details for specific project types are still being evaluated, the basic approach to future projects will be the following:

- New Development: Implement BMPs to achieve 90% TSS and 60% TP removal, including a requirement for infiltration/filtration of 1-inch of runoff volume.
- Redevelopment: Implement BMPs to achieve 70% TSS and 30% TP removal, including a requirement for infiltration/filtration of 0.5-inch of runoff volume.
- Infiltration will not be allowed within the City's wellhead protection areas that have a high sensitivity to groundwater contamination.

While the 1988 to 2005 loading assessment shows an increase in the runoff volume due to the expansion of impervious surfaces from 1988 to 2005, TSS loadings have decreased, and the TP loadings increased only

slightly relative to 1988 levels. This result relates chiefly to the fact that numerous storm water treatment ponds accompanied the new development and re-development that occurred between 1988 and 2005. The results show that these ponds are working to remove significant amounts of total suspended sediment and phosphorus from storm water runoff.

Looking into the future, the projected level of development between 2005 and 2020 will continue to add impervious surface and result in additional annual runoff volume. Runoff infiltration is expected to play an increasingly important role in storm water management. The City is currently in the process of adopting new standards for storm water management which will place the focus on infiltration or filtration. The proposed standards will essentially translate into runoff volume control for both new development and redevelopment. The runoff infiltration or filtration practices have the potential to offset the increase in runoff volume caused by the expansion of impervious surfaces.

Based on this analysis and related work the City has done as part of it's overall water resources management program, the City is proposing to make changes to it's SWPPP. These changes will consist of formalizing the changes to the development and redevelopment standards described above as part of the current update to the City's Water Resources Management Plan. By adopting the updated WRMP, these standards will then be incorporated by reference into City ordinances and become an enforceable component of the City's SWPPP. The City plans to complete the WRMP update by the end of 2007.

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City of Burnsville, Minnesota

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1.0 Introduction

1.1 MS4 Permit – General Requirements for Selected MS4s

Minnesota Permit No. MNR040000 for Small Municipal Separate Storm Sewer Systems (MS4s) defines the conditions for discharging storm water by all small municipalities and other entities for which the permit is required. The main requirement for all permit applicants is to develop and implement a Storm Water Pollution Prevention Program (SWPPP). Part X (Appendix D) of the permit includes non-degradation provisions for 30 Minnesota municipalities referred to as "Selected MS4s".

The Selected MS4s are required to submit additional information to the Minnesota Pollution Control Agency (MPCA) Commissioner and "to determine whether additional control measures beyond those of the permit … can be reasonably taken to minimize the impacts of the discharges." Burnsville is one of the 30 Selected MS4s and, therefore, the City has completed a loading analysis and has prepared this report to comply with the requirements of the permit.

The permit stipulates that those "Selected MS4s that have significant new or expanded discharges" are required to complete a "Nondegradation Report." MPCA's March 2006 Permit Guidance Manual provides some background regarding the significance of new or expanded discharges and how these requirements relate to nondegradation. However, the guidance also states that the application of significance has not been fully defined for MS4s. For the purposes of this analysis and report, MPCA's guidance states that "Nondegradation is achieved if the 1988 levels of flow and pollutants can be achieved." The Selected MS4 can demonstrate that 1988 loading levels can be achieved through implementing additional Best Management Practices (BMPs) as part of their MS4 program.

The specific information to be submitted as part of the Nondegradation Analysis consists of:

1. A loading assessment;
2. A Nondegradation Report;
3. Proposed Storm Water Pollution Prevention Program (SWPPP) modifications to address non-degradation;
4. Public and local water authority comments on the proposed SWPPP modifications to address non-degradation, with a Record of Decision on the comments; and
5. An application to modify the permit, if changes are proposed.

According to the permit, the MPCA "will review the above submittals and will make a determination on the preliminary approval of the proposed Storm Water Pollution Prevention Program." The loading assessment consists of determining the annual Runoff Volume (VOL), the Total Suspended Sediment (TSS), and the Total Phosphorus (TP) for three particular years: 1988 (past conditions), 2005 (present conditions), and 2020 (future conditions).

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1.2 Burnsville Overview

The City of Burnsville is one of the 30 Selected MS4s, due in part to its total population and growth in recent years. Located in the southern part of the Twin Cities Metropolitan Area, the City of Burnsville has a total surface are of approximately 17,200 acres (27 square miles). Between 1990 and 2000 the population of Burnsville increased by 17.5 percent, from approximately 51,250 to approximately 60,220. At present growth rate the total population is expected to reach about 63,000 by 2020. However, recent housing starts data for 2007 point to a slowdown in residential development, both across the region and within the City of Burnsville.

Burnsville covers approximately 17,200 acres, of which approximately 2,713 acres, or 16 percent, is wetlands or other water features. These surface water resources include several lakes, 268 wetlands, 59 storm water or other created ponds, and portions of three designated trout streams that are located wholly or partially within the City. One of the most prominent features in the City is the Minnesota River and the extensive backwater and wetlands associated with it including the Black Dog Fen.

The following list summarizes some of the City of Burnsville's physical characteristics:

- Total surface: Approximately 17,200 acres (27 square miles).
- Bounded by the Minnesota River to the North, City of Savage to the West, City of Lakeville to the South and the Cities of Eagan and Apple Valley to the east.
- As of the US Census of 2000, there were 60,220 people, 23,687 households, and 15,633 families residing in the city. The population density was 2,421 people per square mile and 24,261 housing units at an average density of 975 units per square mile.
- Major Highways include I-35 and the south-metro I-35W/I-35E split, Minnesota State Highway 13.

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- More than 2700 acres of surface water features including lakes, ponds, wetlands and stream segments.
- Surface water system that is part of three watershed organizations: Black Dog Watershed Management Organization (BDWMO); Lower Minnesota River Watershed District (LMRWD); and Vermillion River Watershed Joint Powers Organization (VRWJPO).

2.0 Burnsville Physical Characteristics

Physical characteristics and data needed for this analysis includes previously defined watershed and drainage area boundaries, historical precipitation data for the Burnsville area (to quantify annual runoff volumes), zoning or land use mapping and known land use changes, if available, for each of the three study years. Each of these data sets is discussed below.

2.1 Watersheds and Drainage Areas

Most of Burnsville lies within the larger Minnesota River Basin in east central Minnesota. The Minnesota River Basin includes several smaller watershed units including the Lower Minnesota and Black Dog (including the old Credit River watershed). About 6 percent of Burnsville is within the Vermillion River watershed, which is part of the Mississippi River basin.

The City has delineated watersheds and sub-watersheds within its boundaries using a GIS-based process that interprets the drainage patters and flow routing from the 2-foot Dakota County contour data. The drainage area delineation completed during this analysis generally follows the areas defined in the City's 2002 Water Resources Management Plan (WRMP), and preserves the major drainage boundaries between the three watershed organizations. The refined delineations were completed to better identify drainage basins with the newer contour data and to allow the loading analysis to be consistent with the areas defined in the City's WRMP Update that is currently underway.

The City's drainage system generally consists of urban areas with storm sewer and treatment systems (ponds, rain gardens, infiltration basins) that

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provide treatment of the storm water runoff and detention of design flows for flood risk management. In southwest Burnsville, areas of rural residential land use exist where the drainage system consists primarily of vegetated ditches that are routed to storm water ponds.

A detailed breakdown of each watershed by land use category is included in the summary tables in the appendix of the report. Most of this data is included in the appendix due to the large number of individual drainage areas defined for the City (156). The summary tables also show the aggregate percentage of impervious surface based on the assumptions made for each land use category and pollutant removal estimates as discussed later in this report.

2.1.1 Vermillion River Watershed

The Vermillion River Watershed dominates most of Dakota County. The watershed stretches from Elko/New Market in the southwest to Lake Alimagnet in Burnsville in the northwest to Hastings in the east before discharging to the Mississippi River upstream of Red Wing.

2.1.2 Black Dog Watershed

The Black Dog Watershed covers parts of Burnsville, Lakeville, Apple Valley, Eagan and Savage. It includes the old Credit River watershed that covers southwest Burnsville. About 67 percent of Burnsville is within the Black Dog Watershed, comprising about 72 percent of the total watershed area. One of the primary goals of the watershed management organization (WMO) is to maintain or improve quality in the key ("strategic") water bodies in the watershed. Four lakes have been identified as strategic water bodies by the Black Dog WMO: Crystal Lake; Keller Lake; Lac Lavon; and Sunset Pond. The WMO will monitor these water bodies, but leave direct management in the hands of the City. None the less, Burnsville's water quality goals for these water bodies must meet or exceed the reasonably attainable water quality goals established by the Black Dog WMO. The WMO will also facilitate solutions to inter-community problems.

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2.1.3 Lower Minnesota River Watershed

The remaining 27 percent of Burnsville lies within the Lower Minnesota River Watershed District (LMRWD). The LMRWD stretches along the Minnesota River valley from St. Paul to Chaska, mirroring the river both north and south. Significant resources that lie within both Burnsville and the Lower Minnesota River Watershed District include the Minnesota Valley National Wildlife Refuge, and Black Dog Lake.

2.2 Annual Precipitation and Runoff Data

2.2.1 Precipitation Data Analysis

Weather estimate statistics are typically based on a 30-year interval of records. The rainfall distribution for Burnsville has been assessed based on complete daily precipitation records from 1976 to 2005 for the Dakota-Bloomington weather station (Station No. 215435; 27N-24W-S33). This is the closest station to the City of Burnsville. From this data set, the average total annual rainfall was determined to be 30.3 inches. It is generally assumed that only 90 percent of the total precipitation generates runoff. In the data record used for this study, all the precipitation events greater than 0.15 inches are assumed to generate runoff. A summary of the annual rainfall averages is provided Table 1.

Table 1. Burnsville Area Annual Precipitation Summary

	All Precipitation Events (1)	Runoff Generating Precipitation Events
Average Annual Number of Precipitation Days	185.0	51.3
Total Annual Average Precipitation (inches)	30.3	27.7
Average Precipitation Event Depth (inches)	0.16	0.54
Median Precipitation Event Depth (inches)	0.11	0.37

(1) Includes data listed as "T" for trace precipitation. T days are included in the total and averages listed.

2.2.2 Runoff Volume Estimates

Determining the runoff volume on an annual basis can be somewhat complex. For each watershed the annual runoff is a function of soil

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characteristics, rainfall distribution, amount of total impervious and the distribution of the impervious surfaces (i.e., connected versus disconnected). The issue is further complicated due to the fact that soil characteristics may vary seasonally and/or with the rainfall distribution (i.e., frozen, wet, moist or dry).

State-wide estimates for the annual runoff indicate that within the Burnsville area the runoff is in the 5 inch range. This state wide estimate of the runoff was derived from stream flow measurements, and it should be noted that not all of the runoff volume that reaches the stream represents surface water flow. Instead, a fraction of this volume reaches the streams as groundwater flow. The Hydrology Guide for Minnesota produced by the Natural Resources Conservation Service (NRCS) also shows the Annual Runoff for the Burnsville area to be approximately 5 inches.

A common way to compute the runoff volume is the NRCS Curve Number (CN) Method. The Curve Number is a combined measurement of both soil infiltration capacity and surface coverage (i.e., land use). It ranges from a CN value of 30 for the most pervious natural surfaces such as sandy soils woods and meadows to a CN value of 98 for impervious surfaces such as streets and parking lots. Soils are grouped into four hydrologic soil groups A, B, C, and D. Group A soils represents the most pervious soils (typically very sandy) and Group D soils the least pervious (typically organic soils with high clay content). In each soil group, cropland, high density residential, commercial, and industrial areas tend to have the highest CN values. At the opposite end, wooded areas and meadows have some of the lowest CN values.

The aggregate curve number for pervious surfaces within the City of Burnsville is approximately 69, which is also a representative CN value for Group B lawns and pastures soils characterized by a “fair” (i.e., moderate) grass coverage.

The runoff depth (i.e., depth of surface water if the runoff were evenly distributed across the entire drainage area) was computed for each significant individual precipitation event between 1976 and 2005 using the same NRCS

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formula, and applied separately for pervious and impervious portions:

$$Q_p = \frac{[P - 0.2*(1000/CN_p - 10)]^2}{P + 0.8*(1000/CN_p - 10)} \quad Q_i = \frac{[P - 0.2*(1000/CN_i - 10)]^2}{P + 0.8*(1000/CN_i - 10)}$$

where P represents the precipitation level expressed in inches.

Using CN = 98 for impervious surfaces and CN = 69 for pervious surfaces the average annual runoff depth was computed for both pervious and impervious surfaces by summing the results for all runoff producing precipitation events and dividing the sum by 30 years.

Table 2. Annual Runoff Depths for Pervious and Impervious Areas.

Date of Record	Precipitation (in)	Pervious Surfaces Runoff Depth (in)	Impervious Surfaces Runoff Depth (in)
30-year Sum	830.8	32.0	573.7
Annual Average	27.7	1.07	19.12
Annual Average with 1-inch Infiltration BMPs in place (1)	27.7	0.38	2.93
Annual Average with 0.5-inch Infiltration BMPs in place (2)	27.7	0.36	6.19

(1) Assumes first inch of runoff is captured by BMPs. Runoff depth represents what is leaving the site on an annual basis.
(2) Assumes first 0.5 inches of runoff is captured by BMPs. Runoff depth represents what is leaving the site on an annual basis.

The computations summarized in Table 2 indicate that the vast majority of runoff is generated from impervious surfaces. Knowing the average annual runoff depths for both pervious and impervious surfaces, the total annual runoff depth of an area can be estimated by adding the pervious fraction runoff depth and impervious fraction runoff depth:

$$Q = Q_i \times i + Q_p \times (1 - i)$$

where *i* is the impervious percentage of the area.

The impervious fraction for year 2005 for individual watersheds ranges between 4 percent and 85 percent, while the corresponding average annual runoff depth for the 156 watersheds evaluated varies from 1.8 inches to

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16.4 inches. The aggregate average City-wide annual runoff volume for year 2005 is approximately 7.8 inches.

In order to evaluate the effects of the City's infiltration/filtration standard for new development in the future, an annual runoff volume was also estimated that accounted for capturing a 1-inch runoff volume. This was computed in two ways. The first method reduced each daily rainfall depth in the 30-year record by 1 inch and recomputed the runoff volumes as discussed above. The second method reduced the runoff depth by 1 inch for each individual event and pervious and impervious fractions. The average annual runoff depth was 2.93 inches for the first method and 2.76 for the second. The more conservative depth of 2.93 was used in the computations of future loadings after implementation of the infiltration BMPs. The results suggest that the 1-inch standard would capture an estimated 85 percent of the annual runoff volume from (new development) impervious surfaces.

A similar computation was completed for a 0.5 inch runoff volume to evaluate the effect of the proposed 0.5-inch volume control standard for redevelopment projects. The results show that the 0.5-inch level would capture an estimated 67 percent of the annual runoff volume from the redeveloped impervious surfaces.

2.3 Land Use Data Assessment

2.3.1 Current (2005) Land Use

An evaluation of the current (2005) land use has been done using the City of Burnsville's mapped Land Use Plan and a 2005 high-resolution aerial map. There are approximately 29 zoning categories defined by the Land Use Plan. The Plan consists of large and mostly regular shaped polygons. A close examination of these polygons against the physical characteristics of the terrain reveals that land use polygons have been defined more from a zoning perspective. Therefore, discrepancies exist between the land use shown on the plan and actual physical land uses observed in the aerial photography. For example, a large area may be considered to be 'Commercial', when in reality only a portion of the area has been developed and the other portion of the area is still 'Open Space'.

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In order to create a true, physically based, land use map, the polygons defined in the Land Use Plan were adjusted based on the aerial photography. Comparing the aerial photography mapping against the Land Use Plan shows that many of the polygons in various land use categories include swaths of open space, much of which is largely undeveloped. This land will most likely be developed in the future, but for the 2005 analysis the polygons were designated as open space in order to get a more accurate picture of the existing impervious surface area in the City in 2005.

To simplify this analysis and better align the variations in Land Use files between the 1998-2005-2020 years of interest to typical levels of imperviousness, Burnsville's Land Use categories were combined into fewer Generalized Land Use Categories as presented in Table 3. A representative percent impervious was assigned to each generalized category.

The percent imperviousness that was assigned for each land use type was compared against the LandSat Remote Sensing Imagery (Landsat) assembled by the University of Minnesota as a check on the percentages. Landsat produced imperviousness data was evaluated in detail during the early stages of this analysis for its applicability. It was determined that the LandSat Remote Sensing Imagery was not a true or consistent representation of the percent imperviousness for the study years.

The average impervious fractions for Low Density, Medium Density, and High Density Residential areas were determined to be 12%, 30%, and 65%, respectively. In residential areas where there are significant portions of open space the land use polygons were adjusted to add more open space areas. Therefore the percent impervious assumed for the residential areas is a more accurate representation based on actual land cover. Street surfaces are captured separately under the Right of Way category and the open water areas were designated zero percent impervious. A zero percent impervious assumption was used because these bodies of open water do not generate a net runoff volume since evaporation slightly exceeds precipitation an average annual basis in this part of Minnesota.

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Table 3. Land Use Description, Breakdown and Assigned Percentage of Impervious Area

Burnsville Land Use Category	Generalized Land Use Category	Index - ID	Land Use Area (acres) (1)			Assigned % Impervious
			1988	2005	2020	
Cemetery Golf Course Open Space Park/Open Space Vacant	Open Space	OS	6,415	4,303	2,822	5%
Church Commercial Recreation Business General Business Hospital Neighborhood Business Office and Industrial Park Office Business School Senior Public Vacant	Commercial	C	1,158	1,755	2,282	85%
General Industry Industrial Park Vacant	Industrial	IND	630	712	1,260	72%
High Density Residential Mobile Home Park	High Density Residential	HDR	146	172	815	65%
Medium Density Residential Single Family Residential	Medium Density Residential	MDR	3,847	5,083	4,630	30%
Mining	Mining	MINE	456	456	488	50%
Mixed Use	Mixed Use Medium	MIX-M	5	5	132	65%
Right of Way Utility	Right of Way	ROW	2,875	2,898	2,873	85%
Rural Residential	Low Density Residential	LDR	354	447	531	12%
Water – wetland Water – lake Water – pond Water – rain garden	Water	W	1,379	1,434	1,434	0%
TOTAL AREA (acres)	**17,266**	**-**	**17,266**	**17,266**	**17,266**	**-**

(1) The changes in land use acreages from 2005 to 2020, relate to the procedures of this analysis. For example, areas listed as mining land use but shown as open space in 1988 and 2005 aerial photographs, were modified in both the 1988 and 2005 land use files to be considered open space. These same areas for the 2020 analysis were left as shown in the 2020 Land Use Plan as mining. This same procedure was also completed for other land use categories, but may be most evident in the mining category.

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2.3.2 Land Use Changes from 1988 to 2005

The most significant change between 1988 and 2005 has been the increase in residential and commercial, and the decrease in open space. Most of the residential developments that were built during this interval fall under the category of Medium Density Residential in the form of single-family homes.

The storm water ponds constructed in conjunction with the residential developments contributed to a slight increase in the open water surface area. Another land use change between 1988 and 2005 was the addition of commercial and office buildings, primarily along the County Road 42 corridor. A slight increase in light industrial land has occurred as well.

Based on comparison of detailed aerial photographs and a review of the development projects completed during this time period, approximately 100 drainage areas were identified as having some new or re-development activity between 1988 and 2005. Figure 2, in Appendix A, and the data summary tables in Appendix C and D show the changes in land use, percent impervious and estimated loading changes from 1988 and 2005.

The summary tables in the appendix show a net increase in impervious surface of 840 acres. Relative to the total surface of the City (17,266 acres), this translates into a net relative increase of approximately 4.8 percent (i.e., from 33.1 percent to 38.0 percent).

2.3.3 Land Use Changes from 2005 to 2020 (Projected)

The changes in land use between 2005 and 2020 are anticipated to consist of some new development in southwest Burnsville, new and redevelopment in the Minnesota River Quadrant in northwest Burnsville and in-fill and redevelopment in the main transportation corridors along I-35, I35-W, I-35E TH 13 and County Road 42. Most of the residential development will fall under the category of low density residential (LDR) development. Some increase in commercial, office, and light industrial space is expected as well.

Land use changes throughout the City have been incorporated into the loading analysis for new development while only 33 drainage areas were given credit towards loading reductions from redevelopment activity. Based

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on discussions with City staff and our understanding of future development potential in the City, 33 drainage areas were identified as likely to experience the most significant re-development activity between 2005 and 2020. This limited application of the loading reductions from the City's proposed redevelopment standards produces a conservative estimate of the loading reductions city-wide while capturing the larger areas where the most significant redevelopment will occur.

A summary of the areas subject to development between 2005 and 2020 are shown in Figure 3 and in the summary tables in the appendix. The summary tables show a net projected increase in impervious surface by 1,185 acres. Relative to the total surface of the City (17,266 acres) this translates into a net relative increase of approximately 6.9 percent (i.e., from 38.0 percent to 44.9 percent).

3.0 Loading Assessment

As explained above, for each watershed the annual runoff volume was estimated as a function of impervious fraction based on the precipitation distribution from 1976 to 2005, using an average curve number of 69 for pervious surfaces and a curve number of 98 for all impervious surfaces.

The TSS and TP loadings were computed using the constant concentration assumption. Because year 1988 was used as the baseline for the loading comparison, the 1983 NURP average concentration values of 100 mg/L for TSS and 0.33 mg/L for TP were used to determine the total TSS and TP loadings. The same concentration values were conservatively applied for years 2005 and 2020, although measures such as improved sweeping practices between 1988 and 2005 and the effect of the NPDES Phase II Permits adopted in September 2003 are likely to lower the overall TSS and TP average concentrations for years 2005 and 2020 as compared to 1988.

As specified in the MS4 Permit and MPCA guidance, the analysis is required to be in the form of a relative comparison and not a true representation of the loading from various sources or areas. Therefore, the values selected for this analysis are reasonable estimates of the load concentrations.

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3.1 1988 Loading Assessment Evaluation

Year 1988 was used as the baseline for comparison. The runoff volume for each watershed and on a City-wide basis was computed (as presented above) by adding the runoff volume from pervious portions (average CN = 69) to the runoff volume from the impervious portions (CN = 98). The TSS and TP loadings were computed by multiplying the runoff volume by average concentration values of 100 mg/L for TSS and 0.33 mg/L for TP. Storm water treatment facilities, such as ponds, that would result in TSS and TP reductions were not considered in the 1988 analysis.

The results for the year 1988 land use and loading analyses serve as a baseline for comparison and they represent an estimate of the TSS and TP loadings at the source, not the actual effluent loadings which are likely to be lower due to the Best Management Practices actually in place during 1988. Again, because the MPCA has requested a relative loading comparison, this approach allows a reasonable baseline, without expending substantial efforts to quantify what BMPs were in place in 1988.

3.2 2005 Loading Assessment Evaluation

The same procedure discussed in previous sections was used to determine the runoff volumes and loading levels for 2005. Table 4 summarizes the changes in impervious area and the corresponding changes in loading of the three parameters of interest between 1988 and 2005.

The increase in impervious surface between 1988 and 2005 translates into an increase in the annual runoff volume of an estimated 1,264 acre-feet. Reductions in runoff volume that would be occurring from infiltration BMPs were not factored into the analysis for the 1988 to 2005 time period. TSS and TP loadings were assessed based on the same constant concentration assumptions used for year 1988. Thus, an increase in runoff volume would result in a proportional increase in TSS and TP that is generated at the source. Calculated reductions in the 2005 loadings was based on the storm water treatment ponds, rain gardens, infiltration systems and other BMPs

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constructed between 1988 and 2005. While some of these BMPs established in the early 2000's were designed as infiltration/volume control systems, only the TSS and TP removal estimates were applied to these BMPs as part of the 1988 to 2005 analysis.

Table 4. Impervious Surface and Loading Changes from 1988 to 2005.

Drainage Area Name (ID)	Drainage Area (ac)	Change in % Impervious Area 1988 - 2005	Change in Runoff Volume (ac-ft) 1988 - 2005	Change in TSS Loading (tons) from 1988 - 2005	Change in TP Loading (lbs) from 1988 - 2005
Black Dog East (BDE)	642	+ 3%	25.1	-5.5	-14.4
Black Dog West (BDW)	1677	+ 2%	47.4	-40.4	-86.4
Central (C)	2158	+ 4%	114.9	-44.4	-75.0
Crystal Lake (CL)	744	+ 2%	20.8	-3.1	8.0
East (E)	1728	+ 4%	93.4	-19.0	8.3
Keller Lake (KL)	651	+ 5%	47.6	-18.9	-20.7
Lake Alimagnet (LA)	867	+ 7%	88.8	-24.5	-6.4
Lac Lavon 1 (LL1)	47	0%	0.22	0.03	0.20
Murphy Hanrehan (MH)	1469	+ 4%	92.4	-9.8	59.4
Northwest (NW)	2177	+ 2%	57.6	-33.9	-28.1
To Savage (OUT1)	20	0%	0.00	0.00	0.00
River Hills (RH)	668	+ 1%	14.4	2.0	12.9
Sunset Pond (SP)	2695	+ 13%	513.9	-34.1	169.9
West 9 (W9)	1723	+ 6%	147.4	-13.2	32.1
TOTAL	**17,267**	**+ 5%**	**1264**	**-245**	**59.8**

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Between 1988 and 2005 the overall impervious surface increased by 840 acres from 33.2 percent to 38.0 percent. Storm water treatment ponds associated with new developments were constructed during the same period and were accounted for in this analysis. Aerial photographs of the 1988 and 2005 conditions were compared to the current (2007) GIS shape files for

water bodies through out the City. Ponds that were in place during 1988 were removed from the 2007 (current) file to produce a shape file that accounted for only new ponds created during the 1988 to current conditions. This file was used as the basis for treatment reductions for TSS and TP in the 1988 to 2005 analyses.

New ponds were given a conservative estimate of treatment volume based on the surface area of each pond, as taken from the GIS shape file. Assuming an average pond depth of 3 feet (typical and likely conservative), for new storm water ponds the total dead storage volume provided by storm water ponds is approximately 166 acre-feet. In certain key areas and where the treatment volume was known from recent development, information on dead storage of new storm water ponds were adjusted to known conditions. For example, the regional pond for the Heart of the City was adjusted to account for the designed treatment volume instead of using the 3-foot average depth estimate.

The results overall suggest that the new ponds constructed between 1988 and 2005 have a capacity, on average, of treating the storm water runoff from the new impervious surfaces of approximately 58 percent TSS and 38 percent TP removal. This treatment applies to both the new impervious surface created between 1988 and 2005 and to storm water runoff from the older adjacent impervious surfaces within the watershed whose runoff is routed through these ponds and treatment systems. This estimate seems reasonable, yet conservative, given that Burnsville has had standards in place since 1988 that have required treatment from 50 percent removal of TSS for discharges to management class waters to 90 percent removal of TSS for discharges to improvement class waters. The net effect of the new ponds shows a reduction of 245 tons of TSS for year 2005 as compared to year 1988 and a net increase in the TP of 60 pounds for year 2005 as compared to year 1988.

The removal efficiency of a BMP for TSS and TP is based on particle settling dynamics. Results from numerous P8 model runs illustrated in Figure 1 show a logarithmic relationship between the pond storage volume relative to the runoff level and the particle removal effectiveness. In short,

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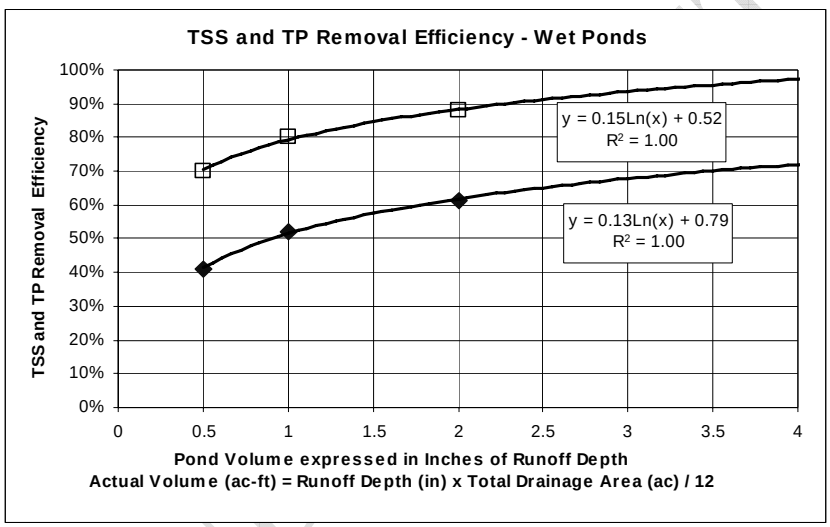
ponds having a dead storage capacity that is equivalent to the runoff volume resulting from 0.5, 1.0, and 2.0 inch rainfall events can retain approximately 70, 80, and 90 percent of the TSS and approximately 40, 50, and 60 percent of the TP, respectively.

Figure 1. Modeled TSS and TP Removal Efficiency for Wet Ponds



Detailed results of the loading assessment for the 1988 to 2005 time period, and for each subwatershed and drainage area, are provided in the spreadsheet files included in the appendix and are presented graphically in Figure 2.

3.3 2020 Loading Assessment Evaluation

Impervious levels for year 2020 were determined by analyzing the areas where land use changes are expected to occur between current conditions and 2020. In general, the expected changes are focused in the Northwest subwatershed in what the City refers to as the Minnesota River Quadrant and in southwest Burnsville in the Murphy Hanrehan subwatershed. Areas of redevelopment will also occur and will likely be focused in the transportation corridors around I-35W and TH13.

Based on the projected changes in land use, the overall increase in impervious surface between 2005 and 2020 is approximately 1,299 acres. This increase represents and impervious percentage increase city-wide from 38.0 percent to 45.5 percent. Even with an increase in the impervious surface

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coverage projected by 2020, the net increase in runoff volume will likely be reduced due to implementation of storm water treatment practices focusing on infiltration and filtration. The City has been implementing infiltration standards in selected areas of the City for several years on all new development projects and the proposed standards in the updated Water Resources Management Plan will address volume reduction and infiltration/filtration requirements for both new and re-development projects. The reduction in runoff volume due to these revised infiltration/filtration standards will result in a commensurate reduction in TSS and TP loadings.

The first step in assessing the loading levels anticipated in 2020 was to apply the City's proposed standard of 90 percent TSS removal and 60 percent TP removal to all new impervious areas. As part of this analysis, the lower annual runoff depth of 2.93 inches was used to quantify runoff volumes and subsequently the TSS and TP loading estimates. Recall that the lower runoff volume represents the volume that would leave the development site after being treated in the infiltration or filtration BMP.

The second step in assessing city-wide loading for 2020 was to estimate the additional treatment that will be realized through implementation of a treatment standard of 70 percent TSS and 30 percent TP reduction, and the corresponding 0.5-inch volume control standard, for redevelopment projects. To accomplish this estimate, the 33 drainage areas referenced, in Section 2.3.3 of this report were assumed to be the only areas where redevelopment would occur. The portion of each drainage area that could see redevelopment was estimated between 2 and 20 percent for each area. The total estimated redevelopment area between current conditions and 2020 conditions under this assumption is about 600 acres, or about 40 acres of redevelopment per year, on average.

The third and final step was to reduce the future load estimates resulting from the Step 1 by the load removed by the redevelopment BMPs estimated in Step 2. The results are the overall load changes from 2005 to 2020 as

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presented in Table 5, including the projected changes in land use and impervious surface.

Table 5. Changes in Impervious Surface and Loadings from 2005 to 2020

Drainage Area Name (ID)	Drainage Area (ac)	CHANGE in % Impervious from 2005 - 2020	CHANGE in Runoff Volume from 2005 - 2020 (ac-ft)	CHANGE in TSS from 2005 - 2020 (tons)	CHANGE in TP from 2005 - 2020 (lbs)
Black Dog East (BDE)	643	2%	0.1	-0.5	-0.6
Black Dog West (BDW)	1677	5%	-1.6	-2.9	-3.2
Central (C)	2158	7%	-14.1	-8.47	-16.4
Crystal Lake (CL)	744	7%	13.2	0.9	11.6
East (E)	1728	3%	0.8	-2.1	-0.3
Keller Lake (KL)	651	3%	5.0	0.4	4.4
Lake Alimagnet (LA)	869	7%	14.9	1.1	13.0
Lac Lavon 1 (LL1)	46	0%	0.0	0.0	0.0
Murphy Hanrehan (MH)	1469	2%	-10.6	-3.4	-12.3
Northwest (NW)	2176	24%	-91	-40.7	-126
To Savage (OUT1)	20	22%	1.1	0.08	1.0
River Hills (RH)	667	1%	1.1	0.07	0.9
Sunset Pond (SP)	2695	6%	-268	-57.2	-253
West (W)	1723	1%	1.3	-0.7	0.7
Totals	**17,267**	**8%**	**-348**	**-113**	**-381**

This analysis shows that there is a projected net decrease in both TSS and TP between 2005 and 2020 when factoring in the City's proposed revisions to its development and redevelopment standards. Furthermore, the projected decrease in TP between 2005 and 2020 is large enough to reduce the increase in TP shown in the 1988 to 2005 analysis. The results show that within the areas projected to be developed between 2005 and 2020, and given the assumptions discussed above, there will be a decrease in annual runoff volume of 348 acre-feet by the year 2020. Given the City-wide annual runoff volume estimate of 11,409 acre-feet, this represents approximately a 3.0 percent reduction in the overall annual runoff volume by 2020. Please see Figure 3 for a map of the City with the results shown for the 2005 to 2020 analysis.

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4.0 Results and Discussion

Results of the loading assessment generally show the expected result of an increase in the annual runoff volume between 1988 and 2005. As projected for the 2005 to 2020 time period, the results show a reduction in the runoff volume due to the City's proposed volume control standards. As development occurs, the increase in impervious surfaces will result in a greater portion of the annual rainfall being subject to runoff. When considering the future effects of infiltration practices for new and redevelopment projects, the annual runoff is still projected to increase from these surfaces, but will be captured in the new BMPs prior to discharging form the project sites. These proposed standards have and will continue to provide treatment of TSS and TP loads to help the City achieve its overall water quality goals for its wealth of water resources. Overall loading assessment results are summarized in Table 6 and graphically in Figure 4..

Table 6. 1988, 2005, and 2020 Loadings Summary

Year	Imp. surface (acres)	Imp. %	Runoff Volume (ac-ft)	Annual TSS (tons)	Annual TP (lbs)	Comments
1988	5,723	33.2%	10,145	1,379	9,104	Assuming No Storm Water Treatment
2005	6,563	38.0%	11,409	1,134	9,162	Assuming Storm Water Treatment by Ponds Only - Based on Ponds Created between 1988 and 2005
2020	7,748	44.9%	11,061	1,021	8,783	Runoff volume, TSS, and TP loads are assumed for the new impervious areas. Revised development and redevelopment standards considered.
1988 to 2005 relative changes	+840	+14.7%	+12.4%	-17.7%	0.65%	Increase in Runoff Volume, Reduction in TSS and minor increase in TP levels
2005 to 2020 relative changes	+1,185	+18.1%	-3.1%	-10.0%	-4.1%	Increase in Runoff Volume, Reduction in TSS and TP levels

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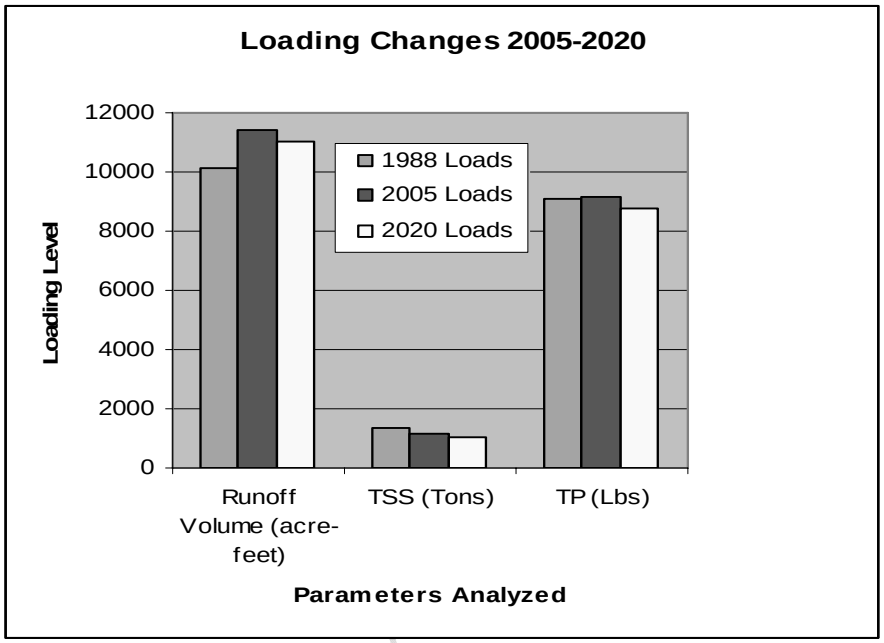
Figure 4. Summary of Loading Changes 1988 to 2020



4.1 Discharges to Waters with Prohibited and Restricted Discharges

The Black Dog Fen Preserve wetland complex is listed as a water body with both restricted discharge requirement and prohibited discharge requirement. The City has been requiring infiltration of at least a 1-inch runoff volume for projects in the contributing watersheds and intends to continue to implement the volume control standards currently in place for watersheds that discharge to the Black Dog Fen Preserve. In addition, the proposed redevelopment standards will further protect the Black Dog Fen wetland system.

4.2 Discharges Affecting Wetlands

A detailed assessment of the potential for impact to wetlands resulting from an increase in runoff volume or from an increased depth or duration of inundation was not completed. Based on the relative small increase in runoff volumes determined from these analyses, there are no significant issues stemming from the increased runoff volumes. In addition, the City's current Wetland Protection and Management Plan and Water Resources Management Plan have standards that limit the depth and duration of "bounce" that can be allowed in wetlands throughout the City. The standards vary based on the wetland classification system identified in the Plan.

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4.3 Potential Impacts on Stream Morphology

The increase in runoff volume is unlikely to cause significant degradation to stream channels or to the water quality of receiving waters from streambank erosion. One possible concern is that urban streams tend to show increased bank erosion due to increased peaks or an extended duration of bank-full flows. In Burnsville most of the runoff is routed through treatment systems, ponds and wetlands prior to reaching receiving waters. Thus, the peaks are largely attenuated. Most of the potential areas of concern for increased flows are well vegetated with little signs of erosion. Any known significant stream or drainage channel erosion areas have been corrected in recent years as part of the City's surface water management program.

4.4 Discharges Affecting Source Water Protection Areas

One of the key recommendations of the study, and one the City has already been implementing, is to require infiltration BMPs to reduce the volume of runoff leaving a development site. In doing so, the delivery of both TSS and TP from the site to downstream waters will also be reduced.

A challenge for Burnsville is that much of the northern portions of the City are located in Vulnerable Wellhead Protection Areas. The City has developed its proposed development and redevelopment standards to prohibit infiltration in these areas and require filtration as an alternative. The City has prepared mapping that graphically identifies where infiltration is prohibited to protect these Drinking Water Supply Management Areas.

4.5 Street Sweeping and Other Considerations

Many factors can play a role in reducing the pollutant loads to surface waters. The NPDES MS4 permit includes six minimum control measures that address activities ranging from public education efforts, to cleaning out ponds and street sweeping improvements, to reducing or eliminating the use of phosphorus-containing fertilizers. None of these factors have been specifically accounted for in this analysis. Some of these items include:

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- Conducting a street sweeping program that prioritizes sweeping efforts for both safety and water quality concerns and has increased street sweeping frequency in key areas based on the prioritized system. The City also purchased a vacuum sweeper to the fleet and has been using it for several years.

- Conducting an annual pond cleanout program to maintain and improve the efficiency of treatment ponds throughout the City.

- Added a dedicated erosion and sediment control site inspector in 2004 to enforce the City standards for construction site management and permanent BMP construction observations.

5.0 Related Water Resources Plans and Studies

The following plans and studies comprise the key elements of the City's overall water and natural resources management program.

5.1 MS4 Storm Water Pollution Prevention Plan (SWPPP)

On May 31, 2006, the City of Burnsville submitted the Storm Water Pollution Prevention Program (SWPPP) as required under MPCA General Permit MN R 040000. The document defines the main goal which is to preserve, protect, and improve the water resources impacted by storm water runoff. The document also defines in detail the specific BMPs in all of the six areas required by the permit: Public Education and Outreach, Public Involvement and Participation, Illicit Discharge Detection and Elimination, Construction Site Runoff Control, Post Construction Runoff Control, and Pollution Prevention and Good Housekeeping.

The City reapplied for the revised permit in June 2006 and incorporated the required BMPs into an updated SWPPP. The City has also recently updated their SWPPP to incorporate a BMP to address current and future impaired waters within the City or to which the City discharges to.

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5.2 Water Resources Management Plan (WRMP)

The City's WRMP summarizes the goals and policies adopted by the City areas including: Water Quantity, Water Quality, Recreation Fish and Wildlife, Enhancement of Public Participation Information and Education, Public Ditch System, Groundwater, Wetlands, Erosion, and Shoreland Management. The WRMP, along with the City's NPDES SWPPP, form the basis for the overall storm water management program in the City. The City's WRMP was developed in accordance with Minnesota Rule, Chapter 8410 and is consistent with the Plans of the Black Dog WMO, Lower Minnesota River WD and Vermillion River JPO.

The City is in the process of updating its 2002 WRMP. One of the main components of the update is in the revision to storm water management standards for new development and redevelopment projects. While some of the details for specific project types is still being evaluated, the basic approach to future projects will be to require the following:

- New Development: Implement BMPs to achieve 90% TSS and 60% TP removal, including a requirement for infiltration/filtration of 1-inch of runoff volume.
- Redevelopment: Implement BMPs to achieve 70% TSS and 30% TP removal, including a requirement for infiltration/filtration of 0.5-inch of runoff volume.
- Infiltration will not be allowed within the City's wellhead protection areas that have a high sensitivity to groundwater contamination.

5.3 Wetland Protection and Management Plan

Burnsville covers approximately 17,097 acres, of which approximately 2,713 acres, or 16 percent, is wetlands or other water features. These surface water resources include several lakes, 268 wetlands, 59 storm water or other created ponds, and portions of three designated trout streams that are located wholly or partially within the City. Wetlands alone constitute 1,759 acres, or about 10% of the city area. One of the most prominent features in the City is

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the Minnesota River and the extensive backwater and wetlands associated with it. The Minnesota River associated wetlands and Black Dog fen within the Minnesota Valley National Wildlife Refuge account for 843 acres, or just over half of the wetland within the city limits.

The draft 2007 Wetland Protection and Management Plan has been developed to provide the City with an updated wetland inventory and functions and values analysis, to provide enhanced management strategies to preserve and protect the wetland resources, and to comply with local watershed organizations plans. The regulatory framework developed in this Plan will be incorporated into the City's existing planning and zoning regulations and implemented by ordinance. This Plan is an update to the original Plan completed in 1998.

As part of the Plan update, hydrologic guidelines have been changed to be more specific for the three wetland management classes: *Protection; Improvement; and Management*. *Protection* wetlands will require that excess hydrology be diverted if it is isolated or does not currently received storm water. If a *Protection* basin is not isolated, or currently receives untreated discharge, than the bounce on a 10-year event must be less than 6 inches, and must not exceed existing inundation by more than 1 day for 1 and 2 year events and 3 days on a 10 year event. *Improvement* basins allow for a bounce on a 10-year event of 9 inches, and inundation duration to be no more than existing conditions plus 3 days for 1 and 2 year events, and 5 days for 10-year events. *Management* basins allow for a bounce on a 10-year event of 12 inches, and inundation to be no more than existing conditions plus 5 days for 1 and 2-year events and 15 days for a 10-year event. Outlet controls standards have also been established to limit water level manipulations. These provisions will continue to protect the City's wetland resources.

5.4 Lake Management Plans and Studies

The City has completed diagnostic studies of several key lakes within the City including: Lake Alimagnet, Crystal, Keller, Earley, Lac Lavon and Twin Lakes. The intent of these lakes studies, in part, is to identify realistic and achievable goals for water quality (i.e., water clarity) and to help

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understand what activities and practices within each watershed may be impacting the water quality. The City is involved in ongoing monitoring of the water quality in these water bodies and will continue to monitor the conditions and work with the respective watershed management organizations to make adjustments to program activities as new data is evaluated.

6.0 Conclusions

An assessment of storm water runoff volume and TSS and TP pollutant loadings was conducted according to the requirements and guidelines of the NPDES Permit for Selected MS4s. Overall, the results show:

- 1988 to 2005 Changes: an increase in runoff volume of about 12 percent, a relatively small increase (less than one percent) in the loading of TP and a reduction in TSS loading of about 18 percent.
- 2005 to 2020 Changes: a decrease in runoff volume of about 3 percent, a reduction of about 4 percent in the loading of TP and a reduction in TSS loading of about 10 percent.
- Overall 1988 to 2020: an increase in runoff volume of about 9 percent, a reduction of about 3.5 percent in the loading of TP and a reduction in TSS loading of about 26 percent

While the assessment shows an increase in the runoff volume, the TSS loadings have decreased over both analysis periods and the TP loadings increased only slightly between 1988 and 2005. This result relates chiefly to the fact that numerous storm water treatment ponds accompanied the new development and re-development that occurred between 1988 and 2005. The results show that these ponds are working to remove significant amounts of total suspended sediment from storm water runoff.

It should be reiterated that the evaluation of Runoff Volume, TSS and TP presented above is based on a series of conservative assumptions. For example, in computing the runoff volume, the entire impervious surface was considered connected. However, in many cases of new development between

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1988 and 2005 some of the development consisted of Low Density Residential units. Thus, a large portion of the added impervious surface would be disconnected, producing volume reductions that were not specifically accounted for in the analysis.

The TSS and TP loading estimates are also conservative. The TSS and TP reduction for 1988 to 2005 was based exclusively on single wet basin retention assumptions. Given that some of the ponds were built in series, or are connected in series as part of the drainage system, the pollutant load reduction is likely further enhanced by the treatment train concept. Furthermore, the effect of grassed swales and ditches on reducing the TSS and TP loadings has not been factored in. Nor has any credit been taken for improvements in street sweeping equipment or practices, or from the state law governing the use of phosphorus fertilizers.

It seems reasonable to conclude that the increase in Runoff Volume is commensurate with the size of the City. Runoff Volume reduction is a relatively new area to the storm water management arena while the potential adverse effects are still being studied and debated. The most common impacts cited in connection with the runoff volume increase are a pronounced degradation of the natural stream banks and more frequent inundation of the wetlands. The City is not aware of channels and/or stream sections that have increased erosion that can be directly attributable to increase runoff volumes. Therefore, the City does not consider the relative small increase in volume identified in this analysis to be significant.

Looking into the future, the projected level of development will continue to add impervious surface and result in additional annual runoff volume. Runoff infiltration is expected to play in increasingly important role in storm water management.

The City is currently in the process of adopting new standards for storm water management which will place the focus on infiltration or filtration. The proposed standards will essentially translate into runoff volume control for

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both new development and redevelopment. The runoff infiltration or filtration practices have the potential to offset the increase in runoff volume caused by the expansion of impervious surfaces.

Additionally, the City will play and active role in adopting specific policies aimed at enhancing the surface water quality. The current MS4 permit contains aggressive plans for Construction and Post Construction Runoff Control as well as Pollution Prevention (Good Housekeeping) sections.

Based on this analysis and related work the City has done as part of it's overall water resources management program, the City is proposing to make changes to it's SWPPP. These changes will consist of formalizing the changes to the development and redevelopment standards described above as part of the current update to the City's Water Resources Management Plan. By adopting the updated WRMP, these standards will then be incorporated by reference into City ordinances and become an enforceable component of the City's SWPPP. The City plans to complete the WRMP update by the end of 2007.

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Appendix A

Figures 2 and 3 – Loading Changes

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Appendix B

Precipitation Data and Computation Spreadsheets (Printed)

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Appendix C

Land Use Data and Computation Spreadsheets (Printed)

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Appendix D

Loading Analysis Spreadsheets (Printed)

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Appendix E

2006 NPDES MS4 SWPPP - BMPs Summary Sheets that address the Nondegradation Loading Assessment and Reporting Requirements

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Appendix F

CD Pocket - Electronic Files of Nondegradation Analysis Spreadsheets and Maps

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