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St Croix River ORVW Restricted Discharge Water

Stillwater, MN

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Appendix A

1. Introduction

1.1 PURPOSE AND SCOPE

The purpose of this appendix to Stillwater's Part IX. Appendix C submittal is to present load calculation methods and results in support of the assessment requirement. The geographical limits for the loading calculations, called the Project Area throughout the remainder of this report, are shown on figure 1 of the main submittal and include the entire municipal jurisdiction of Stillwater.

This appendices include the technical modeling information used to quantify the City's storm water loadings,
as well as the supporting information necessary for the reader to understand the modeling methods and results. Specifically, the report is organized into the following sections:

- Modeling approach and model input requirements.
- Modeling Results that identify key changes in land use, as well as average annual total phosphorus (TP), total suspended solids (TSS) and runoff volume for the Project Area as a whole and for each of the subwatersheds within the Project Area draining to an St. Croix River for the three time periods 1985, 2007, and 2030.

The intent of the loading calculations was to provide defensible, calculated values that illustrate the degree to which the City of Stillwater's storm water management program achieves or does not achieve compliance with the nondegradation rules for St. Croix River restricted discharge Outstanding Resource Value Water (ORVW). This was accomplished by first calculating the estimated pollutant loads for the land use conditions at three time periods: Baseline (1985), Present (2007), and 2030. Next, the treatment effect of storm water Best Management Practices (BMPs) was calculated to determine how the 2007 and 2030 condition's pollutant loads were reduced to meet the Baseline condition loads.

1.2 WATER QUALITY PRIMER

It is widely recognized that pollutant loads can vary dramatically for any given land use as a result of time of the year, climatic conditions, human activities, or other variables such as soils, slope, and vegetative cover. Pollutant loading to receiving waters is expressed in terms of mass per unit time. In this report, loads are presented as pounds per year and referred to as annual load. Pollutant load is the product of pollutant concentration and total runoff volume.

For general subwatershed loading analyses of the type acceptable for the Nondegradation Rule requirements, a static pollutant concentration (termed Event Mean Concentration or EMC) is chosen from a range of values to reflect typical runoff quality for a specific type of land use for an annual analysis period. For phosphorus, these annual EMC values range from 150-200 parts per billion (ppb) for runoff from relatively undisturbed land (forest, grassland, etc.) to as high as 400-800 ppb for modified landscapes supporting land uses such as residential, commercial, or agricultural row crop.

The runoff volume applied to the pollutant concentration to generate a load estimate is dependant on rainfall depth and land use characteristics of the subwatershed. A volumetric runoff coefficient (Rv) is used to represent the proportion (expressed as a decimal fraction) of precipitation that results in runoff for each type of land use. Runoff coefficients vary according to the amount of impervious cover present. Areas of high impervious cover prevent rainfall from soaking into the ground, increasing runoff volume and generating high runoff coefficients. Areas of low impervious cover and well established vegetation result in lower surface runoff volumes, and consequently, lower runoff coefficients. Annual volumetric runoff coefficients vary from between 0.05 and 0.1 for well-vegetated, undisturbed land uses (forest, grassland, etc.) to upwards of 0.3 to 0.7 for high density residential and commercial/industrial development with high impervious coverage. Agricultural land uses like row crops often fall between these two ranges, though the values can be highly variable depending on the soil, slope, extent and type of tile drainage, crop type, and other factors.

2. Description of Modeling Approach

2.1 POLLUTANT SELECTION FOR LOADING CALCULATIONS

Determining which model to use for the nondegradation loading calculations depends upon which pollutants are capable of adversely affecting the classified use of the ORVW. The St Croix River is classified as a Scenic and Recreational River segment. Recreational Rivers are defined as a river that may have undergone some impoundment or diversion in the past and that may have adjacent lands which are considerably developed (Minn. Rule Ch. 6105.0060). Qualities that may affect recreational use include items such as water clarity, oxygen content, turbidity, and health of game fish stocks. The pollutants selected for this loading assessment are Total Suspended Solids (TSS) and Total Phosphorus (TP). These two pollutants can negatively affect the recreational qualities of this stretch of the river.

The St Croix Basin Water Resources Planning Team noted in its "St Croix Basin Phosphorus-Based Water Quality Goals" report that excess phosphorus is a major concern for the water quality of the St. Croix River. Excess TP can cause eutrophication leading to excessive algal and aquatic macrophyte growth. The effects of eutrophication are well-understood. It can decrease water clarity by increasing the biomass within the water column. Eutrophication also leads to depletion of oxygen within the unmixed portion of the water stratum, such as backwaters or deep pools with a large river system such as the St Croix River. These depleted oxygen zones then negatively affect important fish habitats causing a stressor to fish populations, especially game fish. All of these effects have a negative influence on the recreational qualities of a water body.

TSS can have negative effects on water quality as well, in that increased TSS loadings can raise the turbidity in the water column. Furthermore, increases in TSS are associated with increases in other pollutants which adsorb to surfaces of the solids. These other pollutants include, but are not limited to, heavy metals, bacteria, and nutrients (e.g., phosphorus and nitrogen). Therefore, controlling TSS loading is very important to protect the quality of waters with recreational uses. By directly managing TSS loadings, other pollutants adsorbed to suspended solids surfaces will be managed, as well.

Runoff volume was also considered as part of this study, although the St Croix River may not be in need of volume control because its large volumetric discharge is significantly greater than the volume received from the City of Stillwater.

2.2 SELECTED DOCUMENTATION FOR LOADING CALCULATIONS

A GIS based approach was used to generate the land use data needed to calculate Total Phosphorus (TP), Total Suspended Solids (TSS) and Runoff Volume loadings. This data was used to generate input data for a simplified spreadsheet model. This spreadsheet summarizes pollutant and water volume loads from the individual drainage areas.

TP and TSS are simply determined by multiplying the loading rate in pounds/acre/year for the corresponding land use by the acreage. Later sections describe how the loading rate is derived. Runoff volume is determined by the formula utilized in W.W. Walker's PondNet model. The formula is as follows:

Runoff volume (ac-ft/yr) = Rv* P/L * A/12

P = Average annual precipitation for Stillwater expressed in inches (33.1 inches or 2.76 feet)

Rv = Volumetric runoff coefficient expressed as a decimal fraction to represent the proportion of precipitation that results in surface runoff over an average year.

L = Season length in years

A = Area of subwatershed in acres

The analysis is based entirely on changes in land use and the estimated resulting changes in runoff volume and pollutant loading.

2.3 ANNUALIZED RUNOFF

The intent of the loading assessment is to determine the relative changes in pollutant loadings to the St Croix River over three different time periods:

- 1985 (Baseline condition),
- 2007 (Present condition), and
- 2030 (Ultimate condition).

The analysis summarized here utilizes average annual runoff and pollutant load calculations. Water quality BMP's for developments that occurred prior to 2007 have been quantified in the results by a review of water quality modeling conducted as part of Stillwater's Local Surface Water Management Plan and for the following Long Lake Management Plan.

Wet ponds have been the primary BMP used by local governments, including Stillwater, over the last 10-15 years to improve storm water quality. The number of ponds that have been constructed was found in the Stillwater Local Surface Water Management Plan (LSWMP), and the Lake Management Studies indentified above. The TP and TSS removal efficiency associated with these ponds was then applied to the corresponding subwatershed within the loading calculations.

Water quality treatment for 2030 conditions was based on the current watershed rules which require no increase in runoff volume for the 2-year event. This volumetric control was related to TP and TSS removal on a strict percentage basis.

2.4 OVERVIEW OF DATA REQUIREMENTS

Storm water runoff characteristics and receiving water quality is affected mainly by the size and land use composition of the contributing subwatershed and the performance of any BMPs used to decrease pollutant loading from that subwatershed. Stormwater pollutant loads can be estimated from:

- A pollutant Event Mean Concentration (EMC) (variable by land use)
- A runoff coefficient (Rv) for each identified land use
- A representative annual average precipitation amount

Contributing subwatershed areas are determined by the topography and the natural and human-made conveyance infrastructure in the area around the receiving water. Quantifying the effect of these key variables is important to credibly model any system. The following sections describe how this information was generated for the loading assessment effort.

2.4.1 Soils Information

Generally, native soils in the City of Stillwater fall into the Hydrologic Soil Group (HSG) category of HSG B soils (moderate infiltration rates and runoff potential). The Rv values in this report generally pertain to HSG B soils. Therefore, no adjustment to these Rv values was needed to account for HSG A, C or D soils. Typically, adjustment is not needed for urban land uses due to the similar amount of compaction and imported fill material assumed to occur as a result of development, which is independent of HSG type. The non-urban land uses usually requiring adjustment are agricultural row crop, rural residential, grassland/shrubland/woodland and open space.

2.4.2 Land Use Information

Land use information was obtained for the Baseline (1985), Present (2007), and Ultimate (2030) development conditions from the City of Stillwater, and is shown on Figures 2, 3, and 4 that precede this appendix. The land use classifications utilized for this project are also described below:

- Agriculture – the dominant non-urban land use, and consists primarily of row crop agriculture.
- Commercial Land and Buildings –a range of commerce, entertainment, retail, dining, and related uses.
- Golf Course – public and private golf courses.
- High Density Residential – variety of high density buildings starting at 12 units per acre.
- Business Park/ Industrial – traditional industrial, limited manufacturing and processing of products.
- Institutional – All public uses such as city and county buildings, hospital and cemeteries.
- Low Density Residential - Residential at a density of about 1 to 4.4 units per acre.
- Low-Medium Density Residential – Residential at approximately 4.4 to 9.7 units per acre.
- Marina
- Medium Density Residential – mix of townhomes and small scale apartments at approximately 6 to 14.5 units per acre.
- Downtown Mixed Use– Historic downtown area – residential, retail shops, restaurants, offices, etc.
- Neighborhood Commercial –small areas of neighborhood goods and services near residential areas.
- Park or 0pen Space – Park, recreation, and open space related land uses
- Research & Development Park – large land parcels for corporate center, research facility, educational institution, medical campus, medical campus, or office campus.
- Railroad – Included in the 1985 and 2007 Land Use only for Railroad areas.
- Road – reflects the location of all public right-of-way within the City.
- Surface Water – Lakes, Rivers, Ponds.
- Wetlands

2.4.3 Overview of Land Use-Dependent Variables

Pollutant loads are the product of runoff volume and pollutant concentration (represented as an Event Mean Concentration or EMC). Runoff volume is a function of precipitation depth and a runoff coefficient (Rv). Both runoff coefficients and pollutant concentrations in runoff vary with land use type. The runoff coefficients and runoff pollutant concentrations for TP and TSS assigned to each land use category were held constant in each condition modeled (i.e., Baseline, Present, 2030).

The main consideration in developing input parameters reflective of each land use was to generate unit load estimates within accepted literature value ranges for Minnesota and the upper Midwest. Selection of input parameters was based largely on literature values. For agricultural row crop and low density residential, it was also appropriate to reflect the general view among knowledgeable water quality professionals that raw TP export rates for agricultural row crops with conservation practices are slightly to moderately lower than raw export rates for residential. If the load estimate and the Event Mean Concentration (EMC) or the load estimate and the Rv for a given land use were available, the missing value could be derived arithmetically through the following relationship:

$$\text{EMC} \times P \times Rv \times 2.71 = \text{Pollutant loading rate}$$

Where:
EMC = Event Mean Concentration of total phosphorus or total suspended solids in runoff from the land use, expressed as mg/l

P = Average annual precipitation for Stillwater expressed in feet (33.1 inches or 2.76 feet)

Rv = Volumetric runoff coefficient expressed as a decimal fraction to represent the proportion of precipitation that results in surface runoff over an average year.

2.71 = a unit conversion factor

Pollutant loading rate = annual load for total phosphorus or total suspended solids for the land use, expressed in lbs/acre/yr.

The following section presents the values assigned to each land use category. The subsequent sections provide more detail to support the selection of the data inputs for the urban and non-urban land uses.

2.4.4 Land Use-Dependent Input Variables

For each of the major land use categories within the Project Area, a combination of EMCs and Rv values were selected, which resulted in a representative average annual loading rate. These values are critical to the modeling results and are presented in Table 2.1.

Table 2.1 – Input Values used for Stillwater Loading Calculations

Land Use	Impervious Coverage[1]	Rv	TP EMC	TP Loading Rate[2]	TSS EMC	TSS Loading Rate[2]
	(%)	(fraction)	(ppb)	(lbs/ac/yr)	(ppm)	(lbs/ac/yr)
Agriculture	n/a	0.14	540▲	0.57	163▲	171
Commercial Lands and Buildings	70	0.46	350†	1.20	140†	480
Golf Course	6	0.07	550	0.29	216	112
High Density Residential	65	0.43	450•	1.44	140•	448
Industrial	70	0.46	350	1.20	140	480
Institutional	70	0.46	450	1.54	140	480
Low Density Residential	30	0.22	450	0.72	140	225
Low-Medium Density Residential	35	0.25	450	0.83	140	257
Marina	70	0.46	350	1.20	140	480
Medium Density Residential	45	0.31	450•	1.03	140•	321
Mixed Use	90	0.58	350	1.52	140	607
Neighborhood Commercial	70	0.46	350	1.20	140	480
Park or Open Space	6	0.07	250	0.13	216	112
Research & Development Park	70	0.46	350	1.20	140	480
Railroad	40	0.28	400	0.83	140	289
Road	40	0.28	400	0.83	140	289
Surface Water	n/a	0.00	0	0.00	0	0
Wetland	n/a	0.00	0	0.00	0	0

*[1] Non-urban land uses with "n/a" for impervious coverage signify the absence of the following relationship between impervious coverage and runoff coefficient: Rv=[0.607*Impervious Fraction]+0.033*

[2] All loading rates are based on average annual precipitation depth of 33.1 inches/year.
Source: National Weather Service, 1975-2005, Oakdale, South St. Paul, and Stillwater Stations

† Bannerman, et al. 1993

▲ Cave, et al. 1994

• Minnesota Pollution Control Agency (MPCA). 2000

The values themselves were derived using a combination of detailed site specific study results from the upper Midwest, generally accepted literature values from credible sources, knowledge of local conditions, and professional judgment. More detailed explanations of how the load values were determined are presented in the following sections.

2.4.5 URBAN TOTAL PHOSPHORUS LOADING RATES

For urban land uses, the volumetric runoff coefficient was derived from the impervious coverage using a relationship developed as part of the NURP study (Beduhn,1994) as reflected by the following equation:

Rv = 0.607 x (Impervious fraction) + 0.033

For urban land uses, EMCs generally decrease as impervious coverage increases as documented in numerous references for the upper Midwest (MPCA 2000; Bannerman, et. al. 1993; University of Wisconsin Extension 1995; Cave, et. al. 1994). However, significantly higher volumetric runoff coefficients associated with higher impervious coverage more than compensate for the lower EMCs, resulting in higher overall loads as urban land use intensity increases. The urban phosphorus loads generated are within accepted literature loading rates for this part of the country and appear reasonable relative to each other, with land uses having higher impervious coverage generating higher TP loads.

2.4.6 NON-URBAN TOTAL PHOSPHORUS LOADING RATES

Reference EMC and Rv values for non-urban uses, especially row crop agriculture, were harder to come by. For agricultural row crop values, an EMC of 540 ppb was chosen based on a detailed field monitoring study aimed at developing credible EMC values for three row crop-dominated agricultural subwatersheds in Michigan (Cave et al., 1994). This reference is considered a credible source for agricultural values for the following reasons:

1. The study was the most comprehensive, field-based monitoring study available for derivation of EMCs for upland runoff in crop-dominated subwatersheds in the upper Midwest.
2. The study area has a climate similar to that of the Twin Cities metro area.
3. Mean annual precipitation in the reference agricultural subwatersheds is 31.6" per year, nearly the same as the approximately 33.1 inches per year for the Stillwater area. Furthermore, precipitation totals for the years in which monitoring data was collected to support development of agricultural EMCs was near the long-term mean, with 30.8 inches and 34.9 inches of precipitation recorded at a nearby monitoring station in 1991 and 1992, respectively.
4. Hydrologic Group B soils cover between 79% and 95% of the three monitored subwatersheds, closely matching the soil coverage in Stillwater.

The Rv value for agricultural row crop was the most difficult variable to select because of the wide range of conditions inherent in this land use that can affect runoff (soils, topography, tile drainage, tillage practices, crop cover, etc.). The Rv value of 0.14 was chosen based in part on the fact that this value produces a pollutant loading rate (0.55 lbs/ac/yr) for this land use that is about 20% below that for the low density residential land use (0.69 lbs/ac/yr). This reflects the general view among knowledgeable water quality professionals that raw TP export rates for agricultural row crops with conservation practices are slightly lower than raw export rates for residential. EMCs and Rv values for other rural uses were stepped down from the agricultural row crop values described above to reflect either lower runoff volumes because of continuous plant cover, lower EMCs due to reduced sediment transport and supplemental nutrient additions, or both.

MPCA's manual Protecting Water Quality in Urban Areas (MPCA, 2000) provides a TP EMC of 230 μg/L for open space/non-urban land use. The modeled TP EMCs were conservatively assigned to the open space land use at 250 μg/L.

2.4.7 URBAN TOTAL SUSPENDED SEDIMENT LOADING RATES

Representative EMCs for Total Suspended Sediment (TSS) were researched for key land uses, and the formula presented previously relating EMCs to the Rv values was used to develop unit loads for each land use.

The principle source for EMCs for urban land uses was MPCA's manual Protecting Water Quality in Urban Areas (MPCA, 2000). The manual provides a summary of mean TSS concentrations based on NURP data for runoff from residential and commercial land uses as well as open space. Thus, a value of 140 mg/l was used as the TSS EMC for the urban residential and the commercial/industrial uses, and the open/non-urban value of 216 mg/l was used as the EMC for other non-agricultural land uses dominated by pervious coverage, such as rural residential, woodland, park, and golf course.

The resulting loads are shown in the preceding Table 2.1 and reflect the strong influence of the Rv values representing each land use. For the dominant urban land uses, TSS loading rates vary from 214 lbs/ac/yr for low density residential to 438 lbs/ac/yr for high density residential to approximately 468 lbs/ac/yr for commercial/industrial use. This compares favorably with selected loading rates provided by Bannerman (2001) for areas in Madison, WI, where he estimated average annual TSS loading rates of 212 lb/ac/yr for a mature residential development (3 units/ac) and 496 lb/ac/yr for commercial development.

2.4.8 NON-URBAN TOTAL SUSPENDED SEDIMENT LOADING RATES

For agricultural row crop values, an EMC for TSS of 163 ppm was used (Cave, et al. 1994). This value was derived through the field monitoring of three agricultural subwatersheds cited in the Rouge River watershed project in southern Michigan. The open/non-urban value of 216 mg/l cited in the MPCA's manual (2000) was used as the EMC for other non-agricultural land uses dominated by pervious coverage, such as very low density residential, open space, and golf course.

The numbers selected to represent TSS loading rates in Table 2.1 for the various land uses reflect the general consensus among water resources professionals that while the concentration of suspended solids in urban runoff is often lower than that in rural runoff, the total annual unit loads in urban areas are often comparable to or higher than those for rural areas.

2.5 PRECIPITATION

A 31-year (1975-2005) normal annual precipitation of 33.1 inches was used for the loading assessment model throughout the entire assessment timeframe. This data was recorded in Oakdale, South St Paul and Stillwater by the National Weather Service. Together, volumetric runoff coefficients and annual precipitation depth applied to a specific area result in total annual runoff volume.

2.6 PROJECT AREA AND SUBWATERSHED BOUNDARIES

The geographical limits of the Project Area include the entire jurisdictional boundary of Stillwater and encompasses approximately 5,795 acres. The Project Area major subwatershed boundaries are shown on figure 1, which precedes this appendix. The City of Stillwater is divided into eight subwatersheds that fall within the jurisdiction of three watershed management organizations: Browns Creek Watershed District, the Middle St. Croix Watershed Management Organization, and the Carnelian Marine St. Croix Watershed District.

2.7 WET DETENTION BMPS

Water bodies with standing water have historically been shown to be most effective at treating runoff. Constructed, stormwater "wet" ponds have been the primary BMP used by local governments, including Stillwater, over the last 10-15 years to improve stormwater quality. In general, wet detention BMPs reduce loadings of pollutants by slowing the flow rate of stormwater so that a portion of the particles carried in suspension or along the bottom of the pipe or channel entering the pond settle out before the water leaves the pond through the outlet. They can also remove dissolved pollutants (especially nutrients like phosphorus) through uptake due to biological activity in the ponds themselves. Thus, a single well-designed and constructed pond of the type required by the City of Stillwater to mitigate the impacts of new development has the capacity to remove 50-60% of the Total Phosphorus (TP) load it receives over the course of a year and 80-90% of the Total Suspended Solids (TSS) load. The treatment provided by wet detention BMPs is by far the dominant influence in mitigating pollutant loads carried by urban stormwater in Stillwater.

Information on existing BMP's in the City of Stillwater has been gathered from various reports. The Stillwater Local Surface Water Management Plan identifies existing BMP's for portion of Brown's Creek, St. Croix, and Twin Lakes Subwatersheds. The Long Lake Management Plan prepared by the Brown's Creek Watershed District contains information on BMP's in the Long Lake Subwatershed. These reports were used to identify phosphorus, total suspended solid, and volume load reductions in the existing (2007) system.

Appendix C lists the ponds included in the Baseline and Present condition assessment. In the Ultimate system, it is assumed that the requirements of each specific watershed will be met. In Brown's Creek Watershed and Carnelian Marine St. Croix Watershed's this corresponds to treatment sized to infiltrate the excess 2-year storm runoff created by new impervious surfaces, measured against presettlement conditions. In the Middle St. Croix Watershed Management Organization areas the applicable standard is infiltration of ½-inch of runoff off new impervious surfaces and ¼-inch of runoff off disturbed pervious surfaces. However, there is no proposed development within the Middle St. Croix Watershed Organization areas so their volume management standard does not affect the loading calculations.

2.8 STORMWATER MANAGEMENT NOT MODELED

In 2002, Legislature passed a law that banned the use of lawn fertilizers containing phosphorus in the Twin Cities Metro Area effective January, 2004, and then expanded the ban to be effective statewide in January 2005 (MDA, 2005). However, phosphorus fertilizer may still be purchased. Consequently, the effects of this ban are not quantified in the phosphorus loading rates used in Stillwater's loading calculations. Similarly, any TSS or TP reductions obtainable through street sweeping and regular cleaning of stormwater infrastructure such as sump manholes and ponds have not been included in these loading calculations.

3. Loading Calculation Modeling Results

3.1 BACKGROUND

This chapter summarizes the results of the loading calculations for the City of Stillwater. Load calculations were conducted for each of the eight subwatersheds using the modeling approach as described in Section 2. Pollutant loads are calculated in two ways: first as raw loadings without consideration of BMPs within the subwatershed, then second as modified loadings representing the effect of existing and future BMPs within the subwatershed. Existing BMP location and performance was determined from the Stillwater Local Surface Water Management Plan and available Lake Management Plans while future BMP performance was calculated based on the requirements of existing City ordinance and watershed rules.

Figures 2 through 4 precede this appendix and show:

- Figure 2 - Project Area for the Baseline (1985) condition.
- Figure 3 - Project area for the Present (2007) and
- Figure 4 - Project Area for the Ultimate (2030) condition.

Appendix B provides detailed spreadsheet calculations of loads for each of the three pollutants.

3.2 OVERVIEW OF MODELING RESULTS FOR PROJECT AREA

3.2.1 INTRODUCTION

This section presents a summary of the loading assessment for the entire 5,795 acre Project Area. The summary of the loading assessment includes the following:

- A comparison of land use between the three conditions.
- TP, TSS and runoff volume loadings generated by the entire Project Area for the three conditions.

3.2.2 LAND USE OVERVIEW

Table 3.1 summarizes the changes in each land use category between the Baseline, Present, and 2030 conditions for the Project Area.

Table 3.1 – Summary of Land Use Changes for the Project Area

Land Use	Baseline Condition (Ac)	Present Condition[1]			Ultimate Condition[1]		
		Acres	Change (Ac)	Change (%)	Acres	Change (Ac)	Change (%)
Agriculture	1,058	119	-939	-89	0	-1,058	-100
Commercial Land & Buildings	183	312	128	70	147	-37	-20
Golf	286	286	0	0	286	0	0
High Density Residential	39	52	13	34	49	10	26
Industrial	44	33	-11	-25	119	74	167
Institutional	218	256	38	17	132	-86	-39
Low Density Residential	1,190	1,544	353	30	1,611	420	35
Low-Medium Density Residential	555	701	146	26	937	383	69
Marina	17	17	0	0	17	0	0
Medium Density Residential	4	90	86	2,049	115	111	2,638
Mixed Use	0	0	0	--	49	49	--
Neighborhood Commercial	0	6	6	--	6	6	--
Park or Open Space	725	735	11	2	636	-88	-12
Research & Development Park	0	9	9	--	86	86	--
Railroad	27	27	0	0	0	-27	-100
Road	699	840	141	20	839	140	20
Surface Water	683	701	18	3	701	18	3
Wetland	64	64	0	0	64	-1	-1
Total	5,795	5,795			5,795		

[1] Change shown is compared to Baseline condition

3.2.3 OVERVIEW OF LOADINGS GENERATED IN THE PROJECT AREA

Summaries of the loadings generated for TP, TSS and runoff volume for each of the three conditions (Baseline, Present, and Ultimate) are shown in Table 3.2. The loads shown in the tables are a summation of the total loads generated within the Project Area. For loadings generated by specific land use types, refer to the loading assessment model spreadsheets in Appendix B. The loadings presented in table 3.2 are "raw" loadings from the project area and do not represent reductions in these loadings due to the many BMPs that have been installed by Stillwater and the Watersheds as part of their stormwater management program.

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Table 3.2 – Summary of Raw Modeled Loadings (Project Area)

Condition	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)
Baseline (1985) Condition	3,385	1,155,733	2,872
Present (2007) Condition	3,674	1,269,918	3,231
Ultimate Condition	3,715	1,281,854	3,281

3.3 OVERVIEW OF MODELING RESULTS FOR BROWN'S CREEK SUBWATERSHED

3.3.1 INTRODUCTION

Brown's Creek Subwatershed is located in the northern portion of Stillwater and falls mostly under the jurisdiction of the Brown's Creek Watershed District. It encompasses 842 acres of the Project Area. The summary of the loading assessment includes the following:

- A comparison of land use between the three conditions.
- TP, TSS and runoff volume loadings generated by the Browns Creek Subwatershed for the three conditions.

3.3.2 LAND USE OVERVIEW

Table 3.3 summarizes the changes in each land use category between the Baseline, Present, and 2030 conditions for the Browns Creek Subwatershed.

Table 3.3 – Land Use Change Summary Table (Brown's Creek Subwatershed)

	Baseline Condition (Ac)	Present Condition	Ultimate Condition
Land Use		Acres	Acres
Agriculture	133	17	0
Commercial Land & Buildings	6	6	0
Golf	205	205	205
High Density Residential	2	2	2
Industrial	0	0	0
Institutional	1	1	0
Low Density Residential	217	248	259
Low-Medium Density Residential	8	15	59
Marina	1	1	1
Medium Density Residential	0	7	11
Downtown Mixed Use	0	0	0
Neighborhood Commercial	0	0	0
Park or Open Space	87	144	123
Research & Development Park	0	0	0
Railroad	14	14	0
Road	90	101	101
Surface Water	21	25	25
Wetland	55	55	55
Total	842	842	842

3.3.3 OVERVIEW OF LOADINGS GENERATED IN BROWNS CREEK SUBWATERSHED

Summaries of the loadings generated for TP, TSS and runoff volume for each of the three conditions (Baseline, Present, and Ultimate) are shown in Table 3.4. The loads shown in the tables are a summation of the total loads generated within the Brown's Creek Subwatershed. For loadings generated by specific land use types, refer to the loading assessment model spreadsheets in Appendix B. These loadings are not adjusted for existing BMP's.

Table 3.4 – Summary of Modeled Loadings (Brown's Creek Subwatershed)

	TP Load	TSS Load	Runoff Volume
	(lbs/yr)	(lbs/yr)	(ac-ft/yr)
Baseline (1985) Condition	409	141,661	334
Present (2007) Condition	395	142,284	337
Ultimate Condition	410	144,634	347

Table 3.5 below adjusts the loading results from Table 3.4 above, to account for existing and proposed BMP's within the project area. Existing BMP reductions have been applied to the 2007 (Existing) loads, and in 2030 – since these BMP's will remain in place. Calculations showing existing BMP performance are presented in appendix C. Existing BMP's include ponds and infiltration basins. This information is obtained from Stillwater's LSWMP which includes data on existing BMP's in each drainage area. Loads calculated for the Ultimate condition for all loading points are based on the assumptions that:

- The City of Stillwater and the Brown's Creek Watershed District will continue to apply the same ponding and infiltration requirements to new developments in the future as they do today.
- BMP's that are in place currently will have the same efficiency rate in the future due to proper maintenance and periodic rehabilitation.

Table 3.5 – Summary of Modeled Loadings with Existing & Proposed BMP's

	TP Load	TSS Load	Runoff Volume
	(lbs/yr)	(lbs/yr)	(ac-ft/yr)
Baseline (1985) Condition	409	141,661	334
Present (2007) Condition	331	118,261	317
Ultimate Condition	329	111,669	306

Following are the key findings reflected in the above modeling results:

Calculated loads of total phosphorus and total suspended solids and runoff volume decrease from Baseline to Present due to the implementation of Existing BMP's as described Appendix B. From the present condition to Ultimate, the land use changes from Open Space to Residential, are offset by the proposed implementation of TP, TSS and Runoff reductions as required by the BCWD. Thus, the Ultimate loadings decrease from Existing and Baseline conditions.

3.4 OVERVIEW OF MODELING RESULTS FOR LILY LAKE SUBWATERSHED

3.4.1 INTRODUCTION

Lily Lake Subwatershed is located in the southeastern portion of Stillwater and falls under the jurisdiction of the Middle St. Croix Watershed District. It encompasses 558 acres of the Project Area. The summary of the loading assessment includes the following:

- A comparison of land use between the three conditions.
- TP, TSS and runoff volume loadings generated by the Lily Lake Subwatershed for the three conditions.

3.4.2 LAND USE OVERVIEW

Table 3.6 summarizes the changes in each land use category between the Baseline, Present, and 2030 conditions for the Lily Lake Subwatershed.

Table 3.6 – Land Use Change Summary Table (Lily Lake Subwatershed)

Land Use	Baseline Condition (Ac)	Present Condition	Ultimate Condition
		Acres	Acres
Agriculture	24	0	0
Commercial Land & Buildings	53	78	22
Golf	0	0	0
High Density Residential	24	26	28
Industrial	19	25	80
Institutional	74	74	40
Low Density Residential	123	132	134
Low-Medium Density Residential	33	45	76
Marina	0	0	0
Medium Density Residential	4	4	4
Downtown Mixed Use	0	0	0
Neighborhood Commercial	0	0	0
Park or Open Space	74	39	36
Research & Development Park	0	0	0
Railroad	0	0	0
Road	70	76	76
Surface Water	61	61	61
Wetland	0	0	0
Total	558	558	558

3.4.3 OVERVIEW OF LOADINGS GENERATED IN LILY LAKE SUBWATERSHED

Summaries of the loadings generated for TP, TSS and runoff volume for each of the three conditions (Baseline, Present, and Ultimate) are shown in Table 3.7. The loads shown in the tables are a summation of the total loads generated within the Lily Lake Subwatershed. For loadings generated by specific land use types, refer to the loading assessment model spreadsheets in Appendix B. These loadings are not adjusted for existing BMP's.

Table 3.7 – Summary of Modeled Loadings (Lily Lake Subwatershed)

	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)
Baseline (1985) Condition	435	150,549	387
Present (2007) Condition	478	164,886	430
Ultimate Condition	457	158,136	413

Loads increase from the Baseline to the Existing due to an increase in residential development from agriculture and open space. Data on existing BMP's was unavailable and thus is not accounted for in either the Present or Ultimate Conditions summary above.

Stillwater has essentially reached full development within this subwatershed and its 2030 Land Use Plan indicates that no new development will occur within this watershed, so there will be little opportunity to implement MSCWMO rules on new development. Despite this, loadings decrease from Existing to the Ultimate condition. This is from areas where either potential redevelopment or changing land use designation may occur.

For areas of redevelopment, the MSCWMO rules apply only to areas of new construction, where soils are compacted, where runoff characteristics are changed or vegetation is removed. In cases where the redeveloping property is not highly impervious it is conceivable that this redevelopment standard would allow an increase in runoff volume. Therefore, loading reduction standards have not been applied to the Ultimate condition, as the extent that loading and runoff reductions may be required is unknown.

3.5 OVERVIEW OF MODELING RESULTS FOR LONG LAKE SUBWATERSHED

3.5.1 INTRODUCTION

Long Lake drainage area is located in the southwestern portion of Stillwater and falls within the jurisdiction of the Brown's Creek Watershed District. The subwatershed encompasses 1,390 acres of the Project Area. The summary of the loading assessment includes the following:

- A comparison of land use between the three conditions.
- TP, TSS and runoff volume loadings generated by the Long Lake Subwatershed for the three conditions.

3.5.2 LAND USE OVERVIEW

Table 3.8 summarizes the changes in each land use category between the Baseline, Present, and 2030 conditions for the Long Lake Subwatershed.

Table 3.8 – Land Use Change Summary Table (Long Lake Subwatershed)

Land Use	Baseline Condition (Ac)	Present Condition	Ultimate Condition
		Acres	Acres
Agriculture	537	65	0
Commercial Land & Buildings	60	165	116
Golf	0	0	0
High Density Residential	3	7	7
Industrial	0	9	38
Institutional	25	44	2
Low Density Residential	308	486	543
Low-Medium Density Residential	0	55	56
Marina	0	0	0
Medium Density Residential	0	34	48
Downtown Mixed Use	0	0	0
Neighborhood Commercial	0	0	0
Park or Open Space	194	162	138
Research & Development Park	0	9	86
Railroad	0	0	0
Road	132	215	215
Surface Water	131	138	138
Wetland	0	0	0
Total	1,390	1,390	1,390

3.5.3 OVERVIEW OF LOADINGS GENERATED IN THE LONG LAKE SUBWATERSHED

Summaries of the loadings generated for TP, TSS and runoff volume for each of the three conditions (Baseline, Present, and Ultimate) are shown in Table 3.9. The loads shown in the tables are a summation of the total loads generated within the Project Area. For loadings generated by specific land use types, refer to the loading assessment model spreadsheets in Appendix B. These loadings are not adjusted for existing BMP's.

Table 3.9 – Summary of Modeled Loadings (Long Lake Subwatershed)

	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)
Baseline (1985) Condition	776	263,131	639
Present (2007) Condition	966	338,357	870
Ultimate Condition	988	349,804	907

Table 3.10 below adjusts the loading results from Table 3.9 above, to account for existing and proposed BMP's within the project area. Existing BMP reductions have been applied to the 2007 (Existing) loads, and in 2030 – since these BMP's will remain in place. Calculations showing existing BMP performance are presented in Appendix C. This information was obtained from the Long Lake Management Plan- Appendix C:P8 Modeling Results. Loads calculated for the Ultimate condition for all loading points are based on the assumptions that:

- The City of Stillwater and the Brown's Creek Watershed District will continue to apply the same ponding and infiltration requirements to new developments in the future as they do today.
- BMP's that are in place currently will have the same efficiency rate in the future due to proper maintenance and periodic rehabilitation.

Table 3.10 – Summary of Modeled Loadings with Existing & Proposed BMP's

	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)
Baseline (1985) Condition	776	263,131	639
Present (2007) Condition	707	165,795	870
Ultimate Condition	652	140,232	833

Following are the key findings reflected in the above modeling results:

Calculated loads of TP and TSS decrease from Baseline to Present due to the existing BMP reductions that have been accounted for. There was no available information on existing BMP's ability to reduce the runoff volume and therefore the Runoff Volume increases from the Baseline to the Present condition.

Assumed load reductions as required by the current City storm water ordinance and Watershed Rules concerning TP, TSS, and Runoff volume were applied to the Ultimate Condition for all land uses that develop from Park/Open Space, or Agriculture. Thus TP and TSS loadings from Present to Ultimate continue to decrease past Baseline conditions. Runoff volume also decreases from Present to Ultimate.

3.6 OVERVIEW OF MODELING RESULTS FOR MCKUSICK LAKE SUBWATERSHED

3.6.1 INTRODUCTION

McKusick Lake drainage area is located in the central portion of Stillwater and falls within the jurisdiction of the Middle St. Croix Watershed Management Organization. The subwatershed encompasses 638 acres of the Project Area. The summary of the loading assessment includes the following:

- A comparison of land use between the three conditions.
- TP, TSS and runoff volume loadings generated by the McKusick Lake Subwatershed for the three conditions.

3.6.2 LAND USE OVERVIEW

Table 3.11 summarizes the changes in each land use category between the Baseline, Present, and 2030 conditions for the McKusick Lake Subwatershed.

Table 3.11 – Land Use Change Summary Table (McKusick Lake Subwatershed)

Land Use	Baseline Condition (Ac)	Present Condition	Ultimate Condition
		Acres	Acres
Agriculture	5	0	0
Commercial Land & Buildings	4	4	0
Golf	18	18	18
High Density Residential	0	0	0
Industrial	0	0	0
Institutional	30	30	7
Low Density Residential	235	287	310
Low-Medium Density Residential	69	69	81
Marina	0	0	0
Medium Density Residential	0	0	0
Downtown Mixed Use	0	0	0
Neighborhood Commercial	0	0	0
Park or Open Space	112	54	46
Research & Development Park	0	0	0
Railroad	0	0	0
Road	95	107	107
Surface Water	62	62	62
Wetland	7	7	7
Total	638	638	638

3.6.3 OVERVIEW OF LOADINGS GENERATED IN THE MCKUSICK LAKE SUBWATERSHED

Summaries of the loadings generated for TP, TSS and runoff volume for each of the three conditions (Baseline, Present, and Ultimate) are shown in Table 3.12. The loads shown in the tables are a summation of the total loads generated within the Project Area. For loadings generated by specific land use types, refer to the loading assessment model spreadsheets in Appendix B. These loadings are not adjusted for existing BMP's.

Table 3.12 – Summary of Modeled Loadings (McKusick Lake Subwatershed)

	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)
Baseline (1985) Condition	381	130,386	330
Present (2007) Condition	417	137,879	356
Ultimate Condition	402	132,296	342

Loads increase from the Baseline to the Existing due to an increase in residential development from agriculture and open space. Data on existing BMP's was unavailable and thus is not accounted for in either the Present or Ultimate Conditions summary above.

Stillwater has essentially reached full development within this subwatershed and its 2030 Land Use Plan indicates that no new development will occur within this watershed, so there will be little opportunity to implement MSCWMO rules on new development. Despite this, loadings decrease from Existing to the Ultimate condition. This is from areas where either potential redevelopment or changing land use designations occur.

For areas of redevelopment, the MSCWMO rules apply only to areas of new construction, where soils are compacted, where runoff characteristics are changed or vegetation is removed. In cases where the redeveloping property is not highly impervious it is conceivable that this redevelopment standard would allow an increase in runoff volume. Therefore, loading reduction standards have not been applied to the Ultimate condition, as the extent that loading and runoff reductions may be required is unknown.

3.7 OVERVIEW OF MODELING RESULTS FOR THE "NOT MODELED" SUBWATERSHED

3.7.1 INTRODUCTION

The "Not Modeled" Subwatershed is located in the southern extremities of Stillwater and falls within the jurisdiction of the Middle St. Croix Watershed Management Organization. It encompasses 30 acres of the Project Area. The summary of the loading assessment includes the following:

- A comparison of land use between the three conditions.
- TP, TSS and runoff volume loadings generated by the "Not Modeled" Subwatershed for the three conditions.

3.7.2 LAND USE OVERVIEW

Table 3.13 summarizes the changes in each land use category between the Baseline, Present, and 2030 conditions for the Not Modeled Subwatershed.

Table 3.13 – Land Use Change Summary Table (Not Modeled Subwatershed)

Land Use	Baseline Condition (Ac)	Present Condition	Ultimate Condition
		Acres	Acres
Agriculture	0	0	0
Commercial Land & Buildings	3	3	3
Golf	0	0	0
High Density Residential	1	1	1
Industrial	0	0	0
Institutional	11	17	17
Low Density Residential	5	0	0
Low-Medium Density Residential	0	0	0
Marina	0	0	0
Medium Density Residential	0	0	0
Downtown Mixed Use	0	0	0
Neighborhood Commercial	0	0	0
Park or Open Space	0	0	0
Research & Development Park	0	0	0
Railroad	0	0	0
Road	9	9	9
Surface Water	0	0	0
Wetland	0	0	0
Total	30	30	30

3.8.3 OVERVIEW OF LOADINGS GENERATED IN THE "NOT MODELED" SUBWATERSHED

Summaries of the loadings generated for TP, TSS and runoff volume for each of the three conditions (Baseline, Present, and Ultimate) are shown in Table 3.14. The loads shown in the tables are a summation of the total loads generated within the "Not Modeled" Subwatershed. For loadings generated by specific land use types, refer to the loading assessment model spreadsheets in Appendix B. These loadings are not adjusted for existing BMP's.

Table 3.14 – Summary of Modeled Loadings (Not Modeled Subwatershed)

	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)
Baseline (1985) Condition	34	11,184	29
Present (2007) Condition	39	12,688	33
Ultimate Condition	39	12,688	33

Available data sources indicate that there are no BMPs within the "Not Modeled" Subwatershed and that no development is proposed within this area for the 2007 to 2030 time period. Consequently, no changes in pollutant loading will occur over the 2007 conditions. A slight increase in pollutant loadings occurred over the 1985 to 2007 period as development concluded in this subwatershed.

3.8 OVERVIEW OF MODELING RESULTS FOR THE ST. CROIX SUBWATERSHED

3.8.1 INTRODUCTION

The St. Croix Subwatershed is located along the eastern portion of Stillwater and falls within the jurisdiction of the Middle St. Croix Watershed Management Organization. It encompasses 1,455 acres of the Project Area. The summary of the loading assessment includes the following:

- A comparison of land use between the three conditions.
- TP, TSS and runoff volume loadings generated by the St. Croix Subwatershed for the three conditions.

3.8.2 LAND USE OVERVIEW

Table 3.185summarizes the changes in each land use category between the Baseline, Present, and 2030 conditions for the St. Croix Subwatershed.

Table 3.15 – Land Use Change Summary Table (St. Croix Subwatershed)

Land Use	Baseline Condition (Ac)	Present Condition Acres	Ultimate Condition Acres
Agriculture	0	0	0
Commercial Land & Buildings	58	56	5
Golf	63	63	63
High Density Residential	9	16	11
Industrial	26	0	0
Institutional	74	81	48
Low Density Residential	78	76	89
Low-Medium Density Residential	443	445	482
Marina	16	16	16
Medium Density Residential	0	1	0
Downtown Mixed Use	0	0	49
Neighborhood Commercial	0	0	0
Park or Open Space	92	102	101
Research & Development Park	0	0	0
Railroad	5	5	0
Road	248	250	249
Surface Water	343	343	343
Wetland	0	0	0
Total	1,455	1,455	1,455

3.8.3 OVERVIEW OF LOADINGS GENERATED IN THE ST. CROIX SUBWATERSHED

Summaries of the loadings generated for TP, TSS and runoff volume for each of the three conditions (Baseline, Present, and Ultimate) are shown in Table 3.16. The loads shown in the tables are a summation of the total loads generated within the St. Croix Subwatershed. For loadings generated by specific land use types, refer to the loading assessment model spreadsheets in Appendix B. These loadings are not adjusted for existing BMP's.

Table 3.16 – Summary of Modeled Loadings (St. Croix Subwatershed)

	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)
Baseline (1985) Condition	908	309,180	798
Present (2007) Condition	900	304,676	785
Ultimate Condition	887	301,570	777

Table 3.17 below adjusts the loading results from Table 3.16 above, to account for existing and proposed BMP's within the project area. Existing BMP reductions have been applied to the 2007 (Existing) loads, and in 2030 – since these BMP's will remain in place. Calculations showing existing BMP performance are presented in appendix C. Existing BMP's include wet detention ponds, infiltration basins and swales. This information is obtained from Stillwater's LSWMP which includes data on existing BMP's in each drainage area. Loads calculated for the Ultimate condition for all loading points are based on the assumptions that:

- The City of Stillwater and the Brown's Creek Watershed District will continue to apply the same ponding and infiltration requirements to new developments in the future as they do today.
- BMP's that are in place currently will have the same efficiency rate in the future due to proper maintenance and periodic rehabilitation.

Table 3.17 – Summary of Modeled Loadings with Existing & Proposed BMP's

	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)
Baseline (1985) Condition	908	309,180	798
Present (2007) Condition	842	275,188	778
Ultimate Condition	829	272,081	770

Following are the key findings reflected in the above modeling results:

Calculated loads of total phosphorus, suspended solids and runoff volume decrease from Baseline to Present, and from Present to Ultimate Conditions. The land use changes that occur in this subwatershed, without the presence of BMP's (see Table 3.16), already incur decreased loadings. The existing BMP's further contribute to this over time.

Stillwater has essentially reached full development within this subwatershed and its 2030 Land Use Plan indicates that no new development will occur within this watershed, so there will be little opportunity to implement MSCWMO rules on new development. For areas of redevelopment, the MSCWMO rules apply only to areas of new construction, where soils are compacted, where runoff characteristics are changed or vegetation is removed. In cases where the redeveloping property is not highly impervious it is conceivable that this redevelopment standard would allow an increase in runoff volume. Therefore, loading reduction standards have not been applied to the Ultimate condition, as the extent that loading and runoff reductions may be required is unknown.

3.9 OVERVIEW OF MODELING RESULTS FOR THE TWIN LAKES SUBWATERSHED

3.9.1 INTRODUCTION

The Twin Lakes Subwatershed is located in the northwestern corner of Stillwater and falls mostly within the jurisdiction of the Carnelian Marine-St. Croix Watershed District. It encompasses 110 acres of the Project Area. The summary of the loading assessment includes the following:

- A comparison of land use between the three conditions.
- TP, TSS and runoff volume loadings generated by the Twin Lakes Subwatershed for the three conditions.

3.9.2 LAND USE OVERVIEW

Table 3.18 summarizes the changes in each land use category between the Baseline, Present, and 2030 conditions for the Twin Lakes Subwatershed.

Table 3.18 – Land Use Change Summary Table (Twin Lakes Subwatershed)

Land Use	Baseline Condition (Ac)	Present Condition	Ultimate Condition
		Acres	Acres
Agriculture	21	0	0
Commercial Land & Buildings	0	0	0
Golf	0	0	0
High Density Residential	0	0	0
Industrial	0	0	0
Institutional	0	0	0
Low Density Residential	19	9	14
Low-Medium Density Residential	0	8	18
Marina	0	0	0
Medium Density Residential	0	0	0
Downtown Mixed Use	0	0	0
Neighborhood Commercial	0	0	0
Park or Open Space	16	33	18
Research & Development Park	0	0	0
Railroad	0	0	0
Road	3	6	6
Surface Water	52	54	54
Wetland	0	0	0
Total	110	110	110

3.9.3 OVERVIEW OF LOADINGS GENERATED IN THE TWIN LAKES SUBWATERSHED

Summaries of the loadings generated for TP, TSS and runoff volume for each of the three conditions (Baseline, Present, and Ultimate) are shown in Table 3.19. The loads shown in the tables are a summation of the total loads generated within the Twin Lakes Subwatershed. For loadings generated by specific land use types, refer to the loading assessment model spreadsheets in Appendix B These loadings are not adjusted for existing BMP's.

Table 3.19 – Summary of Modeled Loadings (Twin Lakes Subwatershed)

	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)
Baseline (1985) Condition	30	10,408	24
Present (2007) Condition	23	9,683	22
Ultimate Condition	33	11,760	29

Table 3.20 below adjusts the loading results from Table 3.21 above, to account for existing and proposed BMP's within the project area. Existing BMP reductions have been applied to the 2007 (Existing) loads, and in 2030 – since these BMP's will remain in place. Calculations showing existing BMP performance are presented in Appendix C. Existing BMP's consist of wet detention ponds. This information is obtained from Stillwater's LSWMP which includes data on existing BMP's in each drainage area. Loads calculated for the Ultimate condition for all loading points are based on the assumptions that:

- The City of Stillwater and the Brown's Creek Watershed District and the CMSCWD will continue to apply the same ponding and infiltration requirements to new developments in the future as they do today.
- BMP's that are in place currently will have the same efficiency rate in the future due to proper maintenance and periodic rehabilitation.

Table 3.20 – Summary of Modeled Loadings with Existing & Proposed BMP's

	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)
Baseline (1985) Condition	30	10,408	24
Present (2007) Condition w/Existing Features	20	8,529	22
Ultimate Condition	28	9,677	26

Following are the key findings reflected in the above modeling results:

Calculated loads of total phosphorus, suspended solids and runoff volume all decrease from Baseline to Present. This is due to the implementation of existing BMP's.

In the Ultimate condition, there are several areas where either redevelopment will occur, or a land use designation transfer will occur.   Since, CMSCWMO rules apply only to areas of new construction, loading reduction standards have not been applied to all the Ultimate land use changes, as the extent that loading and runoff reductions may be required is unknown. However, the areas where land use developed from Park/Open Space, current City storm water ordinance and Watershed Rules were taken into account. Overall, the loadings still increased in the Ultimate condition for this subwatershed.

3.10 OVERVIEW OF MODELING RESULTS FOR DIVERSION TO MCKUSICK LAKE SUBWATERSHED

3.10.1 INTRODUCTION

Diversion to McKusick Lake Subwatershed is located along the west central edge of Stillwater and falls within the jurisdiction of the Brown's Creek Watershed District. It encompasses 772 acres of the Project Area. The summary of the loading assessment includes the following:

- A comparison of land use between the three conditions.
- TP, TSS and runoff volume loadings generated by the Diversion to McKusick Lake Subwatershed for the three conditions.

3.10.2 LAND USE OVERVIEW

Table 3.21 summarizes the changes in each land use category between the Baseline, Present, and 2030 conditions for the Diversion to McKusick Lake Subwatershed.

Table 3.21 – Land Use Change Summary Table (Diversion to McKusick Lake Subwatershed)

Land Use	Baseline Condition (Ac)	Present Condition	Ultimate Condition
		Acres	Acres
Agriculture	338	38	0
Commercial Land & Buildings	0	0	0
Golf	0	0	0
High Density Residential	0	0	0
Industrial	0	0	0
Institutional	2	8	18
Low Density Residential	204	307	262
Low-Medium Density Residential	0	63	165
Marina	0	0	0
Medium Density Residential	0	44	52
Downtown Mixed Use	0	0	0
Neighborhood Commercial	0	6	6
Park or Open Space	150	202	174
Research & Development Park	0	0	0
Railroad	8	8	0
Road	52	76	76
Surface Water	14	18	18
Wetland	2	2	2
Total	772	772	772

3.10.3 OVERVIEW OF LOADINGS GENERATED IN THE DIVERSION TO MCKUSICK LAKE SUBWATERSHED

Summaries of the loadings generated for TP, TSS and runoff volume for each of the three conditions (Baseline, Present, and Ultimate) are shown in Table 3.22. The loads shown in the tables are a summation of the total loads generated within the Diversion to McKusick Lake Subwatershed. For loadings generated by specific land use types, refer to the loading assessment model spreadsheets in Appendix B. These loadings are not adjusted for existing BMP's.

Table 3.22 – Summary of Modeled Loadings (Diversion to McKusick Lake Subwatershed)

	TP Load	TSS Load	Runoff Volume
	(lbs/yr)	(lbs/yr)	(ac-ft/yr)
Baseline (1985) Condition	412	139,235	330
Present (2007) Condition	456	159,464	397
Ultimate Condition	499	170,966	432

Table 3.23 below adjusts the loading results from Table 3.22 above, to account for proposed BMP's within the project area. There is no information on existing BMP's. Loads calculated for the Ultimate condition for all loading points are based on the assumptions that:

- The City of Stillwater and the Brown's Creek Watershed District will continue to apply the same ponding and infiltration requirements to new developments in the future as they do today.

Table 3.23 – Summary of Modeled Loadings with Existing & Proposed BMP's

	TP Load	TSS Load	Runoff Volume
	(lbs/yr)	(lbs/yr)	(ac-ft/yr)
Baseline (1985) Condition	412	139,235	330
Present (2007) Condition	456	159,464	397
Ultimate Condition	461	151,244	388

Following are the key findings reflected in the above modeling results:

Loads increase from Baseline to the Present condition. This is due to new development, and the absence of data on existing BMP's.

TSS and Runoff Volume decreases in the Ultimate condition from Existing. This is due to the current City storm water ordinance and Watershed Rules that will be applied to development within the 2030 Boundary. Although TP in the Ultimate condition is reduced (fromTable 3.25), it still does not fall below Present conditions. This is because the increased phosphorus production exceed the reductions that are accomplished by the proposed BMP's.

3.11 OVERVIEW OF ADJUSTED LOADINGS – PROJECT AREA SUMMARY

Table 3.2 from earlier in appendix A calculates raw pollutant loadings for Stillwater's discharge to the St. Croix River. The calculations represented in table 3.2 do not account for existing BMPs or future BMPs taht would be installed with future development to meet existing watershed rules.

Table 3.2 – Summary of Raw Modeled Loadings (Project Area)

Condition	TP Load	TSS Load	Runoff Volume
	(lbs/yr)	(lbs/yr)	(ac-ft/yr)
Baseline (1985) Condition	3,385	1,155,733	2,872
Present (2007) Condition	3,674	1,269,918	3,231
Ultimate Condition	3,715	1,281,854	3,281

Table 3.24 presents the final summary of Project Area discharge to the St Croix River over the three time frames and results from the analysis of existing and future BMPs within each of the eight subwatersheds as discussed above.

Table 3.24 – Summary of Modeled Loadings with Existing & Proposed BMP's

Condition	TP Load	TSS Load	Runoff Volume
	(lbs/yr)	(lbs/yr)	(ac-ft/yr)
Baseline (1985) Condition	3,385	1,155,733	2,872
Present (2007) Condition	3,290	1,042,691	3,204
Ultimate Condition	3,197	988,023	3,111

Following are the key findings reflected in the above modeling results:

1. Two factors contribute to Stillwater having reduced TP and TSS loading over the 1985 to 2007 period:
    a. A good portion of the City developed before 1985
    b. Much of the development since 1985 occurred in the 1990's and 2000's when Stillwater required water quality ponding to NURP standards through ordinance.
2. Runoff volume increased in the 1985 to 2007 period, as expected. Runoff volume will slightly decrease in the 2007 to Ultimate Condition as Stillwater and the watersheds implement volume management standards on new development.

3. Stillwater's target for retrofit mitigation should be the 332 acre-feet of increase runoff volume that occurred in the 1985 to 2007 period.

Appendix B

Project Area	Baseline (1985) Condition			Present (2007) Condition			Ultimate Condition		
Land Use	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)
Agriculture	598	180,654	409	67	20,351	46	0	0	0
Commercial Land & Buildings	220	87,983	232	374	149,472	394	176	70,478	186
Golf	82	32,168	55	82	32,168	55	82	32,168	55
High Density Residential	56	17,459	46	75	23,476	62	71	22,048	58
Industrial	53	21,331	56	40	15,944	42	142	56,945	150
Institutional	336	104,469	275	394	122,655	323	203	63,282	167
Low Density Residential	862	268,240	707	1,118	347,876	916	1,167	362,930	956
Low-Medium Density Residential	458	142,643	376	579	180,124	474	775	241,049	635
Marina	21	8,292	22	21	8,292	22	21	8,292	22
Medium Density Residential	4	1,347	4	93	28,950	76	119	36,882	97
Downtown Mixed Use	0	0	0	0	0	0	74	29,629	78
Neighborhood Commercial	0	0	0	7	2,983	8	7	2,983	8
Park or Open Space	94	81,373	139	96	82,605	141	83	71,433	122
Research & Development Park	0	0	0	11	4,388	12	104	41,452	109
Railroad	22	7,853	21	22	7,853	21	0	0	0
Road	577	201,920	532	694	242,782	640	692	242,283	638
Surface Water	0	0	0	0	0	0	0	0	0
Wetland	0	0	0	0	0	0	0	0	0
Total	3,385	1,155,733	2,872	3,674	1,269,918	3,231	3,715	1,281,854	3,281

Brown's Creek	Baseline (1985) Condition			Present (2007) Condition			Ultimate Condition		
	TP Load	TSS Load	Runoff Volume	TP Load	TSS Load	Runoff Volume	TP Load	TSS Load	Runoff Volume
Land Use	(lbs/yr)	(lbs/yr)	(ac-ft/yr)	(lbs/yr)	(lbs/yr)	(ac-ft/yr)	(lbs/yr)	(lbs/yr)	(ac-ft/yr)
Agriculture	75	22,764	52	9	2,825	6	0	0	0
Commercial Land & Buildings	7	2,806	7	7	2,806	7	0	71	0
Golf	59	23,069	39	59	23,069	39	59	23,069	39
High Density Residential	3	933	2	3	933	2	3	933	2
Industrial	0	0	0	0	0	0	0	0	0
Institutional	2	688	2	2	688	2	0	0	0
Low Density Residential	157	48,967	129	179	55,833	147	188	58,441	154
Low-Medium Density Residential	7	2,185	6	13	3,979	10	49	15,193	40
Marina	2	611	2	2	611	2	2	611	2
Medium Density Residential	0	0	0	7	2,269	6	11	3,399	9
Downtown Mixed Use	0	0	0	0	0	0	0	0	0
Neighborhood Commercial	0	0	0	0	0	0	0	0	0
Park or Open Space	11	9,738	17	19	16,184	28	16	13,790	24
Research & Development Park	0	0	0	0	0	0	0	0	0
Railroad	11	3,961	10	11	3,961	10	0	0	0
Road	74	25,939	68	83	29,127	77	83	29,127	77
Surface Water	0	0	0	0	0	0	0	0	0
Wetland	0	0	0	0	0	0	0	0	0
Total	409	141,661	334	395	142,284	337	410	144,634	347

Lily Lake	Baseline (1985) Condition			Present (2007) Condition			Ultimate Condition		
Land Use	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)
Agriculture	13	4,040	9	0	0	0	0	0	0
Commercial Land & Buildings	63	25,263	67	93	37,323	98	27	10,638	28
Golf	0	0	0	0	0	0	0	0	0
High Density Residential	34	10,696	28	37	11,585	31	40	12,561	33
Industrial	23	9,008	24	29	11,753	31	96	38,574	102
Institutional	114	35,402	93	114	35,402	93	62	19,312	51
Low Density Residential	89	27,740	73	95	29,659	78	97	30,223	80
Low-Medium Density Residential	27	8,493	22	37	11,589	31	63	19,498	51
Marina	0	0	0	0	0	0	0	0	0
Medium Density Residential	4	1,347	4	4	1,347	4	4	1,347	4
Downtown Mixed Use	0	0	0	0	0	0	0	0	0
Neighborhood Commercial	0	0	0	0	0	0	0	0	0
Park or Open Space	10	8,314	14	5	4,332	7	5	4,088	7
Research & Development Park	0	0	0	0	0	0	0	0	0
Railroad	0	0	0	0	0	0	0	0	0
Road	58	20,247	53	63	21,896	58	63	21,896	58
Surface Water	0	0	0	0	0	0	0	0	0
Wetland	0	0	0	0	0	0	0	0	0
Total	**435**	**150,549**	**387**	**478**	**164,886**	**430**	**457**	**158,136**	**413**

Long Lake	Baseline (1985) Condition			Present (2007) Condition			Ultimate Condition		
	TP Load	TSS Load	Runoff Volume	TP Load	TSS Load	Runoff Volume	TP Load	TSS Load	Runoff Volume
Land Use	(lbs/yr)	(lbs/yr)	(ac-ft/yr)	(lbs/yr)	(lbs/yr)	(ac-ft/yr)	(lbs/yr)	(lbs/yr)	(ac-ft/yr)
Agriculture	303	91,607	207	37	11,069	25	0	0	0
Commercial Land & Buildings	72	28,744	76	197	78,981	208	139	55,719	147
Golf	0	0	0	0	0	0	0	0	0
High Density Residential	4	1,275	3	10	3,235	9	10	3,235	9
Industrial	0	0	0	10	4,191	11	46	18,370	48
Institutional	39	12,022	32	69	21,339	56	3	780	2
Low Density Residential	223	69,505	183	352	109,444	288	393	122,391	322
Low-Medium Density Residential	0	0	0	45	14,091	37	47	14,522	38
Marina	0	0	0	0	0	0	0	0	0
Medium Density Residential	0	0	0	35	11,037	29	49	15,363	40
Downtown Mixed Use	0	0	0	0	0	0	0	0	0
Neighborhood Commercial	0	0	0	0	189	0	0	189	0
Park or Open Space	25	21,762	37	21	18,155	31	18	15,544	27
Research & Development Park	0	0	0	11	4,388	12	104	41,452	109
Railroad	0	0	0	0	0	0	0	0	0
Road	109	38,216	101	178	62,238	164	178	62,238	164
Surface Water	0	0	0	0	0	0	0	0	0
Wetland	0	0	0	0	0	0	0	0	0
Total	776	263,131	639	966	338,357	870	988	349,804	907

McKusick Lake	Baseline (1985) Condition			Present (2007) Condition			Ultimate Condition		
	TP Load	TSS Load	Runoff Volume	TP Load	TSS Load	Runoff Volume	TP Load	TSS Load	Runoff Volume
Land Use	(lbs/yr)	(lbs/yr)	(ac-ft/yr)	(lbs/yr)	(lbs/yr)	(ac-ft/yr)	(lbs/yr)	(lbs/yr)	(ac-ft/yr)
Agriculture	3	938	2	0	0	0	0	0	0
Commercial Land & Buildings	5	1,960	5	5	1,960	5	1	234	1
Golf	5	2,009	3	5	2,009	3	5	2,009	3
High Density Residential	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0
Institutional	47	14,624	39	47	14,624	39	11	3,446	9
Low Density Residential	170	52,943	139	208	64,584	170	224	69,814	184
Low-Medium Density Residential	57	17,864	47	57	17,864	47	67	20,838	55
Marina	0	0	0	0	0	0	0	0	0
Medium Density Residential	0	0	0	0	0	0	0	0	0
Downtown Mixed Use	0	0	0	0	0	0	0	0	0
Neighborhood Commercial	0	0	0	0	0	0	0	0	0
Park or Open Space	15	12,591	21	7	6,022	10	6	5,138	9
Research & Development Park	0	0	0	0	0	0	0	0	0
Railroad	0	0	0	0	0	0	0	0	0
Road	78	27,457	72	88	30,817	81	88	30,817	81
Surface Water	0	0	0	0	0	0	0	0	0
Wetland	0	0	0	0	0	0	0	0	0
Total	381	130,386	330	417	137,879	356	402	132,296	342

Not Modeled	Baseline (1985) Condition			Present (2007) Condition			Ultimate Condition		
	TP Load	TSS Load	Runoff Volume	TP Load	TSS Load	Runoff Volume	TP Load	TSS Load	Runoff Volume
Land Use	(lbs/yr)	(lbs/yr)	(ac-ft/yr)	(lbs/yr)	(lbs/yr)	(ac-ft/yr)	(lbs/yr)	(lbs/yr)	(ac-ft/yr)
Agriculture	0	0	0	0	0	0	0	0	0
Commercial Land & Buildings	4	1,489	4	4	1,534	4	4	1,534	4
Golf	0	0	0	0	0	0	0	0	0
High Density Residential	1	425	1	1	425	1	1	425	1
Industrial	0	0	0	0	0	0	0	0	0
Institutional	17	5,374	14	26	8,069	21	26	8,069	21
Low Density Residential	4	1,185	3	0	0	0	0	0	0
Low-Medium Density Residential	0	0	0	0	0	0	0	0	0
Marina	0	0	0	0	0	0	0	0	0
Medium Density Residential	0	0	0	0	0	0	0	0	0
Downtown Mixed Use	0	0	0	0	0	0	0	0	0
Neighborhood Commercial	0	0	0	0	0	0	0	0	0
Park or Open Space	0	54	0	0	3	0	0	3	0
Research & Development Park	0	0	0	0	0	0	0	0	0
Railroad	0	0	0	0	0	0	0	0	0
Road	8	2,658	7	8	2,658	7	8	2,658	7
Surface Water	0	0	0	0	0	0	0	0	0
Wetland	0	0	0	0	0	0	0	0	0
Total	34	11,184	29	39	12,688	33	39	12,688	33

St. Croix	Baseline (1985) Condition			Present (2007) Condition			Ultimate Condition		
Land Use	TP Load	TSS Load	Runoff Volume	TP Load	TSS Load	Runoff Volume	TP Load	TSS Load	Runoff Volume
	(lbs/yr)	(lbs/yr)	(ac-ft/yr)	(lbs/yr)	(lbs/yr)	(ac-ft/yr)	(lbs/yr)	(lbs/yr)	(ac-ft/yr)
Agriculture	0	0	0	0	0	0	0	0	0
Commercial Land & Buildings	69	27,722	73	67	26,869	71	6	2,281	6
Golf	18	7,091	12	18	7,091	12	18	7,091	12
High Density Residential	13	4,130	11	23	7,298	19	16	4,894	13
Industrial	31	12,323	32	0	0	0	0	0	0
Institutional	113	35,274	93	124	38,717	102	74	22,937	60
Low Density Residential	57	17,616	46	55	17,203	45	64	19,987	53
Low-Medium Density Residential	367	114,026	300	368	114,384	301	398	123,974	327
Marina	19	7,681	20	19	7,681	20	19	7,681	20
Medium Density Residential	0	0	0	1	225	1	0	0	0
Downtown Mixed Use	0	0	0	0	0	0	74	29,629	78
Neighborhood Commercial	0	0	0	0	0	0	0	0	0
Park or Open Space	12	10,295	18	13	11,473	20	13	11,302	19
Research & Development Park	0	0	0	0	0	0	0	0	0
Railroad	4	1,443	4	4	1,443	4	0	0	0
Road	205	71,579	189	207	72,293	190	205	71,794	189
Surface Water	0	0	0	0	0	0	0	0	0
Wetland	0	0	0	0	0	0	0	0	0
Total	908	309,180	798	900	304,676	785	887	301,570	777

Twin Lakes	Baseline (1985) Condition			Present (2007) Condition			Ultimate Condition		
Land Use	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)
Agriculture	12	3,545	8	0	25	0	0	0	0
Commercial Land & Buildings	0	0	0	0	0	0	0	0	0
Golf	0	0	0	0	0	0	0	0	0
High Density Residential	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0
Institutional	0	0	0	0	0	0	0	0	0
Low Density Residential	14	4,271	11	7	2,067	5	10	3,136	8
Low-Medium Density Residential	0	0	0	6	1,956	5	15	4,707	12
Marina	0	0	0	0	0	0	0	0	0
Medium Density Residential	0	0	0	0	86	0	0	86	0
Downtown Mixed Use	0	0	0	0	0	0	0	0	0
Neighborhood Commercial	0	0	0	0	0	0	0	0	0
Park or Open Space	2	1,776	3	4	3,729	6	2	2,011	3
Research & Development Park	0	0	0	0	0	0	0	0	0
Railroad	0	0	0	0	0	0	0	0	0
Road	2	816	2	5	1,819	5	5	1,819	5
Surface Water	0	0	0	0	0	0	0	0	0
Wetland	0	0	0	0	0	0	0	0	0
Total	30	10,408	24	23	9,683	22	33	11,760	29

Diversion to McKusick Lake	Baseline (1985) Condition			Present (2007) Condition			Ultimate Condition		
Land Use	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)	TP Load (lbs/yr)	TSS Load (lbs/yr)	Runoff Volume (ac-ft/yr)
Agriculture	191	57,760	131	21	6,432	15	0	0	0
Commercial Land & Buildings	0	0	0	0	0	0	0	0	0
Golf	0	0	0	0	0	0	0	0	0
High Density Residential	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0
Institutional	3	1,085	3	12	3,816	10	28	8,736	23
Low Density Residential	148	46,014	121	222	69,085	182	189	58,938	155
Low-Medium Density Residential	0	75	0	52	16,260	43	136	42,318	111
Marina	0	0	0	0	0	0	0	0	0
Medium Density Residential	0	0	0	45	13,986	37	54	16,687	44
Downtown Mixed Use	0	0	0	0	0	0	0	0	0
Neighborhood Commercial	0	0	0	7	2,794	7	7	2,794	7
Park or Open Space	19	16,844	29	26	22,708	39	23	19,558	33
Research & Development Park	0	0	0	0	0	0	0	0	0
Railroad	7	2,449	6	7	2,449	6	0	0	0
Road	43	15,007	40	63	21,934	58	63	21,934	58
Surface Water	0	0	0	0	0	0	0	0	0
Wetland	0	0	0	0	0	0	0	0	0
Total	412	139,235	330	456	159,464	397	499	170,966	432

Appendix C

Existing BMP Information from Stillwater LSWMP
Browns Creek Subwatershed

Sub-basin		BMP		Total Phosphorus Load				Total Suspended Solids				Runoff Water Volume			
ID	Area	Type	Area	Inflow	Outflow	Reduction	Load Reduction (lb/yr)	Inflow	Outflow	Reduction	Load Reduction (lb/yr)	Inflow	Outflow	Reduction	Load Reduction (ac-ft/yr)
	(ac)		(ac)	(lb/yr)	(lb/yr)	(%)		(lb/yr)	(lb/yr)	(%)		(ac-ft/yr)	(ac-ft/yr)	(%)	
BC-02	2.38	Landlocked					0.0				0.0				0.0
BC-03	13.71	Wet Detention Pond	0.3	6.5	2.5	62.5	4.1	2,035.0	164.7	91.9	1,870.3	6.8	6.8	0.0	0.0
BC-04a	2.14	Wet Detention Pond	0.8	0.4	0.2	47.6	0.3	35.3	0.3	99.1	35.0	2.4	2.4	0.0	0.0
BC-04b	5.12	Landlocked					0.0				0.0				0.0
BC-04c	25.76	None		14.8	14.8	0.0	0.0	4,609.2	4,609.2	0.0	0.0	15.5	15.5	0.0	0.0
BC-04w	54.51	None		4.3	4.3	0.0	0.0	705.2	705.2	0.0	0.0	10.0	10.0	0.0	0.0
BC-05	8.06	Wet Detention Pond	0.3	4.1	1.4	65.6	2.7	1,280.1	67.2	94.8	1,213.0	4.4	4.4	0.0	0.0
BC-06	7.02	Wet Detention Pond	0.2	1.4	0.4	70.4	1.0	444.8	10.9	97.5	433.8	1.5	1.5	0.0	0.0
BC-07	45.44	None		14.9	14.9	0.0	0.0	4,616.6	4,616.6	0.0	0.0	15.7	15.7	0.0	0.0
BC-08a	12.81	Wet Detention Pond	0.8	6.6	2.0	70.0	4.6	2,034.6	51.8	97.5	1,982.7	6.9	6.9	0.0	0.0
BC-08b	3.81	Wet Detention Pond	0.5	3.9	2.3	76.0	1.5	634.5	32.6	94.9	602.0	8.9	8.9	0.0	0.0
BC-08c	15.72	Wet Detention Pond	1.1	3.8	0.9	76.0	2.9	1,154.3	12.2	98.9	1,142.1	4.2	4.2	0.0	0.0
BC-08d	3.52	Infiltration Basin	1.3	1.2	0.0	100.0	1.2	372.8	0.0	100.0	372.8	1.3	0.0	100.0	1.3
BC-08e	1.83	Infiltration Basin	0.5	3.2	0.0	98.7	3.1	105.8	0.0	100.0	105.8	12.1	0.2	98.6	12.0
BC-08f	15.9	None		2.1	2.1	0.0	0.0	638.6	638.6	0.0	0.0	2.3	2.3	0.0	0.0
BC-09a	7.28	Wet Detention Pond	0.3	6.8	2.5	63.7	4.4	2,139.4	158.1	92.6	1,981.3	7.0	7.0	0.0	0.0
BC-09b	2.84	Infiltration Basin	0.3	3.0	0.2	93.0	2.8	318.6	11.9	96.3	306.7	7.6	0.6	91.7	6.9
BC-10	31.11	Wet Detention Pond	2.9	2.3	0.5	77.0	1.8	694.6	3.5	99.5	691.1	2.6	2.6	0.0	0.0
BC-12a	0.97	Landlocked					0.0				0.0				0.0
BC-12b	44.76	Wet Detention Pond	0.4	20.3	11.2	45.1	9.2	5,618.2	1,049.9	81.3	4,568.4	35.2	35.2	0.0	0.0
BC-13	24.9	Wet Detention Pond	1.3	1.7	0.3	81.4	1.4	471.0	2.0	99.6	469.0	2.2	2.2	0.0	0.0
BC-15	54.13	Wet Detention Pond	9.0	15.4	2.3	85.4	13.2	4,750.1	19.2	99.6	4,730.9	16.5	16.5	0.0	0.0
BC-16	29.31	None		14.2	14.2	0.0	0.0	4,425.8	4,425.8	0.0	0.0	14.9	14.9	0.0	0.0
BC-17	53.98	None		5.7	5.7	0.0	0.0	1,720.6	1,720.6	0.0	0.0	6.3	6.3	0.0	0.0
BC-18	57.95	None		14.8	14.8	0.0	0.0	4,569.3	4,569.3	0.0	0.0	15.9	15.9	0.0	0.0
BC-19a	13.2	Wet Detention Pond	2.6	7.7	1.6	79.7	6.1	2,379.4	20.7	99.1	2,358.7	8.0	8.0	0.0	0.0
BC-19b	2.43	Wet Detention Pond	1.3	0.5	0.0	92.5	0.5	143.9	0.3	99.8	143.7	0.7	0.7	0.0	0.0
BC-19c	4.93	Wet Detention Pond	0.3	12.8	9.6	24.5	3.1	1,526.4	510.5	66.6	1,015.9	37.1	37.1	0.0	0.0
BC-19d	30.44	None		1.0	1.0	0.0	0.0	237.0	237.0	0.0	0.0	1.8	1.8	0.0	0.0
BC-20	47.17	Landlocked					0.0				0.0				0.0
BC-21	83.76	None		0.9	0.9	0.0	0.0	141.3	141.3	0.0	0.0	2.2	2.2	0.0	0.0
BC-22	16.45	Landlocked					0.0				0.0				0.0
BC-23	13.19	Landlocked					0.0				0.0				0.0
BC-24	93.49	None		10.4	10.4	0.0	0.0	3,202.5	3,202.5	0.0	0.0	11.0	11.0	0.0	0.0

Total							63.6				24,023.2				20.1

Existing BMP Information from Stillwater LSWMP
St. Croix
Subwatershed

Sub-basin		BMP		Total Phosphorus Load				Total Suspended Solids				Runoff Water Volume			
ID	Area	Type	Area	Inflow	Outflow	Reduction	Load Reduction (lb/yr)	Inflow	Outflow	Reduction	Load Reduction (lb/yr)	Inflow	Outflow	Reduction	Load Reduction (ac-ft/yr)
	(ac)		(ac)	(lb/yr)	(lb/yr)	(%)		(lb/yr)	(lb/yr)	(%)		(ac-ft/yr)	(ac-ft/yr)	(%)	
SCX-01	19.89	Landlocked					0.0				0.0				0.0
SCX-02	16.2	Landlocked					0.0				0.0				0.0
SCX-03a	4.42	Wet Detention Pond	0.1	1.1	0.4	64.9	0.7	342.8	20.8	93.9	321.9	1.2	1.2	0.0	0.0
SCX-03b	7.84	Wet Detention Pond	0.1	1.8	0.6	65.9	1.2	539.1	23.2	95.7	515.9	1.9	1.9	0.0	0.0
SCX-03c	43.97	Wet Detention Pond	0.1	9.0	4.8	46.4	4.2	2,743.4	600.5	78.1	2,143.0	9.7	9.7	0.0	0.0
SCX-03d	12.3	Wet Detention Pond	0.2	10.5	6.6	37.3	3.9	2,260.6	571.6	1,689.0	1,689.0	16.4	16.4	0.0	0.0
SCX-03e	9.32	None		2.1	2.1	0.0	0.0	629.1	629.1	0.0	0.0	2.2	2.2	0.0	0.0
SCX-04a	6.74	Landlocked					0.0				0.0				0.0
SCX-04b	63.87	Wet Detention Pond	0.2	62.7	44.9	28.5	17.9	19,626.1	7,873.3	59.9	11,752.8	64.6	64.6	0.0	0.0
SCX-04c	118.3	None		74.9	74.9	0.0	0.0	23,397.1	23,397.1	0.0	0.0	77.7	77.7	0.0	0.0
SCX-05	52.45	Wet Detention Pond	1.1	19.7	6.7	65.9	13.0	6,125.5	311.9	94.9	5,813.6	20.7	20.7	0.0	0.0
SCX-06a Cell 1	1.51	Wet Detention Pond	0.1	2.5	0.9	62.5	1.6	776.9	67.5	91.3	709.4	2.6	2.6	0.0	0.0
SCX-06a Cell 2		Wet Detention Pond	0.0	0.9	0.8	18.3	0.2	67.5	27.9	58.6	39.6	2.6	2.6	0.0	0.0
SCX-06a Cell 3		Wet Detention Pond	0.0	0.8	0.8	1.3	0.0	27.9	17.2	38.3	10.7	2.6	2.6	0.0	0.0
SX-06a Swale		Swale	0.0	0.8	0.7	12.0	0.1	17.2	13.0	24.7	4.3	2.6	2.2	12.5	0.3
SCX-06b	2.46	Wet Detention Pond	0.2	3.5	1.1	67.9	2.4	1,084.6	47.5	95.6	1,037.0	3.6	3.6	0.0	0.0
SCX-06c	4.83	Infiltration Basin	0.1	7.9	5.0	36.7	2.9	2,180.1	682.1	68.7	1,498.0	10.6	9.4	11.0	1.2
SCX-06d	19.12	None		18.9	18.9	0.0	0.0	5,891.2	5,891.2	0.0	0.0	19.5	19.5	0.0	0.0
SCX-07	9.18	None		5.4	5.4	0.0	0.0	1,688.3	1,688.3	0.0	0.0	5.6	5.6	0.0	0.0
SCX-08	53.75	None		50.0	50.0	0.0	0.0	15,633.0	15,633.0	0.0	0.0	51.5	51.5	0.0	0.0
SCX-09	41.88	None		44.8	44.8	0.0	0.0	14,009.6	14,009.6	0.0	0.0	46.1	46.1	0.0	0.0
SCX-10	23.27	None		23.4	23.4	0.0	0.0	7,220.2	7,220.2	0.0	0.0	24.7	24.7	0.0	0.0
SCX-11	53.96	None		47.0	47.0	0.0	0.0	14,605.6	14,605.6	0.0	0.0	49.1	49.1	0.0	0.0
SCX-12	39.77	None		42.0	42.0	0.0	0.0	13,115.7	13,115.7	0.0	0.0	43.5	43.5	0.0	0.0
SCX-13	106.16	None		96.3	96.3	0.0	0.0	30,131.0	30,131.0	0.0	0.0	99.1	99.1	0.0	0.0
SCX-14	7.05	None		10.9	10.9	0.0	0.0	3,407.2	3,407.2	0.0	0.0	11.2	11.2	0.0	0.0
SCX-15	12.12	None		23.0	23.0	0.0	0.0	7,217.5	7,217.5	0.0	0.0	23.6	23.6	0.0	0.0
SCX-16	87.58	None		86.7	86.7	0.0	0.0	27,129.4	27,129.4	0.0	0.0	89.1	89.1	0.0	0.0
SCX-17	34.37	None		13.4	13.4	0.0	0.0	4,132.6	4,132.6	0.0	0.0	14.3	14.3	0.0	0.0
SCX-18a	2.38	Wet Detention Pond	0.1	2.2	0.9	59.2	1.3	698.4	79.1	88.7	619.2	2.3	2.3	0.0	0.0

SCX-18b Cell A	7.94	Wet Detention Pond	0.3	10.7	4.4	58.5	6.3	3,354.9	400.6	88.1	2,954.3	11.0	11.0	0.0	0.0
SCX-18b Cell B		Wet Detention Pond	0.5	4.4	3.2	29.1	1.3	400.6	50.3	87.4	350.3	11.0	11.0	0.0	0.0
SCX-18b Cell C		Infiltration Basin	0.1	3.2	1.5	51.1	1.6	50.3	23.9	52.5	26.4	11.0	5.4	50.9	5.6
SCX-18b Cell D		Infiltration Basin	0.1	1.5	1.5	4.5	0.1	23.9	20.9	12.6	3.0	5.4	5.1	5.5	0.3
SCX-18c	43.9	None		45.6	45.6	0.0	0.0	14,268.6	14,268.6	0.0	0.0	47.0	47.0	0.0	0.0
SCX-19	19.43	None		22.6	22.6	0.0	0.0	7,054.4	7,054.4	0.0	0.0	23.2	23.2	0.0	0.0
SCX-20	55.33	None		56.1	56.1	0.0	0.0	17,561.4	17,561.4	0.0	0.0	57.7	57.7	0.0	0.0
SCX-21	11.92	None		2.6	2.6	0.0	0.0	787.4	787.4	0.0	0.0	2.7	2.7	0.0	0.0
SCX-22	10.17	None		3.5	3.5	0.0	0.0	1,092.0	1,092.0	0.0	0.0	3.7	3.7	0.0	0.0
SCX-23	68.64	None		56.3	56.3	0.0	0.0	17,613.4	17,613.4	0.0	0.0	58.0	58.0	0.0	0.0
SCX-24	86.94	None		101.0	101.0	0.0	0.0	31,617.8	31,617.8	0.0	0.0	104.0	104.0	0.0	0.0
Total							58.4				29,488.5				7.4

Existing BMP Information from Stillwater LSWMP

Twin Lake Subwatershed

Sub-basin		BMP		Total Phosphorus Load				Total Suspended Solids				Runoff Water Volume			
ID	Area	Type	Area	Inflow	Outflow	Reduction	Load Reduction (lb/yr)	Inflow	Outflow	Reduction	Load Reduction (lb/yr)	Inflow	Outflow	Reduction	Load Reduction (ac-ft/yr)
	(ac)		(ac)	(lb/yr)	(lb/yr)	(%)		(lb/yr)	(lb/yr)	(%)		(ac-ft/yr)	(ac-ft/yr)	(%)	
Twin-01	53.1	None		12.1	12.1	0.0		3,718.8	3,718.8	0.0	0.0	13.1	13.1	0.0	0.0
Twin-02	7.94	Wet Detention Pond	0.7	2.5	0.6	74.8	1.9	778.9	10.2	98.7	768.7	2.7	2.7	0.0	0.0
Twin-03	2.68	Wet Detention Pond	0.3	1.3	0.4	70.1	0.9	393.4	8.1	97.9	385.4	1.4	1.4	0.0	0.0
Twin-04	4.1	None		1.6	1.6	0.0		502.7	502.7	0.0	0.0	1.7	1.7	0.0	0.0
	67.82						2.8				1,154.1				0.0

Existing BMP Information from Long Lake Management Plan 2006

Long Lake Subwatershed

Area in Subwatershed	TP Generated (lbs/yr)	TP Upstream Generated (lbs/yr)	TP Output (lbs/yr)	TP Removal Efficiency %
Bruers Pond	42.2	0	15.32	63.7
Central Legends	22.36	0	7.41	66.9
Direct Drainage	29.81	0	29.81	0.0
Highway 36 North	15.9	41.65	49.99	13.1
Marine Circle Pond	31.76	0	14.89	53.1
Marketplace East	93.77	23.34	80.23	31.5
Marketplace North	173.94	59.41	154.01	34.0
Marketplace West	11.79	369.62	340.67	10.7
North Croix wood	48.02	12.63	23.3	61.6
North Legends	0.04	0.97	0.93	7.9
North Liberty	4.36	1.05	3.92	27.5
South Legends	7.77	5.87	9.14	33.0
South Liberty	3.12	0	1.96	37.2
	484.84	514.54	731.58	26.8

Ultimate Potential Load Reductions - Long Lake

2007 Land Use	2030 Land Use	Subwatershed	Acres	TP Loading 2030 LU	Reduction % by Watershed Rules	Reduction in TP (lb)	TSS 2030	Reduction % by Watershed Rules	TSS Reduction (lb)	Runoff Volume 2030	Reduction % by Watershed Rules	Runoff Reduction
PARK OR OPEN SPACE	LDR	Long	7.21	5.22	36.00	1.88	1,624.74	62.00	1,007.34	4.28	80.00	3.42
PARK OR OPEN SPACE	LDR	Long	3.751	2.72	36.00	0.98	0.00	62.00	0.00	2.23	80.00	1.78
PARK OR OPEN SPACE	LDR	Long	2.364	1.71	36.00	0.62	532.72	62.00	330.28	1.40	80.00	1.12
AGRICULTURE	MDR	Long	13.136	13.54	63.00	8.53	4,212.56	93.00	3,917.68	11.10	80.00	8.88
AGRICULTURE	R & D PARK	Long	0.497	0.60	84.00	0.50	238.36	93.00	221.67	0.63	80.00	0.50
AGRICULTURE	R & D PARK	Long	22.756	27.28	84.00	22.92	10,913.59	93.00	10,149.64	28.75	80.00	23.00
AGRICULTURE	R & D PARK	Long	20.187	24.20	84.00	20.33	9,681.52	93.00	9,003.82	25.50	80.00	20.40
AGRICULTURE	R & D PARK	Long	7.473	8.96	84.00	7.53	3,583.99	93.00	3,333.11	9.44	80.00	7.55
LDR	R & D PARK	Long	7.194	8.63	84.00	7.25	3,450.18	93.00	3,208.67	9.09	80.00	7.27
			84.57	92.86		70.53	34,237.66		31,172.21	92.41		73.93

Ultimate Potential Load Reductions - Browns Creek

2007 Land Use	2030 Land Use	Subwatershed	Acres	TP Loading 2030 LU	Reduction in TP (lb)	TSS 2030	TSS Reduction (lb)	Runoff Volume 2030	Runoff Reduction
PARK OR OPEN SPACE	LDR	BrownsCr	1.21	0.87	0.31	272.22	168.77	0.72	0.57
PARK OR OPEN SPACE	LDR	BrownsCr	0.50	0.36	0.13	112.90	70.00	0.30	0.24
PARK OR OPEN SPACE	LDR	BrownsCr	0.49	0.35	0.13	109.29	67.76	0.29	0.23
PARK OR OPEN SPACE	LDR	BrownsCr	0.49	0.35	0.13	109.52	67.90	0.29	0.23
PARK OR OPEN SPACE	LDR	BrownsCr	0.31	0.22	0.08	68.73	42.61	0.18	0.14
LDR	LMDR	BrownsCr	3.75	3.10	1.71	964.48	882.50	2.54	2.03
LDR	LMDR	BrownsCr	0.53	0.43	0.24	135.25	123.75	0.36	0.29
AGRICULTURE	LMDR	BrownsCr	4.75	3.93	2.16	1,221.61	1,117.77	3.22	2.57
AGRICULTURE	LMDR	BrownsCr	3.39	2.80	1.54	871.14	797.10	2.29	1.84
LDR	LMDR	BrownsCr	3.14	2.60	1.43	807.63	738.98	2.13	1.70
AGRICULTURE	LMDR	BrownsCr	0.63	0.52	0.29	161.48	147.75	0.43	0.34
AGRICULTURE	LMDR	BrownsCr	7.78	6.43	3.54	2,001.21	1,831.11	5.27	4.22
LDR	LMDR	BrownsCr	1.56	1.29	0.71	402.15	367.96	1.06	0.85
PARK OR OPEN SPACE	LMDR	BrownsCr	10.70	8.84	4.86	2,751.51	2,517.63	7.25	5.80
			39.22	32.11	17.25	9,989.11	8,941.60	26.31	21.05

Ultimate Potential Load Reductions - Twin Lake

2007 Land Use	2030 Land Use	Subwatershed	Acres	TP Loading 2030 LU	Reduction in TP (lb)	TSS 2030	TSS Reduction (lb)	Runoff Volume 2030	Runoff Reduction
PARK OR OPEN SPACE	LDR	Twin	1.49	1.08	0.65	336.22	268.97	0.89	0.71
PARK OR OPEN SPACE	LMDR	Twin	1.80	1.85	1.11	462.31	369.85	1.22	0.97
PARK OR OPEN SPACE	LMDR	Twin	1.41	1.16	0.70	361.78	289.42	1.78	1.42
			4.70	4.10	2.46	1,160.30	928.24	3.88	3.10

Ultimate Potential Load Reductions - Twin Lake

2007 Land Use	2030 Land Use	Subwatershed	Acres	TP Loading 2030 LU	Reduction in TP (lb)	TSS 2030	TSS Reduction (lb)	Runoff Volume 2030	Runoff Reduction
PARK OR OPEN SPACE	INSTITUTIONAL	diversion	0.04	0.07	0.05	21.10	19.62	0.06	0.04
PARK OR OPEN SPACE	LDR	diversion	0.01	0.01	0.00	1.58	0.98	0.00	0.00
PARK OR OPEN SPACE	LDR	diversion	1.10	0.80	0.29	248.33	153.96	0.65	0.52
PARK OR OPEN SPACE	LDR	diversion	0.91	0.66	0.24	204.16	126.58	0.54	0.43
PARK OR OPEN SPACE	LDR	diversion	1.42	1.02	0.37	318.86	197.70	0.84	0.67
PARK OR OPEN SPACE	LDR	diversion	2.50	1.81	0.65	563.36	349.29	1.48	1.19

AGRICULTURE	LDR	diversion	1.59	1.15	0.42	358.98	222.56	0.95	0.76
PARK OR OPEN SPACE	LDR	diversion	1.38	1.00	0.36	310.08	192.25	0.82	0.65
PARK OR OPEN SPACE	LDR	diversion	1.09	0.79	0.28	245.85	152.43	0.65	0.52
PARK OR OPEN SPACE	LDR	diversion	0.74	0.54	0.19	167.43	103.81	0.44	0.35
LDR	LMDR	diversion	5.53	4.57	2.51	1,421.39	1,300.58	3.74	3.00
WETLAND	LMDR	diversion	0.25	0.21	0.11	64.28	58.82	0.17	0.14
AGRICULTURE	LMDR	diversion	0.57	0.47	0.26	146.56	134.10	0.39	0.31
AGRICULTURE	LMDR	diversion	2.48	2.05	1.13	637.93	583.71	1.68	1.34
LDR	LMDR	diversion	2.26	1.87	1.03	580.85	531.48	1.53	1.22
AGRICULTURE	LMDR	diversion	7.95	6.57	3.61	2,044.67	1,870.87	5.39	4.31
WETLAND	LMDR	diversion	0.33	0.27	0.15	84.59	77.40	0.22	0.18
WETLAND	LMDR	diversion	0.21	0.17	0.10	53.74	49.17	0.14	0.11
LDR	LMDR	diversion	0.62	0.51	0.28	159.42	145.87	0.42	0.34
LDR	LMDR	diversion	1.24	1.02	0.56	317.81	290.79	0.84	0.67
LDR	LMDR	diversion	1.64	1.35	0.74	420.66	384.90	1.11	0.89
LDR	LMDR	diversion	2.25	1.86	1.02	577.76	528.65	1.52	1.22
AGRICULTURE	LMDR	diversion	1.66	1.37	0.76	427.60	391.25	1.13	0.90
LDR	LMDR	diversion	4.68	3.86	2.13	1,202.07	1,099.89	3.17	2.53
LDR	LMDR	diversion	1.32	1.09	0.60	340.44	311.50	0.90	0.72
LDR	LMDR	diversion	0.36	0.30	0.16	92.31	84.46	0.24	0.19
PARK OR OPEN SPACE	LMDR	diversion	5.15	4.26	2.34	1,324.97	1,212.35	3.49	2.79
LDR	LMDR	diversion	2.76	2.28	1.26	710.18	649.82	1.87	1.50
PARK OR OPEN SPACE	LMDR	diversion	0.13	0.10	0.06	32.14	29.41	0.08	0.07
PARK OR OPEN SPACE	LMDR	diversion	0.12	0.10	0.05	29.57	27.06	0.08	0.06
LMDR	LMDR	diversion	0.01	0.01	0.00	2.57	2.35	0.01	0.01
LDR	LMDR	diversion	2.35	1.94	1.07	603.22	551.94	1.59	1.27
LDR	LMDR	diversion	2.91	2.40	1.32	746.95	683.46	1.97	1.57
PARK OR OPEN SPACE	LMDR	diversion	0.48	0.40	0.22	124.19	113.64	0.33	0.26
LDR	LMDR	diversion	1.53	1.27	0.70	393.66	360.20	1.04	0.83
LDR	LMDR	diversion	2.43	2.01	1.11	625.85	572.65	1.65	1.32
LDR	LMDR	diversion	0.94	0.78	0.43	241.44	220.92	0.64	0.51
AGRICULTURE	LMDR	diversion	3.36	2.78	1.53	864.72	791.21	2.28	1.82
LDR	LMDR	diversion	3.35	2.77	1.52	862.14	788.86	2.27	1.82
PARK OR OPEN SPACE	LMDR	diversion	1.90	1.57	0.86	487.51	446.07	1.28	1.03
LDR	LMDR	diversion	3.38	2.80	1.54	870.12	796.16	2.29	1.83
LDR	LMDR	diversion	0.32	0.26	0.14	81.25	74.35	0.21	0.17
LDR	LMDR	diversion	1.02	0.84	0.46	260.98	238.80	0.69	0.55
LDR	LMDR	diversion	1.62	1.34	0.73	415.52	380.20	1.09	0.88
AGRICULTURE	LMDR	diversion	0.00	0.00	0.00	0.51	0.47	0.00	0.00
PARK OR OPEN SPACE	LMDR	diversion	0.00	0.00	0.00	0.51	0.47	0.00	0.00
LDR	LMDR	diversion	0.09	0.08	0.04	24.17	22.12	0.06	0.05

LDR	LMDR	diversion	0.09	0.08	0.04	24.17	22.12	0.06	0.05
AGRICULTURE	MDR	diversion	2.57	2.65	1.67	823.53	765.88	0.99	0.79
AGRICULTURE	MDR	diversion	3.12	3.21	2.02	999.90	929.91	1.20	0.96
AGRICULTURE	MDR	diversion	2.28	2.35	1.48	730.53	679.39	0.88	0.70
RAILROAD	PARK OR OPEN SPACE	diversion	0.96						0.00
RAILROAD	PARK OR OPEN SPACE	diversion	2.52						0.00
			89.50	71.65	38.61	22,292.11	19,722.41	55.06	44.05