APPENDIX IIIA
STORM WATER MANAGEMENT PLAN

Part 2 EXECUTIVE SUMMARY

This portion of the wellhead protection (WHP) plan for City of Robbinsdale includes:

- the results of the Potential Contaminant Source Inventory,
- the Potential Contaminant Source Management Strategy,
- reference to the existing Emergency/Alternative Water Supply Contingency Plan, and
- the Wellhead Protection Program Evaluation Plan.

Part 1 of the wellhead protection plan presented the 1) delineation of the wellhead protection area (WHPA) and the drinking water supply management area (DWSMA) and 2) the vulnerability assessments for the system's wells and the aquifer within the DWSMA. Part 1 of the WHP plan was submitted to the Minnesota Department of Health (MDH) and approved on December 20, 2005. The boundaries of the WHPA/DWSMA are shown in Figure 1.

The *vulnerability assessment* for the aquifers within the DWSMA was performed using available information and indicates that the vulnerability of the aquifers used by the system varies from high to low.

The *potential sources of contamination* to the aquifer vary with the vulnerability rating:

- Low vulnerability areas –wells
- Moderate vulnerability areas –tanks and wells
- High vulnerability areas - All land uses and potential contaminant sources.

Also, automotive disposal systems, large sewer systems, and cesspools must be inventoried throughout the DWSMA. This information was presented to the WHP Team during the Second Scoping meeting held with the MDH, March 21, 2006, when the necessary requirements for the content of Part 2 were outlined and discussed in detail.

Sections 4-7 of this part of the WHP Plan (hereafter referred to as Plan) provide data and analysis in support of the approaches taken to address potential contamination sources. Section 8 of this report describes the approaches taken in terms of goals, objectives, and actions to be taken.

In Section 4, the required *data elements* indicated by MDH in the Scoping 2 Decision Notice are addressed. Pertinent data elements include information about hydrology, geology, water quality, and water quantity

A *potential contaminant source inventory* and general *land use* information is given in Section 5. The potential contaminant source and land use inventory reflects the vulnerability of the aquifer in each land parcel and what is known about the data elements in Section 4.

Section 6 addresses the possible impacts that *changes in the physical environment, land use, and water resources* may have on the public water supply. Limited re-development and no significant increases in groundwater appropriations within the DWSMA are anticipated within the next ten-year period.

The *problems and opportunities* concerning land use issues relating to the aquifer, well water, and the DWSMA and addressed in Section 7. The major concerns addressed in the plan are 1) other wells located within the DWSMA that could become pathways for contamination to enter the aquifer; 2) the pumping effects of high-capacity wells that may alter the boundaries of the delineated WHPA or cause the movement of contamination toward public water supply well(s) and 3) the potential sources of contamination identified in Section 5 of this plan.

The drinking water protection *goals* that the public water supplier (PWS) would like to achieve with this plan are listed in Section 8. In essence, the PWS would like to:

- maintain or improve on the current drinking water quality
- increase public awareness of groundwater protection issues
- protect the aquifer
- continue to collect data on water quality
- practice water conservation

The *objectives and action plans* for managing potential sources of contamination are also contained in Section 8. Actions aimed toward educating the general public about groundwater and land use issues, gathering information about other wells and potential contaminant sources, using the collected data in water supply and land use planning, and collecting data relevant to wellhead protection planning are the general focus.

Section 9 contains *guidance for use* for City of Robbinsdale staff.

Section 10 contains a *guide to evaluate the implementation* of the management strategies of Section 8. The wellhead protection program for City of Robbinsdale will be evaluated a minimum of every two years.

Section 11 references the *Water Emergency Management Plan* approved by the Minnesota Department of Natural Resources and the Metropolitan Council.

Finally, Section 12 discusses the *review process* and addresses any comments brought by local units of government and the public.

TABLE OF CONTENTS

Appendices:

Figures:

Tables:

SECTION 1

INTRODUCTION

Storm water management planning addresses the effects of human activities on the hydrologic environment. The process of urbanization has long been known to increase runoff and flood potential. More recently an increased awareness of the degradation of water quality from urban runoff, and the role of wetlands in the water cycle has lead to a broader focus in water resource planning.

1.1. Executive Summary

This plan is intended to meet the statutory requirements for a local plan under MS 103B.235. The plan conforms with the objectives and policies adopted by the two watershed management organizations (WMOs) which include Robbinsdale: the Shingle Creek Watershed Management Commission and the Bassett Creek Water Management Commission. The plan addresses local responsibility for the following identified issues:

- Runoff Management
- Floodplain Management
- Shoreland Management
- Water Quality Monitoring
- Erosion and Sedimentation Control
- Storm Water Treatment
- Wetlands Management
- Ground Water Protection

The scope of this plan is limited to the corporate limits of the City of Robbinsdale. Many of the issues in water planning span municipal boundaries. In recognition of this fact, watershed districts have been created by the State to manage water resources based upon physically-based watersheds rather than arbitrary legal boundaries.

This local plan is intended to provide a detailed framework for the implementation and regulation of the water management policies of the WMOs. It addresses the methods of meeting allowable peak discharge rates for storm runoff and analyzes areas of local problems with the municipal trunk storm sewer system. Specific WMO requirements for this local plan are shown on the following page in Table 1.

Table 1
Local Water Management Plan Requirements

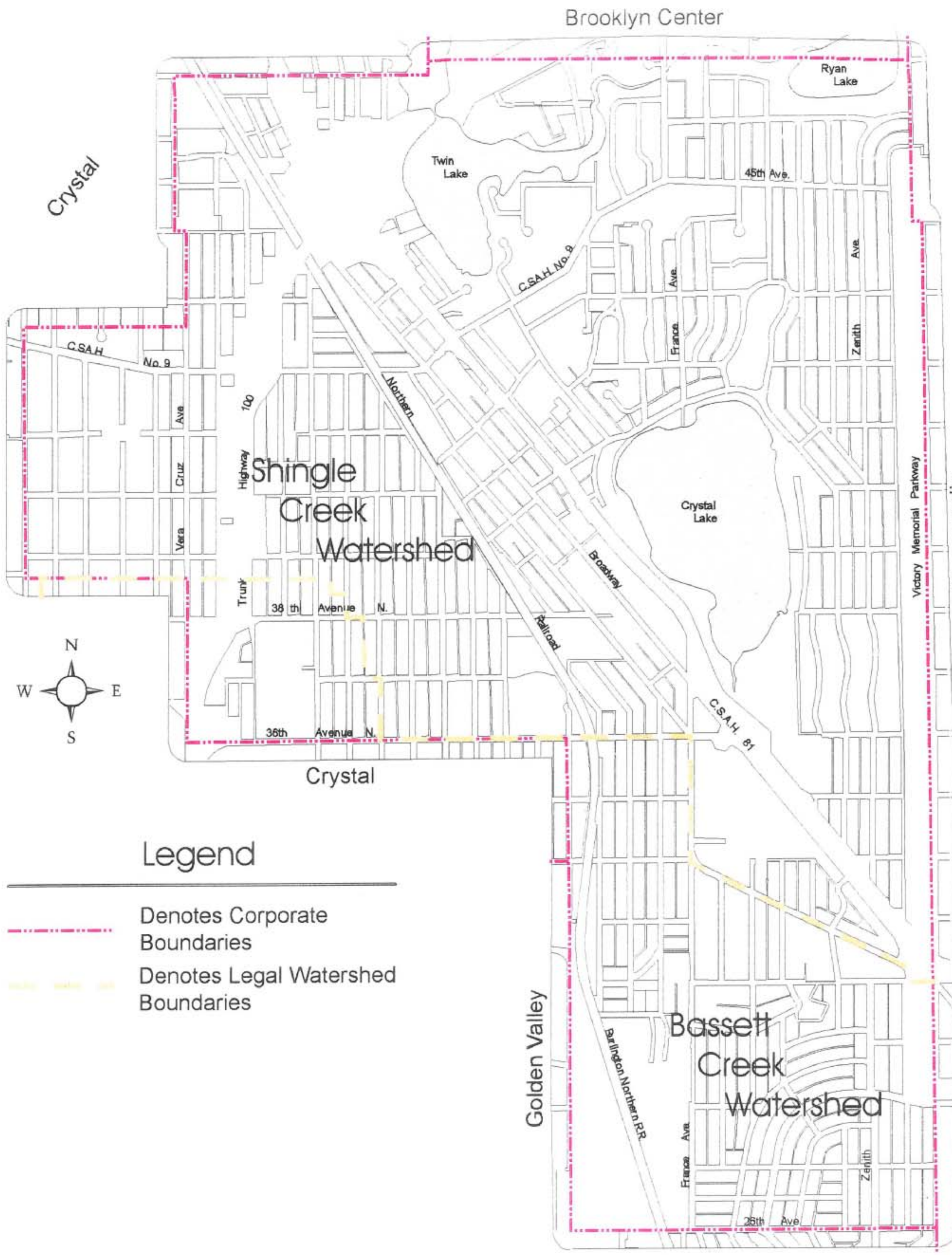
	Component	Status	Action
Regulations/ Standards	Shoreland Protection Ordinance	N	Adopt shoreland ordinance conforming to requirements of **M.R.** Chapter 6120.
	HCD "Erosion & Sediment Control Manual" Standards	N	Adopt erosion control ordinance conforming to Hennepin Soil & Water Conservation District standards.
	Management Standards of the SCWMC	C	Complies, no action required.
Programs	Storm Water Runoff Management	N	Perform analysis, and show conformance with peak rates and elevations adopted by SCWMC
	Floodplain Management	C	Complies, no action required.
	Storm Water Treatment	N	Develop strategies for sedimentation, skimming, & nutrient removal of runoff.
	Wetland Management	N	Prepare a wetlands inventory map, tabulation of wetland classifications, & summary of regulations.

Notes:
N = Non-conforming, regulation/program needs modification or
mplementation. C = Existing regulation/program is sufficient.

1.2. Water Resource Management Related Agreements

In 1982, the Minnesota Legislature passed the Metropolitan Surface Water Management Act (M.S. Chapter 473) giving local governments in the metropolitan area new responsibilities for surface water management. The Act required that all watersheds in the metro area be governed by a WMO or Watershed District. A WMO is created by Joint Powers Agreements among the communities with areas lying within the watershed. The WMO's jurisdiction is encompassed within a legal boundary which approximates the physical watershed divides. The City of Robbinsdale lies within two watersheds as shown on Figure 1.

Approximately three quarters of Robbinsdale lies within the Shingle Creek watershed draining to the northeast through Twin, Crystal, and Ryan Lakes. The balance of the community lies within the Bassett Creek watershed draining southward along T.H. 100 and through Walter Sochacki Park (Rice Lake) to Bassett Creek.



City of Robbinsdale Water Management Plan	**Study Area**	1 Figure

The Minnesota Legislature amended the Act in 1987 to include specific responsibilities for groundwater management and retitled the Act as the "Metropolitan Water Management Act". The WMOs act as planning bodies to define issues of common concern and to ensure consistency of management policy.
The local governmental units retain primary responsibility for regulation and implementation of watershed policies.

In addition to WMOs, a number of Federal and State agencies have authority over various aspects of water resources. WMO and local plans must be consistent with these regulations.

A listing of some of the key agencies follows:

The Metropolitan Council
The Minnesota Department of Natural Resources (MDNR)
The Minnesota Pollution Control Agency (MPCA)
The Minnesota Board of Water and Soil Resources (BWSR)
The Minnesota Department of Health
The U.S. Environmental Protection Agency
The U.S. Army Corps of Engineers
The U.S. Fish and Wildlife Service

Section 2

LAND RESOURCE INVENTORY

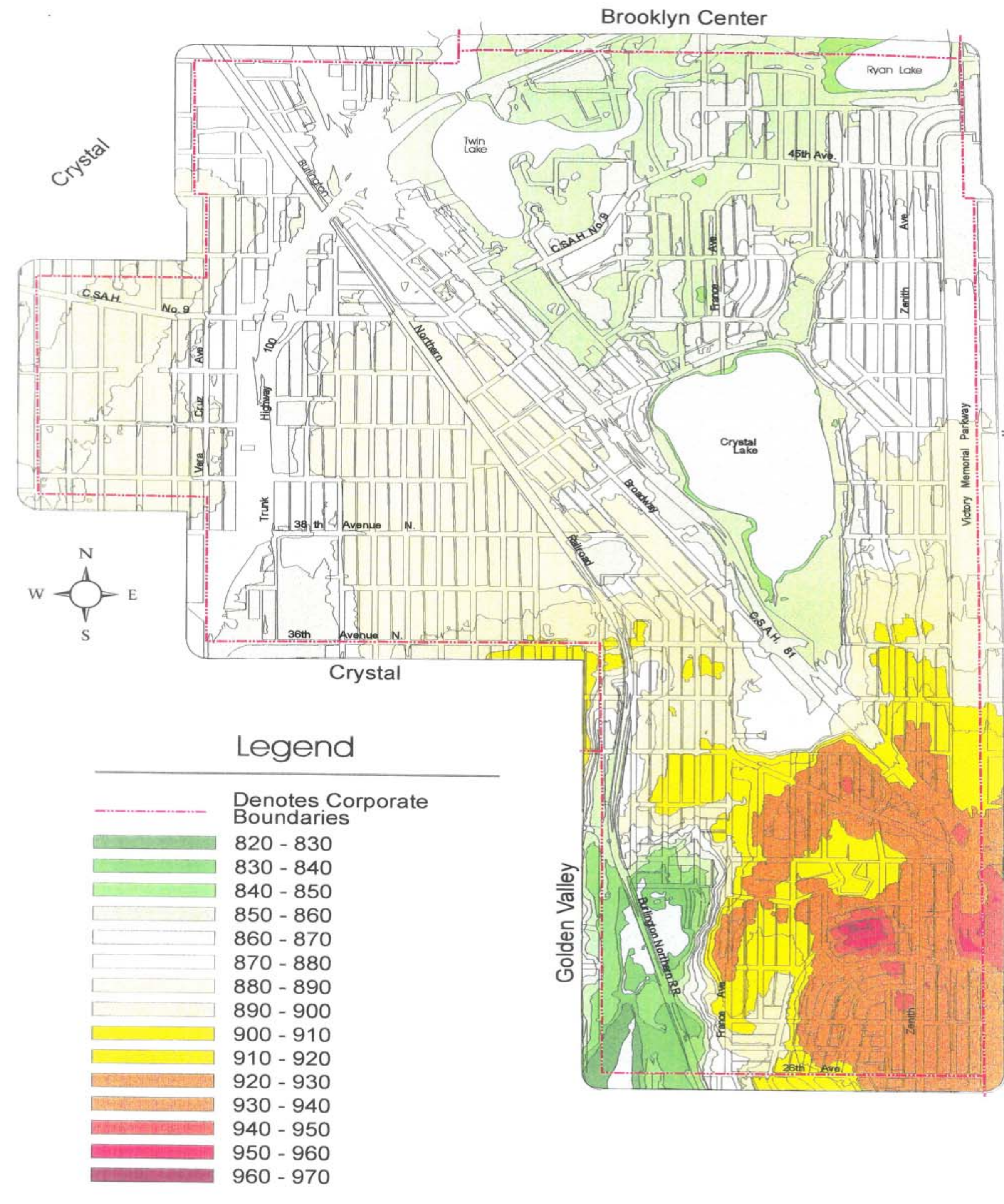
2.1. Climate

The mean annual temperature in the Twin Cities area is 44°F. The monthly mean temperature varies from 12°F in January to 73°F in July. Temperature extremes vary from a record low of -34°F on January 1, 1936 to a high of 108°F on July 14, 1936. The average date of the last frost is April 30, and the average first autumn frost occurs about October 13.

Precipitation averages about 27 inches annually in the Robbinsdale area. The wettest month is June with an average precipitation of 4 inches, while the driest month is January with an average precipitation of only 0.7 inches. Seasonal snowfall averages a total of 44 inches. Precipitation frequency-duration curves for Robbinsdale are illustrated in Appendix IIIB.

2.2 Topography

The range of topographic relief in Robbinsdale is about 145 feet. The lowest area is at Rice Lake in the extreme southwestern corner of the city at elevation 829. The highest point in town is 961 above sea level along McNair Drive between Chowen and Zenith Avenues. Figure 2 illustrates the topographic features.



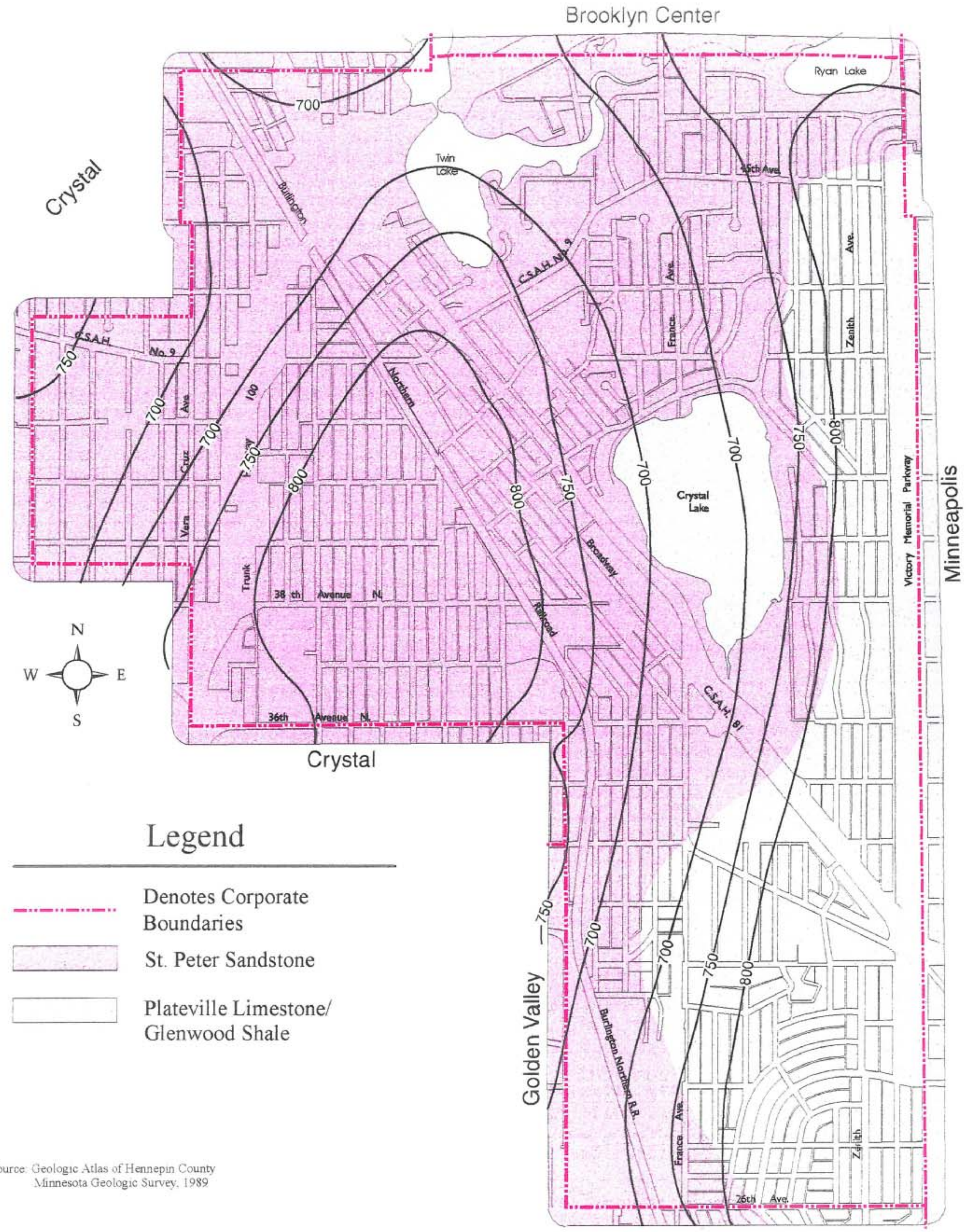
City of Robbinsdale Water Management Plan	Topography	2 Figure

2.2.1. Geology

The bedrock structure underlying the City consists of imestone and sandstone overlain with glacial drift varying in thickness from 25 to 200 feet. All the bedrock units in Hennepin County are marine sedimentary rocks of the early Paleozoic age (525-450 million years ago). Older Proterozoic bedrock formations exist beneath the Mount Simon Sandstone, the lowest Paleozoic formation. A description of the individual formations is included in Section 3.1.2 as part of the discussion of bedrock aquifers.

The bedrock underlying Robbinsdale consists of two major units: the Plattville Limestone and Glenwood Shale formation, and the St. Peter Sandstone. The majority of the City's bedrock is the St. Peter Sandstone, but the eastern edge of Robbinsdale lies over the margin of a dome of Plattville Limestone that stretches east into north Minneapolis. The top of the bedrock (bottom of the drift) ranges from approximately 750 to 850 feet above sea level. The bedrock geology is depicted on Figure 3.

A buried bedrock valley filled with glacial drift, runs north to south through Robbinsdale extending from Twin Lake under Crystal Lake to Rice Lake and Bassett Creek. Another smaller valley extends approximately along the alignment of T.H. 100 to Twin Lake. These valleys were formed by glacial streams that carried melt-water to the pre-historic Minnesota River.



Source: Geologic Atlas of Hennepin County
Minnesota Geologic Survey, 1989

City of Robbinsdale Water Management Plan	Bedrock Geology	3 Figure

2.2.2. Soils

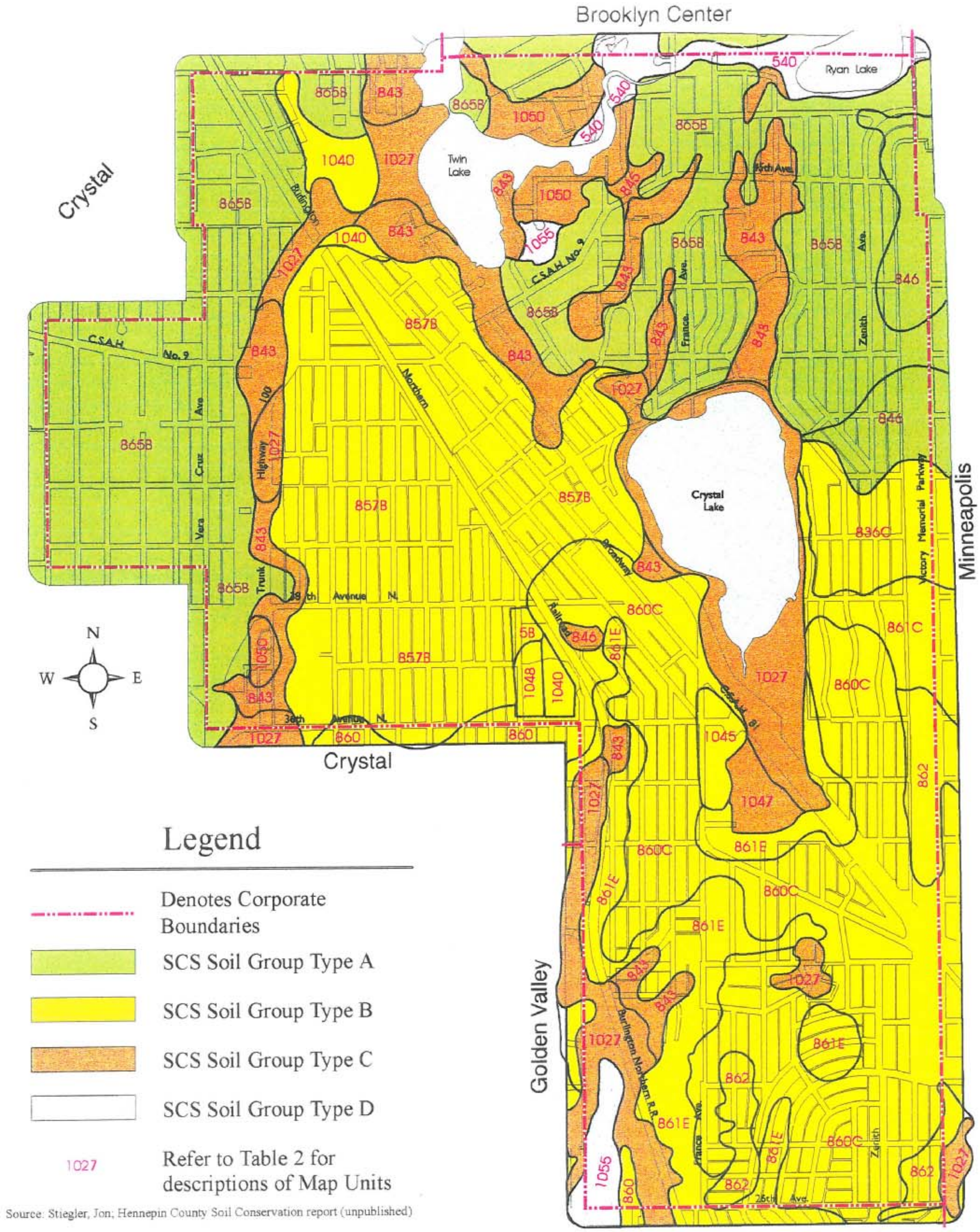
The surficial geology of Robbinsdale consists of sediments deposited during the Quaternary Period which began about 2 million years ago and extends to the present. The City is entirely covered with glacial sediments laid down during the last glaciation, the late Wisconsinan which occurred approximately 25,000 to 10,000 years ago.

The soils in the southwestern two-thirds of Robbinsdale (roughly west of C.S.A.H. 81 and south of Crystal Lake) consist of mixed till of yellowish or reddish-brown sandy loam. This material was deposited by the Des Moines lobe glacier approximately 16,000 years ago. The soils are predominately of the Kingsley, Hayden, and Dakota associations with moderate to high moisture capacity and moderate permeability.

The retreat of the Des Moines lobe led to the formation of Glacial Lake Fridley in southeastern Anoka county. The outlet of this lake, the glacial River Mississippi, cut a valley through the previous glacial deposits and placed additional sand and gravel in a series of terraces. The northeasterly third of Robbinsdale lies on the upper terrace of this valley. These soils generally tend to be sand, gravel sand, and loamy sand covered by thin loam or organic sediment. Most of the soils in this area are from the Hubbard and dutch elm associations with low available moisture capacity and very high permeability.

Lakes and bogs formed in the deep bedrock valleys when ice blocks left behind by the retreating glaciers melted and formed depressions in the drift sediments. In many areas post-glacial organic deposits have filled smaller depressions with silt and peat.

Figure 4 depicts the soil types found in Robbinsdale and Table 2 gives a summary description of each map unit.



City of Robbinsdale Water Management Plan	Soil Types	4 Figure

Table 2 - Soil Classifications and Characteristics

Map Symbol	SCS Group	Area (Ac)	Association Name	Characteristics
5B	B	3	Dakota Loam (0-8% slopes)	Loamy, well-drained soils, 22 to 36 inches thick over deep sand. Moderate to high available moisture capacity, medium internal drainage, and fairly rapid permeability. Depth to water table: 5 - 10 feet.
7B	A	2	Hubbard Loamy Sand (0-6% slopes)	Loamy sand approximately 35 inches thick over deep sand. Low available moisture capacity and rapid permeability.
540	D	15	Seelyeville Muck	Peaty muck deposits 3-10 or more feet deep over silty sediments. Very high moisture availability and rapid permeability; the water table is at or near the surface.
836C	C	42	Braham Complex-Urban (4-12% slopes)	Loamy fine sand 18-40 inches thick overlying loamy till. Occurring in knobs and hills, mainly along sandy stream terraces. Low to moderate available moisture. The upper layers are rapidly permeable. Water table depth greater than 5 feet.
843	C	141	Udorthents, Wet Substratum Complex	Variable fill consisting of sand, gravel, asphalt and concrete debris overlaying organic peat and silt. Depth varies from 2 - 20 feet. About 30-65% of the map unit is covered with impervious surfaces.
846	A	61	Duelm Complex-Urban	Loamy sand ranging from 4-20 feet in thickness. Low available moisture, rapid permeability, and a water table depth of 3-5 feet. Roughly 30-65% of the surface is covered with impermeable materials.
857B	B	369	Waukegan-Dakota Complex (0-8% slopes)	Surface layer of 8 inches of loam over stratified sand and gravel. This soil has moderate available moisture capacity and high permeability. The water table is a minimum 6-10 feet deep and surface is 30-65% impervious.
860C	B	291	Hayden Complex-Urban (2-18% slopes)	Very dark gray loam roughly 7 inches thick covers 29 inches of yellowish brown clay loam. The available moisture capacity is high with moderate permeability. The water table is below 5 feet.
861C	B	29	Kingsley-Hayden Complex (2-18% slopes)	A surface layer 4-6 inches thick of sandy loam over 26-30 inches of reddish-brown sandy loam. Permeability is moderate to slow, and the available water capacity is high.
861E	B	118	Kingsley-Hayden Complex (18-35% slopes)	Generally identical to unit 861C except for steeper slopes. The erosion hazard in these soils is severe.
862	B	49	Dundas-Nessel Complex	Very dark gray loam 4-8 inches over 8 inches of silty loam in the Dundas soils, and 29 inches of clay loam in the Nessel soils. Permeability is moderate to slow with high available moisture capacity. Depth to water table is 1-3 feet in the Dundas soils and 3-5 feet in Nessel soils.
865B	A	462	Hubbard Complex (0-8% slopes)	A top layer of 12 inches of loamy sand covers subsoil of yellowish-brownish sand. Hubbard soils have very low available moisture capacity and rapid permeability. the water table is from 5 to more than 10 feet deep.
1027	C	124	Udorthents, Wet Substratum	This unit consists of miscellaneous fill over poorly drained mineral and organic soils. Depth and composition of fill vary widely.
1040	B	19	Udorthents. Sloping (borrow land)	Miscellaneous sloping land that has been excavated for construction and revegetated. Less than 30% impervious surfacing.
1045	B	9	Commercial, Loamy Substratum	Cut and fill areas for building construction. 85-100% impervious cover.
1047	C	12	Commercial, Wet Substratum	Filled-in wet soils otherwise similar to unit 1045.
1048	B	5	Industrial, Loamy Substratum	Similar to unit 1045 except with more open space (65-85% impervious).
1050	C	37	Industrial, Wet Substratum	Similar to unit 1048 but with a wet substratum.
1055	D	12	Aquolls & Histosols, Ponded	Level, very poorly drained mineral and organic soils adjacent to lakes and streams. Typically ponded or saturated and supporting hydrophilic plants.

Source: Stiegler, Jon; Hennepin County Soil Conservation Service report (unpublished)

2.3. Land Use

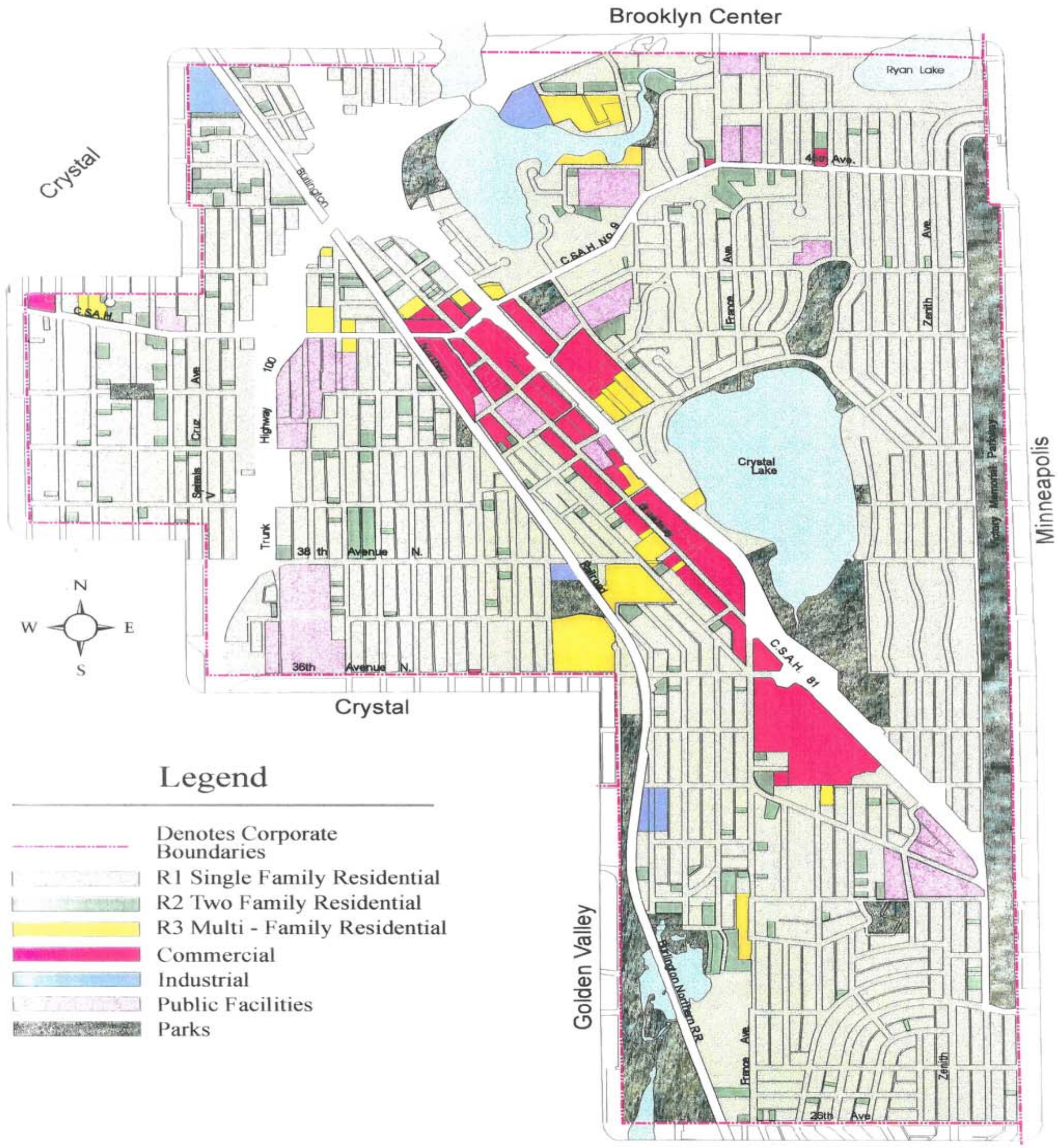
The City of Robbinsdale is a "fully developed" first tier suburb located in the northwest quadrant of the Twin Cities metropolitan area. Figure 5 illustrates the land use based upon the 1989 zoning map. The primary land use is residential (predominately single family) followed in area by transportation (roadways) and open space (lakes and parks).

While the City has been fully developed for many years, the land use patterns are not static. Table 3 compares the 1977 land use with that of 1995. The general trend for land use in the City is towards redevelopment and intensification. Such alterations are virtually impossible to accurately predict. Therefore, for purposes of this plan the land use has been assumed to equate to current zoning. This assumption may underestimate future redevelopment, but over estimates current land use by ignoring vacant or under-utilized parcels. Major known redevelopment plans, such as North Memorial Hospital's expansion have been included in the mapping.

Table 3

Land Use Comparison
1979-1995

Land Use	1979 Acreage	1995 Acreage	Percent Change
Residential	822.7	848.9	+3.2
Commercial	62.7	64.2	+2.4
Park	193.1	193.1	-
Public/Semi-Public	85.8	89.0	+3.7
Industrial	48.0	49.0	+2.1
Vacant	39.0	7.1	-81.8
Roadway	529.3	529.3	-
Water	128.0	128.0	-



Water Management Plan City of Robbinsdale	Land Use	5 Figure

2.4. Vegetation

Because Robbinsdale is a fully developed urban area, little of the native vegetation remains. The pre-settlement vegetation consisted of oak savannah and prairie communities. The current overstory tree cover is typified as urban forest. This vegetation is comprised of boulevard trees with private landscaping, shrubs, and lawn areas beneath the canopy.

In the 1970's and 80's much of the urban forest was decimated by Dutch Elm disease. Active reforestation and disease control programs have prevented a dramatic decline in the City's tree coverage, and have added diversity of the plant stock.

Section 3

WATER RESOURCE INVENTORY

This section presents an evaluation and inventory of the various components of Robbinsdale's water resources. Included in this inventory are assessments of the surficial and bedrock aquifers, the locations of potential groundwater contamination, and the locations of municipal water supply wells. The surface water inventory includes evaluations and descriptions of the city lakes and wetlands. An evaluation of storm water runoff, surface water quality, and aquatic vegetation and fisheries is included.

3.1. Groundwater

Groundwater consists of two basic elements: the shallow (surficial) aquifers and the deeper bedrock aquifers. Surficial aquifers flow through the glacial till (soil) layers under the surface and often interconnect with the surface in low areas such as wetlands and lakes. The surficial aquifers are recharged by rainfall percolating through the soil and their shallow nature and interconnection to surface waters makes this resource very vulnerable to contamination from the surface. The deeper bedrock aquifers typically serve as the principal source of municipal well water supply. These aquifers flow through confined layers of permeable bedrock such as sandstone sandwiched between layers of less permeable stone.

3.1.1. Surficial Aquifers

The surface geology of Robbinsdale is primarily sand and gravel outwash and glacial till. Within the glacial deposits there are unconfined (water table) aquifers. These aquifers are vulnerable to contamination because of their proximity to the surface. Contaminants have a relatively direct access to these aquifers through short infiltration paths. Recharge areas for drift aquifers are those locations were water can reach the water table through percolation of water through soil and drift materials (Montgomery 1990). Figure 6 is an illustration of the vulnerability of the surficial aquifers to contamination.

3.1.2. Groundwater Contamination

There are four sites that are listed by the MPCA as potential or actual hazardous waste sites (Table 4). These sites have a potential to contaminate groundwater as well as surface waters.

Table 4

Hazardous Waste Sites

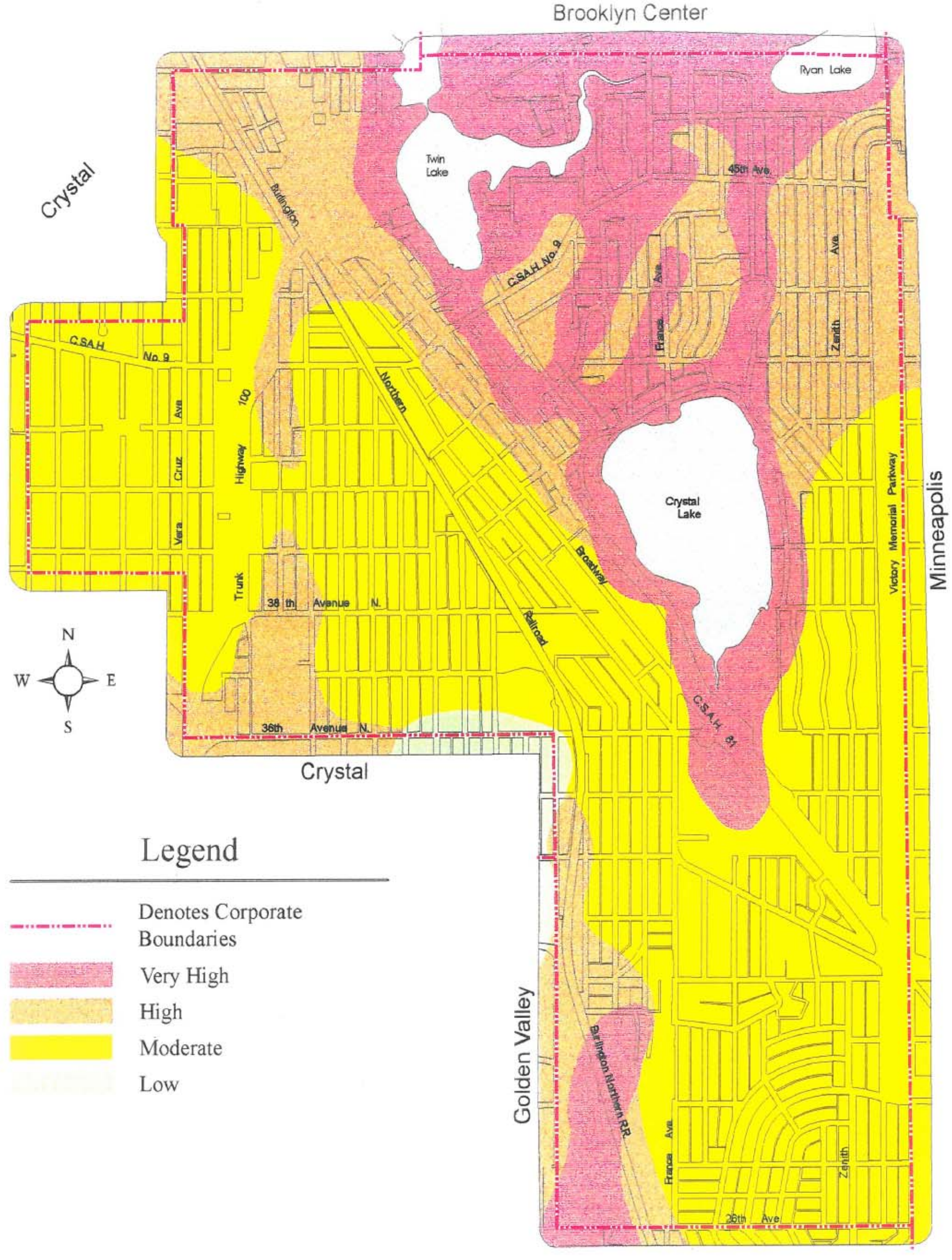
MPCA ID #	Name	Address
MNMDI0000250	Dump #1	36th Ave. & June Ave.
MNMDI0000252	Dump #2	June Ave. & Culver Rd.
MND985666080	Dev. Site	41st Ave. & Broadway
unassigned	Former Oil Dump	45th Ave. & Toledo Ave. N.
MNMDI0000249	Former City Dump	N. side of Crystal Lake

Source: MPCA 1993

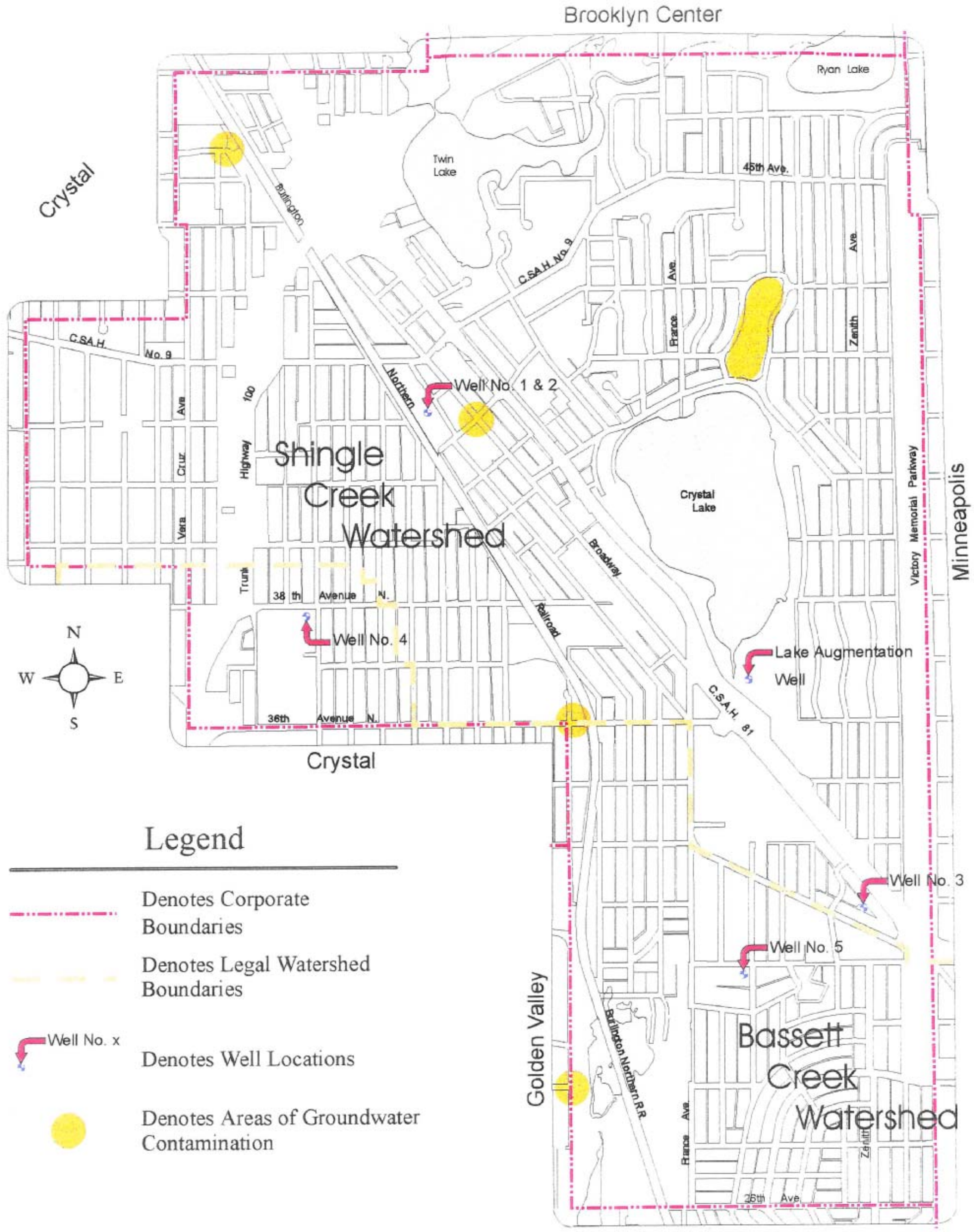
The former Robbinsdale city dump site is located near Shoreline Drive and Sanborn Park on the north side of Crystal Lake. The former dump allegedly contains paints, oils and automotive bodies. Dredgings from Crystal Lake were used to level and create Sanborn Park in the late 1940's. Preliminary and potential Hazard Ranking System scores for the former dump site by the MPCA were 20.60 and 30.10, respectively (MPCA 1987).

The Robbinsdale development site, located in the vicinity of 41st and Broadway, has contamination of the soil and groundwater with tetrachloroethylene and trichloroethylene. Monitoring wells were contaminated up to 100 feet from municipal well #1. There is also potential of contamination of Crystal Lake (1/4 mile away from site) from groundwater discharge (MPCA 1987).

Municipal wells for the City of Robbinsdale and for the City of Brooklyn Center are within 3 miles of both sites. A surface water intake, which supplies the City of Minneapolis and surrounding municipalities is located on the Mississippi River within 2 miles of both sites. Figure 7 shows the location of municipal wells as well as the locations of known waste sites.



City of Robbinsdale Water Management Plan	Sensitivity of Water-Table to Pollution	6 Figure



City of Robbinsdale Water Management Plan	**Municipal Well Locations**	**7** Figure

3.1.3. Bedrock Aquifers

The metropolitan area is under laid by three major bedrock aquifers; the Prairie du Chien-Jordan aquifer, the Franconia-Ironton-Galesville aquifer, and the Mt. Simon-Hinckley aquifer. Figure 8 describes the position and characteristics of each of these aquifers. Bedrock aquifers are much deeper than water table aquifers and have a more complex recharging process. Robbinsdale receives its municipal water from the Prairie du Chien/Jordan bedrock aquifer. Bedrock aquifers are less likely to be contaminated by surface waters because of their depths and low infiltration rates.

Observation Wells

There are eight observation wells located within Hennepin County. Of these, none are located within the city of Robbinsdale. However, there are three wells located to the west at locations: T118, R21, S7; T118, R21, S32 and T118, R21, S32.

3.1.4. Municipal Wells

Robbinsdale has six municipal wells that service approximately 14,460 people. Wells 1 through 5 are used for consumption and well number 6 is used for Crystal Lake water level maintenance. Municipal Wells number 1, 2 and 3 are improperly located as specified in Minnesota Rules, Chapter 4725. Buried sewer lines are located within 50 feet of each well, a violation of the current rules. Well numbers 1 and 6, along with samples taken from Tom Thumb in Robbinsdale, were found to have volatile hydrocarbons present. Well data from 1992 can be found in Table 5 and Appendix E.

Table 5

Water Well Summary

	WELL #1	WELL #2	WELL #3	WELL #4	WELL #5	WELL #6
Year Installed	1938	1944	1948	1953	1956	1972
Casing Diameter(in)	20	8	20	16	16	16
Depth	624	600	471	404	467	297
Water Bearing Formation*	SP/F	S/F	S/J	S/J	S/J	---
Filter Influent						
Total Iron mg/I	<.05	<.05	---	---	---	---
Total Manganese mg/1	.20	.24	---	---	---	
Filter Effluent						
Total Iron mg/1	<.05	.07	<.05	---	.80	
Total Manganese mg/1	<.02	<.02	.09		.15	

Source: City of Robbinsdale and Department of Health

*SP/F = St. Peter/Franconia

S/F = Shakopee/Franconia

S/J = Shakopee/Jordan

Surface	Geologic Unit	Description	Water Resource
	Glacial Drift (40 - 90' thick)	Till, outwash, and valley-train sand and gravel, lake deposits and alluvium; vertical and horizontal distribution is varied and complex.	Surficial Aquifer
	St. Peter Sandstone (110 - 150' thick)	Sandstone, white, fine to medium-grained, well-sorted; 0-50 feet of siltstone and shale near bottom of formation.	Aquifer
	Red Shale (0 - 40' thick)	Shale, confining layer of St. Peter formation.	Confining Layer
	Prairie du Chein Dolomite	Dolostone varying in thickness. Karsted and rubbly where less than 50 feet thick.	Aquifer
	Jordan Sandstone	Quartzose sandstone carbonate cemented in the upper 10-15 feet.	Aquifer

Source: Geologic Atlas of Hennepin County

City of Robbinsdale Water Management Plan	**Geologic Units & Aquifers**	**8 Figure**

3.2. Water Bodies

Water bodies include lakes, streams, rivers, and wetlands. These resources are a critical link in the hydrologic cycle and serve many vital functions including water supply, storm water storage, wildlife habitat, fisheries, and recreation.

3.2.1. Lakes

Robbinsdale has three lakes entirely or partially within its city limits. Crystal Lake (MDNR 27-34) is entirely within Robbinsdale. Ryan Lake (MDNR 27-58) has about 70 percent of its surface area in Robbinsdale. A third lake, Twin Lake (MDNR 27-42-1), has its south basin and a small portion of its middle basin (MDNR 27-42-2) within Robbinsdale. Crystal, Ryan and Twin Lakes are all within of the jurisdiction of Shingle Creek Watershed. This section describes each lake, the existing water quality and aquatic vegetation.

3.2.1.1. Crystal Lake

Crystal Lake is about 78 acres in size with a maximum depth of 39 feet. Crystal Lake is entirely within the Robbinsdale city limits. The average depth of the lake is 11.4 feet with a littoral area (area to the 15 ft contour) of 68 %. The volume of Crystal Lake is approximately 925 acre-feet. Crystal Lake has one public access and is zoned by the Minnesota Department of Natural Resources (MDNR) as recreational development. A surface water resource data base can be found in Appendix C.

The lake is troubled by winter kills, caused by the depletion of dissolved oxygen from its waters, and water level fluctuations. In 1973 air diffusers were installed to replenish the dissolved oxygen during the winter months. To alleviate water level fluctuations, a groundwater well at the south end of Crystal Lake is used to maintain water levels during dry years. In 1992 a lake stabilization project was constructed by the City which consisted of an 800 gpm pumping station and forcemain. This artificial outlet pumps lake water into the Minneapolis storm drain system at the intersection of Xerxes Avenue and 42nd Avenue North. The lake water then flows through the gravity system to discharge into Shingle Creek.

Runoff from approximately 1,300 acres of watershed are routed via twelve storm drain systems into Crystal Lake (Table 6). No water quality data is available for the inflows. Pollutant loading from the storm drains undoubtedly has a negative impact on the Lake.

Table 6

Inflows to Crystal Lake

Storm Drain	Acres	Storm Drain	Acres
1	105.7	8	60.1
2	162.4	9	4.6
3	190.9	10	554.7
4	152.8	11	15.9
5	8.2	12	12.7
6	5.4		
7	7.6	Local Runoff	37.1
Totals	633.0		685.1

The extent of seasonal and annual variations in observed water quality parameters provide a range with which to compare and evaluate data. These ranges for the City's lakes are generally unknown. Historic data only shows a "snapshot" in time due to small sampling numbers and frequency.

Historical water quality of Crystal Lake indicates a decline in water quality probably due to development of its watershed. Total phosphorus, a major growth nutrient, increased almost six fold in the last four decades and total Kjeldahl nitrogen, a measure of organic nitrogen, increased over four times (Table 7). A comparison 1986 lake data with the North Central Hardwood Forest (NCHF) region average ranges indicate Crystal Lake has about four times more phosphorus than the upper range for the region (Table 8).

The 1990 MPCA Lake Water Quality Assessment Report lists Crystal Lake's phosphorus at 79 percentile. This means that 79 percent of the lakes in the NCHF region have lower average phosphorus concentrations.

Water quality data on file with the U.S. Environmental Protection Agency's water quality database (STORET) can be found in Appendix D.

Table 7

Surface Water Quality
Crystal Lake

	1986	1974	1972	1948	1946
Sulfate ton (mg/1)		--	34.8	14.0	23.5
Total Phosphorus (mg/I)	0.205	--	0.092	0.100	0.035
Soluble Phosphorus (mg/1)		--	0.034	0.015	0.000
Orthophosphorus (mg/1)	--	--	0.058	0.085	0.035
Ammonia Nitrogen (mg/I)	0.020	--	0.31	0.05	--
Nitrite Nitrogen (mg/I)		--	0.005	0.008	0.007
Nitrate Nitrogen (mg/1)	--	--	0.020	0.100	0.020
Total Kjeldahl N (mg/1)	2.04	--	1.56	0.368	0.450
Organic Nitrogen (mg/1)		--	0.020	--	--
Total Nitrogen (mg/I)		--	1.60	0.476	0.477
Alkalinity (mg/I as CaCO3)	71	--	150	120	85
pH8.1		--	7.8	--	--
Chloride (mg/1)	--	--	44.0	10.8	19.4
Chlorophyll-a (,tg/1)	51	2.34	---	---	---

Source Historical Data: MDNR

Table 8

Comparison of Crystal Lake Water Quality to the NCHF Region

Parameter	NCHF AVG.	Crystal Lake AVG.
Total Phosphorus (p.g/1)	23-50	205
Chlorophyll (ig/1)	5-22	51
Secchi Disk (feet)	4.9-10.5	4.5
Total Kjeldahl Nitrogen (mg/1)	0.60-1.2	2.04
Nitrate + Nitrite-N (mg/1)	<0.01	NA
Alkalinity (mg/1)	75-150	71
pH	8.6-8.8	8.1
Conductivity (uS/cm)	300-400	434

Summer averages from Wilson and Schupp (1991)

Aquatic Macrophytes

An aquatic macrophyte inspection was conducted by the MDNR in August of 1980. Emergent vegetation covered about 20 % of Crystal Lake. Stands of narrow and broadleaf cattails (Typha anustifolia and Typha latifolia respectively) were found along the north shore and in the southern tip of the lake. Hardstem and softstem bulrush (Scirpus acutus and Scirpus validus respectively) were common in light stands along the southern shore.

Submergent vegetation had grown to a maximum depth of 3 feet. There were no definite stands noticeable anywhere around the lake. Flatstem and narrowleaf pondweed (Potamogeton zosterformis and Potamogeton spp. respectively) were noticed along the southwest shore and lesser duckweed (Lemna minor) was noticed along the northeast and southeast shores (MDNR 1980).

3.2.1.2. Ryan Lake

Ryan Lake is a small lake of 32 acres but has been recorded as small as 18 acres. It has a maximum depth of 33 feet and has a littoral area of 54%. Ryan Creek runs out of Lower Twin Lake and into the west side of Ryan Lake and then exits on the northeast side and runs east to Shingle Creek. Ryan Lake has no public accesses. The lake is zoned by the MDNR as recreational development.

Water Quality

Little is known about the water quality of Ryan Lake. Ryan is a hard water eutrophic lake. Comparison of historical and 1986 water quality data for Ryan Lake indicate a possible decline in water quality. Total phosphorus increased from 60 pg/1 in 1946 to a current average concentration of 90 [tg/1 an increase of 50%. Total Kjeldahl nitrogen increased 32% from 1.06 mg/1 in 1962 to a current 1.4 mg/1 (Table 9). The data is within the seasonal/annual variation.

Comparing parameters to the averages of other lakes in the NCHF shows that it has greater concentrations of both total phosphorus and total Kjeldahl nitrogen and lower Secchi disk readings (Table 10).

Aquatic Macrophytes

There have been no surveys conducted on Ryan Lake macrophytes.

Table 9

Surface Water Quality
Ryan Lake

	1986	1974	1962	1947	1946
Total Phosphorus mg/1	0.090	--	0.086	0.055	0.060
Orthophosphorus mg/1			--	0.045	0.057
Ammonia Nitrogen mg/1	--	--	0.08	0.00	--
Nitrite Nitrogen mg/	--	--	0.00	0.00	--
Nitrate Nitrogen mg/1	--	--	0.045	0.06	--
Total Kjeldahl Nitrogen mg/11.4	1.4	--	1.06	--	--
Organic Nitrogen mg/1		--	--	0.20	--
Carbon Dioxide mg/1	--	--	4.0	--	--
Total Alkalinity mg/1 (CaCo3)	--	--	121	137	100
Chloride	--	--	--	4.6	3.3
Chlorophyll-a ug/1	--	1.6	--	--	

Historical Data Source: MDNR

Table 10

Comparison of Ryan Lake
Water Quality to the NCHF Region

Parameter	NCHF AVG.	Ryan Lake AVG.
Total Phosphorus (pg/1)	23-50	90
Chlorophyll (m/1)	5-22	NA
Secchi Disk (feet)	4.9-10.5	2.8
Total Kjeldahl Nitrogen (mg/1)	60-1.2	1.4
Nitrate + Nitrite-N (mg/1)	<.01	NA
Alkalinity (mg/1)	75-150	NA
pH	8.6-8.8	NA
Conductivity (uS/cm)	300-400	NA

NCHF = North Central Hardwood Forest

Summer averages from Wilson and Schupp (1991)

3.2.1.3. Twin Lake

Twin Lake consists of three interconnected basins; Upper, Middle and Lower Twin Lake. These basins lie in three different city limits; Robbinsdale, Crystal and Brooklyn Center. The south bay of Twin Lake is located solely in Robbinsdale, there is also a small portion of the middle bay's southern tip in Robbinsdale.

The total area of Twin Lake is about 212 acres of which about 30 acres are in Robbinsdale. Twin Lake's south bay is 24 acres and has a maximum depth of 20 feet. The average depth is 10 feet and the lake has an approximate volume of 246 acre-feet. The south bay's inflow is from the middle bay through a channel under Highway 100 and the outflow is Ryan Creek. Twin Lake's middle bay is 58 acres; approximately 6 acres are in Robbinsdale. Twin Lake's middle bay has a maximum depth of 45 feet and a average depth of 18 feet. Twin Lake has three public accesses. Shoreline zoning, classified by the MDNR, is general development.

Water Quality

There is very little water quality data exclusively on lower Twin Lake (south bay). When Twin Lake's south bay is compared to NCHF averages, the concentrations of total phosphorus and chlorophyll-a are 3 times greater than the NCHF upper limits. Total Kjeldahl nitrogen was 1.2 times the NCHF concentrations and Secchi disk readings were 6 times lower. Table 11 is a comparison of middle and south bays of Twin Lake to the NCHF region averages.

A comparison of historical water quality of middle Twin Lake to the latest available data shows a decline in water quality. Total phosphorus increased from 44 ng/1 in 1950 to a current average concentration of 68 ug/1. Total Kjeldahl nitrogen increased from 0.258 mg/1 in 1950 to a current 1.55 mg/I (Table 12).

Aquatic Macrophytes

An aquatic macrophyte inspection was conducted by the MDNR in the summer of 1986. Emergent vegetation covered about 15 % of Twin Lake (upper, middle and lower). Cattails (Typha latifolia) and white waterlilies (Nymphaea tuberosa) were abundant with purple loosestrife (Lythrum salicaria), reed canary grass (Phalaris arundinacea), yellow waterlily (Nyphar variegatum), little white waterlily (Nymphaea tetragona) and narrowleaf cattails (Typha angustifolia) being common. Among the rare and occasional species were threeway sedge (Dulichium arundinaeoum), arrowhead (Sagittaria spp.) and softstem bulrush (Scirpus validus).

Cattails, reed canary grass, and purple loosestrife were found along the shoreline of the upper and middle bays. Bulrush was found only south of the beach in the middle bay. Arrowhead was found around the point in the upper bay.

Submergent vegetation had grown to a maximum depth of 10 feet. Coontail (Ceratophylum demersum) was abundant with narrowleaf pondweed (Potamogeton spp.), Canada waterweed (Elodea canadensis) and whitestem pondweed (Potamogeton praelongus) also being common.

Among the rare and occasional species were curled pondweed (Potamogeton crispus), sago pondweed (Potamogeton pectinatus), lesser duckweed (Lemna minor) and flatstem pondweed (Potamogeton zosterformis).

Sago pondweed was found in small bays and in the channel leading to Ryan Creek. Waterlilies and duckweed were found in scattered marshy areas around the three basins (MDNR 1986).

Table 11

Comparison of Twin Lake Water Quality to the NCHF Region

Parameter	NCHF Avg.	Twin Lake South Bay* Avg.	Twin Lake Middle Bay Avg.
Total Phosphorus (pg/1)	23-50	85	**68**
Chlorophyll (pg/1)	5-22	63	54
Secchi Disk (feet)	4.9-10.5	0.8	0.9
Total Kjeldahl Nitrogen (mg/I)	60-1.2	1.43	1.55
Conductivity (uS/cm)	300-400	355	349

Summer averages from Wilson and Schupp (1991)

*Based on one sample

Table 12

Surface Water Quality Middle Twin Lake

	1991 mg/1	1985 mg/1	1950 mg/1
Sulfate Ion	----	----	17.4
Total Phosphorus	0.068	0.046	0.044
Soluble Phosphorus		----	0.018
Orthophosphorus	----	----	0.026
Ammonia Nitrogen	----	----	0.020
Nitrite Nitrogen	----	----	0.010
Nitrate Nitrogen	----	----	0.040
Total Kjeldahl Nitrogen	1.55	1.19	0.258
Total Nitrogen		----	0.308
Total Alkalinity as CaCO3	----	----	80
Secchi Transparency (meters)	0.92	3.1	

Historical Data Source: MDNR

3.2.1.4. Ecological Concerns

The MDNR Natural Heritage Program has determined that Water Willows (Decon verticillatus, a species of special concern) has been detected on the shorelines of Twin Lake and Ryan Lake.

3.2.1.5. Trophic State Index

Trophic State Index (TSI) was used to provide a way of assessing a lake's eutrophication productivity state. Trophic State Indexes are calculated using three key parameters; total phosphorus, chlorophyll-a and Secchi disk (water transparency). TSI values are calculated with three separate equations:

Total Phosphorus (TSIP)	=	14.42 In (TP) + 4.15
Chlorophyll-a (TSIC)	=	9.81 In (Chl a) + 30.6
Secchi Disk (TSIS)	=	60 - 14.41 In (SD)

with TP and Chl a expressed in micrograms per liter (ug/1) and Secchi disk in meters.

The TSI values obtained from the calculations range from 0 to 100. TSI values between 0 and 40 are considered oligotrophic, from 41 to 50 mesotrophic, from 51 to 70 eutrophic and greater than 70 are hypereutrophic. Oligotrophic waters are similar to those of northern Minnesota where there is little nutrient, very clear water, few weeds and fewer but larger gamefish. At the other end of the scale, hypereutrophic, there is a very excessive amount of nutrient in the water resulting in less than 1-foot transparency, many weeds, algae, and roughfish. The trophic states for the index are defined by using each doubling of algal biomass as the criterion for the division of each state (Carlson 1977).

TSI values can be compared to other lakes to obtain a reference point to the lake water quality compared with similar lakes in the same ecoregion. There are five ecoregions in Minnesota. All of Robbinsdale's surface water are in the North Central Hardwood Forest (NCHF) ecoregion.

Crystal Lake

Crystal Lake is a hard water hypereutrophic lake. A comparison of Crystal Lake's parameters to the averages of other lakes in the NCHF shows that it has over four times the amount of total phosphorus and over twice as much chlorophyll-a (Table 8 and Appendix D).

Crystal Lake has an average TSI of 68.5. Total phosphorus concentrations were high with an average of 205 ug/1 (64 observations) and a TSI rating of 80.9. Chlorophyll-a concentrations were 51 ug/1 (17 observations) for a TSI value of 69.5. Secchi disk readings averaged 4.5 feet (17 observations) and a TSI value of 55.4. Crystal Lake, four decades ago, was probably mesotrophic compared to its hypereutrophic state today.

Ryan Lake

Ryan Lake has an average TSI of 65.7. Total phosphorus concentrations averaged 90 tg/l (9 observations) and yielded a TSI rating of 69.0. Chlorophyll-a concentrations were not available. Secchi disk readings averaged 2.8 feet (34 observations) and a TSI value of 62.4. Ryan Lake, four decades ago, was likely moderately eutrophic compared to its almost hypereutrophic state today.

Twin Lake

Middle Twin Lake had an average TSI of 65.3. Total phosphorus concentrations were high at 68 pg/I for a TS! rating of 65. Chlorophyll-a concentration was at 54 n.g/1 for a TSI rating of 70. Secchi disk (water transparency) was 3.0

feet and a TSI value of 61.

South Twin Lake has an average TSI of 68.0. The total phosphorus concentration was high at 85 lig/I yielding a TSI of 68. Chlorophyll-a was 63 1.tg/1 and a TSI rating of 71. The Secchi disk was 2.5 feet for a TSI value of 64. Twin Lake (South Bay) can be classified as a moderately eutrophic lake with the south bay being hypereutrophic. Four decades ago, the lakes were probably slightly eutrophic.

3.2.2. Fish & Wildlife

Twin Lake and Crystal Lake are the principal recreational fisheries for Robbinsdale. Human development has limited wildlife habitat to those species compatible with the urban environment. Major open spaces associated with wetlands, such as Walter Sochacki park, provide important habitat and nesting areas for many native species.

3.2.2.1. Fisheries

Responsibility and management of the fishery in Robbinsdale surface waters is the jurisdiction of the MDNR, Region 6 (St. Paul).

Crystal Lake

Crystal Lake has a history of winterkills and may have had a partial summerkill in 1988. Crystal Lake is currently being aerated in the winter to prevent winterkills and to improve water quality.

Northern Pike and hybrid Muskellunge have recently been stocked (Appendix G) and the current Lake Management Plan calls for stocking of Northern Pike at the rate of one pound per littoral acre (265 5/1b fish) two out of three years. Stocking was scheduled for 1989, 1990, 1992 and 1993. A survey in 1988 captured five hybrid Muskellunge which were in the IV year age group and exhibited exceptional growth rates. Northern Pike catch rates were well above state and local medians. Largemouth Bass were also sampled at levels above state and local medians and had good growth rates.

Black Bullheads, hybrid Sunfish, and Yellow Perch were at median levels, while Golden Shiners, White Sucker, Yellow Bullhead, Pumpkinseed, Bluegills and Black Crappies were well above both medians (MDNR 1990).

Ryan Lake

Ryan Lake reportedly experienced a winterkill in 1976-1977 and in 1978-1979. Although there is no recorded documentation on the winterkills there is a dominance of bullheads that suggest they may have occurred. In a lake survey in 1986; Black Bullhead, Brown Bullhead, Northern Pike, and hybrid Sunfish were found at above local median numbers. Pumpkinseed, Bluegill, and Black Crappie were sampled at below local median levels. There has not been any stocking of Ryan Lake since 1957 (MDNR 1986).

Twin Lake

Twin Lake also has a history of winterkills with the last one occurring in 1988-1989. There has been no stocking of Twin Lake since 1976. A fisheries survey completed in 1990 indicated that Northern Pike, Carp, Black Bullhead, Bluegill, Black Crappie and Yellow Perch were all caught at levels higher than local medians. Bowfin, Golden Shiner, Yellow Bullhead, and Brown Bullhead were found to be near local median levels. Hybrid Sunfish, Green Sunfish, Pumpkinseed, White Crappie and Walleye were caught in numbers lower than local medians. In general, fish sizes were close to local medians, except Black Crappies, which were of smaller than average size. The survey also confirmed reports of Columnaris infections in Crappie populations. The survey encourages the removal of carp and bullheads by commercial fisherman (MDNR 1988).

3.2.2.2. Ecological and Management Classifications

Crystal Lake
The MDNR classifies and manages Crystal Lake as Centrarchid (Sunfish Family). A Centrarchid lake is a lake medium to small in size with weeds, medium fertility, has hardwater and may contain roughfish. The MPCA water management classification of Crystal Lake is warm-water gamefish.

Ryan Lake
The MDNR classifies Ryan Lake as Roughfish-Gamefish and is managed as Centrarchid. A RoughfishGamefish lake are lakes with panfish and predator species, are fertile and have large populations of roughfish and occasionally winterkill. The MPCA water management classification of Ryan Lake is Centrarchid.

Twin Lake
The MDNR classifies Twin Lake as Centrarchid and is managed as Centrarchid. The MPCA water management classification of Twin Lake is also Centrarchid.

3.2.3. Wetlands

The last ten years have been a period of rapid change in the recognition and regulation of wetlands. The Wetland Conservation Act of 1991 established a program to protect and preserve wetlands and to provide a process for controlling alteration by development or agriculture. The Metropolitan Surface Water Management Act requires that local plans adopt strategies for management and conservation of wetlands.

3.2.3.1. Methodology

Wetland boundaries were identified by Westwood Professional Services, Inc. on 1" = 200' scale aerial photographs dated April 1985, which were obtained from the Hennepin County Surveyor's Office. U.S. Fish and Wildlife Service National Wetland Inventory maps and Minnesota DNR Protected Waters Inventory maps provided a basis for wetland identification. No independent field evaluation was performed. Although County Soil Surveys are also routinely reviewed to identify potential wetland locations, the Hennepin County Soil Survey does not classify soil series within Robbinsdale because this area was urbanized before field work for the soil survey was undertaken. Consequently, the Hennepin County Soil Survey holds no benefit for identifying wetlands within the City of Robbinsdale.

Wetlands were identified in accordance with the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (Federal Interagency Committee for Wetland Delineation, 1989) and the Corps of Engineers Wetlands Delineation Manual (U.S. Army Corps of Engineers, 1987). These manuals are currently followed to delineate wetlands regulated under the Minnesota Wetland Conservation Act of 1991 and Federal Clean Water Act, respectively. In almost every case, application of these manuals yields identical wetland boundaries.

Wetlands were classified according to Wetlands and Deepwater Habitats of the United States (FWS/OBS Publication 79/31; Cowardin et al. 1979) and Wetlands of the United States (USFWS Circular 39; Shaw and Fredine 1971). These classification systems are referred to as NWI and Circ.39, respectively, in Table 13.

3.2.3.2. Regulatory Authorities

The wetland mapping prepared under this plan shows approximate wetland areas and is not meant as a substitute for field delineation of wetland boundaries. The wetlands shown in this plan may differ significantly from a field delineation, and there may well be existing wetlands that are not included. When earthwork or any other activity that could potentially drain or fill wetlands is proposed in the vicinity of identified wetlands, project proposers should be required to field delineate wetland boundaries and coordinate with agencies responsible for administering wetland protection and permitting programs. Depending on the type and extent of activity proposed, a substantial number of resource and review agencies could become involved. For most activities, however, the following list of wetland review authorities will be sufficient:

Program	Review and Permitting Authority
Wetland Conservation Act of 1991	North Robbinsdale: Shingle Creek WMO Contact Fred Moore (550-5000) or Dale Claridge (473-4224)
	South Robbinsdale: Bassett Creek WMO Contact Len Kremer (832-2781)
DNR Protected Waters Program	Minnesota DNR Metro Waters Contact Ceil Strauss (772-7910)
Section 404 of Clean Water Act	U.S. Army Corps of Engineers Contact Joe Yanta (290-5362)

Robbinsdale has adopted a resolution establishing the Shingle Creek WMO as the Local Governmental Unit (LGU) to administer the Wetland Conservation Act of 1991 on behalf of the City. The wetland identification mapping prepared for this plan is available for review at the City offices for preliminary purposes only. All final determinations of wetland identification and delineation will be handled by the Watershed.

3.2.3.3. Identified Wetlands

Twelve wetland basins were identified within the City of Robbinsdale. Characteristics of these wetlands are summarized in Table 13, shown on Figure 9 and described below . The Minnesota DNR has designated eight of these basins as protected waters or wetlands. The DNR requires that a protected waters permit be obtained for any alteration of the course, current, or cross section below the Ordinary High Water Level (OHWL) of these basins. In some cases, an official determination of the OHWL has not been made. Draining or filling of any wetlands not regulated by the DNR or located above the OHWL of DNR protected waters is prohibited by the Minnesota Wetland Conservation Act of 1991 unless prior approval is obtained from the local government unit. All four basins that are not under the jurisdiction of the DNR are located in the southern portion of the city. Regardless of state or local regulatory authority, all wetlands are regulated under the Federal Clean Water Act, which is administered by the U.S. Army Corps of Engineers.

Basin A South Twin Lake

Only the southern portion of the south lobe of Twin Lake falls within Robbinsdale. The DNR has estimated the full size of Twin Lake, including the portions in Brooklyn Center and Crystal, at 229 Acres. The 100-year flood elevation of Twin Lake has been estimated at 855.1 by the Shingle Creek WMO and at 856.0 by the Federal Emergency Management Agency (FEMA). The lake is classified as a Lacustrine limnetic unconsolidated bottom (L1 U13: Type 5 open water) wetland. The lake drains east through DNR protected wetland 27-640W and eventually into Ryan Lake. In 1990 the SCWMO replaced the existing 48 inch culvert under France Avenue with a larger 6 foot by 4 foot box culvert and a control weir to maintain the level of Twin Lake while increasing the 100-yr. flow capacity.

Basin B Unnamed Marsh

Basin B is a Palustrine emergent semi-permanently flooded (PEMF; Type 4 deep marsh) wetland designated as DNR protected wetland 27-640W. No official or estimated OHWL exists for this basin. However, notes in the DNR files dated February 20, 1985, placed the OHWL at 853.5, correcting an earlier reference to an OHWL of 852.5.

Basin C Unnamed Channel

Basin C is an unnamed DNR protected watercourse that flows from Basin B to Ryan Lake. Based on aerial photograph review, it is classified as a Palustrine emergent semi-permanently flooded/unconsolidated bottom (PEMF/PUB; Type 4/5 deep marsh/open water) wetland. Although the DNR has identified this channel as a DNR protected watercourse, it has no protected waters number or OHWL. The limits of DNR jurisdiction on all protected watercourses are considered to be the top of the banks of the channel.

Basin D Ryan Lake

With the southern portion of the basin in Robbinsdale and the northern portion in Brooklyn Center, the DNR has identified Ryan Lake as DNR protected water 27-58P. The basin is classified as a Lacustrine limnetic unconsolidated bottom (L I UB; Type 5 open water) basin with a fringe of Palustrine emergent semi-permanently flooded (PEMF; Type 4 deep marsh) wetland at its western end. The basin was surveyed by the DNR in 1995; an official OHWL of 849.6 was established at that time. The Shingle Creek WMO obtained a DNR protected waters permit to install a new 54-inch RCP outlet under the railroad tracks on the Brooklyn Center side of this basin in August of 1990.

Basin E Crystal Lake

Crystal Lake is the only lake located entirely within Robbinsdale and is a Lacustrine limnetic unconsolidated bottom (L1UB; Type 5 open water) basin with a Palustrine forested broad-leaf deciduous temporarily flooded (PF01A; Type 1L Bottomland hardwoods) wetland fringe on its west shore. Because the lake has no natural outlet and was prone to large fluctuations in water levels, the City of Robbinsdale obtained a DNR permit to establish an outlet in November of 1992. The lake has an OHWL of 847.5 and a natural OHWL of 853.5. The natural OHWL indicates the DNR recognizes evidence that water levels in the lake were typically higher prior to man-induced changes. The DNR revised its OHWL for Crystal Lake from 853.5 to 847.5 in the mid-1980s.

Basin F Unnamed Wetland

Basin F is a Palustrine emergent saturated/seasonally flooded (PEMB/C; Type 2/3 wet meadow/shallow marsh) wetland located south of 36th Avenue and west of the Burlington Northern Railroad on the west edge of Robbinsdale. The basin is contiguous with Grimes Pond (Basin F, DNR protected wetland 27-644W) to the south and is the most northerly wetland in the city falling under the local permitting jurisdiction of the Bassett Creek WMO. Although review of aerial photographs and topographic mapping suggests similar wetland conditions exist on the east side of the Burlington Northern Railroad, these potential wetlands are not indicated on the city wetland map because they were not identified on National Wetland Inventory maps and the city wetland map was not field checked.

Basins G and H Grimes Pond

Grimes Pond, DNR protected wetland 27-644W, is a Palustrine emergent semi-permanently flooded/unconsolidated bottom (PEMF/PUB; Type 4/5 deep marsh/open water) wetland located on the west edge of the city between 31st and 29th Avenues. The Burlington Northern Railroad divides Grimes Pond into two basins. Although the total wetland area exceeds ten acres, the DNR has not assigned a shoreland classification to this basin, nor have they estimated its OHWL.

Basin I Rice Pond

Rice Pond, DNR protected wetland 27-645W, is a Palustrine emergent semi-permanently flooded (PEMF; Type 4 deep marsh) wetland located in the southwest corner of the city and partially in Golden Valley, on the west side of the Burlington Northern Railroad. The DNR has not estimated the OHWL of this basin.

Basin J Unnamed Wetland

Basin J is a Palustrine forested broad-leaf deciduous temporarily flooded (PF01A; Type 1L bottomland hardwoods) wetland located on the west side of the Burlington Northern Railroad between 29th and 27th Streets.

Basin K Unnamed Wetland

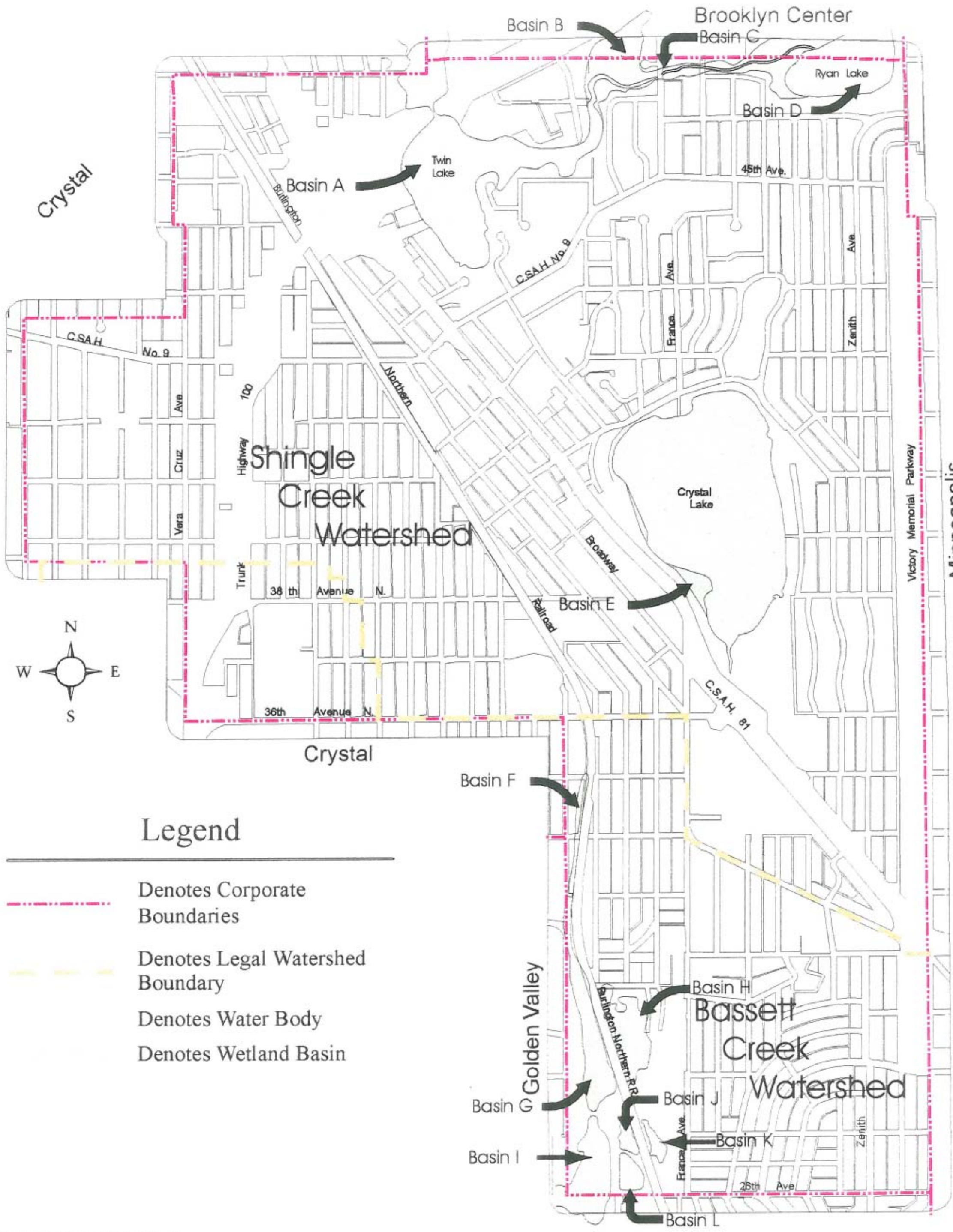
Basin K is a Palustrine emergent saturated/Palustrine forested broad-leaf deciduous temporarily flooded (PEMB/PF01A; Type 2/1L wet meadow/bottomland hardwoods) wetland located on the east side of the Burlington Northern Railroad at the level of 27th Street.

Basin L Unnamed Wetland

Basin L is a Palustrine emergent saturated/Palustrine forested broad-leaf deciduous temporarily flooded (PEMB/PF01A; Type 2/1L wet meadow/bottomland hardwoods) wetland located on the west side of the Burlington Northern Railroad and the west side of Rice Pond south of 27th Street

Table 13
Wetlands Located Within the City of Robbinsdale

Basin Name		Acreage (within city)	Classification NWI	Circ.39	DNR Protected Waters No.	DNR Listing	OHWL	Shoreland Classification	Local Wetland Permitting Authority
A	South Twin Lake	41.3	L 1 UB	5	27-42P	229 acre Lake	853.5	General Development	Shingle Creek WMO
B	unnamed marsh	3.6	PEMF	4	27-640W	7 acre Type 3	853.5	none	Shingle Creek WMO
C	unnamed DNR protected watercourse	0.5	PEMF/PUB	4/5	none	OHWL = top of bank of channel			Shingle Creek WMO
	Ryan Lake	13.3	L I UB west edge=PEMF	5 4	27-58P	35 acre Lake	849.6	Recreational Development	Shingle Creek WMO
	Crystal Lake	84.1	LIUB west edge=PF01A	5 1L	27-34P	70 acre Lake	847.5	Recreational Development	Shingle Creek WMO
F	unnamed wetland	3.9	PEMB/C	2/3	none	not applicable	none	none	Bassett Creek WMO
G	Grimes Pond (west)	7.0	PEMF	4	27-644W	13 acre Type 4	no estimate	none	Bassett Creek WMO
H	Grimes Pond (east)	8.1	PUB	5	27-644W	13 acre Type 4	no estimate	none	Bassett Creek WMO
	Rice Pond	6.5	PEMF	4	27-645W	9 acre Type 4	no estimate	none	Bassett Creek WMO
J	unnamed wetland	0.9	PFOIA	1L	none	not applicable	none	none	Bassett Creek WMO
K	unnamed wetland	0.9	PEMB/ PF01A	2/1L	none	not applicable	none	none	Bassett Creek WMO
L.	unnamed wetland	2.1	PEMB/ PFOIA	2/1L	none	not applicable	none	none	Bassett Creek WMO



City of Robbinsdale Water Management Plan	**Surface Water Features**	**9** Figure

3.3. Storm Water

The City of Robbinsdale contains six major drainage basins. Three of these basins lie within the Shingle Creek watershed and three are in the Bassett Creek watershed. This section discusses each of these major drainage basins and the nature and predicted rate and volume of storm water runoff.

Each basin was delineated on topographic mapping obtained by aerial photography prepared in conjunction with this report. Each major basin was subdivided into smaller sub-basins for analysis by the HEC-1 computer model (Figure 10). This model was used to determine the estimated peak runoff rate and total volume expected from both a 100-year and a five-year rainfall. The 100-year event was used to evaluate consistency with WMO peak discharge and storage requirements. The five-year event was used to assess the capacity of the trunk storm sewer system. The five-year analysis of the trunk storm sewer system is included in Section 4.

Hydrologic Modeling

The HEC-1 Flood Hydrograph Package was originally developed by the U.S. Army Corps of Engineers Hydraulic Engineering Center in 1967. The program has been through three major revisions including the development of a microcomputer (PC) version. The program is a single-event, component model, using semi-distributed parameters to represent land surface runoff, channel routing, reservoir routing, as well as diversion and pump components.

For preparation of the plan, the HEC-1 modeling was conducted using a synthetic rainfall distribution based upon SCS 24-hr distribution (TP-40). Rainfall loses consisting of interception, infiltration and depression storage were represented using the SCS curve number methodology to incorporate soil type, land use and antecedent moisture conditions. Because Robbinsdale is a "fully developed" community, the land use is expected to change very slightly and the modeling estimations for CN were assumed to remain constant. The sub-areas runoff was routed using the SCS unit hydrograph methods which represent each subbasin by a single lag time parameter. Flood routing of runoff through channels was accomplished using MuskingumCunge methods and reservoir elements utilized and Modified Puls methods. Impoundment volumes and elevation-storage relationships were derived from 2-foot interval contours developed from digital terrain models and aerial photography performed in conjunction with this plan.

Storm sewer areas were modeled by estimating total inlet capacities for each sub-area based upon the master facilities plans and diverting this flow to the outfall location where it was re-combined with the overland flow component. This process was used to evaluate key sections of the trunk sewer by comparing the diverted flow to the existing pipe capacity. Tabulations of land use and SCS curve number derivation for each drainage area are included in Appendix IIIB.

The remainder of Section 3.3 discusses the results of the modeling efforts by watershed and major basin. The model results presented represent existing conditions for peak flow and runoff volume from each management sector. Existing ponds and impoundments are included in this model but future improvements were not modeled as these are anticipated to have minimal effects on runoff quantities and were selected for water quality improvement potential or to relieve capacity limitations in the existing storm sewers. The precise effects of future ponding will require refined modeling as part of detailed feasibility studies for each management sector.

3.3.1. Shingle Creek Watershed

The Shingle Creek watershed covers over three fourths of the drainage area within the City. This area consists of three major basins each of which is associated with one of the major City lakes: Crystal Lake, Twin Lake and Ryan Lake.

3.3.1.1. Crystal Lake (LSC2)

Crystal Lake is located in the center of Robbinsdale northeast of C.R. 81 between 37th Avenue North and 42nd Avenue North. The total drainage area contributing to Crystal Lake is 1,229 acres. Approximately 30% of the basin area lies outside of Robbinsdale in Minneapolis. Crystal Lake has no natural outlet and the SCWMC has therefore not studied the area in detail nor adopted a regulated peak discharge from this sub-watershed.

Crystal Lake has experienced increasing lake levels for the past four years. In 1992, the City, in cooperation with the SCWMC, constructed a pumped outlet to stabilize lake levels and protect adjacent properties. Because of the critical nature of this lake, the entire drainage area was modeled for this plan. The entire basin is fully developed with 77% (944 ac.) of single family land use. The basin also includes almost all of the commercial land use in the city.

The predicted 100-year peak flow is 1,142 cfs to the lake from LSC2. The peak discharge to Shingle Creek is limited to the pumped outlet of 2 cfs of "dry-weather" flows. The total runoff from the 100-year event is estimated as 261 ac-ft. which results in a peak lake level of 854.7. Nearly half the peak runoff (602 cfs) is generated by the two sub-basins in the southeast limb of the watershed (CLA and CLB). These two sub-basins contain the Terrace Mall area and the runoff from Minneapolis. Table 14 summarizes the runoff from each of the eight major sub-basins.

In the 100-year storm, significant street flooding occurs at the intersection of 36th Avenue and Xerxes, Dowling Avenue and Xerxes and in the Terrace Mall parking lot. In the western portion of the basin, local inundation affects the apartment complex at Hubbard and 38th Avenue and the intersection of 40th and Noble. North of Crystal Lake minor flooding occurs in the alleys on either side of Grimes Avenue from 42nd to Lake Drive, and in the backyards of the Drew Avenue cul-de-sac.

Table 14
Crystal Lake Basin Runoff (LSC2)

Sub-Basin Identifier	5-yr. Peak (cfs)	100-yr. Peak (cfs)	5-yr. Volume (AcFt)	100-yr. Volume (AcFt)
CLA	155	297	50	120
CLB	180	390	17	37
CLC	65	122	12	28
CLD	117	217	22	51
CLE	44	73	7	22
CLF	55	143	9	25
CLG	12	26	2	7
CLH	19	46	1	4
Totals:	522	1142	120	261

3.3.1.2. Twin Lake (TL1)

The lower bay of Twin Lake and a portion of Middle Twin Lake lie within Robbinsdale. The drainage area TL1 defined in the Shingle Creek Management Plan includes 820 acres tributary to both Middle and Lower Twin Lake in Robbinsdale, Crystal, and Brooklyn Center. The Robbinsdale portion of TL1 comprises 495 acres tributary to the lower bay and 38 acres tributary to the middle bay.

The land use of the basin is 70% (370 ac) single family residential, 7% (35 ac) multi-family, 5% (27 ac) commercial with the balance (18%) as open space and lake surface. The peak discharge from the

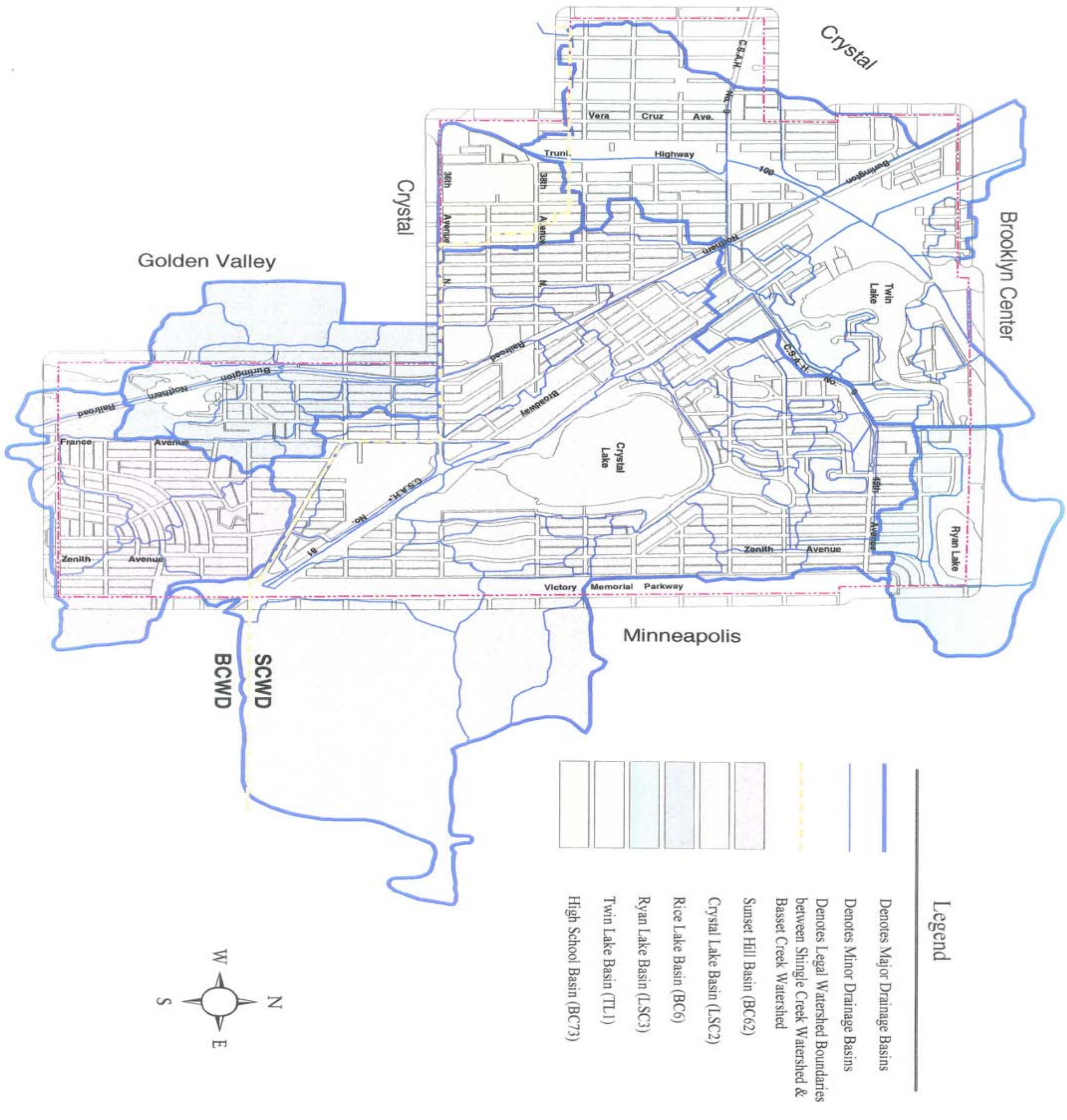
Robbinsdale portion of TL1 is 420 cfs for a 100-year storm with a total runoff volume of 134 ac-ft. TL2 also contributes approximately 4 cfs of flow from Crystal and New Hope which is pumped from a detention facility at 40th and Adair in Crystal.

The 100-year storm is conveyed overland principally along T.H. 100. Significant local inundation occurs along the highway south of the intersection with C.R. 81 to the BN railroad. This local inundation has an estimated volume of 32 ac-ft and a maximum elevation of 863.

Table 15

Twin Lake Basin Runoff (TL1)

Sub-Basin Identifier	5-yr. Peak (cfs)	100-yr. Peak (cfs)	5-yr. Volume (AcFt)	100-yr. Volume (AcFt)
TLA	63	125	23	66
TLB	73	127	6	11
TLC	55	135	22	46
ML	59	138	5	11
Totals:	194	420	56	134



City of Robbinsdale Water Management Plan	Drainage Areas	10 Figure

3.3.1.3. Ryan Lake (LSC3)

The area tributary to Ryan Lake (LSC3) includes portions of Robbinsdale, Brooklyn Center, and Minneapolis and covers a total of 280 acres. The Brooklyn Center plan studied 98 acres within the corporate limits of that city. This plan covers 100 acres of the basin including a 32 acre portion of Minneapolis on the eastern end of the lake. The 100-year peak runoff from the study area is 216 cfs and the volume is 30 ac-ft.

Table 16

Ryan Lake Basin Runoff (LSC3)

Sub-Basin Identifier	5-yr. Peak (cfs)	100-yr. Peak (cfs)	5-yr. Volume (AcFt)	100-yr. Volume (AcFt)
RL1	6	33	2	5
RL2	67	143	7	16
RL3	22	63	3	9
Totals:	86	216	12	30

3.3.2. Bassett Creek Watershed

The southeastern corner of the City lies within the Bassett Creek Watershed and includes the sub-watersheds BC6 and BC62 which are roughly bounded on the north by 36th Avenue, Grimes Avenue, and Oakdale Avenue. In addition, a much smaller area centered around the old high school drains to the southwest through Crystal and Golden Valley.

3.3.2.1. High School (BC73)

Approximately 70 acres in the northeast quadrant of 36th Avenue and T.H. 100 drain south into Crystal. The land use of this area is 60% single-family residential with the balance of the area in the former high school property.

The 100-yearpeak flow is 81 cfs. The runoff ponds in a low area east of Unity Avenue and discharges into storm sewer under 36th Avenue North.

3.3.2.2. Sunset Hill (BC62)

Located in the extreme southeast corner of Robbinsdale, BC62 is roughly bounded by France Avenue on the west, Lowry on the north, and Memorial Parkway to the east. The land use in this 200 acre basin is 80% single-family residential, 2% multi-family, 4% institutional, and 14% open space.

The predicted 100-year peak discharge of 248 cfs is outlet to lower Rice Lake in Golden Valley near the extension of 26th Avenue to the BN railroad. Significant street flooding occurs at the intersection of Parkview and York Avenues, and to a lesser extent at France and 26th. Manor Park near Lowry and Chowen experiences roughly 2 feet of inundation and significant ponding occurs along the east side of the railroad between 26th and 27th Avenues.

Table 17

Sunset Hill Basin Runoff (BC62)

Sub-Basin Identifier	5-yr. Peak (cfs)	100-yr. Peak (cfs)	5-yr. Volume (AcFt)	100-yr. Volume (AeFt)
BC62	109	248	22	54

3.3.2.3. Rice Lake (BC6)

The Rice Lake basin (BC6) is centered along the Burlington Northern Railroad tracks from 36th Avenue southerly to the city limits. The 260 acre watershed contains 191 acres (73%) of single-family residential 55 acres (21%) of open space and water. The remainder is multi-family residential. BC6 includes roughly 75 acres outside Robbinsdale in both Crystal and Golden Valley to the west.

The predicted peak flow to Grimes Pond (South Halifax Park) is 263 cfs. The ponded volume is estimated at 35 ac-ft with a maximum elevation of 837.0. An additional 28 ac-ft of ponding occurs in northern Rice Lake on the west side of the railroad in Walter Sochacki Park which is connected to Grimes Pond by a culvert under the railroad. A peak inflow of 146 cfs from the area to the northwest combines with flows from Grimes Pond to generate a peak lake elevation of 837.0. Northern Rice Lake outlets to the southern basin of Rice Lake via a 12-inch culvert under a pedestrian path in Sochacki Park.

Ponding occurs either side of the railroad tracks at the extension of 34th Avenue North. Ponding also occurs along the west side of June Avenue at the extensions of 33rd and Lowry Avenues.

Table 18

Rice Lake Basin Runoff (BC6)

Sub-Basin Identifier	5-yr. Peak (cfs)	100-yr. Peak (cfs)	5-yr. Volume (AcFt)	100-yr. Volume (AcFt)
Rice Lake	65	146	14	28
Grimes Pond	104	263	13	35

3.4. Water Quality

3.4.1. Water Quality Standards

Minnesota Rules Chapter 7050 (MRC 7050) describes the legal standards for the protection of the quality and purity of the waters of the State of Minnesota. The MRC 7050 classifies waters into seven different categories according to their quality and use. A summary of the categories is as follows:

1. Domestic Consumption
   - A. Drinking water quality without treatment
   - B. Drinking water with chlorination
   - C. Drinking water with treatment and chlorination

2. Fisheries and Recreation
   - A. High quality fisheries and recreation
   - B. Intermediate fisheries and recreation
   - C. Rough fish propagation and boating

3. Industrial Consumption, except food processing
   - A. Use without chemical treatment
   - B. General industrial purposes
   - C. Industrial cooling and materials transport

4. Agriculture and Wildlife
   - A. Irrigation quality
   - B. Livestock and wildlife drinking quality

5. Aesthetic Enjoyment and Navigation

6. Other Non-specific Uses

7. Limited Resource Value

The waters in Robbinsdale have been classified in the unlisted waters of Minnesota (MRC 7050.0430) as 2B, 3B, 4A, 4B, 5, and 6 (MPCA 1990).

In addition to the State standards, the Bassett Creek Watershed Management Commissions has adopted water quality standards ranking water bodies by the water quality required to support current and future uses.

T a b l e 1 9

Definition of Management Classifications According to Desired Uses

Category	Definition
Level I	Level I water bodies fully support all water-based recreational activities including swimming, scuba diving and snorkeling.
Level II	Level II water bodies are appropriate for all recreational uses except full body contact activities. Recreational activities for these water bodies include: sailboating, water skiing, motorboating, canoeing, wind surfing and jet skiing.
Level III	Level III water bodies will support fishing, aesthetic viewing activities and observing wildlife.
Level IV	Level IV water bodies are water resources generally intended for runoff management (i.e. storm water detention) and have no significant recreational use values.

Source: BCWMC Water Quality Standards, Part 1

3.4.2. Computer Modeling

The Minnesota Lake Eutrophication Analysis Procedure (MINLEAP) model was used to analyze the lakes in the City of Robbinsdale. MINLEAP is the model used by the MPCA as the first level of assessment when predicting eutrophication of lakes with a minimal amount of data. This model was designed to be used as a screening tool for estimating lake conditions and for identifying problem lakes.

The model is designed to predict eutrophication indicators based on observed and ecoregion averages. The most current water quality data are entered for average in-lake total phosphorus (TP), chlorophyll-a (CHL a) and Secchi depth (SD). Determination of the average annual precipitation, evaporation, runoff coefficients, atmospheric loadings and stream loading rates are developed by the computer model based on ecoregion averages assigned to the North Central Hardwood Forests (NCHF).

Data input to the computer model included watershed size, the average depth, the ecoregion and the averages of the three parameters of TP, CHL a and SD. STORET data was used to determine the summer averages (June to August) of the parameters for the three lakes. Crystal Lake's most recent data was from 1986, Twin Lake's South Bay and Twin Lake's Middle Bay was from 1985 and 1991, and Ryan Lake's was from 1980 except for CHL a which was from 1974.

3.4.2.1. Crystal Lake

Predictive values by MINLEAP are skewed for Crystal Lake because MINLEAP is based on an open drainage system and uses average stream loading rates of the NCHF. Crystal Lake is a closed basin lake and has no natural channels for inlets or outlets, thus, predicted concentrations of the parameters would theoretically be higher, nutrient loading values will be less and hydraulic residence time will be much longer. A summary of the MINLEAP results can be found on Table 20 and complete model results is located in Appendix F.

Modeling predicted a phosphorus retention coefficient for Crystal Lake of 69 percent (percentage of phosphorus the lake retains). Actually, the retention coefficient is for all practical purposes 100 percent since there is no lake outlet. Phosphorus loading (mass) was predicted at 104 kg/yr. based on an average inflow phosphorus concentration. The hydraulic residence time, the amount of time it takes to exchange all the water in the lake, was predicted to be 1.7 years. However, the residence time could be tens of years or longer since the only outward movement of lake water would be through evaporation or seepage.

The predicted phosphorus value was lower than the observed value (50 ug/1 and 262 μg/l, respectively). Predicted Secchi depth was close to measured average (1.20 and 1.34, respectively). Predicted chlorophyll-a was also less. The observed average chlorophyll-a concentration was of 53 1.1.g/1 and 19 vigil. In each case, the observed values are closer to what the predicted values should be, given the closed basin scenario. An inspection of the 1986 dissolved oxygen profiles indicate internal phosphorus loading is likely occurring and dissolved oxygen concentrations will not support a fishery below 15 ft most of the year.

3.4.2.2. Ryan Lake

Based on the few input values available, modeling predicted a phosphorus retention coefficient of 36 percent. Phosphorus loading was predicted at 449 kg/yr. The hydraulic residence time was predicted to be 0.15 years (58 days). Predicted phosphorus and Secchi values were, for all practical purposes, identical to observed values (phosphorus; 95 ps/1 and 111 [ig/1, respectively; Secchi; 0.70 and 0.76 meters, respectively).

Current chlorophyll-a data was not available, so historical (MDNR 1974) was used to run MINLEAP. Predicted chlorophyll-a (51 i,ig/1) was substantially different from the observed 1.9 pg/l. Ryan Lake's chlorophyll-a may average much higher than the observed value. MINLEAP predicts the frequency chlorophyll-a concentrations greater than 30 mato be more than 70 percent of the summer. Chlorophyll-a concentrations in the 20 pg/lto 30 μg/1 range are indicative of excessive algae. Concentrations of more than 30 1.1g/1 are excessive and include severe algal blooms.

3.4.2.3. Twin Lake South Bay

Twin Lakes south bay had a predicted phosphorus retention coefficient of 32 percent. Phosphorus loading was predicted at 434 kg/yr. The hydraulic residence time was predicted to be 0.10 years (37 days).

The predicted phosphorus value was higher than the observed value (101 ug/I and 85 p.g/1, respectively). Predicted Secchi depth was slightly less than the observed average (0.72 and 0.75, respectively). The predicted chlorophyll -*a* concentration (56 ps/1) was slightly less than the observed average of 63 Algal problems are predicted for the south bay of Twin Lake more than 76 percent of the summer. Severe algal blooms are predicted almost 40 percent of the summer.

3.4.2.4. Twin Lake Middle Bay

Twin Lakes middle bay had a predicted phosphorus retention coefficient of 54 percent. Phosphorus loading was predicted at 363 kg/yr. The hydraulic residence time was predicted to be 0.55 years.

The predicted phosphorus value was near the observed value average (70 ug/1 and 68 mil, respectively). Predicted water transparency was also close to the observed average (1.0 and 0.92, respectively). Predicted chlorophyll-a concentration (32 pg/1) was less than the observed average of 541.1g/1.

3.4.2.5. North Rice Lake and Grimes Pond

No MINLEAP modeling was performed for these two water bodies. Both bodies are categorized as Level III resources by the BCWMC with very limited direct contact. Robbinsdale will cooperate with implementation of the Lake Management Plan prepared by the Commission.

Table 20

M I N L E A P
Predicted Values

Water Body	Residence Time (Years)	Average Inflow TP (ug/1)	Lake Outflow (hm3/yr.)	TP Load (kg/yr.)	Phosphorus Retention Coefficient
Crystal Lake	1.7	160	.65	104	.69
Ryan Lake	.15	149	3.0	449	.36
Twin Lake South Bay	.10	149	2.9	434	.32
Twin Lake Middle Bay	.55	150	2.4	363	.54

Section 4
CONVEYANCE SYSTEMS

4.1. Streams

Ryan Creek is the only stream within Robbinsdale city limits. Very little data, streamflow or water quality, is available for Ryan Creek. Ryan Creek connects Twin Lake and Ryan Lake and then continues to flow into Shingle Creek. Peak outflow at Twin Lakes outlet is predicted as 100 cubic feet per second for the 100-year event. (Montgomery 1990). In 1990, there was little or no stream flow and the creek was frequently dry (Montgomery 1991).

4.2. Floodplains

The Federal Emergency Management Agency prepared a *Flood Insurance Study* for Robbinsdale in 1977. This study determined the 100-year and 500-year flood elevations on water bodies and water courses within the city based upon the current land use. The 100-year floodplain delineated in the 1977 study is the basis for the national Flood Insurance Program. Figure 11 depicts the FEMA 100-year floodplains.

The Shingle Creek Watershed Management Plan includes an independent determination of the 100-year flood elevations for Twin Lake and Ryan Lake. This evaluation is based upon full development of the upper watershed and is considered more appropriate for planning purposes for these two lakes. Both Twin and Ryan Lakes have experienced recurrent recent problems with high water. The SCWMC floodplain was delineated using the mapping prepared for this plan to distinguish differences with the FEMA mapping embodied in the City's floodplain ordinance. As shown on Figure 11, there are significant discrepancies that need to be resolved by the Commission. A tabulation of low-lying structures around each lake is included in Appendix B.

The City has a floodplain ordinance in effect which complies with the Minnesota Flood Plain Management Act of 1969. This ordinance regulates the type and extent of development that may occur in the FEMA designated floodplains. A copy of the existing ordinance is included in Appendix I.

Table 21

Comparison of 100-year HWL

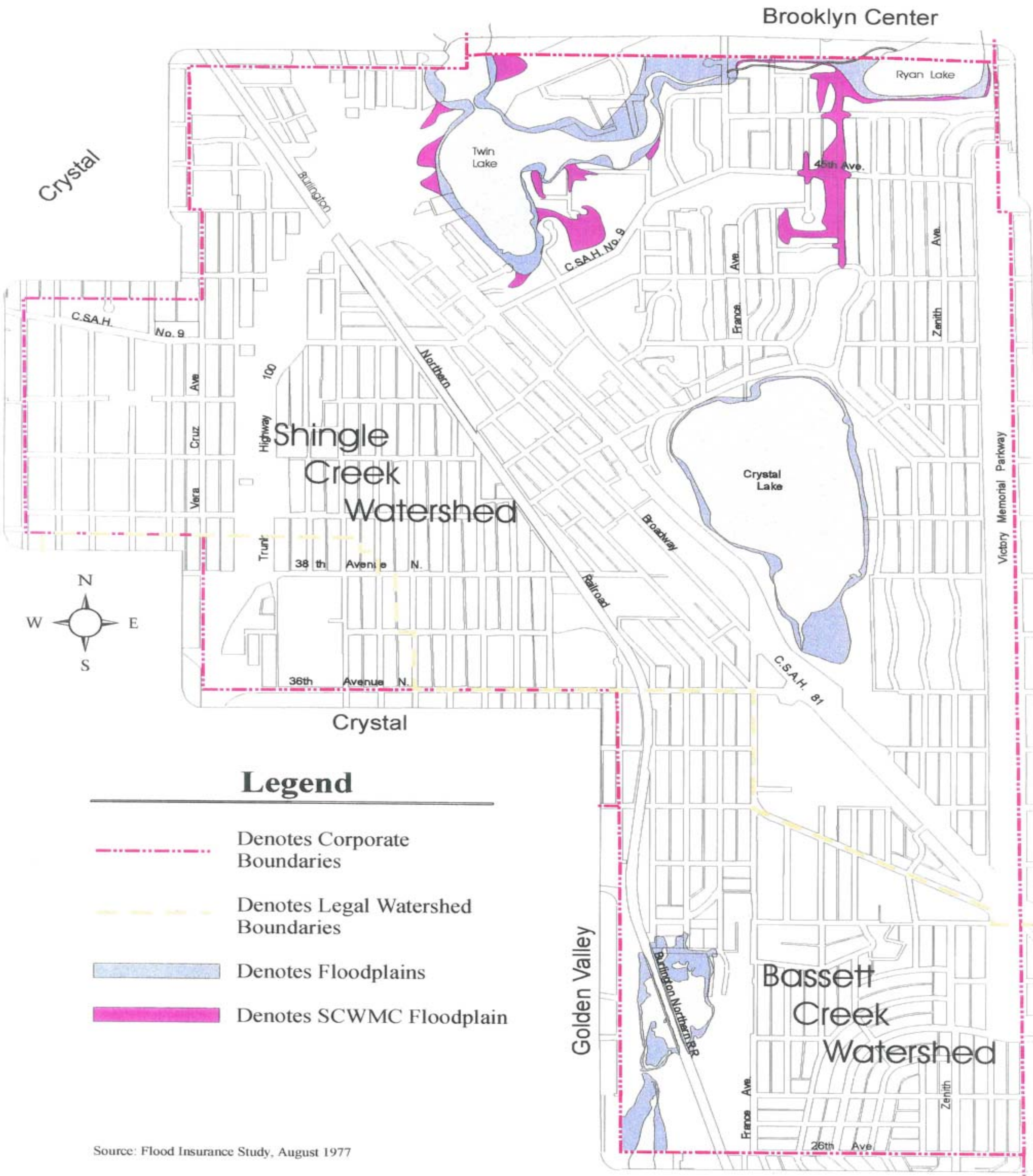
	Twin Lake	Ryan Lake	Crystal Lake	N. Rice Lake	Grimes Pond
FEMA	856	856	855.0	837.6	837.6
WMO	856.1	856.1	855.0	838.0	838.0
Local Plan(1)	856.2	856.2	854.7	837.0	837.0

1) The Local Plan HWL is based upon the 100-yr, 24-hr event. The FEMA and WMO elevation are based upon wider study and include other runoff events such as a 30-day snow melt.

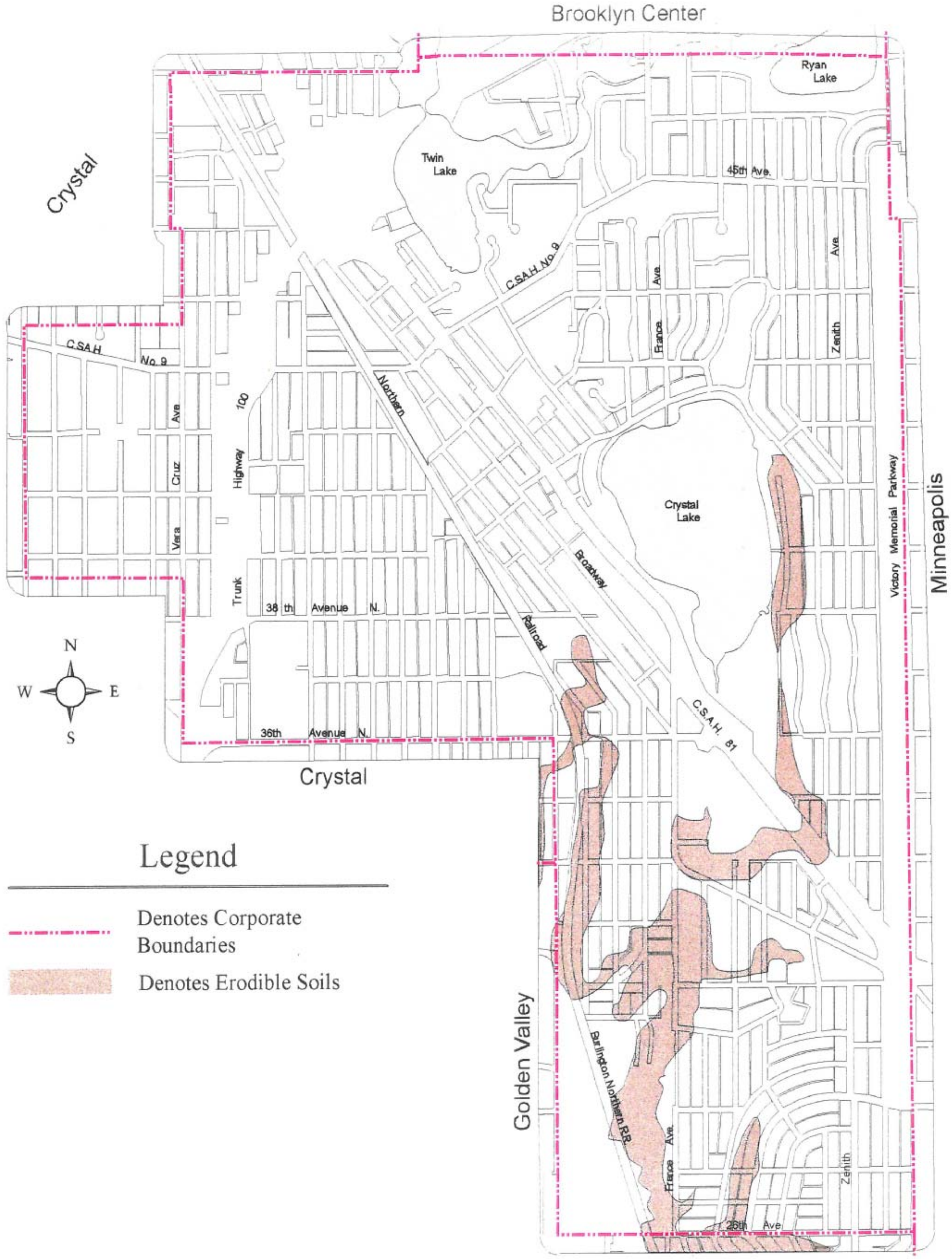
4.3. Erosion & Sedimentation

Erosion from construction sites is the most prevalent source of sediment in an urbanized area. The fact that Robbinsdale is fully developed, limits the risks of this source of erosion to redevelopment and street reconstruction. Other at-risk areas for erosion are denuded or poorly maintained slopes. This is especially true if the dominate soil type is composed of fine, granular material. Figure 12 illustrates areas of the Robbinsdale with the potential for severe erosion.

Additionally, winter sanding and salting operations result in sediment discharges to the City's water bodies with each spring snow melt. While all public streets are cleaned on an annual basis to remove this debris, some studies have indicated that increased frequency of street cleaning can reduce the sediment loading from these sources. Other potential BMPs include construction of sedimentation structures and siltation basins. Further discussion of specific implementation is included in Section 6.



City of Robbinsdale Water Management Plan	Floodplains	11 Figure



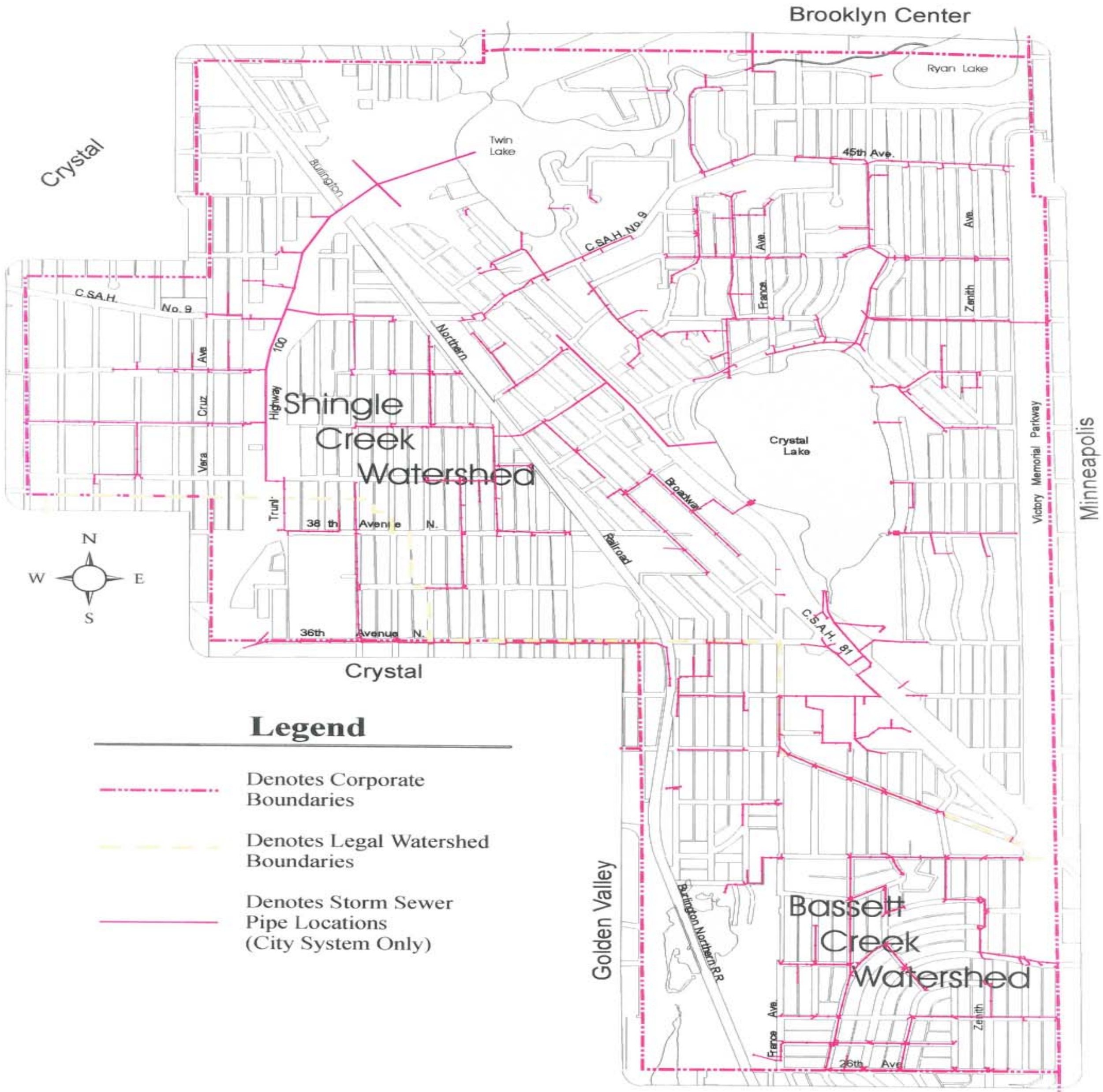
City of Robbinsdale Water Management Plan	Erodible Soils	12 Figure

Storm Sewers

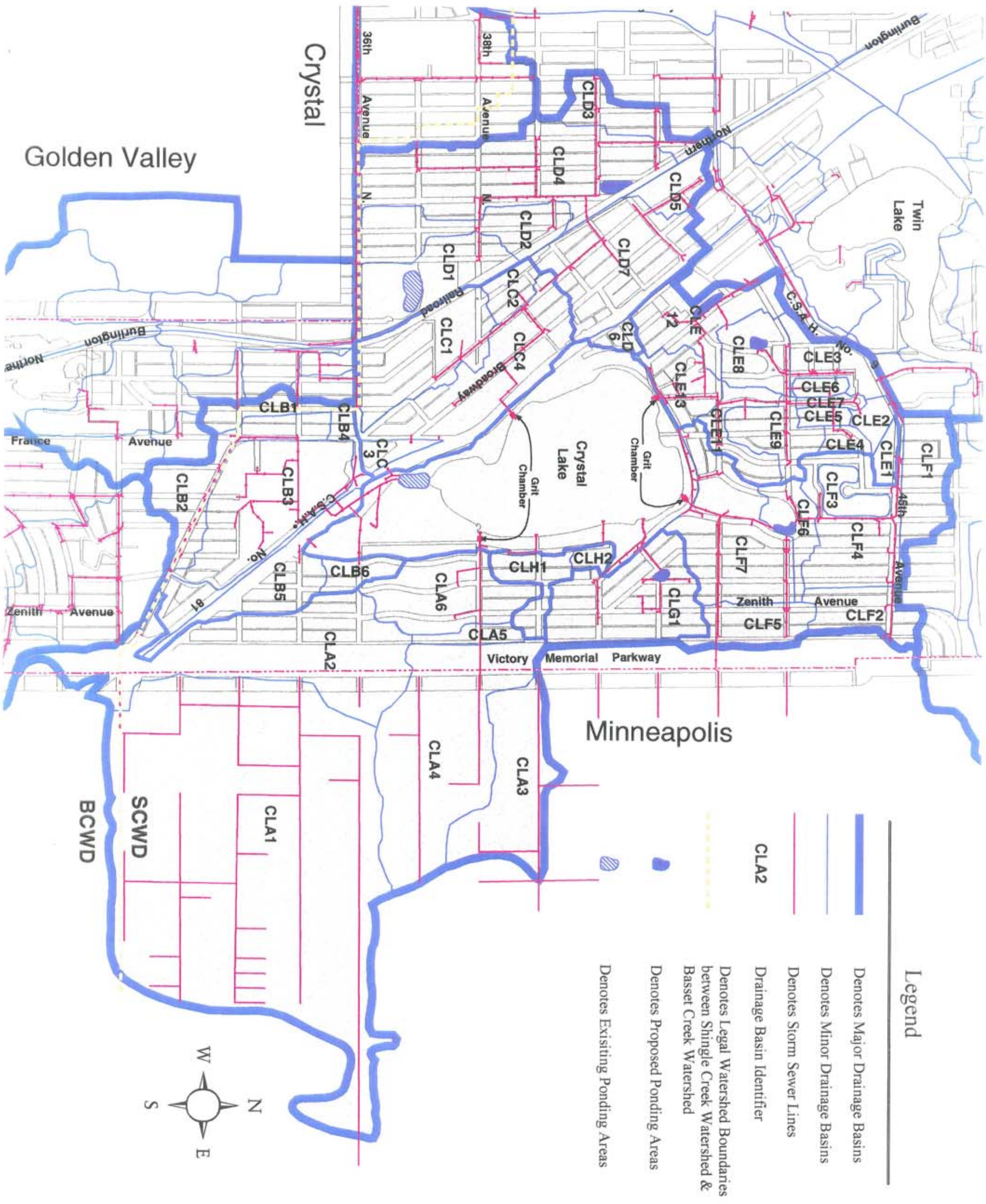
The storm sewer network plays a crucial role in conveying runoff, particularly in smaller rainfalls. Most urban storm sewers are designed to accommodate a 5 or 10-year recurrence rainfall. In larger storms water ponds in various low areas and flows overland along streets and back yard swales. Robbinsdale has experienced recurrent nuisance flooding associated with storm sewer capacity problems. For this reason, the 5-year rainfall event was also modeled to provide a cursory evaluation of trunk storm sewer capacity in each major sewer district.

The estimated flow from each sub-area was compared to the estimated capacity of the principal storm sewer element serving that area. Because of incomplete records and the broad nature of this study, this evaluation is not intended as a rigorous technical evaluation of the true capacity of each line but as an indicator of potential problem areas requiring further investigation. Figure 13 depicts the storm sewer system.

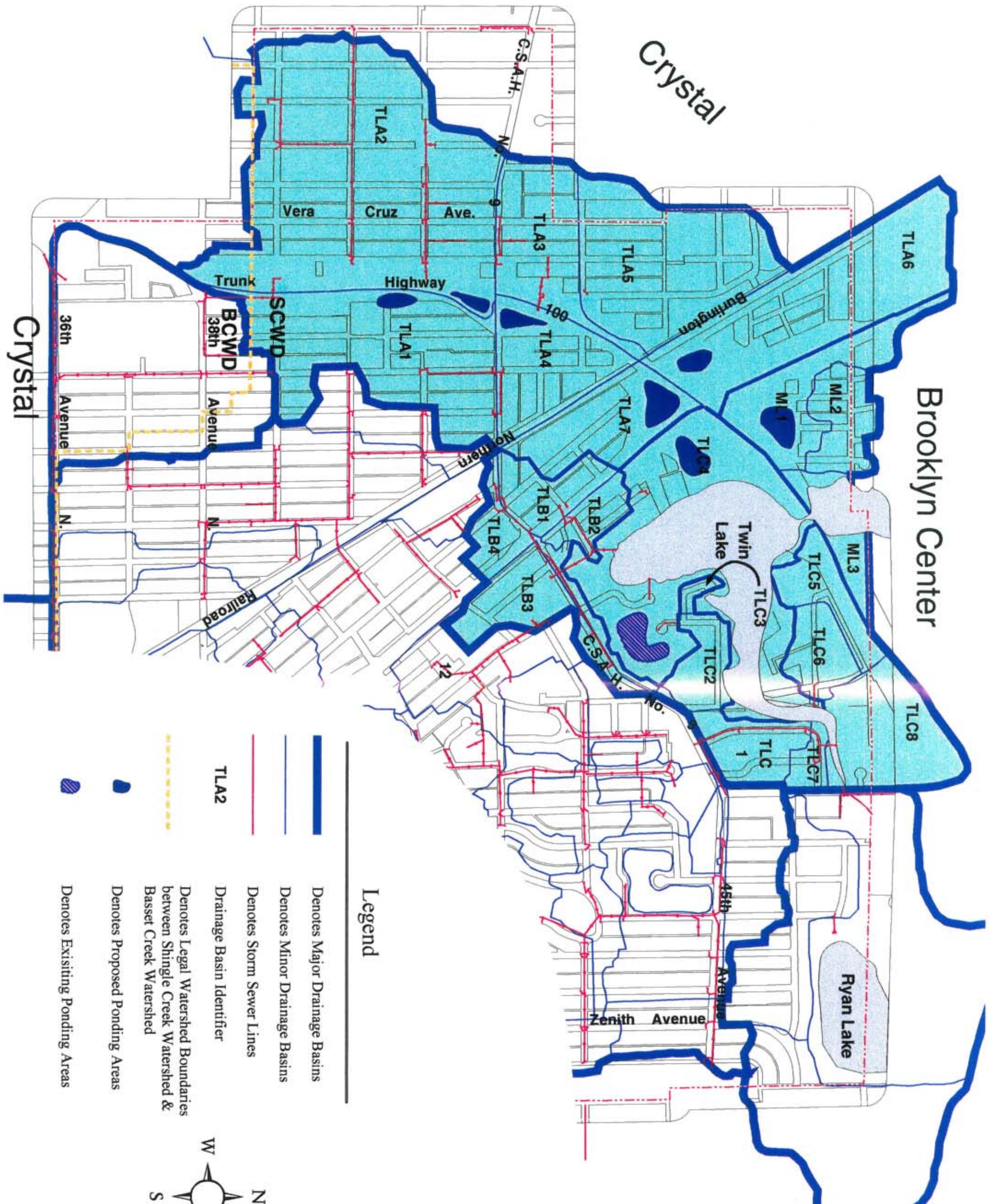
The following pages discuss specific results of the 5-yr modeling effort for each basin.



City of Robbinsdale Water Management Plan	Storm Sewer System	13 Figure



City of Robbinsdale Water Management Plan	Crystal Lake Basin (LSC2)	14 Figure



City of Robbinsdale Water Management Plan	Twin Lake Basin (TL1)	**15** Figure

4.4.1. Crystal Lake (LSC 2)

The Crystal Lake basin is drained by eight major trunk storm sewers within Robbinsdale plus a major trunk storm drain from western Minneapolis. Figure 14 provides a more detailed delineation of the Crystal Lake sub-areas and the storm sewer serving this basin. Each of these trunk lines is discussed below:

4.4.1.1. Minneapolis (CLA)

This district consists of 461 acres southeast of Crystal Lake. Approximately 360 acres are in Minneapolis. This area drains through a network of piping in Minneapolis which combines at the intersection of Dowling and Xerxes and outlets to Crystal Lake via a 66-inch pipe. Sub areas CLA1 and CLA2 have a total combined flow of 110 cfs. The outlet piping under Xerxes in this area is a 48-inch pipe with a capacity 150 cfs. At the intersection of Xerxes and Dowling, sub-areas CLA 1-5 combine for a total 5-year peak flow of 155 cfs and the 66-inch outlet has a capacity of nearly 300 cfs. This sewer was constructed and is maintained by the Minneapolis Sewer Department.

4.4.1.2. Terrace Mall (CLB)

This district covers 125 acres running southeast from the intersection of 36th Avenue and C.R. 81 to North Memorial Hospital. Sub-areas CLB 1 and 2 have a 5-year discharge of 40 cfs. The 24-inch pipe in France Avenue has an estimated capacity of 30 cfs. Under the 5-year Storm, a portion of CLB 1 drains to the west into the Bassett Creek watershed via storm drains in 35th and 34th Avenues. CLB 3 generates a peak flow of 90 cfs and discharges into 42-inch pipe with a capacity of 55 cfs. Minor local flooding occurs in the frontage road along C.R. 81 until ponding overtops the intersection of 36th Avenue and C.R. 81.

4.4.1.3. West Broadway (CLC)

This drainage district encompasses 88 acres bounded by 36th Avenue, C.R. 81, the BN railroad tracks and 39-1/2 Avenue. The land use is 63% (55 acres) single-family residential, 9% (8 acres) multi-family, and 25% (22 acres) commercial, with roughly 3% open or vacant land. The principal outlet for this area is a 36-inch storm sewer under C.R. 81 at the approximate extension of 38th Avenue North. The predicted peak flow from the 5-year event is 48 cfs. The storm sewer capacity is estimated as roughly 35 cfs.

Local flooding is predicted in the alley between Hubbard and Halifax Avenues south of 39-1/2 Avenue, and in the apartments south of 38th Avenue along Hubbard.

4.1.4. Downtown (CLD)

This area stretches from 36th Avenue to 41st Avenue and from Perry Avenue to C.R. 81. The total area is 172 acres with 127 acres (74%) in single-family development and 14 acres (8%) as multi-family use. 27 acres (16%) of the land use in this district is commercial/industrial with slightly under 5 acres of open space. The predicted 5-year peak runoff is 117 cfs. The principal outlet is a 36-inch trunk storm sewer under C.R. 81 which outlets into Crystal Lake near the end of Lake Curve. The estimated capacity of the trunk sewer is approximately 60 cfs. Roughly three quarters of the drainage area lies southwest of the BN Railroad which outlets via a 24-inch line under the railroad. The capacity of this line is estimated as 38 cfs while the estimated 5-year peak flow is 54 cfs. The city maintains a detention pond in Lee Park which has a 5-year capacity of approximately 3 ac-ft and a 100-year capacity of approximately 7 ac-ft. Local inundation occurs in the area of Triangle Park at the intersection of 40th and Noble and in the street low at 39-1/2 and Major.

4.4.1.5. Grimes Avenue (CLE)

The northwestern portion of the Crystal Lake basin drains through a trunk sewer that has two major branches; one runs to the north along Grimes Avenue and the second runs to the west along Lake Road. The combined trunk drainage area is 99 acres. Slightly more than 83 acres (84%) of the area is single-family residential, 9 acres (9%) is multi-family and 7 acres (7%) is commercial.

The 5-year peak flow is 44 cfs. The 54-inch trunk has a theoretical capacity of 125 cfs based upon record plans. However, the storm sewer (built in 1965) was based upon a lake elevation of 845+. The DNR has adopted an Ordinary Water Level for Crystal Lake of 847.5 that controls the maximum draw-down for the outlet pump. The increased lake level will result in decreased capacity in this trunk. A rough estimate of the present capacity is 85 cfs although a detailed evaluation of the trunk is beyond the scope of this study. The Grimes Avenue branch of the trunk sewer has a capacity of approximately 60 cfs, and the Lake Road branch has a capacity of 25 cfs. Although the pipe capacity is adequate in the trunk, some minor local flooding does occur in the backyard and alley lows along Grimes Avenue. Much of this neighborhood is constructed upon former wetlands that stretched from Crystal Lake northward to Twin Lake. In 1993, the City constructed a storm water lift station to relieve flooding in the alley east of Grimes between 42nd and 43rd Avenues.

4.4.1.6. Chowen Avenue (CLF)

The trunk sewer in Chowen Avenue drains 124 acres stretching from C.R. 9 on the north to York

Avenue to the east. The land use is almost completely single-family (90%) with 9 acres (7%) in park land and the remaining 3% evenly divided between multi-family and commercial/institutional uses. The estimated 5-year peak flow is 55 cfs. The trunk storm sewer capacity is approximately 85 cfs based upon the record drawings. This trunk sewer was designed and installed in the same time frame as the trunk at Grimes Avenue and has experienced the same diminution of capacity from increased lake levels. The current pipe capacity is estimated as roughly 50 cfs. Minor inundation may occur in the backyards around the cul-de-sac of Drew Avenue south of C.R. 9.

4.4.1.7. Shoreline Drive (CLG)

This district which comprises some 35 acres is composed entirely of single-family residential land use. The estimated 5-year peak discharge is 12 cfs. In the past, this area had experience recurrent nuisance flooding because much of the basin lacked any storm sewer. In 1992, the City installed new storm sewer along Shoreline Drive from 41st to Zenith. The outlet to Crystal Lake was also reconstructed and the new piping has a capacity of 60 cfs from the street low at 41st and Shoreline to prevent damage to adjoining property.

4.4.1.8. Crystal Lake Boulevard (CLH)

This 13 acre district along the eastern shore of Crystal Lake is comprised totally of single-family residences. The peak 5-year runoff is 19 cfs which outlet through two 12-inch storm sewers: one at 39th Avenue and another at the cul-de-sac at the end of Crystal Lake Boulevard. The two outlets have a combed capacity of 13 cfs.

4.4.2. Twin Lake (TL 1)

The portion of TL 1 within Robbinsdale spans nearly 500 acres over the northwest quadrant of the City. The basin is bounded on the east by France Avenue, C.R. 9, and Quail Avenue; and on the south by 39th Avenue. Figure 15 depicts the Twin Lake basin and associated storm sewer.

4.4.2.1. T.H. 100 (TLA)

The capacity of the Highway 100 trunk is estimated as 45-50 cfs. The predicted 5-year peak runoff from the 320 acres is 63 cfs. This capacity deficit leads to local flooding in several locations, principally north of C.R. 9 where runoff collects in low areas on either side of the highway.

4.4.2.2. C.R. 9 (TLB)

This basin consists of 44 acres centered along C.R. 9 (Lake Drive) from the Burlington Northern Railroad to Indiana Avenue. The land use is 25 acres (58%) single-family, 2 acres (5%) multi-family, 13 acres (30%) commercial, and 4 acres (9%) open space. The area drains through storm sewers at C.R. 9 and 42-1/2 Avenue which combine in a 58-inch arch metal pipe that outlets to Twin Lake near the cul-de-sac of 42-1/2 Avenue. The capacity of the outlet is approximately 70 cfs while the predicted 5-year peak flow is 73 cfs.

4.4.2.3. Twin Lake Shoreline (TLC)

This 136 acre basin includes Twin Lake and the shorelands directly tributary to the lake bounded by C.R. 81, T.H. 100, C.R. 9, and France Avenue. Most of the shoreline sub-basins have minimal storm sewer with the exception of TLC 1 and TLC 7. The combined area of these two sub-basins is 16 acres which is 88% single-family residential and 10% multi-family. The total predicted 5-year peak runoff is 14 cfs while the capacity of the 36-inch outlet pipe into Ryan Creek is 22 cfs.

4.4.2.4. Middle Twin Lake (ML)

North of T.H. 100 and east of C.R. 81 lies a 38 acre triangle of Robbinsdale directly tributary to Middle Twin Lake. The land use is 61% (23 acres) single-family residential with the balance of the area being open space and lake surface. The area lacks storm sewer and has a 5-year peak runoff of 26 cfs.

4.4.3. Ryan Lake

The Ryan Lake basin is situated in the extreme northeast corner of the City. The area directly tributary to Ryan Lake includes portions of Robbinsdale, Brooklyn Center, and Minneapolis. Winthin Robbinsdale 63 acres lying east of France Avenue and north of C.R. 9 drains to the lake. The land use is 75% single-family with the balance in open space and lake surface. There is a minimal storm sewer in this district with a 12-inch pipe draining the alley adjacent to France Avenue and a flume at the north end of Chowen. The predicted 5-year peak flow from the two sub-areas within Robbinsdale is 15 cfs.

4.4.2.1. T.H. 100 (TLA)

This 320 acre district lies on both sides of highway 100 south of C.R. 81 to 39th Avenue. The land use is 82% (263 acres) single-family residential, 6% (18 acres) multi-family, 9 % open space and parks, and 3% commercial. The entire drainage system is collected via storm sewers which outlet through a major Mn/DOT trunk sewer in T.H. 100. The capacity of the Highway 100 trunk is estimated as 45-50 cfs. The predicted 5-year peak runoff from the 320 acres is 63 cfs. This capacity deficit leads to local flooding in several locations, principally north of C.R. 9 where runoff collects in low areas on either side of the highway.

4.4.2.2. C.R. 9 (TLB)

This basin consists of 44 acres centered along C.R. 9 (Lake Drive) from the Burlington Northern Railroad to Indiana Avenue. The land use is 25 acres (58%) single-family, 2 acres (5%) multi-family, 13 acres (30%) commercial, and 4 acres (9%) open space. The area drains through storm sewers in C.R. 9 and 42-1/2 which combine in a 58 inch arch metal pipe that outlets to Twin Lake near the cul-de-sac of 42-1/2 Avenue. The capacity of the outlet is approximately 70 cfs while the predicted 5-year peak flow is 73 cfs.

4.4.2.3. Twin Lake Shoreline (TLC)

This 136 acre basin includes Twin Lake and the shorelands directly tributary to the lake bounded by C.R. 81, T.H. 100, C.R. 9, and France Avenue. Most of the shoreline sub-basins have minimal storm sewer with the exception of TLC 1 and TLC 7. The combined area of these two sub-basins is 16 acres which is 88% single-family residential and 10% multi-family. The total predicted 5-year peak runoff is 14 cfs while the capacity of the 36-inch outlet pipe into Ryan Creek is 22 cfs.

4.4.2.4. Middle Twin Lake (ML) North of T.H. 100 and east of C.R. 81 lies a 38 acre triangle of Robbinsdale directly tributary to Middle Twin Lake. The land use is 61% (23 acres) single-family residential with the balance of the area being open space and lake surface. The area lacks storm sewer and has a 5-year peak runoff of 26 cfs.

4.4.3. Ryan Lake

The Ryan Lake basin is situated in the extreme northeast corner of the City. The area directly tributary to Ryan Lake includes portions of Robbinsdale, Brooklyn Center, and Minneapolis. Within Robbinsdale 63 acres lying east of France Avenue and north of C.R. 9 drains to the lake. The land use is 75% single-family with the balance in open space and lake surface. There is minimal storm sewer in this district with a 12-inch pipe draining the alley adjacent to France Avenue and a flume at the north end of Chowen. The predicted 5-year peak flow from the two sub-areas within Robbinsdale is 15 cfs.

4.4.4. Rice Lake (BC6)

The southeast corner of Robbinsdale lies in the Bassett Creek watershed and drains into Bassett Creek through a connected series of ponds/wetland collectively referred to as the Rice Lake sub-basin. Figure 16 illustrates this basin.

4.4.4.1. Grimes Pond

This sub-area is bounded by the BN Railroad 36th Avenue, Grimes Avenue and France Avenue. The 99 acre basin drains into Grimes Pond in South Halifax Park which in turn outlet to the west side of the railroad via a 12-inch culvert. The land use is 70% (70 acres) single-family residential, 12% multi-family, and 18% (18 acres) open space and wetland. The predicted 5-year runoff from the basin is 105 cfs. The estimated discharge from the culvert under the railroad is 5 cfs which results in a 5-year pond volume of 7 ac-ft.

Storm sewers are scattered throughout the area with the portion of the basin north of 33rd Avenue draining through four storm sewers to an open ditch along the east side of the railroad where water ponds next to the extension of 34th Avenue. Some capacity problems exist in sub-area BC6H. The storm sewer that drains the intersection of France and 33rd Avenues outlets into the street at Halglo Place; this in turn combines to form roughly 50 cfs of peak flow to the bottom of the slope at 31-1/2 and Halifax.

4.4.4.2. North Rice Lake
West of the Burlington Northern Railroad lies a drainage area of 120 acres tributary to the northern bay of Rice Lake in Walter Sochacki Park. This area includes portions of Robbinsdale, Crystal and Golden Valley. Only roughly 30 acres lies within Robbinsdale, all of which is open space and wetland, with the remaining 90 acres composed of residential areas in the neighboring communities.

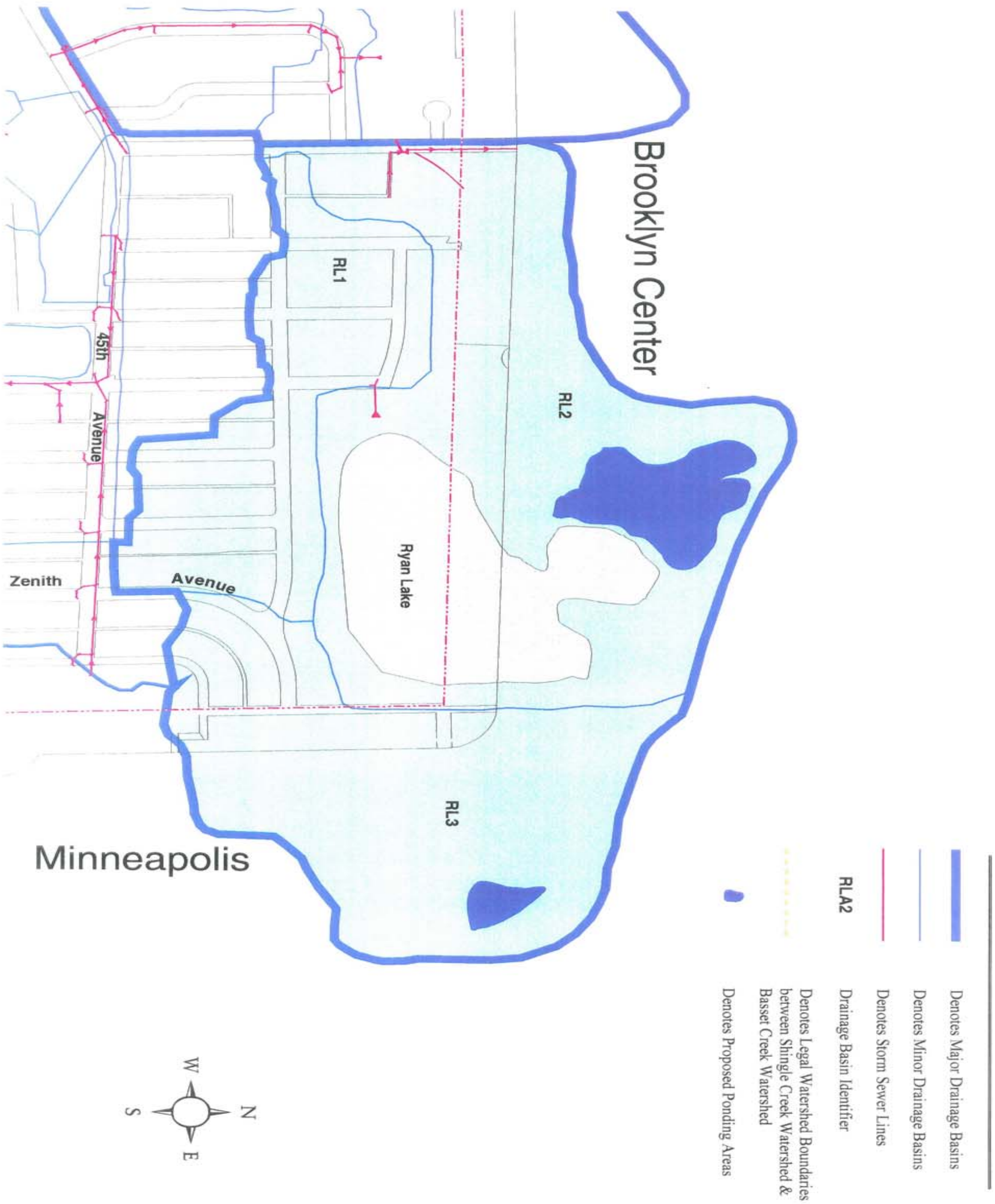
The only storm sewer in this area that is within Robbinsdale's jurisdiction is the outlet of the 36th Avenue storm drain along the railroad.

4.4.5. Sunset Hill (BC62)

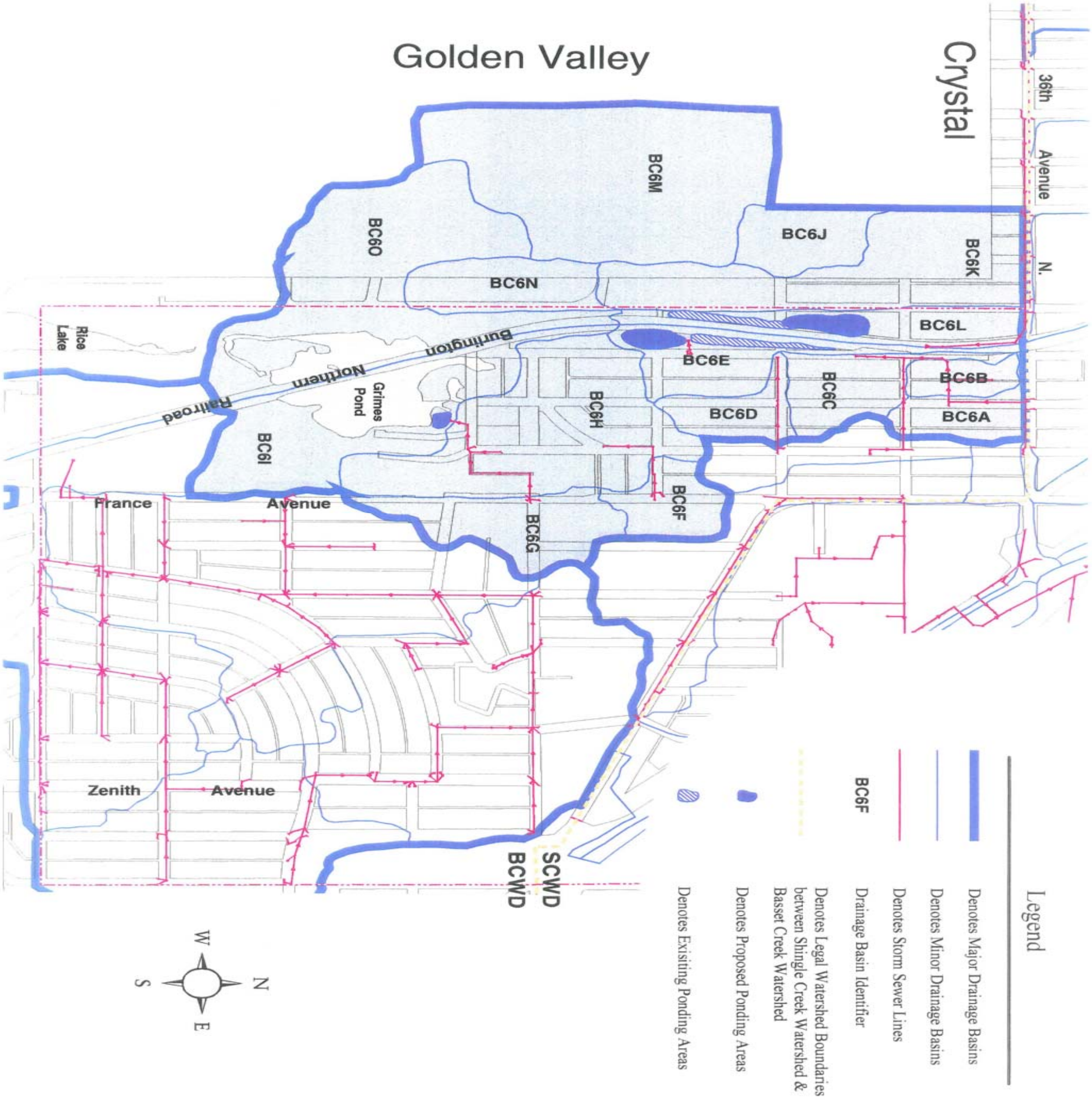
This 201 acre drainage area covers the extreme southeastern corner of Robbinsdale. The land use includes 162 acres (81%) single-family residential, 5 acres (2.5%) multi-family, 7 acres (4%) institutional, and the remaining 27 acres in open space. The entire basin is collected through a system of storm drains which combine in a 36-inch trunk at McNair Drive. The trunk sewer outlets on the east side of the railroad at 261/2 Avenue.

The peak 5-year flow is 109 cfs with an existing pipe capacity of 90 cfs at the outlet under France Avenue. Minor flooding occurs in the upper portions of the basin in the area of the intersection of Parkview and York and in Manor Park.

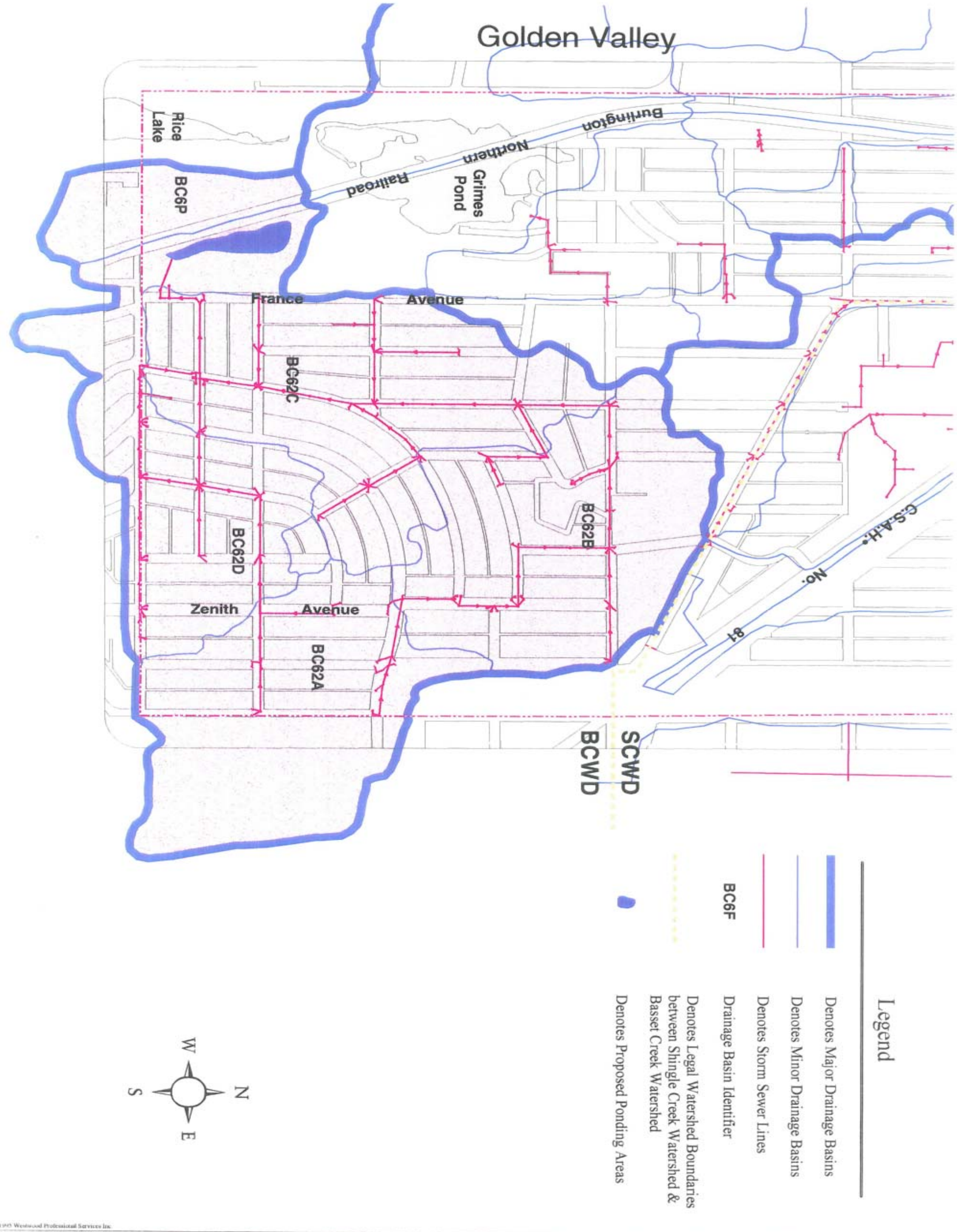
4.4.6. High School (BC73)
This basin has a drainage area of 65 acres consisting of 40 acres of single family residential (61%), 16 acres of public open space (25%), 5 acres of multi-family (8%) and 4 acres of highway. Located in the southwest corner of the city, this area drains to Bassett Creek by a series of storm sewer and open channels running south from 35th Avenue through Crystal and Golden Valley. The 5-year flow is predicted as 29 cfs and the 100-year flow as 81 cfs.



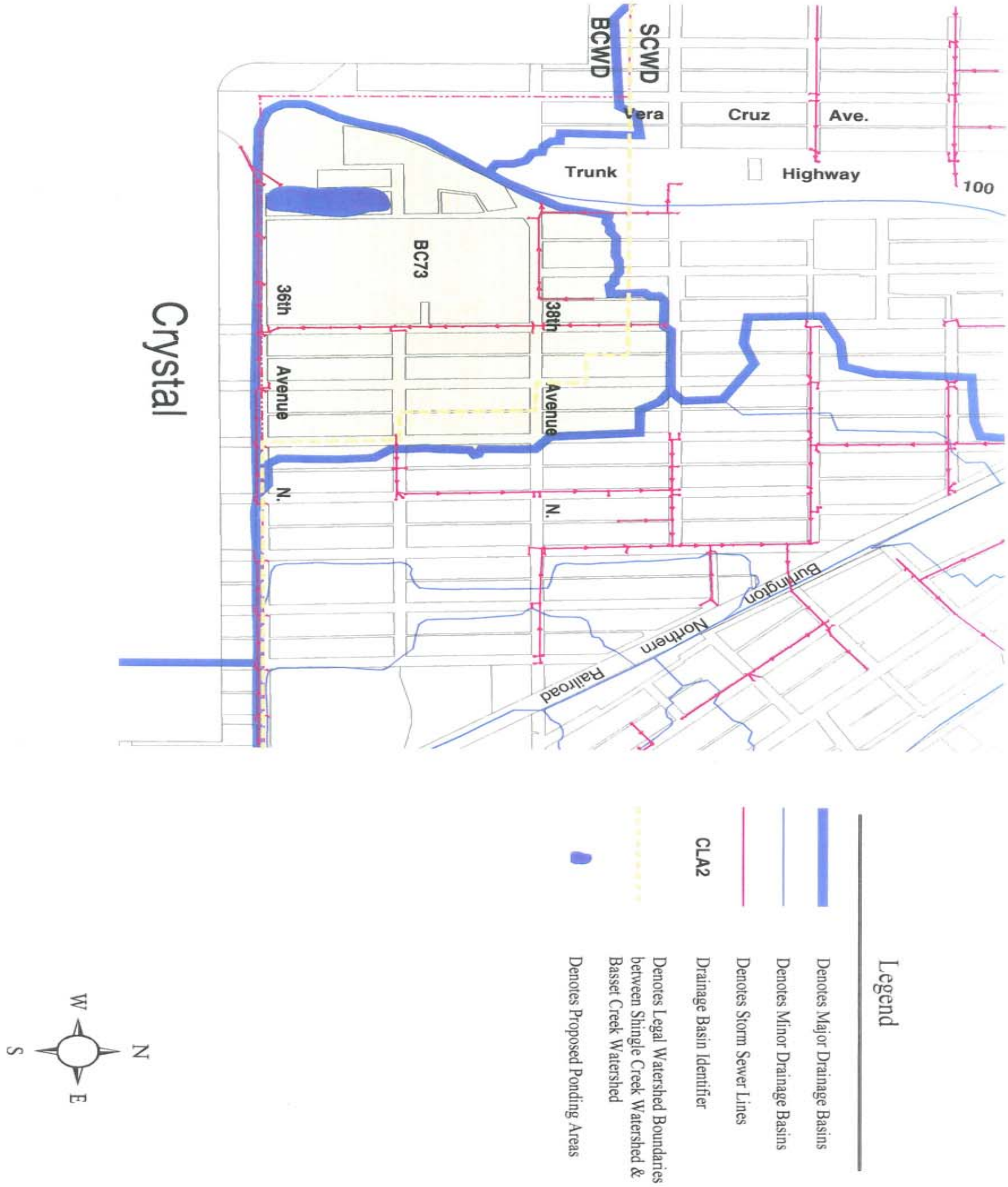
City of Robbinsdale Water Management Plan	Ryan Lake Basin (LSC3)	**16** Figure



City of Robbinsdale Water Management Plan	Rice Lake Basin (BC6)	17 Figure



City of Robbinsdale Water Management Plan	Sunset Hill Basin (BC62)	**18** Figure



City of Robbinsdale Water Management Plan	High School Basin (BC73)	19 Figure

Section 5

OBJECTIVES AND POLICIES

This section identifies the goals, objectives and policies adopted by the City of Robbinsdale for the management of its water resources. A goal is a broad based desired outcome that is derived from legal requirements or specific local concerns. An objective is a specific, quantifiable step in achieving the stated goal, and a policy is a defined rule, standard, or criteria that can be enforced or acted upon to meet the stated objective.

The Goals, Objectives, and Policies outlined in this section are intended to further the implementation of State, Federal and local regulations. The goals augment the management strategies of the Shingle Creek Watershed Management Commission, The Bassett Creek Water Management Commission, and the Board of Water and Soil Resources. The following goals are not listed in a defined priority or ranking.

5.1. Goal 1

Manage storm water runoff to control excessive volumes and discharge rates while minimizing public expenditure.

5.1.1. Objective 1.1

Quantify runoff volumes and rates under existing and future land use conditions consistent with WMO criteria.

5.1.1.1. Policy 1.1.1

Prepare a hydrologic model of the entire City that evaluates the 5-year and 100-year, 24 hour runoff under existing conditions. The results of this model shall be submitted to the WMOs for review and approval as part of the local plan.

5.1.1.2. Policy 1.1.2

Periodically update the hydrologic model to incorporate land use changes from redevelopment and conveyance system modifications.

5.1.1.3. Policy 1.1.3

Evaluate development proposals for consistency with the runoff rates and volumes identified in this plan.

5.1.2. Objective 1.2

Correct the existing storm water conveyance system of existing or anticipated deficiencies to meet the WMO requirements.

5.1.2.1. Policy 1.2.1

Implement the use of municipal storm water storage facilities wherever possible to limit the 100-year discharge to that allowed by the WMO.

5.1.2.2. Policy 1.2.2

Require all new developments and redevelopments to implement rate control to limit the peak discharge from all recurrence rainfalls to that of the existing land use. This shall be documented by submission of a Runoff Water Quality Management Plan prepared in conformance with BCWMC standards. Specifics are included in Appendix IIIA.

5.1.3. Objective 1.3

Minimize the public expense for construction and operation of storm water facilities.

5.1.3.1. Policy 1.3.1

Evaluate BMPs on the basis of life cycle costs to minimize the total public contribution.

5.1.3.2. Policy 1.3.2

Develop multiple use facilities to provide secondary benefit to the community.

5.1.3.3. Policy 1.3.3

Promote public-private partnerships to coordinate water management improvements, policy and program implementation.

5.2. Goal 2

Protect the residents of Robbinsdale and downstream portions of the watershed from loss of life and property by flooding.

5.2.1. Objective 2.1

Manage areas of the City within the defined 100-year flood hazard zones as defined by the Federal Emergency Management Agency.

5.2.1.1. Policy 2.1.1

Identify structures lying within the 100-year floodplain. Work with existing property owners to minimize damage by flood-proofing, emergency action plans or other appropriate measures.

5.2.1.2. Policy 2.1.2

Prohibit encroachment within the floodplain without full mitigation of lost storage capacity.

5.2.1.3. Policy 2.1.3

Evaluate opportunities to regain lost floodplain areas through public acquisition.

5.2.2. Objective 2.2

Minimize areas of the City subject to frequent inundation or minor recurrent flooding.

5.2.2.1. Policy 2.2.1

Evaluate the existing storm sewer using a 5-year rainfall of critical duration to determine system deficiencies. The evaluation performed for the local plan shall be used as the basis for determining areas of critical concern.

5.2.2.2. Policy 2.2.2

Establish the 5-year rainfall event as the minimum criteria for all new or upgraded storm sewer laterals. Establish the 10-year rainfall event as the minimum criteria for all new or upgraded storm sewer trunks.

5.3. Goal 3

Improve surface water quality to protect and enhance fish and wildlife habitat while providing water recreation opportunities.

5.3.1. Objective 3.1

Identify areas of water quality concerns, the existing conditions of existing water bodies, and sources of surface water contamination.

5.3.1.1. Policy 3.1.1

Establish a water quality monitoring program for identifying existing conditions and predicting future problems.

5.3.1.2. Policy 3.1.2

Develop specific water quality criteria for each water body consistent with the identified functions.

5.3.2. Objective 3.2

Promote storm water runoff control and treatment to reduce nutrient and sediment loadings.

5.3.2.1. Policy 3.2.1

Establish a program of public education to reduce discharge of substances that contribute to the degradation of surface water runoff.

5.3.2.2. Policy 3.2.2.

Establish a goal for pollutant removal efficiency equal to or greater than those obtained by implementing the criteria set forth by the Nationwide Urban Runoff Program (NURP) and *"Protecting Water Quality in Urban Areas"* (MPCA, 1989).

5.3.3. Objective 3.3

Control erosion and sedimentation.

5.3.3.1. Policy 3.3.1

Adopt and enforce the policies and practices documented in the *"Hennepin Conservation District Erosion and Sediment Control Manual"* and the BCWMC "Water *Quality Management Policy, Part 2".*

5.3.3.2. Policy 3.3.2

Evaluate the areas of identified erodible soils to ensure adequate vegetative cover and to minimize runoff concentration and velocity.

5.4. Goal 4

Preserve and protect the groundwater resources of the City from depletion or degradation.

5.4.1. Objective 4.1

Identify the groundwater aquifers within Robbinsdale and their vulnerability to contamination.

5.4.1.1. Policy 4.1.1

Compile a database of all public and private water supply wells within the city in cooperation with SCWMC and the Hennepin County Conservation District..

5.4.1.2. Policy 4.1.2

Establish a periodic water quality monitoring program for all wells within the city.

5.4.2. Objective 4.2

Identify and control sources of potential surface contamination of groundwater.

5.4.2.1. Policy 4.2.1

Prepare a database of the addresses of known and potential sources of groundwater contamination based upon historical dump sites and current land use.

5.4.2.2. Policy 4.2.2

Implement a periodic monitoring program to review critical sites such as material storage, service stations, and maintenance facilities, to ensure good housekeeping and management.

5.4.3. Objective 4.3

Protect and enhance groundwater recharge.

5.4.3.1. Policy 4.3.1

Establish ground water protection zones in identified areas of highest contamination risks.

5.4.3.2. Policy 4.3.2

Control development over groundwater recharge areas.

5.5. Goal 5

Preserve and protect wetlands to provide maximum flood control, water quality, wildlife habitat, and aesthetic values for all residents of Robbinsdale.

5.5.1. Objective 5.1

Control development of wetland areas.

5.5.1.1. Policy 5.1.1

Enforce the BWSR rule by assigning LGU authority to the WMO.

5.5.1.2. Policy 5.1.2

Maintain a wetland mapping at city offices for preliminary identification of wetland locations.

5.5.1.3. Policy 5.1.3.

Prepare an inventory of wetland functional values.

5.6. Goal 6

Promote constancy and coordination of water management policies among agencies, neighboring communities and residents.

5.6.1. Objective 6.1

Enhance public awareness of water resource issues.

5.6.1.1. Policy 6.1.1

Develop a public education and participation program for city residents.

5.6.2. Objective 6.2

Promote inter-agency coordination.

5.6.2.1. Policy 6.2.1

Work closely with Minneapolis on addressing issues on the Crystal Lake basin.

5.6.2.2. Policy 6.2.2

Form a working group with representatives of Crystal and Brooklyn Center to pursue solutions to water quality and lake levels on Twin and Ryan Lakes.

5.6.2.3. Policy 6.2.3

Work cooperatively with the Mn/DOT to develop water treatment and storage facilities in conjunction with the T.H. 100 redesign.

Section 6

MANAGEMENT PLAN

This section combines the inventory of resources and evaluation of existing conditions that were discussed in the previous sections of this document to synthesize an understanding of the issues facing the community and to develop an approach to solutions that are consistent with the stated goals and objectives.

Many issues facing Robbinsdale are isolated areas of local concern that can be resolved through the involvement of concerned citizens and city officials. Other issues relate to broader, inter-community facilities that require the cooperation and participation of neighboring municipalities and governmental agencies. Whether the problem is local or regional, all solutions must be developed within the framework of this plan to ensure compliance with watershed regulations and a comprehensive approach to water management.

The following discussion presents the issues and approaches to managing the water resources of Robbinsdale in each of the six major watershed basins.

6.1. Global Management Issues

The following six topics are required to be addressed by this plan and are not confined to specific local problem areas.

6.1.1. Shoreland Management

The uncontrolled use of shorelands of the City of Robbinsdale affects the public health, safety and general welfare not only by contributing to pollution of public waters, but also by impairing the local tax base. In accordance with the objectives of this plan, and the requirements of the SCWMC arid the Minnesota DNR, the City will adopt a Shoreland Management Ordinance conforming to Minnesota Statutes, Chapter 105 and Minnesota Regulations, Parts 6120.2500 to 6120.3900.

The ordinance will be drafted by joint effort of city staff, the City Attorney and implemented as part of the City Code for zoning regulations. This planning and zoning authority is specifically granted to the City under the enabling legislation in Minnesota Statutes, Chapter 462. A model shoreland ordinance consistent with the Department of Natural Resources requirements is included in Appendix H

6.1.2. Wetland Management

Under the provisions of the Wetland Conservation Act of 1991 (WCA) the City must either agree to perform the duties of the Local Governmental Unit (LGU) or designate the WMO to perform the tasks. These duties include making exception and no-loss determinations, approving wetland replacement plans and performing other duties and responsibilities under the WCA. The City of Robbinsdale has passed a resolution requesting that the Shingle Creek Watershed Management Commission and the Bassett Creek Water Management Commission assume these responsibilities. The City will assist the WMOs in preparing and inventory of functional values for all local wetlands upon agreement between the Commissions regarding appropriate methodologies to be employed.

6.1.3. Flood Plain Management

The City of Robbinsdale has in effect an ordinance regulating floodplains that addresses the management requirements of the SCWMC (City Code, Section 530.01). This ordinance will require amendment to eliminate the provisions of Subd. 6 which permits encroachment of the floodway or flood fringe areas so long as the resultant flood stage increase is less than 0.5 foot over the established flood elevation. The SCWMC has enacted a policy that all flood area encroachments shall have no effect on flood elevation. The city ordinance must conform to this management strategy.

In addition to the regulatory requirement, the SCWMC has established 100-year flood elevations for Ryan and Shingle Creeks for fully developed watershed conditions. This flood elevation may differ from that established through the Flood Insurance Studies which referenced the 1974 Shingle Creek Watershed plan. The flood elevations for Crystal Lake, Rice Lake and Grimes Pond were evaluated using the hydrologic methods of this plan and compared to the flood elevations established by the WMO. No significance difference in flood elevation resulted from this analysis.

This plan did not perform an independent analysis of the 100-year elevation for Twin Lake or Ryan Lake. The majority of tributary area for these two lakes lies outside the corporate limits of Robbinsdale and includes five separate communities. For these two lakes, the SCWMC flood elevation was used to delineate the flood plain boundary. The floodplain boundary was determined using the two-foot contour mapping developed for this plan.

Delineation on the current mapping indicated significant discrepancies between the FEMA floodplain and that required by the SCWMC elevation. The revised flood plain incorporates the residential areas along Chowen Avenue as far south as 43rd Avenue North as well as the low area around the cul-de-sac of Robin Avenue. Specific strategies for resolution of this issue are as follows:

- Request that SCWMC update the flood analysis for Twin Lake and Ryan Lake based upon the available topographic mapping and the outlet improvements constructed by the WMO on these lakes.
- Obtain survey information on structure elevations in the effected areas.
- Prepare a new delineation of the 100-year flood elevation based upon WMO results.
- Adopt the new delineation as the official floodplain definition in the City Flood Plain Management District ordinance.

6.1.4. Erosion and Sediment Control

To respond to the potential erosion problems created by construction activities associated with development or redevelopment projects, the City will enact an enforcement program to monitor and address these issues. This program will be based upon the policies and practices detailed in the *Erosion and Sediment Control Manual* as prepared by the Hennepin Conservation District and the minimum standards for Erosion Control Plans as described in Part 2 of the Bassett Creek Watershed Water Quality Management Policy. The City will enforce these practices through the building permit procedure.

Implement a practice of semi-annual street sweeping to minimize sedimentation from public streets.

All construction projects that will involve grading or surface disruption will be required to submit a Grading and Erosion Control Plan. At a minimum, these plans will include:

- A location map indicating the project boundaries, and all lakes, ponds, ditches, creeks and wetlands within 200 feet.
- Existing and proposed topographic map which clearly indicates all hydrologic features and areas where grading will expose soils to erosive conditions.
- The direction of all site runoff.
- Identification of all temporary erosion control measures which will remain in place until permanent vegetation is established.
- A construction implementation schedule
- Identification of all permanent erosion control measures such as outfall spillways and rip rap and their locations.
- The name, address and phone number or party responsible for maintenance of all erosion control measures.

In addition to construction projects, the City will undertake periodic inspections of those areas identified in this plan as having potentially erosive soils and initiate corrective action as required.

6.1.5. Ground Water Protection

Robbinsdale's three major lakes are all situated in the glacial drift and have a dynamic interaction with the surficial groundwater aquifer. As shown on Figure 6, these water bodies are surrounded by a region that is highly susceptible to groundwater pollution. The former dump site in Sanborn Park is also located in this susceptible area. The City will cooperate with the Hennepin Conservation District and the Minnesota Geological Survey, and the SCWMC to determine the ground water quality and the contamination potential from the existing land uses and known surface contamination. The City will adopt the County and WMO groundwater plan following completion of the agencies' work.

Another area of concern is protection of the potable water supply. All five of the water supply wells use bedrock aquifers as the source of water. Well numbers 1 and 2 are driven to the Franconia/Ironton formation and wells 3, 4 and 5 utilize the Jordan sandstone. While surface contamination does not pose a direct threat to the aquifer, the well may become contaminated by flaws in the casings or sealing grout. Well numbers l and 2 are close to a known contamination site as well as potential contamination from nearby sanitary sewers. These wells should be closely monitored as part of a wellhead protection plan approved by the MDH.

6.1.6. Water Quality Monitoring

The SCWMC has adopted a management strategy that provides for implementation of a water quality monitoring program to collect data on Twin Lake, Ryan Lake and Crystal Lake as well as other lakes in the watershed. The BCWMC has implemented a Lake Management Plan for Rice Lake and Grimes Pond. The City of Robbinsdale will cooperate with these efforts and assist in the data collection by recruiting citizen volunteers to perform routine tasks such as Secchi disk measurements and rainfall data.

6.2. Shingle Creek Watershed

The following problems were identified by local experience, the analysis presented earlier in this document, or from regional authorities such as the WMOs. These issues have been grouped by the nature of the concern, the geographic location or jurisdiction, but are presented in no particular order of priority.

6.2.1. Runoff Management

6.2.1.1. Crystal Lake Basin (LSC 2)

Crystal Lake is the dominate water feature of central Robbinsdale. This lake has experienced difficulties with fluctuating water levels. Historically, the City augmented the lake using a groundwater well in Lakeview Terrace Park. In recent years, high water levels lead to construction of a pumped outlet for the lake. With the implementation of this stabilization project, Crystal Lake now has adequate protection from frequent flooding risks.

Of the eight major trunk districts that discharge to Crystal Lake, two have identified drainage problems. These areas also correspond to districts that have inadequate storm sewer capacity. In District CLD the areas lying west of the BN railroad between Noble and Perry Avenues have experienced recurrent street flooding. This is confirmed by the analysis presented earlier. The recommended course of action for this area is as follows:

- Perform a detailed analysis of the existing pipe capacity to determine critical segments of the pipe network.
- Evaluate upgrading the storm sewer to a five-year design as part of a neighborhood street reconstruction program.
- Coordinate with Mn/DOT on the upgrading of T.H. 100 to determine the potential to construct a relief sewer to new storm sewer in the highway.
- Upgrade the capacity of the trunk storm sewer in West Broadway to permit construction of a diversion of some of the flow through a second railroad crossing.

District CLF has also experienced occasional flooding problems in the area around the Drew Avenue cul-de-sac. This is the result of two factors: the area is extremely low (el 848± which is only 0.5 feet above the OWL of Crystal Lake), and the regulated lake level has reduced the capacity of the storm sewer draining this area. The action plan for this basin is as follows:

- Perform a detailed capacity analysis of the existing pipe network.
- Evaluate the cost to upgrade the storm sewer to meet a five-year design.
- Evaluate the cost to install a storm water pump station for the cul-de-sac area.
- Evaluate the potential to divert the storm sewer in C.R. 9 to Ryan Lake via construction of a relief line in Chowen Avenue.

6.2.1.2. Twin Lake Basin (TL 1)

This basin has four major drainage districts, none of which has a history of frequent flooding problems in the upland area away from Twin Lake. The major drainage district, TLA, relies on the T.H. 100 storm sewer system to provide trunk drainage. The analysis performed for this plan indicates that there is likely inadequate capacity in this facility. Because T.H. 100 is also the route for most overland flow conveyance, most excess flows accumulate in the low areas along the highway minimizing problems for the surrounding neighborhoods. The topography and existing infrastructure both dictate that any drainage improvements must necessarily be developed in cooperation with Mn/DOT. Depending on the schedule for the upgrading of T.H. 100, the City may undertake drainage improvements as part of the storm water management plan for the new roadway or as cooperative projects with Mn/DOT and Hennepin County. Opportunities for controlling storm water runoff rates were identified in three key areas:

- Develop a storm water storage basin in the southeast quadrant of T.H. 100 and C.R. 81. The estimated available surface area of this facility is 1.8 acres with a live storage capacity of 4 ac-ft and a permanent pool volume of 7 ac-ft. Effective utilization of this pond would require modifying the highway storm sewer system to route through the facility.
- Develop a storm water storage basin in the southwest quadrant of T.H. 100 and C.R. 81 in the area

known as Graeser Park. The estimated available surface area of this facility is 1.4 acres with a live storage capacity of 5 ac-ft and a permanent pool volume of 5 ac-ft.

- Develop a storm water storage basin in the northwest quadrant of T.H. 100 and C.R. 81 along the south side of 45th Avenue. The estimated available surface area of this facility is 1.2 acres with a live storage capacity of 3 ac-ft and a permanent pool volume of 5 ac-ft.

6.2.1.3. Ryan Lake Basin (LSC3)

The Robbinsdale basin draining to Ryan Lake is not served with storm sewer. Storm water runoff is channeled along the gutterlines of streets to a spillway at the corner of Chowen and 46-1/2 Avenue. The shoreline of Ryan Lake is fully developed as residential usage with very limited area to develop ponding areas. While Ryan Lake has experienced recent recurrent problems with high lake levels, solutions to this problem will require close coordination with the SCWMC and communities tributary to the Twin Lake chain. Brooklyn Center has proposed the development of a storm water treatment basin along the northwest side of Ryan Lake. As discussed in the floodplain management topic, the City will work cooperatively with the SCWMC to seek solutions to Ryan Lake. Other specific actions include:

- Cooperate with Brooklyn Center on the implementation of a storm water treatment basin for Ryan Lake.
- Pursue a cooperative project with Minneapolis to investigate the opportunity to develop ponding in the basin east of Ryan Lake.
- Evaluate the opportunity to construct storm sewer and in-pipe treatment options as part or residential street reconstruction in sub-basin RL1.

6.2.2. Storm Water Treatment

6.2.2.1. Middle Twin & Lower Twin Lakes

Portions of two of the three Twin Lake basins are located within Robbinsdale's corporate limits, but a majority of the watershed for this chain of lakes lies in Crystal, Brooklyn Center, New Hope and Brooklyn Park. This lake is a major recreational facility for the community and is used for swimming, boating and fishing.

The high nutrient loadings to these water bodies has lead to a steady degradation of the water quality in the lake. The Trophic State Index (TSI) for Twin Lake indicates a eutrophic to hypereutrophic condition for the lake because of high phosphorous and Chlorophyll-a concentrations. Maintaining the availability of this resource will require the coordinated efforts of several communities.
Analysis prepared for this plan indicates that total storm water treatment volume to meet NURP guidelines would require approximately 48 ac-ft of wet detention. The required quantity of treatment volume for District TLA is estimated as 26.6 ac-ft. The permanent pool volume provided by the three ponding areas proposed in the runoff discussion would total 17 ac-ft. An additional 4 ac-ft of treatment volume could be developed in Lions Park on the south shore of Twin Lake. Additional ponding opportunities may exist in the core areas of the intersection of C.R. 9 and T.H. 100, the former high school property and open space along Scott Avenue south of the BN railroad.

Opportunities to develop storm water treatment basins in the areas north and east of Twin Lake are limited. It may be possible to establish treatment areas in the low area behind the Robin Avenue cul-de-sac and in the Beach South apartment property. The recommended actions for this area are:

- Seek a cooperative project with Mn/DOT and Hennepin County to develop treatment areas in the T.H. 100 corridor.
- Work with Crystal to maximize the treatment area north of C.R. 81 and west of T.H. 100.
- Investigate the potential to develop treatment areas in Beach South and at Robin Avenue.
- Establish a community education program to promote source controls such as the use of non-phosphorous fertilizers to protect lake water quality.

6.2.2.2. Crystal Lake

Crystal Lake is classified as a recreational facility by the SCWMC. The lake suffers from many of the same water quality problems as the Twin Lake basin. Most of the runoff from the 1,230 acre watershed is untreated. Boating and fishing are important recreational activities on this lake and the City maintains an aeration system to help sustain oxygen levels . Unlike Twin Lake, the watershed for Crystal Lake lies in only two communities-Robbinsdale and Minneapolis. Minneapolis has nearly completed the combined sewer outfall (CSO) project that will separate sanitary and storm water flows. In 1995, Robbinsdale undertook construction of a sediment basin in the southern margin of Crystal Lake to treat storm sewer outlets from sub-areas CLA and

CLB.

In addition to these efforts, Robbinsdale will investigate the following concepts:

- Seek a cooperative project with the City of Minneapolis to install a sediment trap or grit chamber on the 66-inch trunk sewer outlet under 38th Avenue.
- Evaluate incorporating a wet detention facility in Triangle Park and upgrading the treatment in Lee Park as part of storm sewer reconstruction in sub-area CLD.
- Evaluate the potential to develop treatment ponding in the north end of Sanborn Park.
- Evaluate the potential to develop treatment ponding in the United Church of Christ property.
- Evaluate the potential to develop treatment ponding in the open space north of Robin Center.
- Evaluate the potential to develop treatment ponding at the intersection of 41st and Beard Ave.
- Install in-pipe sedimentation devices on all trunk outlets to Crystal Lake.
- Work with Hennepin County to provide treatment of runoff from C.S.A.H. 81. Establish a community education program to promote source controls such as the use of non-phosphorous fertilizers to protect lake water quality.

6.2.2.3. Ryan Lake

Ryan Lake is classified as a recreational water body requiring sediment and nutrient treatment of inflow. This lake is inseparably linked to Twin Lake and water quality improvements must be addressed on a broad basis. Because the potential to develop treatment ponds in this basin is very limited, the City will pursue the following BMPs:

- Install an in-pipe treatment BMP on the storm sewer discharge at France and 46-1/2 Avenue.
- Implement a monthly street sweeping program for the neighborhood bounded by France Avenue and 45th Avenue.
- Establish a community education program to promote source controls such as the use of non-phosphorous fertilizers to protect lake water quality.

6.3. Bassett Creek Watershed

The following problems were identified by local experience, the analysis presented earlier in this document, or from regional authorities such as the WMOs. These issues have been grouped by the nature of the concern, the geographic location or jurisdiction but are presented in no particular order of priority.

6.3.1. Runoff Management

6.3.1.1. Rice Lake (BC 6)

This basin consists of two major districts separated by the BN railroad. The area west of the tracks has no record of drainage problems due largely to the passive land use, minimal storm sewer and limited area. East of the railroad the district tributary to Grimes Pond has experienced nuisance flooding in the area around Halglo Place. The City will perform a detailed analysis of storm drainage in this area to determine the feasibility of extending storm sewer along Grimes Avenue from 31-1/2 Avenue to Halglo Place.

6.3.1.2. Sunset Hill (BC 62)

This district has extensive storm sewer but has potential capacity problems in the upper reaches. Specific runoff management strategies for this area include:

- Perform a detailed analysis of storm sewer capacity to identify critical sections of the drainage network.
- Investigate the potential to divert the Lowry Avenue branch of the storm sewer west along Lowry to connect to the existing pipe in France Avenue.

6.3.2. Storm Water Treatment

6.3.2.1. Grimes Pond and Rice Lake

These two wetland basins are managed as aesthetic areas and are not used for direct contact or water sports. No water quality data exists for these basins. This plan has identified the potential to develop sedimentation basins in four locations:

- Along the west side of the BN railroad between 34th and 35th Avenues.
- Along the east side of the BN railroad at 33rd Avenue.
- In the northeast corner of South Halifax Park.
- Along the east side of the BN railroad between 27th and 26th Avenues.

Detailed evaluation of these areas will be undertaken to determine the feasibility of implementation.

6.3.2.2. High School (BC 73)

This basin has no wetlands or water bodies. Storm water runoff is conveyed by storm sewer through Crystal and Golden Valley to the main stem of Bassett Creek. Analysis conducted for this plan indicates a required treatment volume of approximately 6 ac-ft of permanent pool to meet NURP criteria. A potential ponding area exists at the northeast quadrant of 36th and Unity on existing Mn/DOT property. The City will evaluate the feasibility of developing this facility in cooperation with Mn/DOT.

Section 7

IMPLEMENTATION AND FINANCING

This section outlines the specific schedule, cost and revenue sources to be used to accomplish the management strategies discussed in the previous section. Funding storm water improvements in a fully-developed community poses significant challenges. While the assessment procedure of MS 429 may be used, demonstrating market value benefit to Using Storm Sewer Utility revenues.

- Using Storm Sewer Utility revenues
- Issue General Obligation bond
- Create a special Storm Sewer Improvement District under MS 444.
- Implement special Storm Sewer Utility surcharges for redevelopment and construction projects. The existing storm sewer utility generates approximately $130,000 in annual revenue. The fund balance at the end of 1995 was $232,022. Allocating $65,000 to annual storm sewer maintenance projects would leave an annual budget of $65,000 to fund the projects identified herein.

7.1. Shoreland Management

Implementation will begin upon approval of this plan and be completed within 12 months. No costs are allocated to this component as only staff time is involved.

7.2. Wetland Management

This management strategy has already been implemented. All administrative costs are recovered through permit fees. No additional costs are anticipated.

7.3. Floodplain Management

Implementation of this plan element will begin immediately upon plan adoption. It is the goal of Robbinsdale to resolve floodplain delineation issues within 12 months of plan implementation. This element requires coordination with SCWMC staff and city staff allocation and no direct costs are associated with the activities.

7.4. Erosion and Sediment Control

The City will adopt the provisions of the HCD *Erosion and Sediment Control Manual* within 3 months of approval of this plan. No costs are allocated to this implementation and ongoing enforcement costs will be recovered through permit fees. The costs of an enhanced street sweeping program are included in the cost tabulation.

7.5. Ground Water Protection

The City will implement a wellhead protection plan as an element of the emergency water supply plan. Development of this management strategy is targeted for completion within 24 months of adoption of the local plan. The estimated cost of consultant services to assist the City in preparation of this plan is $15,000.

7.6. Water Quality Monitoring

The City will assist the SCWMC and BCWMC in implementation of a water quality monitoring program and community education measures. The annual cost for publication and training is estimated at $5,000. The program will be implemented within 6 months of adoption of this plan and continue for two years.

7.7. Runoff Management and Storm Water Treatment

7.7.1. Shingle Creek Watershed

7.7.1.1. Crystal Lake Basin

Storm Sewer Capacity Improvements
The City will undertake engineering evaluations and feasibility studies to identify storm sewer improvements in Districts CLD and CLF. These studies will identify the estimated cost of recommended improvements. The cost of these studies is estimated as $12,000 and the completion time frame is 9 months from adoption of this plan.

Storm Water Treatment Improvements
The City will undertake an engineering feasibility study to determine the design and location of the five treatment ponds identified in the management plan. This study will be completed within 24 months of adoption of this plan. Specific costs and implementation schedules will be identified in this study. The cost of the analysis is estimated at $26,000.

The construction of a grit chamber on the Minneapolis trunk sewer outlet to Crystal Lake will be undertaken as a cooperative project between the two cities. The implementation time frame is three years from adoption of this plan and the total estimated cost is $40,000 with an estimated cost sharing of 25% to Robbinsdale.

Construction of grit chambers on the five principal trunk storm sewer outfalls to Crystal Lake is estimated to cost an average of $24,000 per line. The City will begin installation of structures on an annual basis beginning twelve months from adoption of this plan and continue for five years.

7.7.1.2. Twin Lake Basin
The development of the three storm water basins at the junction of TH 100 and CR 81 will require close coordination with MnDOT and Hennepin County. The City will begin this process immediately upon approval of the local plan. Completion of the planning and design process is estimated to require three years with phased construction of the facilities to follow. The estimated construction cost of these facilities is as follows:

- Pond at the SE quad of TH 100/CR81: $80,000
- Pond at the SW quad of TH 100/CR 81: $45,000
- Pond at the NW quad of TH 100/CR 81: $35,000

The incorporation of a treatment facility in Lions Park will also require the cooperation of Mn/DOT. The estimated time frame is similar to the foregoing projects with an estimated cost of $30,000.

7.7.1.3. Ryan Lake Basin
The implementation of an in-pipe sediment chamber for France Avenue is scheduled to be constructed three years from adoption of this plan. The estimated cost of this facility is $8,000.

Establishment of the street sweeping program for this basin will begin within six months of adoption of the local plan with an estimated annual cost of $1,500.

7.7.2. Bassett Creek Watershed

7.7.2.1. Rice Lake Basin

Storm Sewer Capacity Improvements

The implementation of the management plan for this basin will begin with an engineering feasibility study to identify the scope and cost of storm sewer improvements. The schedule for completion of the study is 24 months from adoption of this plan. The study will define the costs and implementation time frame for construction of improvements. The cost of the study is estimated at $7,000.

Storm Water Treatment Improvements

The implementation of the treatment options identified in this plan will require detailed study to determine the final location and costs. This study will be completed within three years of adoption of the local plan at an estimated cost of $12,000.

The estimated construction costs of the sedimentation ponds is as follows:

- West pond @ 34th Avenue: $60,000
- East pond @ 33rd Avenue: $35,000
- Halifax Park pond: $10,000
- East pond @ 27th Avenue: $55,000

7.7.2.2. High School Basin

The implementation of this facility is slated for five years after adoption of the local plan. The cost of the facility is estimated at $35,000.

Table 22 Summary of Implementation of the Plan

Project	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**
Wellhead Protection Plan	$ 7,500	$ 7,500				
Water Quality Program	$ 5,000	$ 5,000				
Crystal Lake Sewer Study	$ 12,000					
Crystal Lake Treatment Study		$ 26,000				
Mpls Grit Chamber			$ 10,000			
Robbinsdale Grit Chambers	$ 24,000	$ 24,000	$ 24,000	$ 24,000		
TH 100 Ponds				$ 53,000	$ 53,000	$ 53,000
Lions Park Pond			$ 30,000			
France Ave. Grit Chamber			$ 8,000			
Street Sweeping	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500
Rice Lake Storm Sewer		$ 7,000				
Rice Lake Treatment Plan			$ 12,000			
Rice Lake Ponds				$ 54,000	$ 54,000	$ 54,000
High School Pond						$ 35,000
Annual Total:	$45,500	$ **71,000**	**S 85,500**	$ **132,500**	$ **108,500**	$ 143,500