Preliminary Engineering Report for the Breezy Point Wastewater Treatment Facility

Prepared for

The City of Breezy Point

November 2001

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PRELIMINARY ENGINEERING REPORT FOR THE

BREEZY POINT WASTEWATER TREATMENT FACILITY

PREPARED FOR:

The City of Breezy Point, Minnesota

November 2001

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

11/16/2001

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TABLE OF CONTENTS

FIGURES

TABLES

1. INTRODUCTION

The City of Breezy Point owns and operates a wastewater treatment facility (WWTF) that treats municipal wastewater. The existing liquid treatment train includes one aerated pond followed by three storage ponds. The treated wastewater is discharged to forested spray irrigation fields. Because wastewater is treated in a pond system, Breezy Point does not currently have or need a dedicated solids treatment train.

The wastewater treatment facilities at the City of Breezy Point have met discharge criteria as set forth in the City's National Pollutant Discharge Elimination System (NPDES) permit; however, growth due to permanent and seasonal residential development is expected to increase wastewater treatment requirements. The City has retained McCombs Frank Roos Associates, Inc. to evaluate the existing wastewater treatment facility and prepare a Preliminary Engineering Report to evaluate methods by which treatment capacity can continue to meet discharge standards in the future.

During 1999, several memos were prepared regarding existing capacity, projected growth and upgrade options for the WWTF.

1. A February 15 memo focused on evaluating the capacity of the existing wastewater treatment infrastructure in Breezy Point.
2. An October 14 memo focused on population projections, design flow projections and a schedule of required upgrades of the existing WWTF based on the capacity of each component.
3. A December 23 memo presented capital costs and recommended a plan and schedule for upgrading the existing WWTF.

These recommendations were presented to the City Council. Information developed for these memos has been updated and is included in this report.

Additional objectives of this report are to:

1. Describe additional treatment alternatives for meeting applicable effluent, water quality and public health requirements for the planning period; specifically, the activated sludge processes: sequencing batch reactors and oxidation ditches.
2. Prepare a preliminary flow schematic of the evaluated alternatives.
3. Prepare a cost-effective analysis of the alternatives considered.
4. Present an implementation plan that will allow the facility to meet discharge permit limits during construction.
5. Prepare an estimate of construction, annual operation and maintenance, and equipment replacement costs.

1.1 Planning Area

The planning area for this Facilities Plan includes the existing collection system within the corporate limits of the City of Breezy Point as shown in Figure 1-1.

Breezy Point was known for many years as a resort owned by Captain Billy Fawcett. This resort, which has since passed through several ownerships, has always been the focal point of the area.

As part of the development by previous owners of the resort complex, large amounts of land were platted, developed with streets and offered for sale to the public. The platted areas designated White Birch Additions are primarily lots larger than 1/2 acre. The platted areas designated Breezy Point Estates are primarily smaller lots.

Originally incorporated as Pelican Lakes, the City's name was changed to Breezy Point in 1969. As a City, it is organized and operates under the laws of the State of Minnesota.

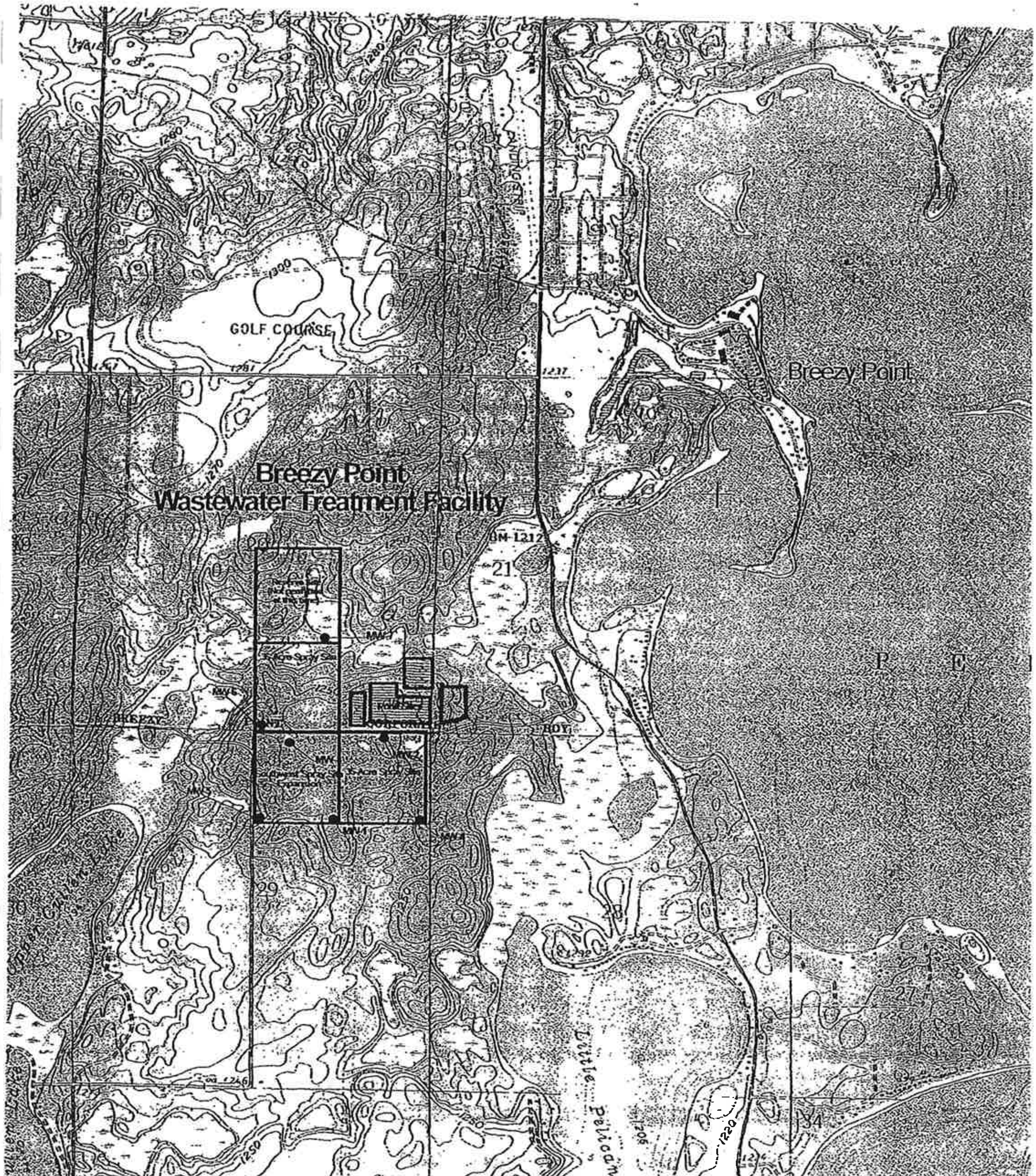

Figure 1-1 – City of Breezy Point

1.2 Environmental Resources

The City of Breezy Point, Minnesota, is located in Crow Wing County in Township 136 North, Range 28 West of the 5th Principal Meridian in North Central Minnesota. Breezy Point is located in a leading recreational area. It is an area of hills and mixed forests of hardwoods and softwoods. The area contains many lakes of varying size providing a wide variety of fishing. It also contains many swimming beaches, golf courses and hunting areas. Winter recreational opportunities include ice fishing, cross-country skiing and snow mobiling.

Pelican Lake, which forms the nucleus for the recreational attraction area, is a large lake approximately 8,500 acres in area with depths to 104 feet. The lake lies within the upper Mississippi watershed and has a shoreline of approximately 24.4 miles.

Minnesota Trunk Highway 371 and County State Aid Highways 11 and 4 provide access to the City of Breezy Point. A private airport is located within City limits. The closest commercial airport is located in Brainerd.

The climate of the area is sub-humid continental with cold winters and moderately warm summers. Average monthly temperatures range from 6°F in January to 73°F in July with extremes ranging from -30°F to 100°F. Breezy Point receives an average of 28 inches of precipitation during the year with an average of 18.5 inches during the period from May 1 through September 30.

The Breezy Point Wastewater Treatment Facility is not located adjacent to any surface water and, therefore, is not affected by any 100-year flood boundaries.

2. PROJECTED FLOWS AND LOADS

2.1 Population of Breezy Point

The city of Breezy Point is unique in its flow patterns observed at the Wastewater Treatment Facilities (WWTF). High flows occur on weekends during the summer when there are high levels of recreational activities and low flows are observed in the late fall and early spring when recreational activity is low. Capacities and design flows at the WWTF must account for this seasonal flow pattern. The population contributing to these flows can be split into two categories, permanent and seasonal.

The permanent population will be defined as the population that has been determined in recent estimations and counts. The flow contributed by the permanent population will be considered to be the lowest average daily flow during any month of the year.

The seasonal population supported by the area is difficult to define. It is made up of both resort-type property and private seasonal/recreational property. Resorts are not required to provide attendance numbers and the number of private seasonal cottages in use at any given period is not easy to identify. The majority of wastewater flow contributed by the seasonal population occurs on weekends.

For design purposes, the population contributing any flows greater than the lowest monthly average daily flows will be defined as seasonal. Future seasonal population will be estimated from past flow trends that demonstrate the typical amount of flow contributed.

2.2 Design Period

Population estimates will be made for five-year intervals over the next 20 years, with the final design year being 2022. This will allow design flows to be defined for these periods. Bottlenecks of treatment capacity can then be identified and a time frame for improvements to the WWTF can be developed from these flow projections. Update and revision of the flow projections will be necessary during final design of the future projects identified in this memo to maximize design life.

2.3 Population Projections

Design population estimates have been developed from past population counts from the state demographer and population estimates and projections provided in the 1997 City of Breezy Point Comprehensive Plan. Both sets of population estimates are shown in Table 2-1.

Table 2-1 – Population Estimates

Year	State Demographer Population Estimates	1997 Comprehensive Plan Population Estimates
1960	134	134
1970	233	233
1980	384	384
1990	432	432
1991	437	
1992	443	
1993	457	
1994	461	
1995	544	544
1996	622	624
1997	635	
1998	701[1]	
1999	774	
2000	979[2]	752[3]
2010		1310[3]

1 – Revised from 1999 estimate
2 – 2000 census
3 – 1997 projection

Two distinctive rates of growth can be seen for Breezy Point in the State Demographer's estimates. A fairly constant rate of growth appears from 1960 up to 1994. A much more rapid rate of growth occurs from 1994 to 2000. Both of these rates of growth are shown as the linear regressions on Figure 2-1. These regressions have been projected forward for twenty years to give a range of high and low possible growth for Breezy Point. Also plotted in Figure 2-1 are the population estimates found in the 1997 Comprehensive Plan. A linear regression line plotted through these points and projected forward through 2020 fits within the high and low growth rates. The projections developed in and extended from the Comprehensive Plan estimates will be adopted as the design population.

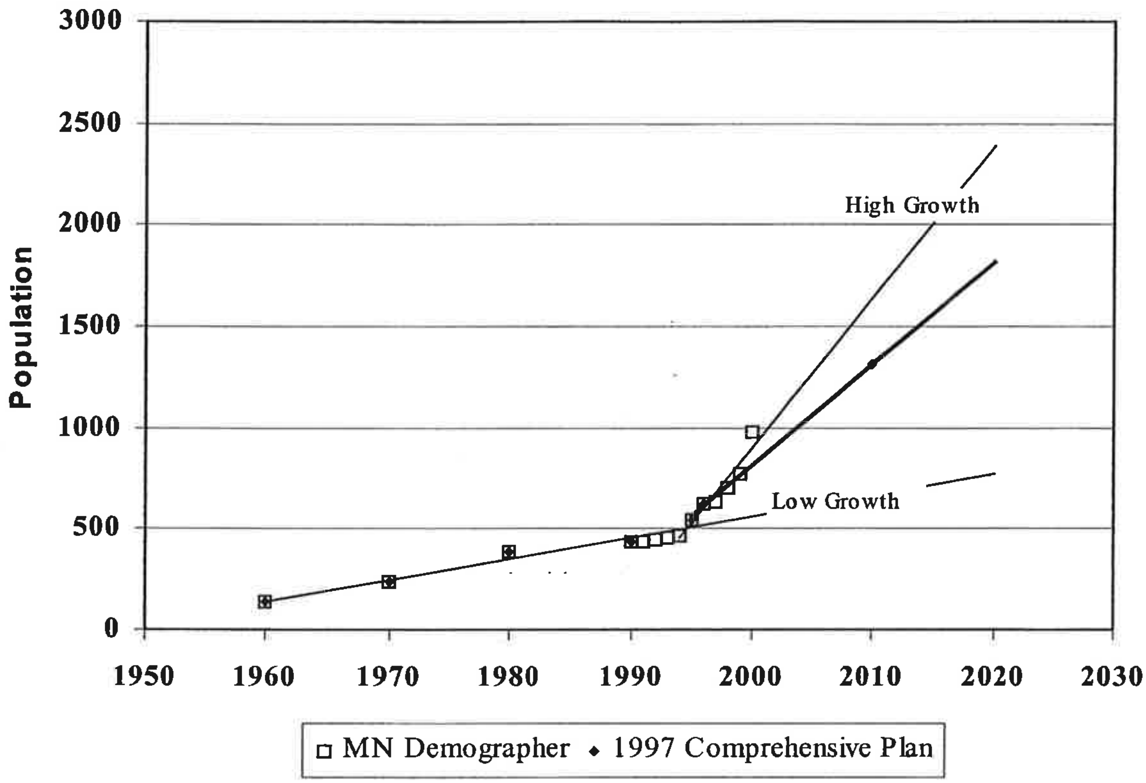

Figure 2-1 – Breezy Point Population

Table 2-2 gives the design population estimates that will be used for the WWTF analysis.

Table 2-2 – Population Estimates for Design

Year	Design Population Estimate
1996	624
2000	979
2007	1160
2012	1411
2017	1662
2022	1913

2.4 Determination of Design Flows

Design flows for analysis of the Breezy Point WWTF can be determined from the calculated population and using past flow records. Influent flow records from 1993 through September 2001 were used to develop flow trends. Figure 2-2 shows the average daily flow during each month using the last five years of data. The figure also shows the range recorded for each month during the last five years.

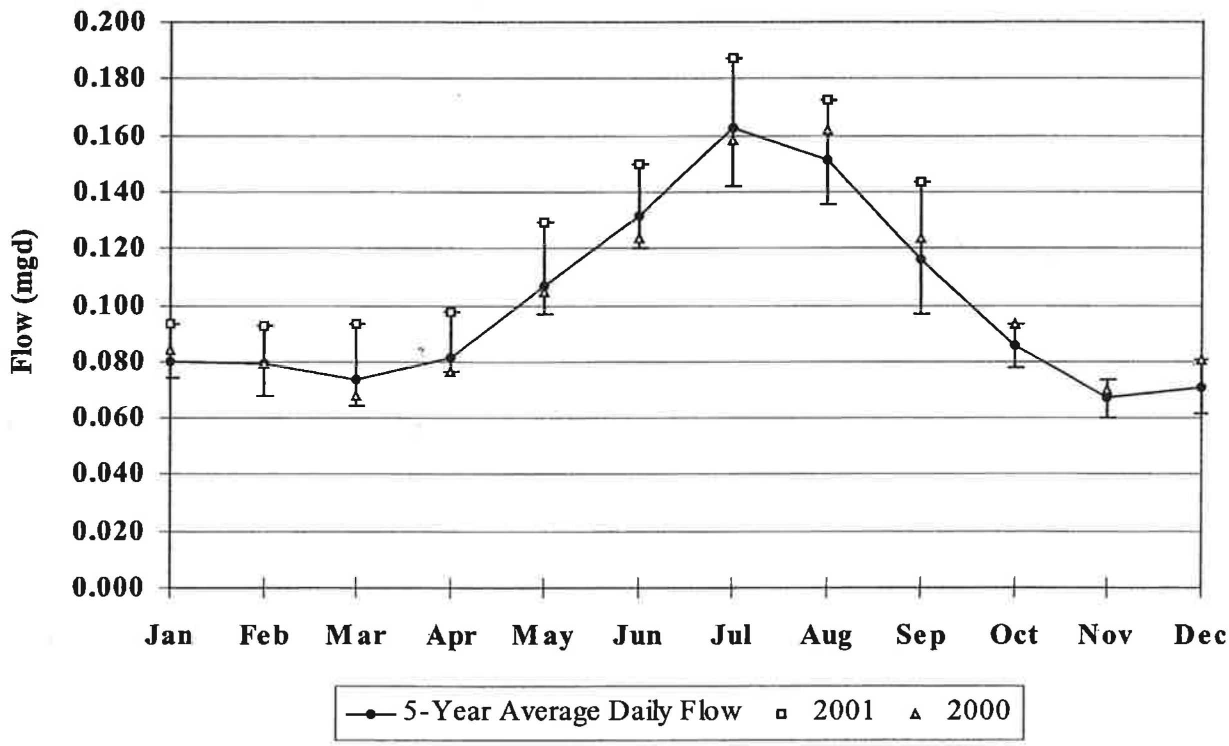

Figure 2-2 – Average Daily Flow (Jan-96 through Sep-01)

The same general trend appears each year, with the high flows occurring in July and low flows during November. The maximum daily flow observed each year is typically seen on the Saturday closest to July 4. During June, July and August of 2000, a total of 120 new hotel units were connected to the sewer collection system. As a result of these additions, the WWTF has experienced the maximum influent flow ever recorded for each month since August 2000 with the single exception of November 2000.

The City of Breezy Point has done an excellent job controlling inflow and infiltration (I/I) into the sanitary sewer. Wet weather due to heavy rains and snow-melt does not appear to influence flows to the WWTF. Therefore, future flows can be predicted based only on population. Figure 2-3 shows per capita flows which can be used for design flows.

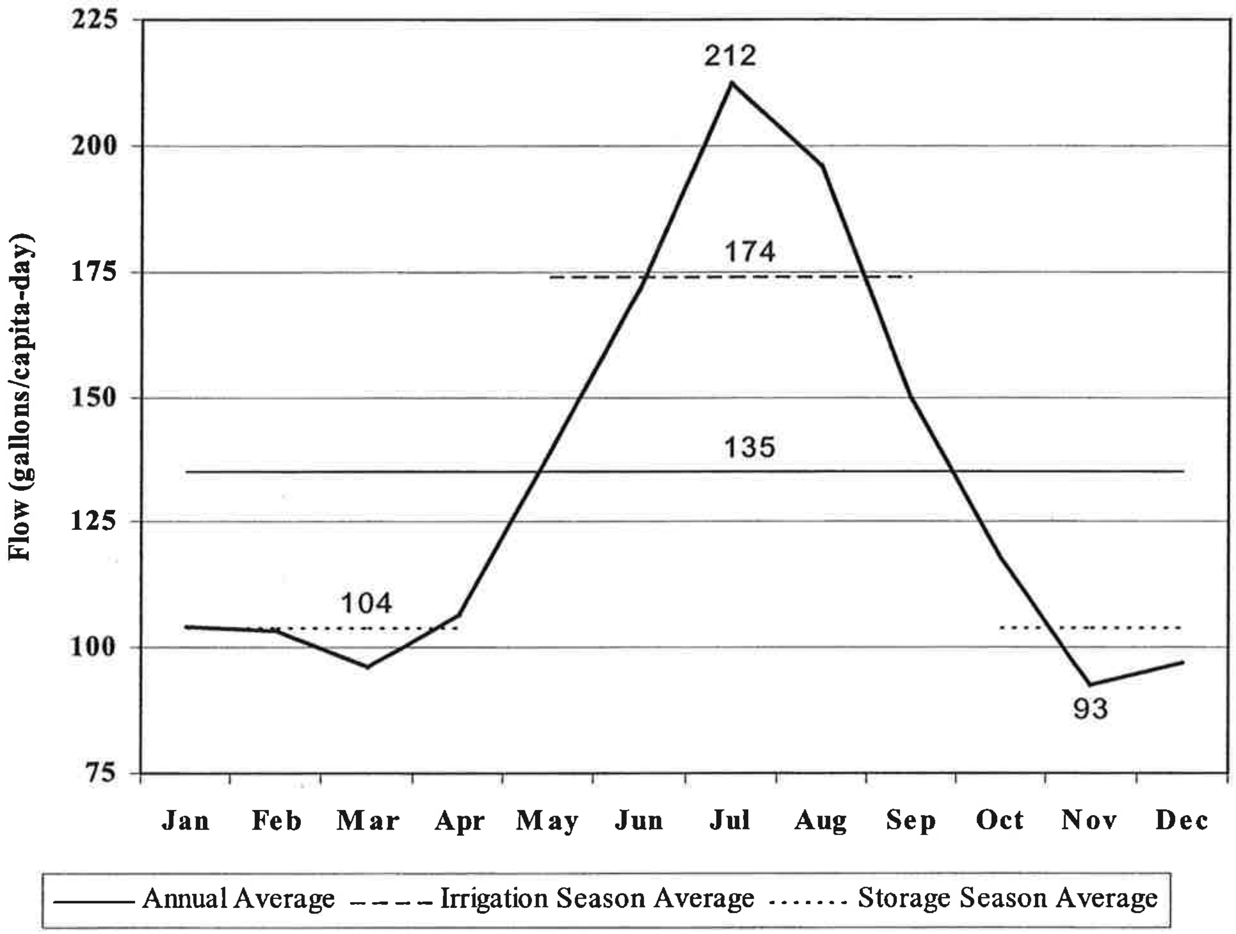

Figure 2-3 – Average Per Capita Flow (Jan-96 through Sep 2001)

The Average Wet Weather flow (AWW) is a flow used for design typically assumed to be the maximum monthly flow that the WWTF will experience during it's design period. Because the maximum monthly flow at the Breezy Point WWTF occurs each year during July, as shown in Figure 2-3, the AWW can be determined for future years by multiplying the projected total population by 212 with the following assumptions:

1. The ratio of permanent to seasonal residents will remain constant.

2. I/I will continue to not be a factor in wet weather flows.
3. The ratio of new housing units which connect to municipal sewer (as opposed to on-site treatment systems) will remain the same.
4. Sewer service is not extended to areas outside of the incorporated area of Breezy Point.

An alternate method of determining design flows was presented in the October 14, 1999 memo. This method is still viable as a flow prediction tool assuming that seasonal and permanent populations actually connected to the municipal sewer are known.

Determination of design flows can be accomplished by multiplying the appropriate per capita flow by the projected population. Figure 2-4 shows a summary of the calculated design flows over the next 20 years.

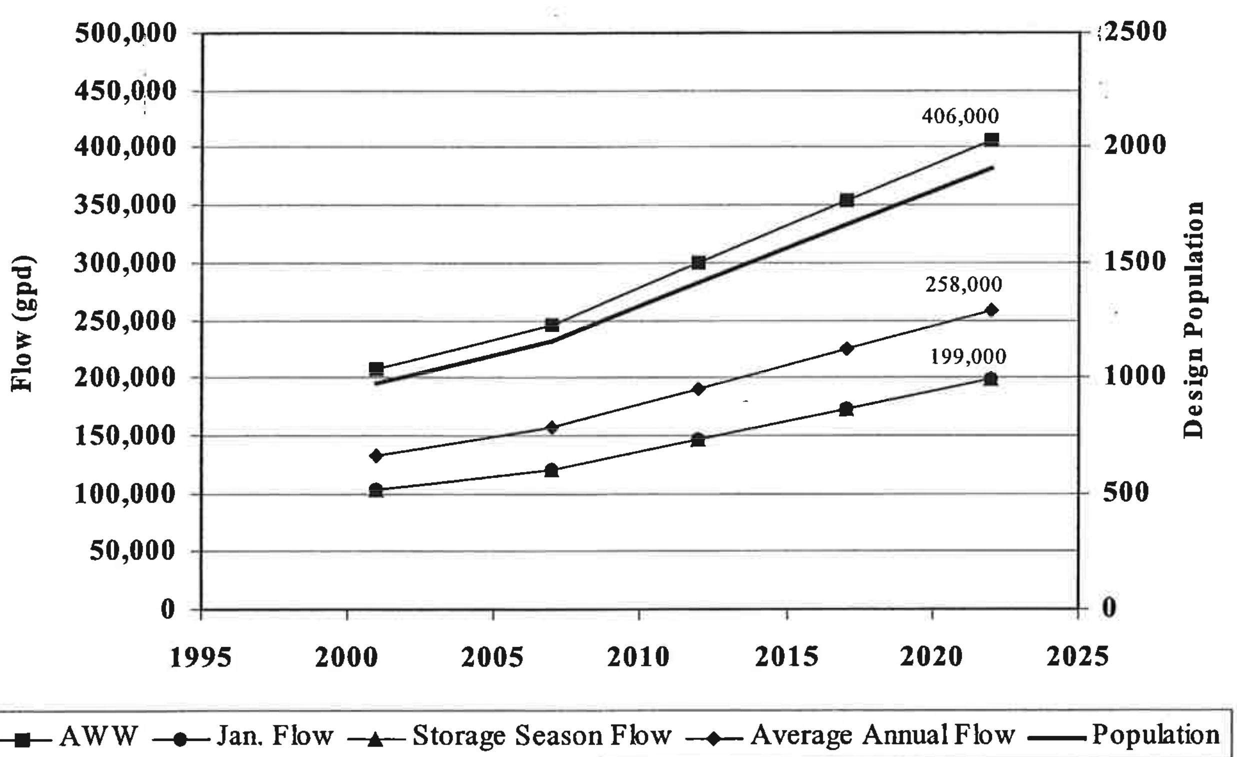

Figure 2-4 – Design Flows

One curious aspect of the flows at Breezy Point is that the January Flow and the storage season flow happen to be the same.

The peak hourly wet weather flow (PHWW) is a design flow that is used to size pumps, preliminary treatment equipment and clarifiers. PHWW is determined using a peaking factor calculated from the service population and the AWW.

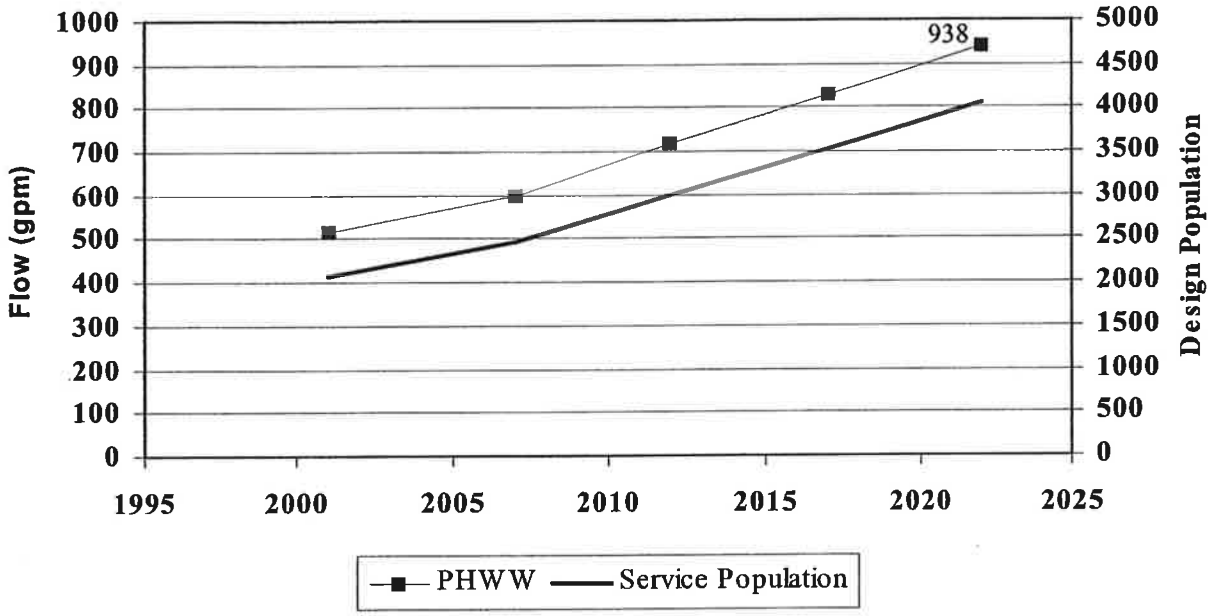

Figure 2-5 – PHWW Design Flow

As an alternative to population projections, growth can be estimated from planned growth projects. Breezy Point has several planned growth projects with the potential to occur over the next few years. Future development can be expressed in terms of equivalent residential units (ERU). Each ERU can be expected to increase the average annual flow by 275gpd and the Average wet weather flow by 400 gpd. The population projection shown in Figure 2-5 is roughly equivalent to adding 725 ERU over the next 20 years. The following developments may occur during the design life of the WWTF.

1. There are currently 200 to 250 residential sewer stubs installed but not connected.
2. The High Village development will add 144 ERU when completed. This project has not begun and was originally projected to take six years to complete.
3. The Golf Course Condos will add 500 ERU when completed. This project has not begun and was originally projected to take 22 years to complete.

4. White Birch Estates will add an additional 63 ERU.
5. A 1000 student school with cafeteria and locker room facilities could increase flows by 35,000 gpd on school days and 5,000 gpd on weekdays with no school. This would increase the AWW by only 5,000 gpd as school is not in session during July, which historically has been the month with highest flows. However, the AAF would increase by 20,000 gpd, which is approximately 75 ERU.
6. Camping Cluster II has 56 campsites left to connect. These connections will increase the AWW by 4,000 gpd, approximately 11 ERU.
7. The Sports Complex completed in 2000 is being served by a septic system. This development would add 33 ERU if the septic system fails.
8. A new, larger restaurant planned for 1998 to replace the old Marina Restaurant has not yet been built. When open, it will add 1 ERU for every additional 8 seats.

If all of these development projects occur, more than 1100 ERU will be added to the WWTF.

In addition to these planned projects, municipal sewer service could be extended to several lakeshore neighborhoods that are currently served by individual sewage treatment systems (ISTS). Lakeshore areas that developed prior to the mid-1970's were frequently constructed on lots too small to allow upgrade of ISTS due to State Rules, which have grown more restrictive in the past 30 years with respect to ISTS setbacks from lakeshore. The incorporated area of Breezy Point includes neighborhoods on Pelican Lake and Ossawinnamakee Lake that do not have municipal sewer. There are also neighborhoods in unincorporated areas on Clear Lake, Ossawinnamakee Lake, Kimble Lake, Bass Lake and Pelican Lake to which Breezy Point is the nearest potential source for municipal wastewater service.

2.5 Design WWTF Loadings

Other important parameters to consider in the evaluation and design of WWTF are the characteristics of the influent wastewater and the loadings that will be experienced at the facility. Wastewater generated in Breezy Point is almost exclusively domestic in nature. The waste should be fairly consistent in strength and character because I/I does not influence and dilute it.

Breezy Point does not have a BOD treatment requirement for discharge; however, if BOD is not removed to below 25 mg/L in the primary pond, the potential for odors in the storage ponds increases. The aerated pond was originally designed to achieve an effluent BOD concentration of 25 mg/L. On an average annual basis, this is approximately 85% removal. The influent waste will be assumed to remain at this constant strength of 167 mg/L during the 20-year design period. Table 2-3 presents the daily BOD loadings expected at this level of strength relative to the design flows.

Table 2-3 – BOD Loads

Year	July Flow (mgd)	BOD (lbs/day)	January Flow (mgd)	BOD (lbs/day)
2001	187,000	260	94,000	131
2007	246,000	343	121,000	169
2012	300,000	418	147,000	205
2017	353,000	492	173,000	241
2022	406,000	566	199,000	277

The WWTF does not have regulated treatment limits for nitrogen or phosphorus removal because it discharges all of the effluent by spray irrigation. If spray irrigation becomes impractical, other discharge options must be considered and limits on nutrient removal may become important factors in treatment.

3. EXISTING FACILITIES

3.1 Pumping Station #1

Pumping Station 1 is currently equipped with two pumps. Original pumps have recently been replaced. In 1997, a rebuilt 25 HP pump was added. The pumping rate for this pump has been measured at 530 gpm at approximately 79 feet of toal dynamic head (TDH). This is well below the design point of 500 gpm at 95 feet of total dynamic head, suggesting either a worn or smaller impeller than could be used. In 2000, a 27 HP pump with a discharge capacity of 925 gpm at 87 feet TDH was installed. At the design point on the pump curve, the motor draws more power than it is rated for; however, the draw is within the service factor for the motor. This may reduce When operated together, the two pumps have a discharge capacity of approximately 1030 gpm.

The pump down volume (the volume between the highest reasonable elevation of the "lead pump on" float and the lowest reasonable elevation of the "pumps off" float) of the Pumping Station 1 wet well is 1,692 gallons. This volume limits the existing pumping station to pumps with capacity of approximately 900 gpm. Higher capacity pumps would run for a shorter time than is desirable for submersible pumps, which would result in higher operation and maintenance costs.

The firm pumping capacity of the station is now 530 gpm. By the year 2005, peak hourly flows are projected to exceed the current firm capacity of the pump station.

A firm pumping capacity of 1.35 MGD (938 gpm) will be needed in Pumping Station #1 by 2020.

3.2 Force Main

Pumping Station 1 collects all wastewater generated in Breezy Point and pumps it through a 10-inch, 4400-ft, cast iron pipe force main. The cast iron force main has the following system head:

Table 3-1 – Force Main System Head

Discharge (gpm)	Head (ft H_2O)	Pump Size (HP)
0	66	-
200	67.3	10
400	70.5	15
600	75.6	20
800	82.3	25
1000	90.6	40
1200	100.5	50
1400	111.8	75

The maximum discharge that the existing force main could reasonably be expected to handle is about 1400 gpm. While it may be possible to find pumps which are rated for high flow, high head conditions, there are not many to select from. Most submersible pumps do not operate efficiently at heads above 120 feet.

Peak-hourly flows for the 20-year design period are not projected to be higher than 938 gpm in the design year 2020. The existing force main appears to have adequate capacity for this period.

3.3 Municipal Wastewater Treatment Facility

The existing liquid treatment train includes one aerated pond followed by three storage ponds. Treated wastewater is discharged to forested spray irrigation fields. Because wastewater is treated in a pond system, Breezy Point does not currently have or need a dedicated solids treatment train.

3.3.1 Influent Pretreatment and Control Building

The Control Building formerly housed a comminutor, and currently houses a Parshall flume and three positive displacement blowers. Upgrade of the comminutor with a mechanically cleaned bar screen and manually cleaned bypass screen was completed in 2001. A screenings rack for dewatering of screenings prior to landfill disposal was also installed as a part of that project.

A 6-inch Parshall flume measures influent flow. The flume has a maximum flow capacity of 1750 gpm at a maximum head of 1.50 feet. Peak hourly flow predicted for the 20-year design period is 938 gpm. Therefore, the existing Parshall flume should provide adequate capacity.

3.3.2 Aerated Pond

The main treatment unit at the wastewater treatment facility is the aerated pond. The pond has a depth of 10 feet and a constant volume of 5.4 million gallons. Three positive displacement blowers supply oxygen, with a firm blower capacity of 700 inlet cubic feet per minute (icfm). One of the blowers has been replaced, but two are original equipment.

3.3.2.1 Hydraulic Loading Considerations

In order to achieve 85% BOD removal, the pond must have a hydraulic detention time of 41 days during the coldest month of winter and 25 days during summer. This limits the existing pond to a maximum monthly flow rate of 0.132 mgd during January and 0.216 mgd during July. Comparing these values with the future flow projections, the July flow will exceed 0.216 mgd before 2007 when the flow is projected to be 0.246 MGD. The winter ADW flow will exceed capacity sometime before 2012 when the flow is projected to be 0.147 MGD. Based on this information, the aerated pond capacity and sizing should be evaluated and improved shortly after 2001.

3.3.2.2 Organic Loading Considerations

Assuming that 3 mg/L of dissolved oxygen is maintained in the pond, and that the BOD discharge is limited to 25 mg/L at 85 percent removal, the existing pond must be limited to a maximum monthly BOD influent load of 183 lbs/day during winter and 263 lbs/day during summer.

Projected organic loadings related to flows expected in the future show that the existing pond will reach its organic loading capacity at the same time it reaches its hydraulic loading capacity. The pond should be evaluated for expansion of capacity shortly after 2001 as dictated by the hydraulic capacity limitations. Even though Breezy Point's WWTF does not have a BOD discharge permit, BOD loadings should be monitored to ensure the ponds maintain adequate capacity.

Organic loadings to the WWTF should continue to change at the same rate as the hydraulic loadings as long as the nature of the wastewater remains primarily domestic. However, if a significant industrial waste is added to the flows received at the WWTF, organic loading may become an important consideration.

3.3.3 Aeration Blowers

The existing aerated pond has coarse-bubble tube diffusers. They have an oxygen transfer efficiency of approximately 6%. With the three existing blowers, this means that the standard oxygen transfer rate is approximately 1050 lbs/day. In wastewater at Breezy Point, this converts to an actual oxygen transfer rate of 525 lbs/day. The MPCA requires a minimum supply of 2 pounds of oxygen for each pound of BOD loaded to the pond; therefore, the blower capacity is sufficient for treating a maximum daily load of 263 pounds of BOD per day.

The blower capacity will be exceeded shortly after 2001 when the BOD maximum monthly loading is expected to reach 260 lbs of BOD/day. In addition to this, the existing blowers are at or near the end of their useful service life.

The City currently operates the blowers an average of 8 hours per day from November through March.

The City has experimented with the use of a solar powered mixer called a Pond Doctor. Based on the data collected during the full-scale pilot study, the unit cannot furnish sufficient oxygen to maintain aerobic conditions. The City currently uses the existing aeration system for 8 hours per day from November through March and on an as needed basis from March through October.

The Pond Doctor appears to improve natural aeration (oxygen produced by algae) during sunny periods but cannot provide enough aeration to meet MPCA criteria. The evaluation of whether or not to continue the use of the Pond Doctor should be based on the energy payback realized from reduced mechanical aeration.

3.3.4 Storage Ponds

Breezy Point currently has a storage capacity of 30.7 million gallons in three storage ponds. MPCA requires a minimum of 210 days (7 months) storage capacity during non-discharge periods. This limits the wastewater flow during storage periods (October 1 to April 30) to an average of 146,200 gpd.

Flows are predicted to exceed the existing capacity of 146,200 gpd during winter storage periods about 2012, when they are expected to reach 147,000 gpd. Therefore, alternatives to improving storage capacity must be considered and evaluated before that time.

3.4 Spray Irrigation System

The original spray field at Breezy Point was permitted at an application rate of 47 inches per year; however, ponding occurred at 36 inches per year. The current NPDES permit limits irrigation to 33 inches per year. At this application rate, Breezy Point's current irrigation capacity is 70.8 mgy. This equates to 194,000 gpd. In 1998, a permit application for the Southwest Irrigation Fields was submitted to the MPCA, which will expand the total irrigated area to 110 acres. This field has not yet been approved. When the SW Irrigation Fields are approved, the capacity based on a 33-inches/year application rate will increase to 97.9 mgy, or an average annual flow of 268,200 gpd.

The capacities listed above may be reduced if more restrictive limits are adopted for spray irrigation application rates. The City of Nisswa has recently been issued a permit by the MPCA for spray irrigation. The permit includes irrigation of a golf course area. The final permitted application rate will be 13.5 inches per year. There are other spray irrigation sites in Minnesota, which have been permitted in the 15 inches per year range. The current available capacity at this application rate, including the 1998 SW Irrigation Fields expansion, would be 121,900 gpd.

At the currently permitted discharge rate with the SW Irrigation Fields included, the average annual capacity of the system should last somewhat beyond the year 2022 when the annual average flows are expected to reach 0.258 MGD. If more restrictive limits are placed on the discharge at Breezy Point WWTF, the capacity could be exceeded when the new permit is issued.

Given these considerations, the spray irrigation system capacity will need immediate consideration if more restrictive application rates are introduced. Therefore, a close watch of impending permit limits should be made and appropriate actions taken to evaluate expansion of the irrigation fields or other discharge options.

3.5 Irrigation Pumps

There are two existing irrigation pumps. One of the irrigation pumps has been replaced, but the other is original equipment, and will likely require replacement soon. The pumps are vertical turbine pumps rated for 660 gpm at 108-psi discharge head. Assuming that the system could be operated an average of 16 hours per day even during a wet summer, the total irrigation capacity would be 101.3 mgy based on the average pumping rate of the irrigation pumps with one pump out of service. The capacity for a twelve-month flow with an eight-hour day operation schedule would yield an existing capacity of 138,800 gpd average annual flows. The existing capacity could be increased to 277,500 gpd by switching to a 16-hour operating schedule.

Expansion of the capacity of the existing pumps would probably be necessary shortly after the year 2017 when the average annual flow is expected to reach 0.224 MGD.

4. WASTEWATER TREATMENT ALTERNATIVES

Any expansion of the wastewater treatment facility for Breezy Point must be capable of meeting requirements and constraints imposed by the EPA, the Minnesota Statutes and Rules, the MPCA, the City of Breezy Point and the general public. Among these requirements are:

1. Meeting effluent limits to the waters of the state as required by the State Rules and enforced by MPCA.
2. Design criteria as set forth in Ten States' Standards.
3. Sludge disposal requirements as established by the EPA and regulated by MPCA.

In addition to these legal requirements, the City and the general public will also have a list of requirements.

1. The new facility should make use of the old facility to the fullest extent practical.
2. New processes should be located on City-owned land.
3. Public nuisances such as odors, noise, traffic impedance and eyesores should be minimized.
4. The facility should be cost-effective and easy to operate with low operation and maintenance costs.

Wastewater treatment can be accomplished in two basic ways: mechanically or naturally. Natural treatment systems require more time and space than mechanical systems, but minimize the amount of human-generated energy sources required for treatment. An example of a natural system is the facultative (without aeration) stabilization ponds that are used by many small communities.

One step above stabilization ponds in terms of complexity and quality of effluent are mechanically aerated ponds. The existing treatment facility at Breezy Point falls into this category. By aerating the primary cell, the City is able to treat wastewater with considerably less land than would be required for stabilization ponds. Aerated ponds, however, are not capable of meeting the requirements that would likely be implemented for discharge to surface water in the Breezy Point area.

Fully mechanical treatment systems offer a multitude of possibilities for wastewater treatment and disposal. Mechanical treatment systems usually consist of preliminary, primary, and secondary treatment plus separate sludge stabilization, storage and disposal. Preliminary treatment can include coarse screening, grit removal, comminution, septage handling, flow equalization and odor control. Preliminary treatment protects downstream processes, conditions the wastewater and prevents public nuisance conditions from developing at the wastewater treatment site.

Primary treatment may include sedimentation, pre-aeration, chemical coagulation, fine screening and dissolved air flotation. Primary treatment is basically solids separation and deals with capture of insoluble material suspended in the wastewater. Typically, 50 to 60% of TSS and 25 to 35% of BOD are removed with primary treatment. Many small mechanical plants do not include primary treatment as the secondary treatment systems can be cost-effectively designed without it.

Secondary treatment uses biological processes in conjunction with sedimentation to first convert soluble biodegradable materials into carbon dioxide, water and microorganisms. With a suspended-growth biological process such as activated sludge, the microorganisms are kept in suspension in a reactor to enhance contact with influent wastewater. Solids separated from the treated water are either returned to the reactor to maintain the appropriate population of microorganisms, or, if not needed, wasted to the sludge treatment process. Fixed-growth processes such as trickling filters allow microorganisms to grow on a support structure with wastewater flowing through. Solids are separated downstream and wasted to the sludge treatment process. There are many permutations of secondary treatment. Two that have been used successfully to treat wastewater in Minnesota are sequencing batch reactors (SBR) and oxidation ditches.

Sludge treatment processes are necessary to stabilize sludge wasted from secondary treatment processes. Stabilization significantly reduces pathogens (Class B) and may further reduce pathogens (Class A), depending on the treatment process selected. Class B processes that have been used successfully in Minnesota include thermal treatment, lime treatment, anaerobic digestion, aerobic digestion, composting and air drying. Class A processes which have been used in Minnesota include heat treatment, thermophilic aerobic digestion and pasteurization. In Minnesota sludge is typically disposed of by land application.

Breezy Point has a number of options for upgrading the wastewater treatment faciltiy. This report will further consider the three options that appear to offer the most cost-effective solutions and future flexibility for the City:

Option 1 - Expansion of the existing pond system

Option 2A - Construction of a sequencing batch reactor system

Option 2B - Construction of an oxidation ditch system

Option 1 was considered in the 1999 series of memos. Information presented at that time has been updated in this report.

For option 2, sludge treatment will be required. The sludge treatment system could be the same for either of the considered secondary treatment processes.

For purposes of planning, it has been assumed that the City will wish to undertake wastewater related projects no more frequently than once every five years. All costs given in this report are applicable for 2001 construction.

4.1 Pumping Station #1 and Influent Force Main

Pumps are typically assumed to have a design life of 15 years. If it is assumed that the City must always have a firm capacity equal to the projected Peak Hourly Flows, that Pumping Station #1 will continue to be a duplex lift station, and that the pumps will have a design life of 15 years the following projects will be necessary:

Table 4-1 – Schedule for Lift Station Upgrade

Year	Project	Cost
2000	Replace existing 425 gpm/20 HP pump with 830 gpm/30HP pump	$30,000
2002	Replace impeller in 530 gpm pump (new capacity may be as much as 675 gpm	$5,000
2012	Replace 675 gpm/25 HP pump with 1040 gpm/50 HP pump Add overflow manhole to increase pump down time to 2 min. Replace 830 gpm/30 HP pump with 1040 gpm/50 HP pump	$90,000
2020+	1040 gpm/50 HP pumps can have impellers replaced as necessary to increase capacity to a maximum flow of approximately 1200 gpm	$5,000

The first project has been completed. The second is being evaluated by the operations staff along with the possibility of purchase of a new or rebuilt pump.

Upgrade of the Lift Station will be required regardless of the future expansion plans for the secondary treatment system; however, the nature of the upgrade could be different. If the secondary treatment process includes a clarifier, it may be necessary to upgrade the pumping station controls with variable frequency drives. This upgrade would allow the pumps to run at lower speeds and would protect the clarifiers from upsets caused by the on-off operation of the lift station. This type of an upgrade would cost approximately $50,000 in addition to the cost of the new pumps.

The influent force main will not require upgrade during the project design life.

4.2 Municipal Wastewater Treatment Facility

The existing liquid treatment train includes one aerated pond followed by three storage ponds. The treated wastewater is discharged to forested spray irrigation fields. Because wastewater is treated in a pond system, Breezy Point does not currently have or need a dedicated solids treatment train.

4.2.1 Preliminary Treatment Processes

4.2.1.1 Comminutor

The comminutor was replaced with a mechanical bar screen in 2001.

4.2.1.2 Bar Screen

By replacing the comminutor with a bar screen, the problems listed above can be avoided; however, the screenings will have to be disposed of in a landfill, a task which is not currently required.

Removal of screenable material should be done for aerated pond systems and is an absolute requirement for mechanical systems such as SBRs or oxidation ditches.

If the comminutor is replaced with a bar screen, it may be possible to specify a piece of equipment which will fit into the existing comminutor room; however, a building expansion will likely be necessary. The cost of a bar screen will range from $150,000 to 250,000 assuming that a building expansion is not necessary. If a building expansion is necessary, an additional $25,000 to 50,000 should be budgeted.

4.2.1.3 Grit Removal

Grit removal is not required for aerated pond systems; however, it should be installed for activated sludge systems.

Grit removal equipment could be installed downstream from a new bar screen in a building expansion. There are several options for grit removal; however, the most applicable option for Breezy Point would be a vortex grit removal system. This type of system would be capable of removing 98% of grit greater than 50 mesh (0.3 mm), 90% of grit from 50 to 70 mesh (0.22 mm) and 75% of grit from 70 to 100 mesh (0.15 mm). Aerated grit removal is an alternative to vortex grit removal. Aerated grit removal requires more space and is less efficient than vortex grit removal.

The benefit of a grit removal system is the reduction in the amount of sand discharged to the activated sludge system. This would have the effect of reducing the frequency of cleaning the concrete tanks. In addition, wear on all sludge handling pumps would be reduced.

A cost estimate is given below for a typical system.

Table 4-2 – Capital Costs for Grit Removal

Item	Cost
Demolition	$10,000
Equipment	70,000
Concrete	15,000
Installation	30,000
Building space	20,000
Subtotal	$120,000
Engineering	24,000
Project Total	$144,000

4.2.2 Secondary Treatment Processes

4.2.2.1 Option 1 – Expansion of the Aerated Pond

To meet summer design flows of 0.406 mgd and winter design flows of 0.199 mgd in 2022, an additional aerated pond 10 feet deep with a volume of 5.4 million gallons could be constructed. This additional capacity will provide summer and winter combined detention times for both ponds of 25 days and 41 days respectively for the 2022 design flows.

The new aerated pond (Pond 1a) will be approximately the same size as the existing aerated pond. It should be possible to operate the aerated ponds in parallel or series. There are two possibilities for locating Pond 1a: west of Pond 1, or in the western portion of Pond 2.

If Pond 1a is located to the west of Pond 1, approximately 4 acres of the existing spray irrigation area will be lost. If Breezy Point is allowed to continue irrigation at the currently permitted rates, the loss of area will reduce the average annual flow capacity of the irrigation sites to 258,400 gpd. This would be sufficient to serve until 2015.

If Pond 1a is located in Pond 2, approximately 7 million gallons of storage capacity will be lost. This capacity would have to be replaced immediately.

Because Breezy Point has more irrigation capacity than storage capacity, and because irrigation capacity is less expensive to replace, the most cost-effective location for Pond 1a is probably west of Pond 1. This issue should be examined more thoroughly during preliminary design.

The construction cost for Pond 1a should be $550,000 to 650,000 plus the cost of aeration equipment.

If it becomes necessary for Breezy Point to discharge to surface water in the future, it will be necessary to install chemical feed equipment and a sand filtration unit. The cost of this equipment is shown in Table 4-3

Table 4-3 – Phosphorus Removal Upgrade for Aerated Pond

Description	10-Year	20-Year
Chemical Handling Equipment	$55,000	$30,000
Sand Filter with Building	440,000	200,000
Recirculation Pumping	100,000	40,000
Subtotal	$595,000	$270,000
Contingencies	89,000	41,000
Construction Cost	$684,000	311,000
Engineering, Legal, Administrative	137,000	62,000
Total	**$821,000**	**$373,000**

4.2.2.1.1 Aeration

Two of the existing blowers are at or near the end of their useful service life. One has been recently replaced. If coarse-bubble diffusers are used in the additional pond, the total blower capacity necessary for the 20-year design period is 1,720 standard cubic feet per minute (scfm). This means that an additional 1020 scfm will be required to support the additional aerated pond. To meet this air capacity requirement, three additional blowers sized the same as the existing blowers will be necessary to provide an additional firm blower capacity of 1,050 icfm. In addition to the new blowers, two of the existing blowers are ready to be replaced.

In the years since the existing aeration system was installed, many communities have had success in aerating stabilization ponds with floating mechanical aerators or aspirators. If additional aeration is required for Pond 1, this will be the most economical option. To make up the gap between the current Pond 1 aeration capacity and the full capacity, two 5 HP floating aspirators could be installed at a cost of $10,000 to 15,000. To completely replace the aeration system in Pond 1 would require four 10 HP aspirators. This would cost $60,000 to 80,000.

When Pond 1a is constructed, it will require approximately 40 HP of floating aspirators. This would cost $60,000 to 80,000.

4.2.2.2 Option 2 - Activated Sludge

Activated sludge is the most popular mechanical wastewater treatment process. It is very flexible and can be adapted to almost any type of biological waste treatment problem. The process utilizes aeration tanks for maintaining dissolved-oxygen levels and return and waste activated sludge for maintaining biological activity. In a conventional activated sludge process, the wastewater and recycled activated sludge are mixed in the aeration tank and are aerated by diffused-air or mechanical aeration. During the aeration period, adsorption, flocculation, and oxidation of organic matter occurs. Treated water is separated from solids in a secondary clarifier before exiting the plant. Activated sludge processes produce residuals that require stabilization before land application.

For Breezy Point, selection of the activated sludge process would allow the use of the existing aerated pond for storage. The existing aeration system could be abandoned.

One advantage of some activated sludge systems is that phosphorus can be removed biologically with chemical back-up. If Breezy Point ever has the need to discharge to surface water such as a stream or lake, phosphorus removal will likely be necessary.

The two options being considered for activated sludge treatment at Breezy Point are sequencing batch reactors and oxidation ditches.

4.2.2.2.1 Process Layout

Figure 4-1 shows the existing wastewater treatment processes as they would fit into an upgrade incorporating mechanical secondary treatment. The main modifications of existing processes would be to remove all of the existing aeration equipment from Pond #1 and to reconstruct the control structure in Pond #1 to allow its use as a storage pond.

Options 2A and 2B are both shown on the diagram for purposes of comparison. Only one option would actually be selected.

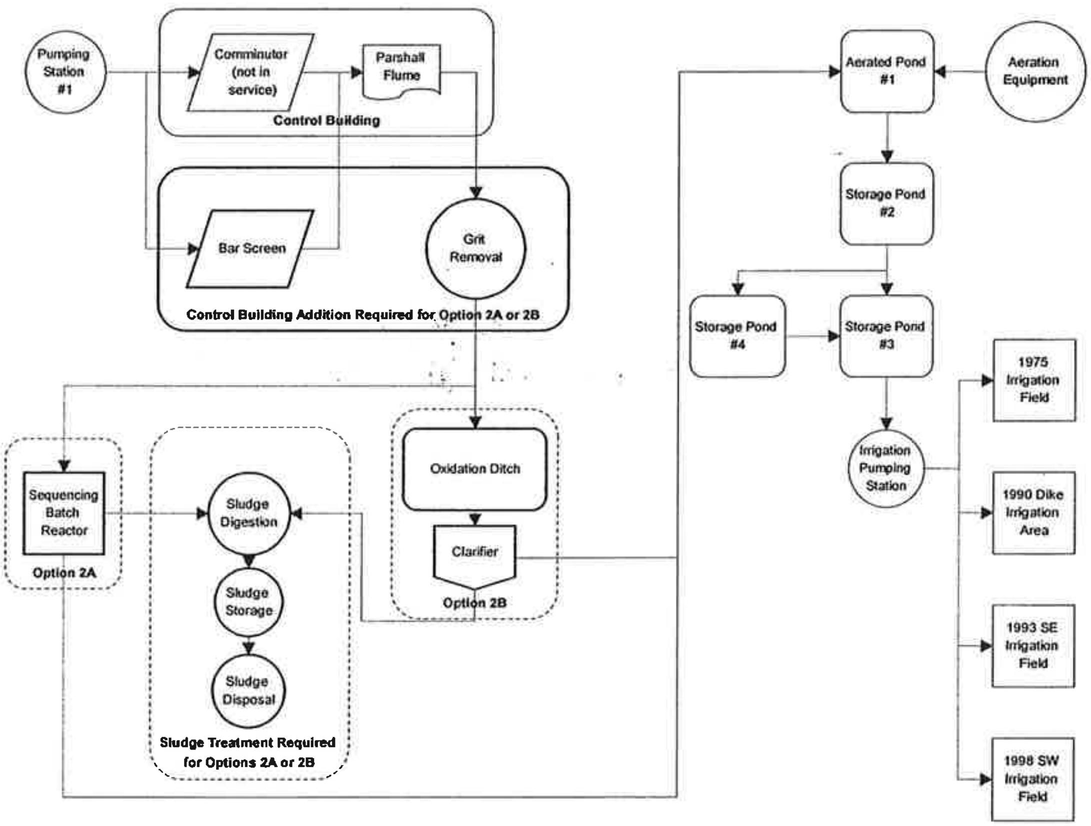

Figure 4-1 – Process Schematic

By making these revisions, the storage capacity could be increased to an average flow of 167,000 gpd during the storage period (October 1 to April 30).

4.2.2.2.2 Option 2A - Sequencing Batch Reator (SBR)

The Sequencing Batch Reactor (SBR) process involves a single, complete-mix reactor in which all steps of treatment typical for an activated sludge process occur. Separate cycle times are used for fill, react, settle, and decant. The SBR is a batch process and usually requires multiple tanks or flow equalization prior to fill. Withdrawal from an SBR is intermittent and therefore requires a flow equalization (surge) tank downstream to the SBR. For Breezy Point, the storage ponds act as a downstream flow equalization tank. Anaerobic and anoxic mixing periods required for biological nutrient removal are achieved within the same reactor by simply modifying the cycle time and controlling the air supply. SBRs operated to enhance biological phosphorus removal are capable of achieving 70 to 80% removal of phosphorus.

The SBR offers a greater amount of flexibility in both operation and planning in comparison with oxidation ditch alternatives. The SBR has high tolerance for peak flows and shock loadings, which would also be an advantage for Breezy Point given the seasonal fluctuations in flow and the intermittent flow of the influent lift station. Elimination of secondary clarifiers and RAS pumping significantly reduces the capital cost.

A two-tank SBR system could be constructed to handle the initial flow as well as the 20-year design flow. If the City wishes to stage construction, a two-tank system could be constructed initially to treat the 10-year flow with a third tank added in ten years.

SBRs produce sludge as a wastewater residual in quantities comparable to other conventional activated sludge processes and therefore, need sludge treatment facilities.

4.2.2.2.3 Option 2B - Oxidation Ditch

The oxidation ditch has been one of the most common permutations of extended aeration activated sludge applied to municipal wastewater treatment. An oxidation ditch consists of a concrete raceway type aeration basin with mechanical aeration. The two most common methods of aeration are horizontal-shaft aerators (brush aerators) and vertical-shaft aerators (surface turbines). The rotation of the aerator maintains a flow velocity sufficiently high to maintain the suspension of mixed liquor.

The oxidation ditch is simple yet rugged and efficient. It has an excellent track record of operation in Minnesota. It offers the advantage of a high degree of reliability in mechanical performance.

Like SBRs, oxidation ditches produce sludge as a wastewater residual in quantities comparable to other conventional activated sludge processes and therefore, need sludge treatment facilities.

Conventional oxidation ditches can be modified with two anaerobic cells and an anoxic cell to incorporate biological nutrient removal. The modified oxidation ditch, is capable of achieving 60%-70% TP removal. The process can also nitrify and denitrify.

The oxidation ditch is not very flexible and will not be effective in handling the fluctuation in low flows (initial operation) and high flow (20-year design). For this reason, it would be necessary to stage construction of the oxidation ditches. The initial project would consist of two ditches and two clarifiers sized to handle the 10-year design flow. In year 10, a third ditch and clarifier could be added to allow the system to treat the 20-year design flow.

Of the systems considered, the oxidation ditch has the highest capital construction cost, due to the large concrete basins which must be constructed for the clarifiers as well as the aeration tank. Grit removal is necessary to prevent excessive wear on the mechanical aerators and to avoid deposition in the aeration tanks.

4.2.2.2.4 Capital Cost Comparison

Table 4-4 details the capital costs associated with the secondary treatment processes discussed above. These costs do not include the cost of preliminary, primary and sludge treatment upgrades. They are presented here for purposes of comparison. Detailed project costs are given later in Chapter 4.

Table 4-4 – Capital Costs for Option 2A and 2B

Item	SBR		Ox. Ditch	
	10-yr	20-yr	10-yr	20-yr
Aeration Tank				
Equipment	$260,000	$130,000	$220,000	$145,000
Installation	150,000	80,000	110,000	70,000
Concrete	185,000	90,000	130,000	70,000
Clarifier				
Equipment			120,000	60,000
Installation			55,000	25,000
Cover			30,000	15,000
Concrete			70,000	35,000
Yard Piping	50,000	20,000	70,000	40,000
Electrical/Controls	200,000	50,000	150,000	30,000
Control/Blower Building	200,000		200,000	
Subtotal	$1,045,000	$370,000	$1,155,000	$490,000
Contingencies	157,000	56,000	173,000	74,000
Construction Cost	$1,202,000	$426,000	$1,328,000	$564,000
Engineering, Legal, Administrative	240,000	85,000	266,000	113,000
Total	**$1,442,000**	**$511,000**	**$1,594,000**	**$677,000**

Contingencies are included at a rate of 15% of the subtotal of equipment and installation costs. Engineering, legal and administrative costs include preparation of plans and specifications, costs associated with bidding, costs associated with bonding, construction observation and time required for administrative functions of the City associated with this project. These costs are estimated to be 20% of the construction contract total.

4.2.2.2.5 Operation and Maintenance Costs Comparison

Operation and maintenance costs for the two options should be similar. Both options will produce similar quantities of waste sludge. Both options will require more personnel for operation of the process and maintenance of the equipment. Projections for annual O&M costs are given in detail late in Chapter 4.

4.2.3 Sludge Treatment Process

The existing system does not require a sludge treatment process other than dredging ponds as sludge accumulates to depths above 18 to 24 inches. Typically, this is done every 20 to 40 years, depending on how close the system is operated to capacity.

A new secondary treatment process will produce sludge in quantities of approximately 1 lb per 1000 gallons of wastewater treated. At this production rate, the system will require sludge treatment for the quantities of sludge shown in Table 4-5.

Table 4-5 – Sludge Production

Year	Daily Volume @ 2.5% solids (gal/day)	Annual Production (T/yr)
2007	753	29
2012	911	35
2017	1074	41
2022	1237	47

Stabilization of the sludge is an important step before final disposal by land application. Stabilization can be designed and operated to achieve Class A or Class B categorization. Class B systems stabilize sludge with a Process to Significantly Reduce Pathogens (PSRP). PSRPs reduce fecal coliform bacteria to less than 2 million MPN per gram of total solids (dry weight basis). Class A systems stabilize sludge with a Process to Further Reduce Pathogens (PFRP). PFRPs reduce fecal coliform bacteria to less than 1000 MPN per gram of total solids (dry weight basis).

Class A sludge that is also categorized as "exceptional quality" (EQ) is not subject to the EPA Part 503 general requirements and management practices for land application. Its use following processing is unrestricted.

Class B sludge is subject to site restrictions on crop harvesting, animal grazing and public access for a certain period of time following land application. The area required for land application depends on the available nitrogen in the sludge, the type of soil in the field, the type of crop grown and, most importantly, the quantity of setbacks, wetlands and sloped areas. Breezy Point would require between 40 and 120 acres of agricultural land for land application of liquid sludge.

Typically, for quantities of land this small, land can be acquired through agreements with local farmers.

As an alternative to liquid sludge processing, Reed Beds are a simple way of treating and storing sludge which has gained popularity for small communities in Minnesota. Reed Beds generate Class B sludge. The reed bed process combines the use of common reed plants (phragmites communis) and a conventional under-drained sand bed. During warm months, the reeds grow in the sand bed and enhance dewatering and stabilization of the wastewater biosolids in three ways. First, root and stem growth penetrate the sludge and provide drainage pathways. This allows more rapid gravity drainage and prevents clogging of the sand layer. Second, the root structure increases the area of contact between the atmosphere and sludge. This increases evaporation. Finally, the plants take up water through their roots and evapo-transpire to the atmosphere through their emergent portions.

Stabilization of the biosolids is enhanced by reeds as well. The stem and root zone, or rhizosphere, provide a conduit for oxygen to the subsurface layers of biosolids. This provides a environment which can support a population of aerobic and facultative micro-organisms. These micro-organisms mineralize organic matter in the sludge to H_2O, CO_2, and N_2. This reduces the volatile solids percentage and total nitrogen. Typically, sludge with a volatile solids concentration of 60% when applied will have a VSS of 25% when removed. This amounts to a 35% reduction in biosolids on a dry weight basis.

During the winter, the reeds are dormant and, therefore, will not take up water and nutrients. Biological activity in the rhizosphere also ceases; therefore, further stabilization of the sludge will be limited. However, due to the severely cold temperatures experienced in Minnesota during winter, it is possible to dewater by freezing and thawing the sludge. The solids concentration of sludge immediately following thawing will be 20-25%.

Under-drainage is collected and pumped to the head of the secondary treatment process. Typically, sludge can be applied to a single reed bed for 7 to 10 years before it is necessary to abandon the bed or remove the dried sludge solids for permanent disposal to farmland.

Sludge loading rates for the reed beds vary depending on the sludge stabilization process. Aerobic sludge is more amenable for reed beds dewatering than anaerobic sludge. Chemical-laden sludge further limits the solids loading rate. For aerobic sludge, a loading rate of 8-10 lbs/sf-yr is typically used. For anaerobic sludge, reed beds loading rate of 5 to 8 lbs/sf-yr is more common. Initially, an appropriate loading rate for Breezy Point would be 10 lbs/sf-yr. If a surface discharge becomes necessary in the future, the loading rate would need to be reduced to 8 lbs/sf-yr. At this loading rate, the City would need 8,000 sf of reed bed cells for the 10-year design. To improve the dewatering capabilities and to facilitate effective subnatant collection, a cluster of 2 reed beds each with a surface area of 4,000 sf could be constructed initially. In Year 10, additional cells could be constructed to handle the additional biosolids and chemical sludge if necessary. In addition to the reed bed cells, a 60-day storage tank with mechanical mixing and two submersible lift stations would also be required. There would be no advantage to staging construction of the storage tank due to its small size.

Capital costs associated with reed beds are presented in Table 4-6. There are other methods of storing, stabilizing and disposing of sludge; however, there is not another alternative which will be significantly less expensive on a capital or O&M costs basis. If the City wishes to produce a Class A product for distribution, capital costs will increase.

Table 4-6 – Capital Costs for Sludge Processing

Item	Cost	
	10-year	20-year
Sludge Storage Tank	$95,000	
Reed Beds		
Gravel	17,000	$17,000
Sand	4,000	4,000
Earthwork	12,000	12,000
Perforated Pipe	8,000	8,000
Manifold	5,000	5,000
Reeds installation	30,000	30,000
Concrete	100,000	100,000
Liner	8,000	8,000
Valves	6,000	6,000
Distribution Piping	8,000	8,000
Subnatant lift station	60,000	
Reed Bed Pump Station	60,000	
Subtotal	$413,000	$181,000
Contingencies	62,000	27,000
Construction	$475,000	$208,000
Engineering, Legal, Administrative	95,000	42,000
Total	**$570,000**	**$250,000**

4.2.4 Storage Ponds

Additional storage will be required to allow the City to maintain 210 days of storage during winter months beyond 2010. The exact amount of storage which should be constructed will need to be determined at that time. The current extent of the City property includes only one area which is not currently being used and which would be suitable for a storage pond. It is located north of Pond 4. This area is lower than the other ponds and is adjacent to some wetland areas, but could potentially be used to construct a new pond with a storage capacity of 9 million gallons. This would give the City storage capacity in excess of what would be required in 2020. The cost of constructing this new pond would be $550,000 to 650,000. If the City constructs new secondary treatment facilities, the existing aerated pond can be converted for use as storage. This would reduce the required amount of additional storage.

4.2.5 Spray Irrigation Fields

It is not possible with the current information to accurately project the service life of the existing irrigation fields. The City should be aware of the potential problems associated with reduced application rates and take opportunity to purchase additional adjacent land as it becomes available. For each 40-acre parcel of land, the City can expect to get about 20 to 25 acres of irrigable land. The cost for each 40-acre site will range from $300,000 to 450,000 depending on the cost of the land, the type of labor used and the actual amount of irrigable land.

4.2.6 Spray Irrigation Pumps

The spray irrigation pumps have sufficient capacity to treat the average annual flow for the next 20 years. The capacity of the irrigation pumps should be evaluated when it becomes necessary to expand or improve the existing spray irrigation fields, which may be immediately necessary.

As with the expansion of the irrigation fields, the pump sizing necessary in 2015 is difficult to predict now and additional flow projections will be required at that time. It will be necessary to replace one of the pumps in the near future as it is near the end of its service life. Replacement of this pump will cost $20,000 to 40,000.

4.3 Financial Analysis

4.3.1 Capital Costs

Table 4-7 shows capital costs for the three options previously discussed. The aerated pond option assumes that surface discharge—and therefore phosphorus removal—will not be required in the future. If it were required immediately, the capital costs would increase by $821,000 for the 10-year design and $373,000 for the 20-year design. The range given for the total reflects this increase. In actuality, it is possible that it will not be necessary for many years, if ever, for the City to discharge to surface water.

Table 4-7 – Capital Cost Comparison (10-Year Design)

Description	Aerated Pond	SBR	Ox. Ditch
Pumping Station and Influent Force Main	$35,000	$35,000	$85,000
Preliminary Treatment			
Bar Screen	250,000	250,000	250,000
Grit Removal		144,000	144,000
Secondary Treatment System	810,000	1,442,000	1,594,000
Sludge Treatment		570,000	570,000
Storage Ponds			
Spray Irrigation Fields	450,000		
Spray Irrigation Pumps	40,000	40,000	40,000
Total	**$1,585,000 to $2,406,000**	**$2,481,000**	**$2,683,000**

If the flow increases as projected previously, another upgrade will be necessary in approximately 2012. Table 4-8 shows the capital costs for the three options for the upgrades necessary at that time.

Table 4-8 – Capital Cost Comparison (20-Year Design)

Description	Aerated Pond	SBR	Ox. Ditch
Pumping Station and Influent Force Main	$90,000	$90,000	$90,000
Preliminary Treatment			
Bar Screen			
Grit Removal			
Secondary Treatment System		511,000	677,000
Sludge Treatment		250,000	250,000
Storage Ponds	650,000	550,000	550,000
Spray Irrigation Fields	450,000	450,000	450,000
Spray Irrigation Pumps			
Total	**$1,190,000 to $1,563,000**	**$1,851,000**	**$2,017,000**

4.3.2 Operation and Maintenance Costs

A cost comparison summary O&M costs for the initial, 10th year and 20th year of operation is given in the following three tables. Again, the range given for the aerated pond option reflects the additional costs associated with chemical addition for phosphorus removal.

Table 4-9 – O&M Costs (Initial Year)

Description	Aerated Pond	SBR	Ox. Ditch
Salaries and Benefits	$93,000	$93,000	$93,000
Utilities	8,900 to 9,200	6,900	7,900
Chemicals	0 to 21,000	1,000	1,000
Equip. Maintenance and Repair	14,200 to 21,300	15,700	17,300
Depreciation	47,800 to 82,000	79,100	86,200
Outside Services	4,400	4,400	4,400
Administrative	7,800	7,800	7,800
Misc.	13,700	13,700	13,700
Total	**$189,800 to 252,400**	**$221,600**	**$231,300**

Table 4-10 – O&M Costs (Year 10)

Description	Aerated Pond	SBR	Ox. Ditch
Salaries and Benefits	$106,000	$106,000	$106,000
Utilities	12,000 to 12,400	9,100	10,500
Chemicals	0 to 27,700	1,400	1,400
Equip. Maintenance and Repair	23,100 to 33,800	26,200	28,500
Depreciation	79,800 to 131,100	130,600	136,600
Outside Services	4,400	4,400	4,400
Administrative	8,900	8,900	8,900
Misc.	13,700	13,700	13,700
Total	**$247,900 to 338,000**	**$300,300**	**$310,000**

Table 4-11 – O&M Costs (Year 20)

Description	Aerated Pond	SBR	Ox. Ditch
Salaries and Benefits	$122,000	$122,000	$122,000
Utilities	15,600 to 16,100	11,700	13,600
Chemicals	0 to 29,100	2,000	2,000
Equip. Maintenance and Repair	23,100 to 33,800	26,200	28,500
Depreciation	79,800 to 131,100	130,600	136,600
Outside Services	4,400	4,400	4,400
Administrative	10,200	10,200	10,200
Misc.	13,700	13,700	13,700
Total	**$268,800 to 360,400**	**$320,800**	**$331,000**

4.3.3 Cost-Effective Analysis

The cost-effective analysis of the three options follows guidelines established by the EPA and MPCA. Costs include estimated capital, operation, maintenance, replacement and salvage values. All costs are presented in terms of present worth value with the following assumptions:

1. The service life of various components are assumed to be:
    a. Land – permanent
    b. Concrete, masonry and earthen structures – 40 years
    c. Piping systems – 40 years
    d. Mechanical process equipment – 20 years
    e. Electrical, HVAC and auxiliary equipment – 20 years
2. The design period is 20 years
3. The time-value of money is 6%
4. Inflation is not applied to future costs. Inflation should be considered on an annual basis when connection and user fees are established.

The benchmark for costs presented here can be based on the Engineering News Record construction cost index (Oct 2001 = 6396.50)

Table 4-12 summarizes the cost-effective analysis.

Table 4-12 – Cost-Effective Analysis

Item	Aerated Pond	SBR	Ox. Ditch
1. Initial Construction	$1,585,000 to 2,406,000	$2,481,000	$2,683,000
2. Present Worth O&M Cost	2,634,000 to 3,440,000	3,119,000	3,244,000
3. Future Construction	1,190,000 to 1,563,000	1,851,000	2,017,000
4. Present Worth of Future Construction	653,000 to 858,000	1,016,000	1,107,000
5. Salvage Value	-1,500,000 to -1,687,000	-2,236,000	-2,472,000
6. Present Worth of Salvage Value	-452,000 to -508,000	-673,000	-745,000
Total Present Worth (1+2+4+6)	**$4,420,000 to 7,212,000**	**$5,943,000**	**$6,289,000**

The cost-effective analysis shows clearly what is obvious from the capital cost estimates and O&M cost estimates: expansion of the existing system is the most cost-effective alternative. It is not surprising that this is the conclusion, given the fact that expansion of the existing system has lower capital and O&M costs than the other alternatives considered. The main advantage of the activated sludge alternatives is that they are applicable for phosphorus removal and discharge to surface water if that becomes a requirement in the future.

The existing system cannot be economically upgraded to allow discharge to surface water at the discharge standards that would likely be required. If phosphorus removal and surface water discharge becomes necessary in the future after the aerated ponds have been upgraded, it will be necessary to add chemical addition and sand filtration equipment to meet the standards. This type of system would commit the City to higher O&M costs (due primarily to the cost of phosphorus removal chemicals) than either of the activated sludge alternatives. The higher numbers for the aerated pond cost-effective analysis reflect these costs for a system discharging 100% to surface water.

In summary, if the City were required to construct a surface water discharge immediately, and discharge 100% to surface water, the aerated pond option would not be cost-effective. The longer the time until the City has to construct a surface water discharge, and the higher the percentage of water which continues to be spray irrigated, the more cost-effective the aerated pond option becomes.

5. IMPLEMENTATION SCHEDULE

5.1 Assumptions

The assumptions made in preparing Table 5-1 are listed below:

1. Growth will occur as outlined previously.
2. The ratio of seasonal to permanent residents will remain the same.
3. Construction projects will be scheduled no more frequently than once every 5 years.
4. All construction projects can be completed during the same season in which they are begun.
5. Construction contingencies at a rate of 15% and engineering, legal and administrative costs are included in the estimates at a rate of 20% of construction costs.
6. Spray irrigation will continue to be allowed at a rate of 33 inches/year.

5.2 Recommended Plan and Schedule

Table 5-1 summarizes the cost and scope of the projects which should be planned for over the next 20 years.

Table 5-1 – Project Schedule

Year	Scope	Cost
2002	1. Construct new bar screen to replace comminutor 2. Replace aeration in Pond 1 3. Construct Pond 1a 4. Install aeration in Pond 1a 5. Replace spray irrigation pump 6. Replace impeller in 530 gpm pump	$1,585,000
2012	7. Replace 675 gpm/25 HP pump with 1040 gpm/50 HP pump 8. Replace 830 gpm/30 HP pump with 1040 gpm/50 HP pump 9. Add overflow manhole at Lift Station 1 10. Construct storage Pond 11. Construct additional spray irrigation fields	$1,190,000

5.3 Actions Required to Implement the Plan

The following actions by the Breezy Point City Council will be required to implement the plan discussed above.

1. ***Review the assumptions and suggest revisions to the assumptions where appropriate.*** For example: more or less growth may be desirable, scheduling of construction activities can be revised, etc.

2. ***Determine whether or not to pursue state PFA funding.*** Low-interest loans may be available for part or all of the work. Securing a low-interest loan will require MPCA approval of the Facilities Plan. The Facilities Plan must be submitted to MPCA by April 12, 2002 in order to secure funding for 2003 construction. For small projects, the cost of securing the loan (additional cost of Facilities Plan, cost of payroll reporting and prevailing wages during construction) will outweigh the benefit of the loan.

3. ***Order operator to evaluate equipment identified as nearing the end of its service life.*** One lift station pump, one spray irrigation pump and the existing aeration equipment may need replacement in the near future. The operator can make a judgment based on O&M experience as to the urgency of replacing each item. If a substantial construction project is

implemented soon, it will be more cost-effective to replace this equipment as a part of that project.

4. ***Order preparation of Facilities Plan (if applicable).*** All of the work presented in this Engineering Report is applicable to a Facilities Plan. A Facilities Plan will also include additional information required by the MPCA. MFRA can prepare a scope of services for either alternative.

5. ***Review and update Sewer Service fees.*** The City should be sure that future growth will continue to pay for necessary expansions of the WWTF. User fees should continue to pay for operation and maintenance costs.

6. ***Order preparation of plans and specifications for 2002 projects.*** If the City decides not to pursue PFA funding, MFRA can begin preparation of plans and specifications for construction in 2002. If the City does decide to pursue PFA funding, the City should wait until after the Facilities Plan receives MPCA approval before ordering plans and specifications for construction in 2003.

7. ***In 2010, re-evaluate growth and develop a final plan for the next phase of the project.*** The City should continue to plan for the costs described above; however, the detailed design of each future project will vary as the City's growth varies from projections.