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VILLAGE OF SISTER BAY
DOOR COUNTY, WISCONSIN

WELLHEAD PROTECTION PLAN

MAY 1996

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EXECUTIVE SUMMARY

PURPOSE

Wellhead protection has become an important aspect of municipal planning in Wisconsin. Almost 94% of municipalities in the state utilize groundwater as the main source of supply for their community water systems. Two-thirds of state extracts 570 million gallons of groundwater per day to supply drinking water. The village of Sister Bay began providing public water from groundwater in 1972.

Amendments to the federal Safe Drinking Water Act governed by the United States Environmental Protection Agency (USEPA) included requirements for wellhead protection programs in 1986. Wisconsin favored this action as it corresponds with goals listed in state statutes (S.160.001, Wis. States.) to prevent the contamination of groundwater supplies and to protect the health, safety, and general welfare of the public.

The community water supply for the village of Sister Bay is especially prone to contamination due the thin, and in some cases non-existent covering soils, and an aquifer consisting of fractured dolomite. Two nearby Door County communities, Ephraim and Sturgeon Bay, have problems with bacteriological contamination in their water supply wells.

This wellhead protection plan includes the following items:

1. A review of available information pertaining to soil and geological characteristics, land use, population projections, and water distribution system requirements for both present and future needs.

2. An evaluation of alternative sites for a proposed third well station.

3. Identification and description of the wellhead protection area.

4. A basis for implementing a wellhead protection plan, that includes a protection ordinance, a contingency plan, a water conservation program, and a public education program.

Hydrogeologic Setting

The Silurian dolomite is the major source of groundwater in Door County. The Silurian dolomite consists of two formations; the Niagara and Alexandrian series. Well yields are highly variable. The vertical and horizontal bedding plan joints form the principle water bearing zones in the system. Most of the water in the upper Niagaraian aquifers is contained in the vertical joints, whereas the larger and more continuous bedding plane joints yield most of the water in the lower Niagaraian and Alexandrian formations.

Precipitation in the form of rain or snow is the primary recharge mechanism for these aquifers. The vertical and horizontal bedding planes provide a means whereby surface water can rapidly enter the aquifer.

The overlying soils are thin ranging in thickness from 0 (bedrock at surface) to over 5 feet. In general, the soils have a low capacity to filter contaminants from water as it moves downward through the soil. In areas where the soil is thicker the filtration capacity is greater.

WELLHEAD PROTECTION AREA DELINEATION - APPROACH

The wellhead protection area is defined in this report as the surface and subsurface area surrounding the water supply well through which contaminants are reasonably likely to move toward and reach these wells in a minimum period of five years. Five years is used because it is required as a minimum in NR 811.16 and because it is considered a reasonably amount of time to plan for and initiate cleanup efforts for well replacement in the event of a major contaminant spill.

Delineation of the wellhead protection area began by making a determination of the groundwater flow direction to each well. Groundwater flow directions were estimated from measurements made in 1971, the only data available. Average amounts of precipitation were noted in records from this period. Based on this and the regional geology, the groundwater flow directions at the writing of this report are not expected to be significantly different. However, because projections of this type are difficult to make, a conservative approach was used to delineate the protection zones to account for any changes.

The groundwater flow to well No. 1 was found to vary between the east and southeast. The groundwater flow to well No. 2 is from the south. At the proposed well No. 3 location, groundwater flows from the east to the well.

ZONE INFLUENCE

A zone of influence is defined as "the land area above the cone of depression". The cone of depression is defined as "the lowering of the groundwater table which develops around a well when water is withdrawn". The dimensions of the cone of depression depend on the pumping rate and aquifer properties.

Zone of influence is determined by calculating the limits of the cone of depression developed after 30 days. The zone of influence represents the area of most concern because any contaminant released in this area would be immediately captured by the pumping well and released into the distribution system. Extensive field work would be required to determine the necessary aquifer properties to enable use of conventional distance - drawdown calculations. This field work was not available at the time this report was written. Instead, two alternate methods were used to calculate the zone of influence.

The first method; the Volumetric Flow equation, estimates the volume of water removed from the aquifer after 30 days of pumping at the maximum rate. To be conservative, no aquifer recharge is included. The only aquifer property needed with this method is an estimate of the porosity.

The second method uses a computer modeling program developed by the USEPA. Software code WHPA uses aquifer properties and pumping rates to determine the horizontal extent of groundwater captured by the well. Extents are determined by the time period selected by the program user and the average groundwater velocity. The velocity is calculated by the software. In this case, the selected time period is 30 days.

The most conservative zone of influence was that calculated by the WHPA code. The zone of influence radius was determined to be 300 feet.

ZONES OF CONTRIBUTION

The zone of contribution is defined as that area from which groundwater will reach the well after a five year period of time. Two methods were used to develop the extent of the zone for each well; the uniform flow method and a computer groundwater flow model. The uniform flow method is a mathematical equation used to determine a probable zone of contribution for a well. To use this equation it is necessary to know aquifer properties such as the hydraulic conductivity, saturated thickness, and the gradient of the groundwater and the well pumping rates. These properties were conservatively estimated from literature values.

A computer modeling code was also used to define the wellhead protection area. The WHPA code uses various aquifer and pumping performance conditions to develop a suitable wellhead protection area. The zone of contribution calculated by the WHPA computer model is oval shaped. The width of the zone of contribution varied at each well site from 600 feet at well No. 2 to 900 feet at well No. 1. The upgradient length of the zone of contribution varied from 3300 feet at well No. 1 to 4500 feet at well No. 2. The zone of contribution has a downgradient dimension ranging from 100 to 170 feet.

The soils overlying the zone of contribution have varying pollution potential. Soils in Door County were rated in their potential to attenuate or clean surface water, as it moves through the soil to the groundwater. A rating of very low indicates little potential to clean pollutants from water, whereas a good rating means the soil has a reasonable capacity to remove pollutants from water as it filters through the soil. At well No. 1 and the proposed well No. 3, the soils closest to the well have a low attenuation potential. From the village limits eastward the pollution attenuation potential of the soil increases. This is primarily because the soils thicken east of the village. The soils at well No. 2 have differing pollution attenuation potential. Some soils are rated good and some are rated low.

The methods previously mentioned were used to create a composite wellhead protection area. This area is broken down into three zones, each with a different level of protection.

Primary Protection Zone

The Primary Protection Zone consists of the zone of influence for each well. The Primary Protection Zone is a 300-foot radius circle centered on the well. In the Primary Protection Zone, the strictest protection limits are in force to ensure protection against immediate contamination to the well and the water supply system.

Management Zone No. 1

Management Zone No. 1 is a segment of a circle which extends from the boundary of the primary protection zone outward to the limit of the zone of contribution. The boundaries of Management Zone No. 1 were chosen to correspond with the probable groundwater flow directions and easily identifiable geographic features. The next level of protection is present in Management Zone No. 1. This zone is not quite as restrictive as that found in the Primary Protection Zone.

Management Zone No. 2

Management Zone No. 2 begins at the boundaries of Management Zone No. 1 and extends outward to a compass entire area one mile from each of the wells. The lowest level of protection is present in this zone.

WELLHEAD PROTECTION PLAN IMPLEMENTATION

The wellhead protection plan is made up of five parts; a wellhead protection ordinance, identification of existing potential sources of contamination, a public education program, a water conservation program, and a contingency plan. A proposed wellhead protection ordinance has been prepared for consideration by the village. This ordinance identifies the various management zones. It provides a basis for prohibiting certain activities in these zones. Prohibited activities are those which, through experience elsewhere, have demonstrated a high potential for groundwater contamination. The level of protection required by the ordinance decreases with distance from the well.

The wellhead protection ordinance also regulates existing operations within the management zones that are engaged in what would be considered a prohibited activity. These facilities are required to prepare a contingency plan to react to a contaminant spill and minimize its potential for damage to the aquifer. These facilities are also required by the ordinance to upgrade their environmental and safety technologies to current standards. Some examples of prohibited activities include septic tanks, drain fields, gas stations, dry cleaners, feed lots, and bulk pesticide/herbicide storage.

An important part of the wellhead protection plan is a public education program. A public hearing is required prior to the adoption of any ordinance. A public hearing can be used as a vehicle to educate the public on the need and the goals of the protection program. There are a number of brochures which discuss the importance of groundwater and the need to protect its fragile resources. These brochures can be obtained from the WDNR, the Wisconsin Rural Water Association and the American Water Works Association. The brochures can be distributed at the public hearing and also made available at the Village Hall for inspection by interested citizens.

The final part of the wellhead protection plan implementation is to prepare water conservation and contingency plans. In the event of a serious spill or if contamination is discovered at one well, the water supply capacity could be seriously affected.

A water conservation plan has two objectives. The first objective is to slow the rate of increase in water use. Slowing the rate of increase will reduce the rate in which groundwater is withdrawn from the aquifer. This will in turn reduce the potential for aquifer contaminants reaching the well. The second objective is the development of an emergency conservation program. This program would be implemented in the event of a major water supply emergency. The intent of the emergency conservation program is to lower the demand to match the available supply.

The objective of the contingency plan is to provide a course of action to be followed when a water supply emergency occurs. The contingency plan provides a list of names and phone numbers of people who must be contacted in the event of an emergency.

WELL NO. 3

The Sister Bay water supply system is based entirely on the use of groundwater. The system consists of two well stations, two booster pump stations and one storage standpipe. A 150,000 gallon elevated storage tank is currently under construction with anticipated completion sometime in 1996. Each well pump has a capacity of 400 gallons per minute. The well pumps can be controlled automatically in response to the water elevation in the standpipe or they can be manually controlled.

In April, 1995, a water study report was prepared by Robert E. Lee & Associates, Inc. for the village of Sister Bay. This water study examined past and present water use information and projected future use rates. The water system study recommended the construction of a third well. A third well station would greatly increase the reliability of the water system and provide for more uniform distribution of water throughout the system.

Three locations for the third well were considered. One location was at the Liberty Grove Sanitary District booster pump station on the north side of Sister Bay. The second location was in the southeast section of the village. The third location examined was in the southwest section of the village.

A present worth analysis was not completed for the three alternative sites. There is not expected to be a significant difference in the present worth of the three alternatives. Non-economic factors were considered more important in evaluating which well site should be recommended. These non-economic factors included the equalization of water supply to the distribution system, groundwater flow direction, the extent of the wellhead protection area and existing and future potential sources of contamination within that area.

One important consideration was to recommend a location for well No. 3 such that the recharge area for this well would be separate from the recharge areas of the other two wells. Separate recharge areas would increase the water system reliability by reducing the potential for a contamination event to affect more than one supply well.

The recommended location for well No. 3 is at the Liberty Grove booster pumps station. The estimated capital cost for the construction of the third well is $328,000.

1

INTRODUCTION

CHAPTER 1

INTRODUCTION

Wellhead protection has become an important aspect of municipal planning in Wisconsin. Almost 94 percent of the municipalities in the state utilize groundwater, water contained in a saturated zone beneath the ground surface, as the main source of supply for their community water systems. Two-thirds of the state extracts 570 million gallons of groundwater per day for the purpose of drinking water alone. The village of Sister Bay began providing public water supply in this fashion in 1972. Amendments to the Federal Safe Drinking Water Act governed by the United States Environmental Protection Agency (USEPA) included state Wellhead Protection Programs in 1986. Wisconsin favored this action as it corresponds with goals listed in the state statutes (s.160.001, Wis. Stats.) to prevent the contamination of groundwater supplies to protect the health, safety, and general welfare of the public.

Groundwater supplies are vulnerable to contamination by pollutants infiltrating through the soils to the underlying aquifer. An aquifer is a geologic formation that contains sufficient saturated permeable material to yield economical quantities of water to wells and springs. The extent of this vulnerability depends on the type of covering soils and the characteristics of the aquifer. The village of Sister Bay community water supply is especially prone to contamination due to the thin, and in some cases, nonexistent covering soils and an aquifer consisting of fractured dolomite. In fact, two other Door County communities, Ephraim and Sturgeon Bay, have problems with bacteriological contamination in their wells.

This wellhead protection plan provides an assessment of current conditions which may affect the groundwater supply and a plan to minimize the potential for contamination. The scope of this plan includes the following:

1. Review of available information pertaining to soil and geologic characteristics, groundwater and aquifer properties, land use, population projections, and water use.

2. Evaluation of alternative sites for proposed well station No. 3.

3. Identification and description of the wellhead protection area.

4. Identification and assessment of existing and potential sources of contamination to the groundwater located within the boundaries of the wellhead protection area.

5. Basis for a public education program.

6. Basis for a water conservation program.

7. Basis for a contingency plan.

8. Basis for a management plan that includes a Wellhead Protection Ordinance for implementation within the village limits, a contingency plan, and a resolution extending to outside influencing agencies.

2

STUDY AREA CHARACTERISTICS

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CHAPTER 2

STUDY AREA CHARACTERISTICS

Planning for the long-range protection of a public water supply system requires an evaluation of the physical properties of the study area. Proper consideration of economic factors influencing growth in the service area must also be made. Physical characteristics of importance to the study area include topography; watershed boundaries, boundaries inclusive of an area delineated using topographic high points as an estimation of drainage directions; bedrock geology; soils; climate; and aquifer properties while economic characteristics of interest include commerce, tourism, industry, agriculture, transportation, and utilities. These factors have a bearing on land use patterns and population growth and consequently affect the location, design, and operation of water supply facilities. This chapter summarizes information related to the physical and economic characteristics pertinent to this plan.

EXTENT OF STUDY AREA

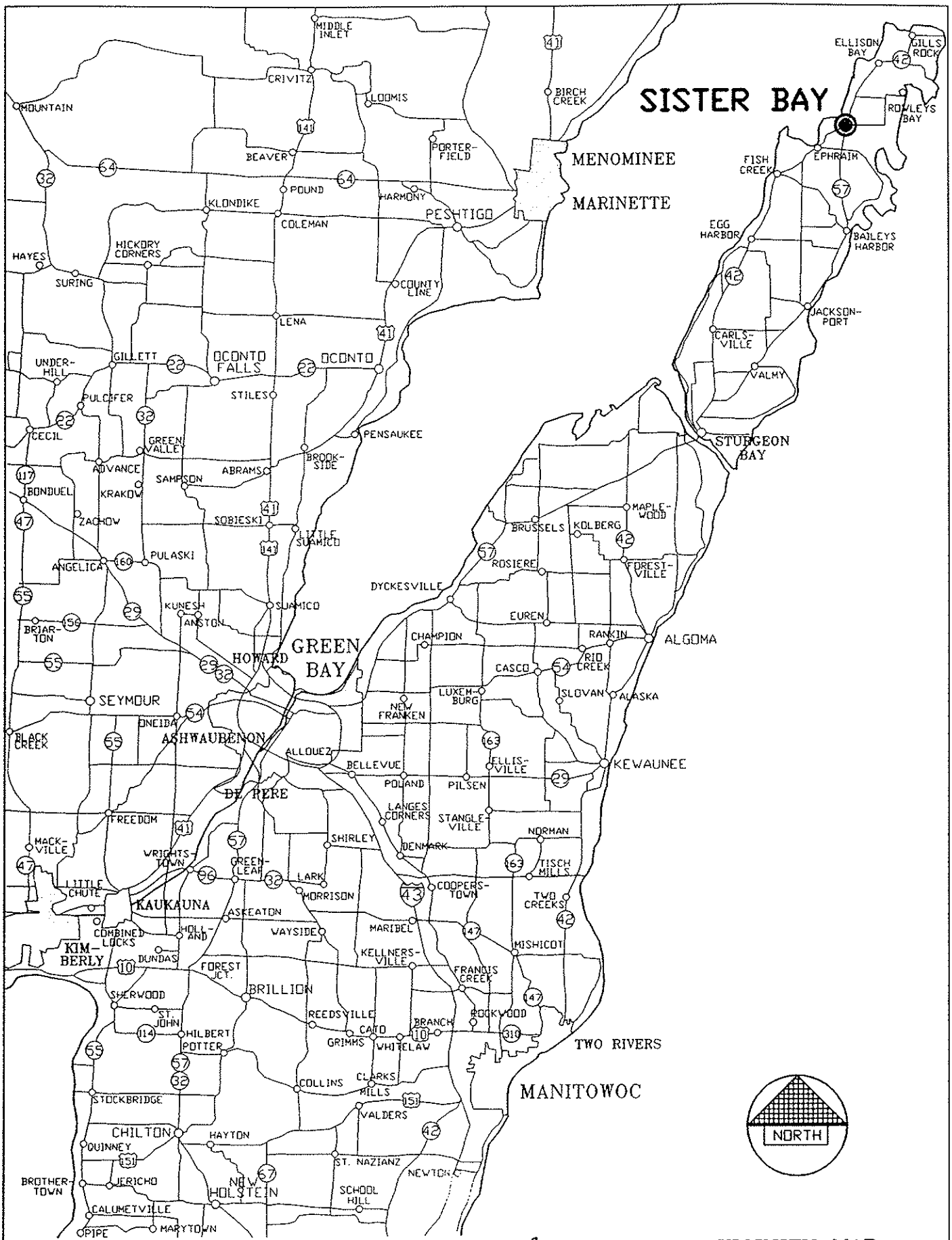
The village of Sister Bay is located in the northwest portion of Door County, Wisconsin, on the bay of Green Bay. It is approximately 30 miles north of Sturgeon Bay. Figure 2-1 is a vicinity map for the village. The village is served by State Trunk Highways (STH) '57' and '42' and County Trunk Highway (CTH) 'ZZ'. The Ephraim/Gibraltar airport is located about four miles to the south of the village.

The village is surrounded almost completely by the lands that make up the town of Liberty Grove. On the village's north side is the town of Liberty Grove Sanitary District No. 1 (LGSD No. 1), which is provided with sewer and water service by the village of Sister Bay. The village of Ephraim is located directly to the south.

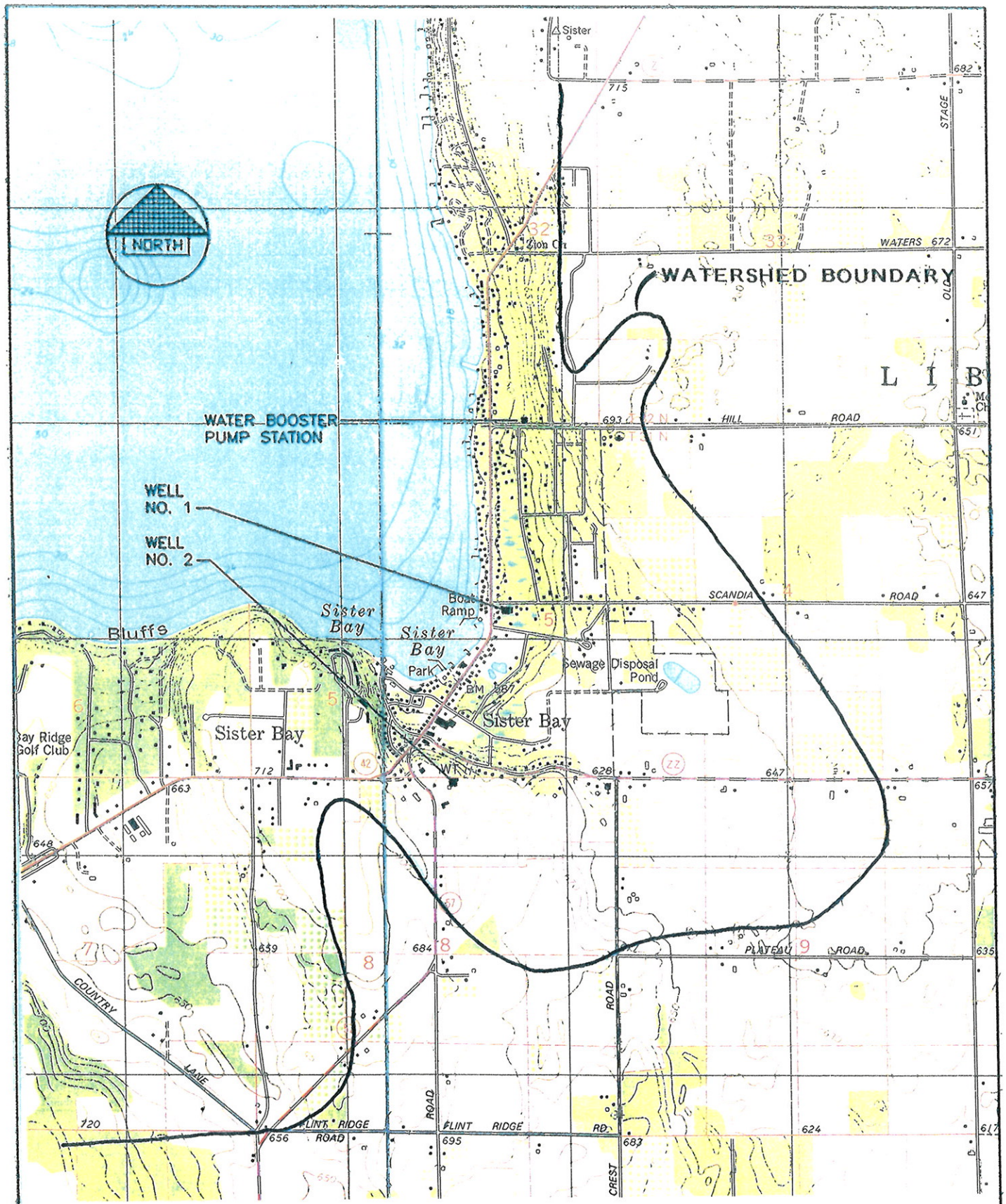
The study area, identified in Figure 2-2, includes the entire village of Sister Bay and the town of Liberty Grove Sanitary District No. 1.

PHYSICAL ENVIRONMENT

The physical environment of the village of Sister Bay and surrounding areas influences the possibility for contamination of the village's groundwater supply. Characteristics of importance include topography, flooding and drainage, geology and soils, water resources, and climate. Information regarding the physical environment was extracted from the U.S. Soil Conservation Service Soil Survey for Door County, the Wisconsin Department of Natural Resources' Geology and Ground Water in Door County, Wisconsin, with Emphasis on Contamination Potential in the Silurian Dolomite and Water Resources of Wisconsin-Lake Michigan Basin.



VICINITY MAP
FIGURE 2-1



U.S.G.S. 7.5 Minute Quad.
Ephraim 1982
Sister Bay 1982

STUDY AREA
FIGURE 2-2

Topography, Flooding, and Drainage

The topography of the study area is identified in Figure 2-2. The area has greatly varying topographic features due to the underlying bedrock. These features can be grouped in three general categories of topographic expression. The first of these includes three separate areas with relief in excess of 700 feet above mean sea level. They are located within the extreme western portion of the study area, the area immediately west of the central business district, and the area within the north sections of the study area. The areas are characterized by relatively level tops, similar to plateaus, with steep slopes. Many of the steep slopes are near vertical bluffs, especially in the area immediately west of the central business district. These areas are the most obvious in terms of topographic expression. The highest elevation of 742 feet is found within the southwestern portion of the study area.

A second group of topographic features includes the eastern and southern portions of the study area. This large area is characterized by a flat to gently rolling land surface occasionally marked by small depressions. The area dips gently to the southeast.

The central business district of the village makes up the third general relief category. It lies in a low region with 582 being the lowest elevation found in this part. This area consists of a low relatively level plain marked by several depressions.

The village of Sister Bay is a part of the Upper Door County Watershed. Within the immediate area there are watershed boundaries beginning in the southwest portion of the study area one-eighth mile south of STH '42', one-quarter mile before the intersection of STH '42' and '57'. This boundary extends to the southeast approximately one-half mile before it heads almost due east for approximately one and one-quarter miles where it winds back around to the northwest toward the bay of Green Bay. This watershed boundary forms a half-circle shape directly around the study area, as shown by the dashed line in Figure 2-2.

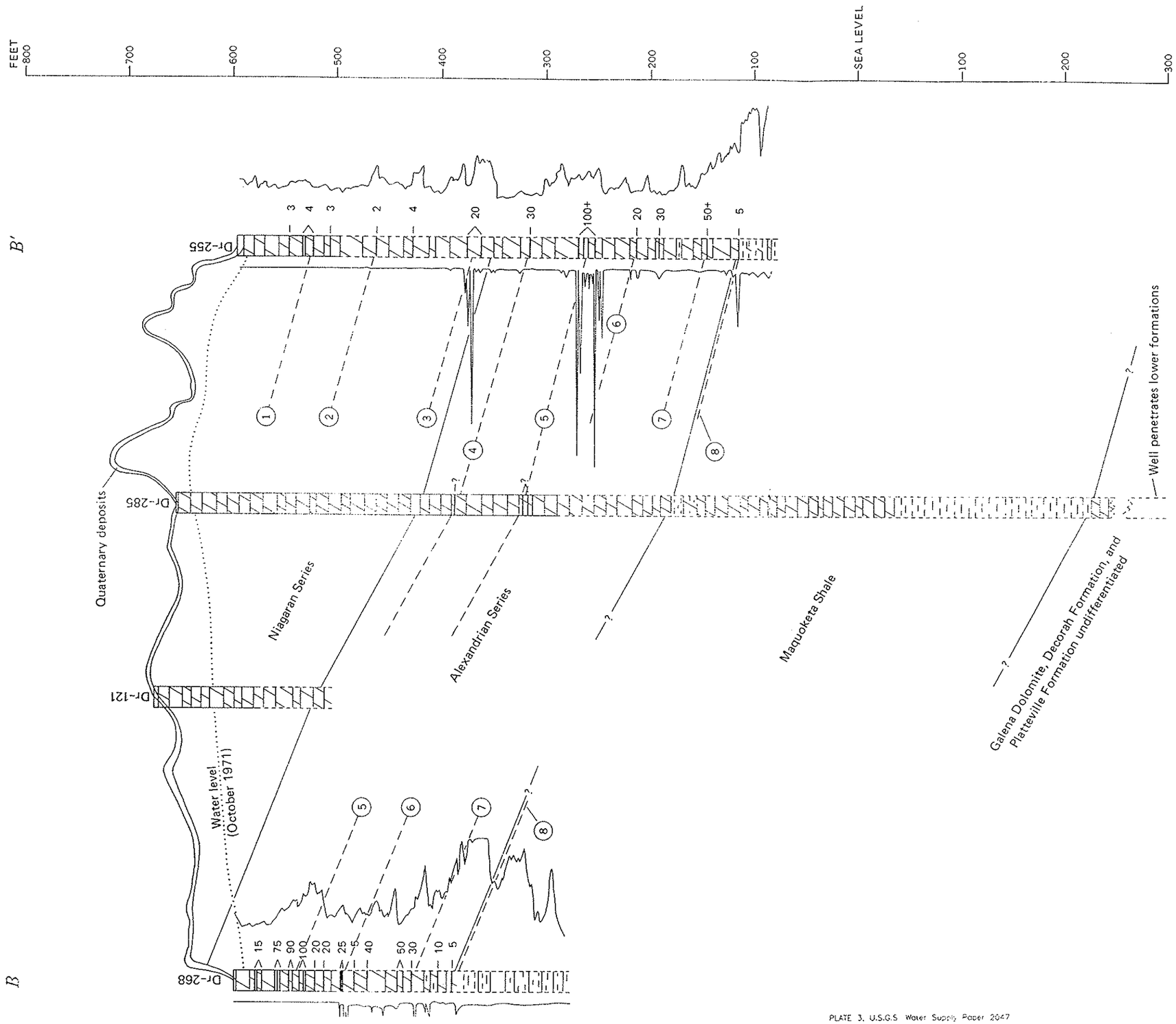
No major rivers drain into or away from the study area due to relatively resistant bedrock, gentle slopes, and close proximity to large bodies of water. Direction of precipitation runoff is primarily southeasterly toward Lake Michigan for the majority of the study area. Runoff into the bay of Green Bay is limited to a narrow zone along the coast. However, within the study area, the central business district of Sister Bay is located at the mouth of the largest drainage area.

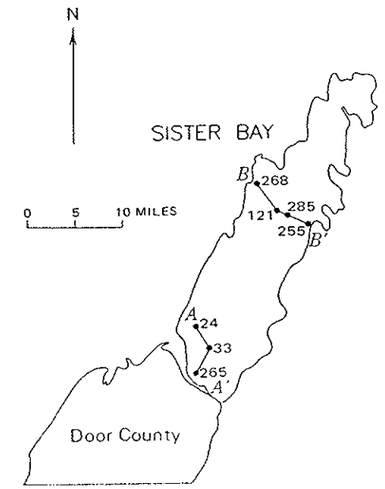
Geology

The bedrock units which underlie the Sister Bay study area range in the age from Precambrian to Silurian. The characteristics of these bedrock units are described in Table 2-1. A geohydrologic cross section through the Silurian dolomite aquifer system of Door County is shown in Figure 2-3. The oldest are impermeable crystalline rock of Precambrian age at depths that average more than 1,500 feet below the land surface. These are overlain by consolidated sedimentary rocks of Cambrian, Ordovician, and Silurian ages. The sedimentary rocks are solidified marine sediments that dip to the southeast at approximately 45 feet per mile. These rock formations also deepen toward the southeast.

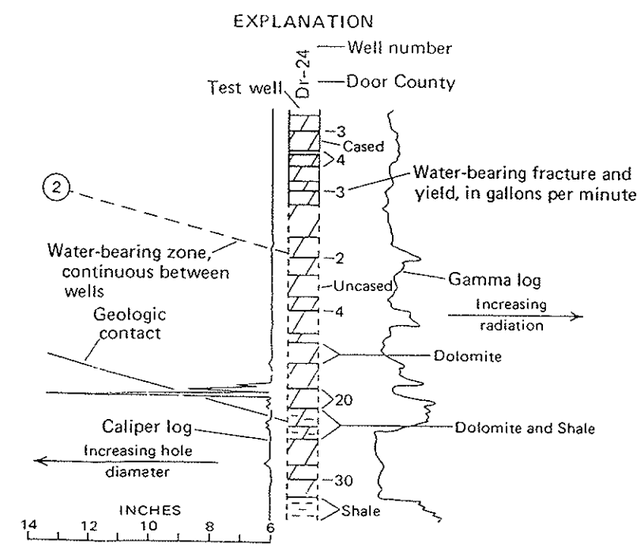
Table 2-1 Lithologic Characteristics of Rock Units in Door County

Rock Units	Lithologic Description	Maximum Thickness (ft)	Average Well Yield and Range (gal/min)	Hydrologic Units	Water Yielding Characteristics
Holocene and Pleistocene deposits	Unsorted mixture of clay silt, sand, gravel, and boulders; stratified sand and gravel; lake silt and clay; organic deposits.	150 ± 50	¾	Sand and gravel aquifer system	Not evaluated because minimum casing requirements close off the entire unit except for a small area in the southeastern part of the county.
Niagaran Series Racine Dolomite, Manistique Dolomite, and Burnt Bluff Formation, undifferentiated	Dolomite and dolomitic limestone, buff-gray, medium-to-coarse grained; thin-bedded-to-massive in the upper part; mostly thin-bedded in the lower part.	350	15 5-60	Niagaran aquifer	In the upper part, water occurs in parallel but discontinuous bedding-plane joints and nearly vertical joints; water in the lower part occurs in more prominent and continuous bedding-plane joints, particularly near the contact with the Mayville. Well yields change in relation to the number and size of joints intersected; generally, they are adequate for domestic and farm supplies.
Alexandrian Series	Dolomite, gray, medium-to-coarse grained, thick-bedded-to-massive; cherty with gypsum near base.	230	40 15-450	Alexandrian aquifer	Water occurs in bedding-plane joints or zones of joints. Bedding-plane joints are recharged into near-vertical joints where the Alexandrian Series is the uppermost bedrock unit. These conditions permit the development of large supplies of groundwater with full penetration of the units.
Maquoketa Shale	Shale, blue-gray, fine-to-medium grained, thin-bedded dolomite and interbedded shale common near the top.	400 ± 50	5 2-20	Confining bed	Groundwater occurs in a fractured zone within the upper few feet of the unit. Remainder of the formation is nearly impermeable. Wells not obtaining water from the fractured zone usually are inadequate for domestic supplies. Unit acts as a barrier to water movement between the Alexandrian aquifer above and the sandstone aquifer below.
Galena Dolomite, Decorah Formation, and Platteville Formation; St. Peter Sandstone; and Prairie du Chein Group, undifferentiated	Dolomite, gray, fine-to-medium grained, cherty and fine-to-coarse grained.	450 ± 50	25 5-200	Upper sandstone aquifer	Water occurs in crevices in the dolomite and in intergranular openings within the sandstone. These units yield small to moderate quantities of water from the sandy units where they are developed, mainly in the southwestern part of the county.
Trempealeau Formation, Tunnel City Group, and Wonewoc Formation, undifferentiated	Sandstone, dolomitic, fine-to-medium grained; fair-to-good sorting; and dolomitic shale and siltstone.	400 ± 500	(?)	Lower sandstone aquifer	Not presently used as a source of water in Door County. A test well through these units near Jackson-port indicated that moderate yields of water could be obtained from the dolomitic sandstone, but only small yields could be expected from crevices, joints, and solution zones with the other units.





LOCATION



GEOHYDROLOGIC CROSS SECTION THROUGH THE SILURIAN DOLOMITE AQUIFER SYSTEM

FIGURE 2–3

Silurian dolomite, the uppermost bedrock, is exposed primarily along the bluffs near the waters of the bay and in outcroppings throughout the study area. This dolomite ranges in thickness up to 580 feet. This dolomite, which includes the Niagara and Alexandrian formations, is brittle rock with many cracks or "fractures" deposited 400 to 425 million years ago. Below the dolomite is a shale formation known as Maquoketa. It reaches a maximum thickness of 450 feet. The Maquoketa shale overlies a dolomite formation, termed Platteville-Galena, which is approximately 500 feet in thickness. This rock formation, in turn, overlies Cambrian sandstones which are 450 feet thick. All of these formations overlie Precambrian igneous rocks that form the bottom bedrock unit.

The Silurian dolomite is the most notable and influential bedrock unit within the area. It composes the landform known as the "Niagara Cuesta." A cuesta is a gently sloping plain that is terminated on one side by a steep slope. The gentle slope of the Niagara Cuesta dips to the southeast throughout much of the study area but is somewhat difficult to observe due to glacial deposits. It does emerge, however, along the waters of the bay west of the Sister Bay central business district as a prominent escarpment. Because of the dolomite's proximity to the surface, especially in the eastern portions of the study area, little agriculture, with the exception of orchard cultivation, is practiced. The Silurian dolomite formation is the primary source of groundwater for the study area.

Many natural crevices and fissures occur in the Silurian dolomite formation, and numerous vertical joints at the surface permit rapid water recharge of the lower, horizontal bedding plane joints. There is a great danger of groundwater pollution for this reason. These crevices present problems for certain uses of soil that is underlain by dolomite.

Glaciers, the last of which melted approximately 10,000 years ago, modified the bedrock surface by scouring highlands and depositing this material in lowlands created by pre-glacial erosion. Three major types of glacial features are identifiable within the study area. These include glaciolacustrine deposits, ground moraine, and end moraine.

Glaciolacustrine deposits are composed primarily of sand , silt, and clay. These sediments were deposited by glacial predecessors of the bay of Green Bay and Lake Michigan. Shorelines of these early lakes fluctuated 20 to 60 feet above the present lake level. The entire central business district of Sister Bay is located upon glaciolacustrine deposits, indicating these areas were inundated by water several thousand years ago. Most of these deposits are located in a diagonal band across the study area extending from northwest to southeast.

End moraines are glacial landforms composed of unsorted sand, gravel, cobbles, and boulders that were deposited at the terminus of the glacial ice. Acting as an enormous bulldozer, the ice pushed and mounded this material into substantial hills. The area of end moraine deposits is located primarily within the northeastern portion of the study area.

Soils

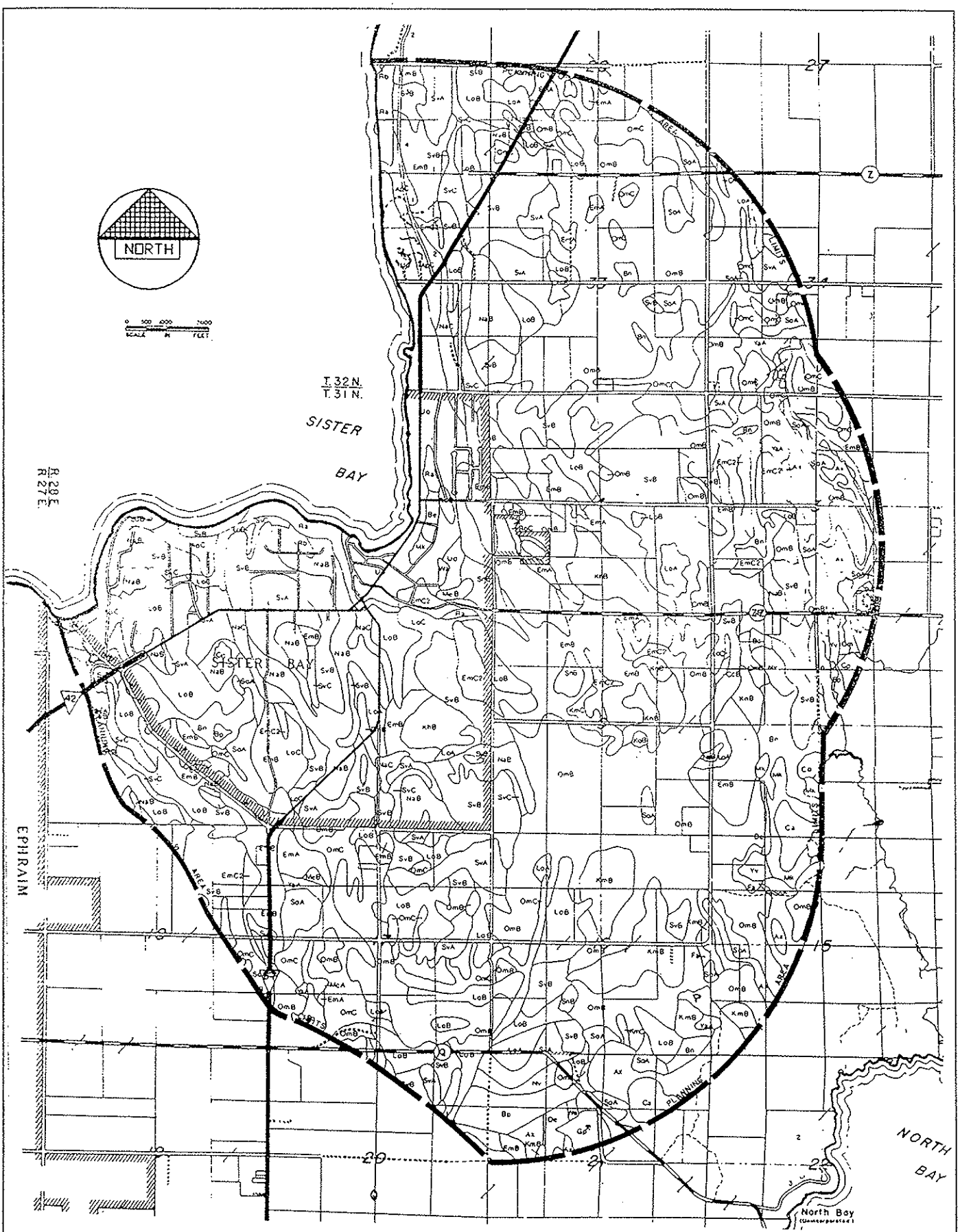
The general character of the soils of the study area is largely the result of various types of glacial deposits overlying the Silurian dolomite. Figure 2-4 shows known soils within the study area. Approximately 30 different known soil types are found in Door County. Table 2-2 summarizes soil characteristics of the predominant soils in the study area and discussed in this section. Figure 2-4 should not be construed to be totally accurate in showing soil boundaries. The purpose of the Soil Conservation Service (SCS) maps is for the general evaluation of soil characteristics in a large geographical area. The maps are not suitable for describing soil conditions in small areas of a community. These soils can be grouped into three broad categories based upon their major characteristics and limitations. The first category includes those soils which are well-drained and consist primarily of sandy loams. These soils are the most desirable for agriculture, urban development and for structures such as basements, septic tank absorption fields, and mound systems. The Omena sandy loam and the Emmet sandy loam soil types dominate the first category. Soils included within the category are located primarily in the northeast quadrant of the study area and in a narrow band extending from approximately the northern study area boundary south along the bay of Green Bay to the central business district and then spreading out in a southeasterly direction.

Table 2-2 Soil Characteristics

Characteristic	Soil Series											
	Major Soils			Minor Soils								
	Summerville	Longrie	Omena	Alpena	Bonduel	Bonduel Wet Variant	Bonduel Shallow Variant	Chippeny	Namur	Namur Variant	Solona	Udorthents
Symbol(s)	Sva, SvB, Svc, SvD	LoA, LoB, LoC	OmB, OmC, OmD, OvB	ApC	Bn	Bp	Bo	Cp	MaB, MaC	Mv	SoA	Uo
Depth to Bedrock, in.	10-20	20-40	>60	>60	20-40	20-40	10-20	20-51	5-12	5-10	>60	>60
Flooding Frequency	None	None	None	None	None	None	None	Frequent	None	None	Occasional	None
Depth of Saturation, ft.	>6.0	>6.0	>6.0	>6.0	1.0-3.0	0-1.0	1.0-3.0	0-1.0	>6.0	1.0-3.0	1.0-3.0	>6.0
Shrink-Swell Potential[a]	Very Low	Very Low	Moderate	Very Low	Moderate	Moderate	Moderate	High	Low	Low	Low	Very Low
Risk of Corrosion[a] Uncoated Steel	Low	Low	High	Low	Moderate	Moderate	Moderate	High	Moderate	Moderate	High	¾
Risk of Corrosion[a] Concrete	Low	Low	Low	Low	Low	Low	Low	Moderate	Low	Low	Low	¾
Permeability (in/hr) First Horizon	0.6-2.0	2.0-6.0	2.0-6.0	2.0-20	0.6-2.0	0.2-6.0	0.6-2.0	0.2-0.6	0.6-2.0	0.6-2.0	0.6-2.0	>20
Permeability (in/hr) Second Horizon	0.6-2.0	0.6-6.0	0.6-2.0	>20	0.6-2.0	0.6-2.0	0.6-2.0	0.2-2.0	¾	0.6-2.0	0.6-2.0	¾
Permeability (in/hr) Third Horizon	¾	0.6-6.0	0.6-2.0	¾	0.6-2.0	0.6-2.0	0.6-2.0	¾	¾	¾	0.6-2.0	¾
Erosion Factors, K[a, b]	.24	.32	0.20	0.17	0.28	¾	¾	¾	0.37	¾	0.37	0.10

[a]Worst condition of three soil horizons.

[b]K is a measure of the susceptibility of the soil to erosion by water. K values range from 0.1 to 0.64. Soils with the highest K values are the most erodible.



SOILS
FIGURE 2-4

Generally, soils of the second broad category are shallow with bedrock in close proximity to the sand surface. Frequent outcropping of bedrock is prevalent. These soils are unsuitable for agriculture, septic tank absorption fields, mound systems, and basements primarily because of the lack of adequate soil depth, The three most abundant soil types of this category are the Summerville loam, the Namur loam, and the Longrie loam. Shallow soils are generally located in the southwest quadrant of the study area and in a crescent shaped band extending from the north-central to east-central boundaries of the study area. Areas with soils mapped within this category are extremely susceptible to groundwater pollution due to the lack of sufficient soil depth for proper filtration of water infiltrating the ground surface to recharge the aquifer.

The third broad category consists of those soils that are poorly drained. They are generally undesirable for agriculture, as well as construction of basements, septic tank absorption fields, and mound systems because they are poorly drained, have a high groundwater table, and are usually unstable. Soils within this category are located primarily within the extreme southern and southeastern portions of the study area. The predominant soils of this category include the Angelica loam and the Carbondale muck.

The study area soils include one predominant soils association which consists of three soil series and several minor soils. This soils association is called the Summerville-Longrie-Omena Association.

The Longrie soils are well drained and are nearly level to sloping. They are on glacial till upland plains and ridges. These soils are underlain by dolomite bedrock at a depth of 20 to 40 inches. Typically, the surface layer is loam, and the subsurface layer is sandy loam. The subsoil is sandy loam in the upper part and loam in the lower part. The substratum, at a depth of about 23 inches, is fine sandy loam glacial till. The available water capacity is low and permeability is moderate.

The Omena soils are well drained and are gently sloping to moderately steep. They are on glacial till upland plains and ridges. Typically, the surface layer is sandy loam. The subsoil is sandy loam in the upper part and loam in the lower part. The substratum, at a depth of about 17 inches, is sandy loam glacial till. The available water capacity and permeability are moderate.

The Summerville soils are well drained and are nearly level to moderately steep. They are on glacial till upland plains and ridges. These soils are underlain by dolomite bedrock at a depth of 10 to 20 inches. Typically, the surface layer is loam, and the subsoil is loam. The available water capacity is very low and permeability is moderate.

Minor soils in this association are mainly Alpena, Chippeny, Bonduel, Bonduel Shallow Variant, Bonduel Wet Variant, Namur, Namur Variant, Solona, and Udorthents soils. These soils are significant since they cover significant areas of the village and study area.

The Alpena soils consist of well drained to excessively drained, nearly level to sloping soils on old glacial lake beach ridges. The substratum to a depth of 12 inches is very friable, gravelly sandy loam. Below the substratum is loose sand and gravel. The available water capacity is very low and permeability is rapid.
The Bonduel soils consist of somewhat poorly drained, nearly level soils on glacial till plains. Dolomite bedrock is at a depth of 20 to 40 inches. Typically, the subsoil is loam and clay loam below which is friable heavy loam and loam. The available water capacity is low and permeability is moderate.

The Bonduel Shallow Variant soils consist of somewhat poorly drained, nearly level soils on glacial till plains where bedrock is extremely shallow. The soil horizons consist of loam and sandy loam. the available water capacity is low and permeability is moderate.

The Bonduel Wet Variant soils consist of poorly drained, nearly level soils in depressions on glacial till plains where dolomite bedrock is at a depth of 20 to 40 inches. The soil profile consists of approximately 3 inches of muck over loam. The available water capacity is low, and permeability is moderate.

The Chippeny soils consist of very poorly drained, nearly level organic soils in shallow old glacial lake basins. The upper 27 inches in a representative profile is muck. The substratum is gravel and stone with loamy fine sand. Bedrock is at a depth of about 38 inches. The available water capacity is high. Permeability is moderately slow to moderate.

The Namur soils consist of well drained, nearly level to sloping soils on glacial till plains where the underlying dolomite bedrock is at a depth of 5 to 12 inches. The available water capacity is very low and the permeability is moderate.

The Namur Variant soils consist of somewhat poorly drained, nearly level soils in depressions of glacial till plains where the underlying dolomite bedrock is at a depth of 5 to 10 inches. The available water capacity is very low and permeability is moderate.

The Solona soils consist of somewhat poorly drained, nearly level soils in depressions and drainageways on glacial till plains. The soil profile includes loam, silty loam, and sandy loam. The available water capacity and permeability are moderate.

The Udorthents soils consist of excessively drained, gently sloping and sloping beach deposits along major lakes. These deposits have very little or no evidence of soil profile development. They consist of coarse gravel and stones and slabs of dolomite as much as 20 inches long.

Most moderately deep and deep soils such as the Omena soils of the Summerville-Longrie-Omena Association are used for cultivated crops, such as corn, small grain, and legumes. A few steeper areas and undrained wet areas are used for pasture or wildlife habitat. Much of the area of shallow soils is used for pasture or remains in woodland or wildlife habitat.

Climate

The climate of Sister Bay is modified by the bay of Green Bay and Lake Michigan. The cool waters of the lakes and bay delay spring, while relatively warm water in fall retards early frost. Summers, on the average, are mild due to the community's proximity to water which moderates daily extremes.

The annual average temperature for Sister Bay, as shown in Table 2-3, is 42.5°F. Although climatological data was gathered at the weather station on Washington Island, the information is representative of Sister Bay's climate due to the station's close proximity and its similar location with respect to the bay of Green Bay. Table 2-3 also shows January to have the lowest average monthly temperature of 16.5°F during the 10-year period from 1968 to 1978. July has the highest average temperature of 65.7°F for the same period. Frost generally leaves by mid-May and reoccurs during the first week of October. The resultant growing season is about 135 days.

Table 2-3 Average Monthly and Annual Temperature

Year	Temperature °F												Annual Average
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1978	15.0	14.8	25.4	36.9	50.1	57.2	63.0	65.5	60.2	47.6	36.0	22.0	41.1
1977	6.6	18.2	32.3	39.7	53.6	57.9	66.4	61.8	57.8	47.4	36.6	23.0	41.8
1976	14.5	24.9	29.2	40.5	47.3	62.4	67.0	64.8	55.7	43.6	30.5	14.4	41.2
1975	21.5	20.5	26.1	35.6	52.8	61.5	68.2	66.3	55.3	49.8	40.3	24.7	43.6
1974	18.6	16.7	28.4	40.3	47.3	57.8	66.6	64.7	54.6	46.2	38.2	29.5	42.4
1973	22.0	21.8	36.7	39.4	47.4	60.0	67.3	68.3	59.0	53.7	37.1	25.0	44.8
1972	14.8	14.1	22.9	33.2	50.7	55.8	63.5	NA	57.4	45.6	35.7	21.7	NA
1971	14.8	17.4	24.8	37.3	46.1	59.6	64.5	62.5	59.5	53.1	35.8	27.2	41.9
1970	NA	16.5	26.1	39.4	47.6	57.8	66.2	65.6	58.3	49.7	35.9	24.2	NA
1969	19.8	21.7	24.7	39.6	47.9	54.8	65.8	69.6	60.0	46.7	35.1	26.2	42.7
1968	18.9	17.7	31.5	42.1	48.9	57.8	63.9	65.1	60.6	49.9	37.6	24.8	43.2
Ave.	16.7	18.6	28.0	38.5	49.1	58.4	65.7	65.4	58.0	48.5	36.3	23.9	42.5

Ice begins forming on the bay in late November and the bay of Green Bay is generally covered entirely with ice by mid-January. During mild winters, the bay may not freeze completely. Ice breakup usually occurs in early April.

The normal annual total precipitation, as shown in Table 2-4, for 1968 to 1978 was 28.92 inches. The lowest monthly average of .97 inches occurs in February, while the highest of 3.60 inches occurs in June. More than one-half the average annual precipitation falls between May and September. The first half of June and middle of August are likely to receive the heaviest summer rains. The end of August is normally the driest summer period.

Table 2-4 Monthly and Annual Total Precipitation

Year	Precipitation, inches												Annual Average
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1978	1.94	.47	.32	2.35	3.19	1.43	3.32	3.35	4.38	3.55	2.25	1.74	28.29
1977	.531.	1.44	4.01	2.65	1.22	2.70	6.13	3.13	4.36	1.87	3.17	2.39	33.60
1976	76	1.32	3.86	1.02	4.14	.85	1.16	1.75	.67	2.93	.43	.74	20.63
1975	2.001	1.18	1.52	1.88	2.75	4.22	1.66	2.68	4.09	.56	5.24	1.25	29.03
1974	.24	.39	.48	2.62	1.94	6.57	3.37	5.64	3.36	1.13	2.19	1.40	30.33
1973	1.25	1.57	1.43	2.26	5.13	4.83	3.94	4.74	2.97	3.09	1.27	2.28	34.76
1972	.91	1.22	1.63	2.35	1.35	1.64	2.13	5.38	4.84	1.50	1.44	2.94	27.33
1971	2.81	1.47	1.91	.52	2.92	2.71	3.54	2.13	2.79	2.71	2.29	3.17	28.97
1970	1.08	.51	.61	1.98	3.58	1.11	3.10	1.01	6.23	3.54	2.40	1.70	26.85
1969	2.55	.04	.75	1.14	1.99	9.00	3.03	.68	2.49	4.48	.48	1.26	27.89
1968	.67	1.01	.50	3.46	3.40	4.48	2.81	4.57	1.79	1.79	1.41	3.08	30.45
Ave.	1.52	.97	1.55	2.02	2.87	3.60	3.12	3.19	2.47	2.47	2.05	2.00	28.92

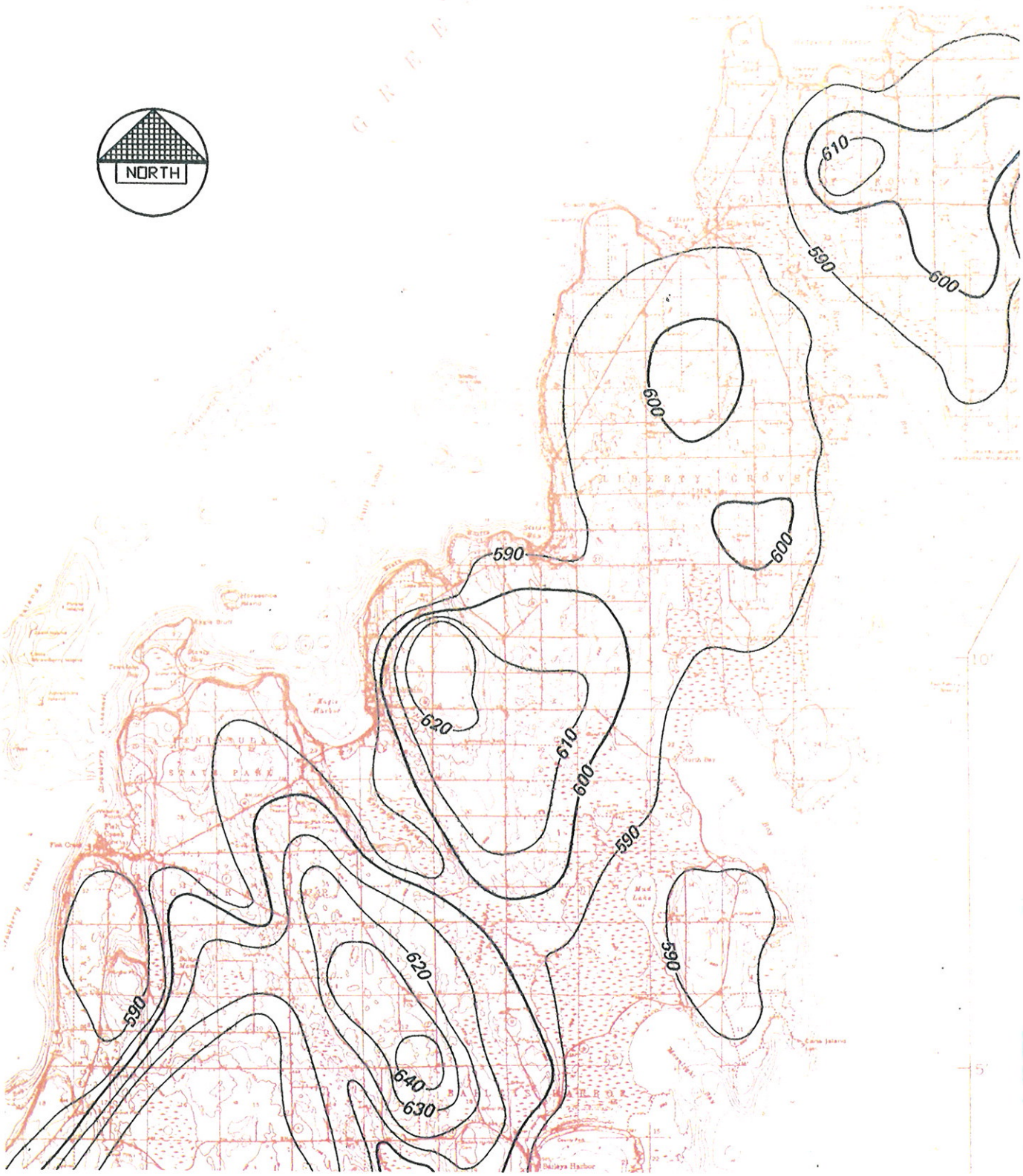
Water Resources

Surface Water. The bay of Green Bay is the major surface water resource for the village of Sister Bay. Although the bay does not serve as a public water supply for any communities in the area, the water quality is such that it has a good potential for this use. The bay provides recreation in the form of boating, fishing, swimming, and scenic enjoyment. Commercial fishing on the bay has long been a part of the county's history. Deeper off-shore waters beyond one-quarter mile from the shoreline are used by the commercial fishing industry.

Other surface waters within the study area include two small ponds within the central business district and small intermittent streams near the eastern boundary of the study area. These surface waters are shown in Figure 2-2.

Groundwater. The Silurian dolomite system, which contains the Niagaran and Alexandrian aquifers, is the major source of groundwater in the study area. Well yields are highly variable and are dependent upon the water-bearing zones open to the well, the occurrence of joints, and the diameter and construction of the wells. The vertical and bedding plane joints form the principal water bearing zones in the system. Most of the water in the upper Niagaran aquifer is contained in the vertical joints, whereas the larger and more continuous bedding plane joints yield most of the water in the lower Niagaran and Alexandrian aquifers. Potential yields of 400 gallons per minute are obtainable from the Silurian dolomite system. Figure 2-5 indicates water table levels for the village, LGSD No. 1, and surrounding areas.

This map was constructed by the USGS from measurements taken during October 1971 and represents the only regional groundwater data available at this time. Precipitation during this period was near average. This information was used without change to project groundwater flow directions.



WATER TABLE OF THE SILURIAN DOLOMITE AQUIFER SYSTEM
FIGURE 2–5

PLATE 4, U.S.G.S. Water Supply Paper 2047
October 1971, Scale: 1:125,000

The principal groundwater quality problems in the study area are hardness, locally high iron concentrations, and contamination from surface sources. Hardness and high iron concentrations are primarily related to geochemical processes. Their impacts on water quality can be minimized through softening and iron removal filters or sequestering with chemicals. Contamination, however, is a more serious groundwater problem. Gasoline, road salt, pesticides, domestic and farm wastes, and septic tank effluent are among the common types of contaminants that enter the dolomite system through groundwater recharge. Their entry is facilitated by the thin soil cover, fractured bedrock, and inadequate sanitary seals on well casings. This topic is discussed in greater detail in Chapter 6.

The village of Sister Bay uses groundwater as the source of water for its municipal water distribution system. The system includes two wells and a 100,000-gallon standpipe. This system provides a water supply for the LGSD No. 1 as well as the village. Water distribution mains lie parallel to all of the sewer mains throughout the village and LGSD No. 1. A further discussion of the water system is included in Chapter 3.

Wetlands. Wetlands within the study area boundaries include an extensive area along the eastern and southern boundaries, a small area within the village of Sister Bay, and isolated depressions in rural areas. These wetlands are defined as areas where water is at, near, or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation and which have soils indicative of wet conditions. These wetlands are considered environmentally sensitive areas where construction including filling, flooding, draining, dredging, ditching, tilling, or excavating is prohibited.

The wetland area within the village is located between Bay Shore Drive and South Spring Road. Part of the area has been developed as a small, well-manicured park. Other portions of this wetland are being encroached upon by single-family homes and parking lots. A spring located within the wetland should be considered prior to any further development.

ECONOMIC ENVIRONMENT OF THE COMMUNITY

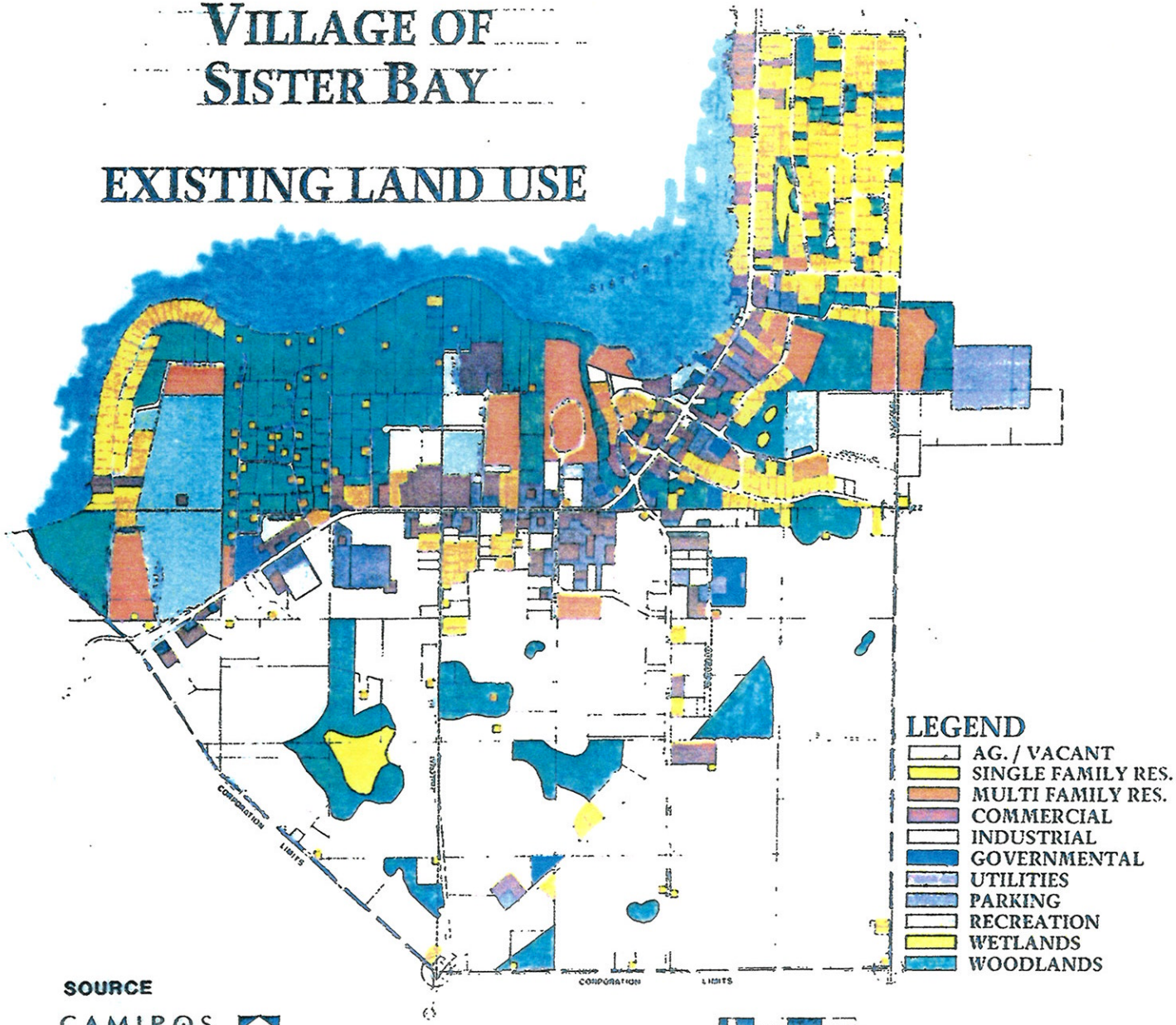
The economic environment of any planning area, as reflected in land use and population growth patterns, is important in the planning for the protection of water supplies as well as the design of water supply facilities. Projected population and land use factors are essential in the development of design criteria for water planning.

Land Use

The village of Sister Bay encompasses a total of 1657.2 acres. Within this area, nine categories of land use can be identified and mapped, as shown in Figure 2-6. These categories are existing residential, commercial, industrial, transportation, communication/utilities, institutional and governmental, outdoor recreation, agriculture/vacant, and wetlands/woodlands.

VILLAGE OF SISTER BAY

EXISTING LAND USE



LEGEND

- AG. / VACANT
- SINGLE FAMILY RES.
- MULTI FAMILY RES.
- COMMERCIAL
- INDUSTRIAL
- GOVERNMENTAL
- UTILITIES
- PARKING
- RECREATION
- WETLANDS
- WOODLANDS

SOURCE

CAMIROS

NORTH

0 500 1000 1500 1600
scale in feet

BLRPC 1988.
Updated 1994, camiros.

LAND USE
FIGURE 2-6

The detailed land use study of the village prepared by the Bay Lake Regional Planning Commission (BLRPC) in 1980 indicated that 26 percent of the village area was devoted to urban or developed uses, while 74 percent was undeveloped, either in agricultural use or in a natural state. In 1987, the estimated undeveloped land was approximately 69 percent. Most of the development has been due to single-family homes and multi-family dwelling condominium unit construction. The village in comparison to other villages in the region has almost twice the number of developed acres per person. In 1975, the villages in the BLRPC region averaged approximately 47.0 developed acres per 100 persons, while in 1979 Sister Bay had approximately 84.02 developed acres per 100 persons.

Development within Sister Bay has occurred along STH '42' and the bay coastline. Additional development is occurring between the coastline and STH '42' in the western portion of the village and along secondary streets paralleling STH '42' in the northern portion. Natural areas, such as woodland and wetlands, are found within the developed portion of the village and in the agricultural portion of the village. The majority of the agricultural lands lie to the south of STH '42'.

Residential Land. Residential land uses include single-family homes, multi-family homes, mobile homes, and land under residential development. Residential development has, for the most part, occurred adjacent to the coastline. Residential development is also occurring linearly along the various roads that enter the village. New residential development, essentially multi-family homes, is taking place on the bluff area just west of the central business district and in areas on the eastern fringe of the central business district.

Commercial Land. Commercial land use activities include commercial sales activities accounting for 35 percent of the commercial acreage and commercial service activities accounting for 65 percent. In general, all of the commercial activity is located in the central business district or in a strip fashion adjacent to either STH '42' or '57'. The central business district is the focal point for the village's commercial, governmental, recreational, and residential activities.

Industrial Land. Industrial land uses consist of outdoor and indoor storage activities which are located along STH '42'.

Transportation. Transportation related land uses include streets and off-street parking. The street category is comprised of state highways, county highways, and local streets. The off-street parking facilities are located in conjunction with the strip commercial development along STH '42'.

STH '42' provides the only direct north and south circulation through the village. The limited north/south routes combined with the fact that the village's central business adjoins STH '42' has caused parking and traffic flow problems in the central business district. Traffic circulation problems are also encountered on the village's west side between STH '42' and the coastline. In this area, most of the streets are not interconnected and dead-end at the coastline or on private property. In the central business district and the northern part of the village, the majority of streets are parallel to STH '42', forming long, linear blocks with no interconnecting streets or walkways.

Communication/Utilities. Major land uses in the communications/utilities category include the village's wastewater treatment facility, which is located on the village's eastern corporate limits, several wastewater pumping stations, the two well stations, the standpipe reservoir located near the intersection of STH '42' and '57', and a telephone switching station located on STH '57'.

Institutional and Governmental. Land uses in this category include churches, cemeteries, schools, libraries, government buildings, and clinics. The majority of these uses are located in the central business district.

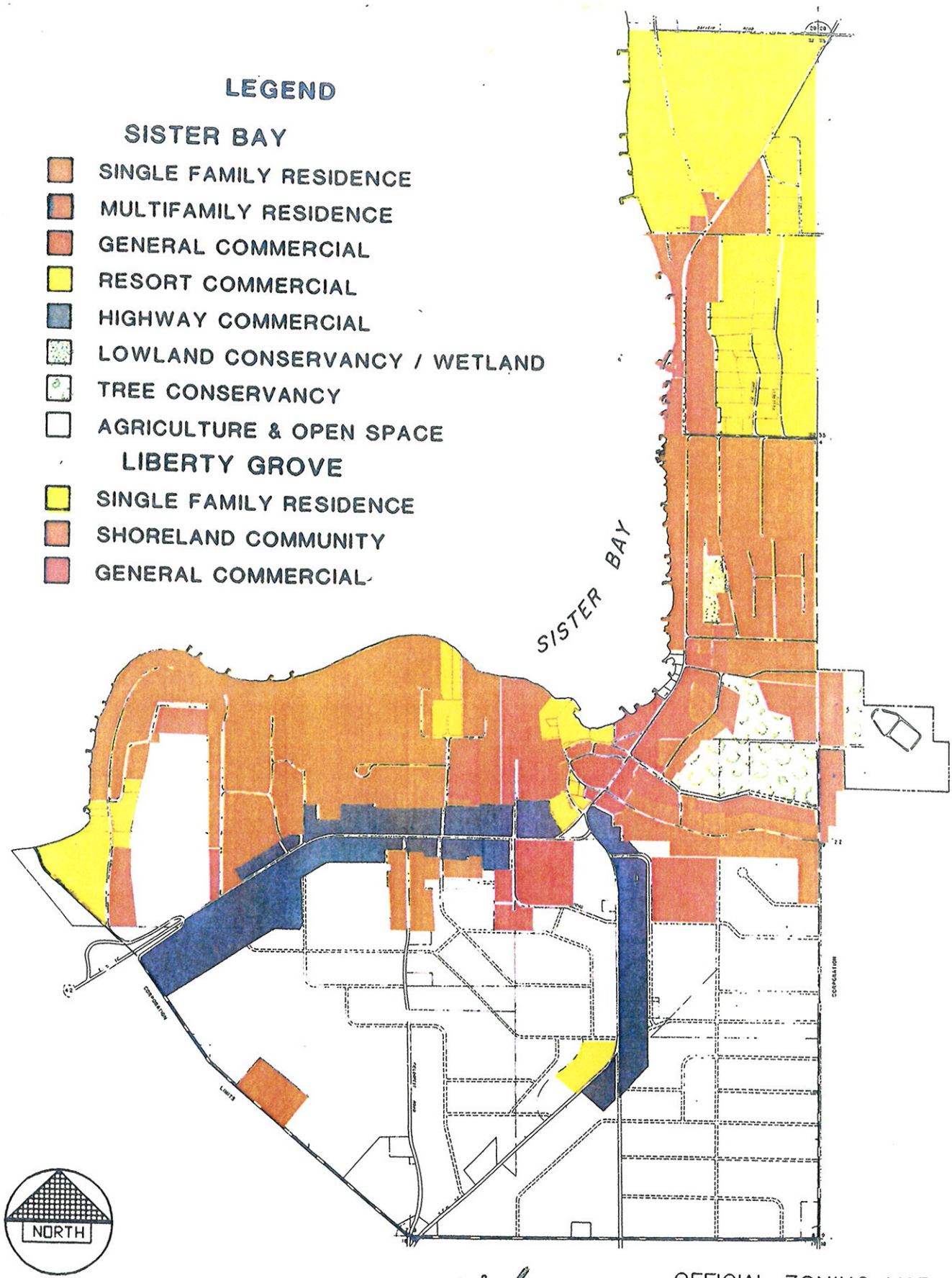
Outdoor Recreation. Major outdoor recreation facilities include a tennis court and swimming pool associated with Sister Bluff Estates; the Sister Bay Village Park and Beach, located in the central business district; the Sister Bay Public Boat Ramp; a village baseball field and tennis court located on Park Lane; a playground area associated with the elementary school; and a privately owned nine-hole golf course located on STH '42'.

Undeveloped Land. Undeveloped land includes natural areas and agricultural land. The majority of the agricultural lands are generally located south of STH '42' and CTH 'ZZ' in Sections 7 and 8. Natural areas are generally located adjacent to the coastline where they are subject to residential and commercial development. A small wetland area of approximately eight acres is located between STH '42' and North Spring Road just north of Scandia Road. This wetland area is also subject to developmental pressures. Additional natural areas include two small ponds in the central business district.

Zoning. The village of Sister Bay established a Zoning Ordinance in 1973 for the purpose of promoting and protecting the public health, safety, morals, comfort, prosperity, and general welfare of the village. The zoning ordinance includes the control of building sites, placement of structures and land use, prevention and control of water pollution, and the preservation of shore cover and natural beauty.

The Official Zoning Map is reproduced as Figure 2-7. This figure identifies seven village districts and locations with specific conditions and/or covenants.

A Single-Family Residence (R1) District is intended to provide a pleasant, safe, and quiet residential environment; free from traffic hazards and public annoyances. Permitted uses are single-family dwellings, churches, municipal buildings except sewage treatment plants, incinerators, warehouses, public garages, public garages, public shops, or storage yards. Public parks, playgrounds, recreational and community center buildings and grounds are also permitted. A household may have an occupation or professional office when it is incidental to the principal residential use.



SOURCE: Bay-Lake Regional Planning Commission, 1988.

OFFICIAL ZONING MAP
FIGURE 2-7

A Multi-Family Residence (R2) District is intended to provide a housing area that is pleasant and convenient but less spacious than the R1 district. These structures must meet all setbacks, yard and lot width, and area requirements for an R2 zone. The maximum dwelling unit density shall be six units per acre. In cases where the lot is larger than one acre, the maximum number of dwelling units shall be determined by multiplying the number of acres in the project by six dwelling units per acre. All fractional products shall be rounded down to the next whole number. Besides the permitted uses of an R1 district, an R2 district can include multiple-family dwellings, boarding and rooming houses, charitable institutions, and medical clinics.

A General Commercial District is intended to provide an area for the business and commercial needs of the village. It is intended to encourage the orderly and attractive grouping of retail stores, shops, offices and other business establishments at convenient locations in the central portion of the village. There are lot area, width, height and yard requirements in this district. Permitted uses include, but are not limited to, retail stores and shops, business and professional offices and studios, restaurants and taverns, and medical clinics.

The Resort Commercial District is intended to establish a convenient and ample area for providing resorts, as well as recreational and service facilities for visitors to the village. The district does have lot area, width, height and yard requirements. Permitted uses include tourist houses and resorts, hotels and motels, parks, playgrounds, beaches, and similar open areas.

The Highway Commercial District is intended to provide for specialized commercial activities along major streets and highways. Lot area, width, height and yard requirements must be met. Permitted uses include drive-in restaurants, gift shops, and specialty shops.

The Agriculture and Open Space District provides for the continuation of general agriculture and related uses in those areas suited to farming. The intent is to conserve areas with adequate soil types, drainage and topography for farming, and to preserve the rural landscape from an uneconomical scattering of residential, commercial, and industrial development in such areas.

General farming is a permitted use provided that buildings in which farm animals are kept at least 100 feet from the nearest residence on a non-farm lot. Farm buildings housing animals, barn yards or feed lots shall be at least 100 feet from any navigable water and shall be located so that manure will not drain into any navigable water. Single-family farm residences are also permitted in this district.

The LGSD No. 1 is governed by county zoning. A Resolution to the town of Liberty Grove will be proposed to cooperate with future decisions regarding zoning in order to avoid situations adverse to the protection of the community groundwater supply.

Population

Population projections for the village of Sister Bay and LGSD No. 1 were prepared in 1987 during wastewater facilities planning. These projections included estimates for both permanent and seasonal population. The Bay Lake Regional Planning Commission in their 1989 Comprehensive Plan Update agreed with the population estimates used for planning purposes. These estimates have been revised to reflect the most recent population trends and extended to include the year 2015. As shown in Table 2-5, the total population (permanent and seasonal) is expected to increase to 3,735 by the year 2015. Due to the large difference in population between the summer and the remainder of the year, the largest value must be used for design purposes. For this reason, seasonal population is considered as an important factor in this plan. The trend of increasing growth is shown graphically in Figure 2-8.

Table 2-5 Population Projections

Year	Permanent Population	Seasonal Population	Total Population
1990	964	1,446	2,410
1995	1,087	1,631	2,718
2000	1,177	1,766	2,943
2005	1,274	1,911	3,185
2010	1,380	2,070	3,450
2015	1,494	2,241	3,735

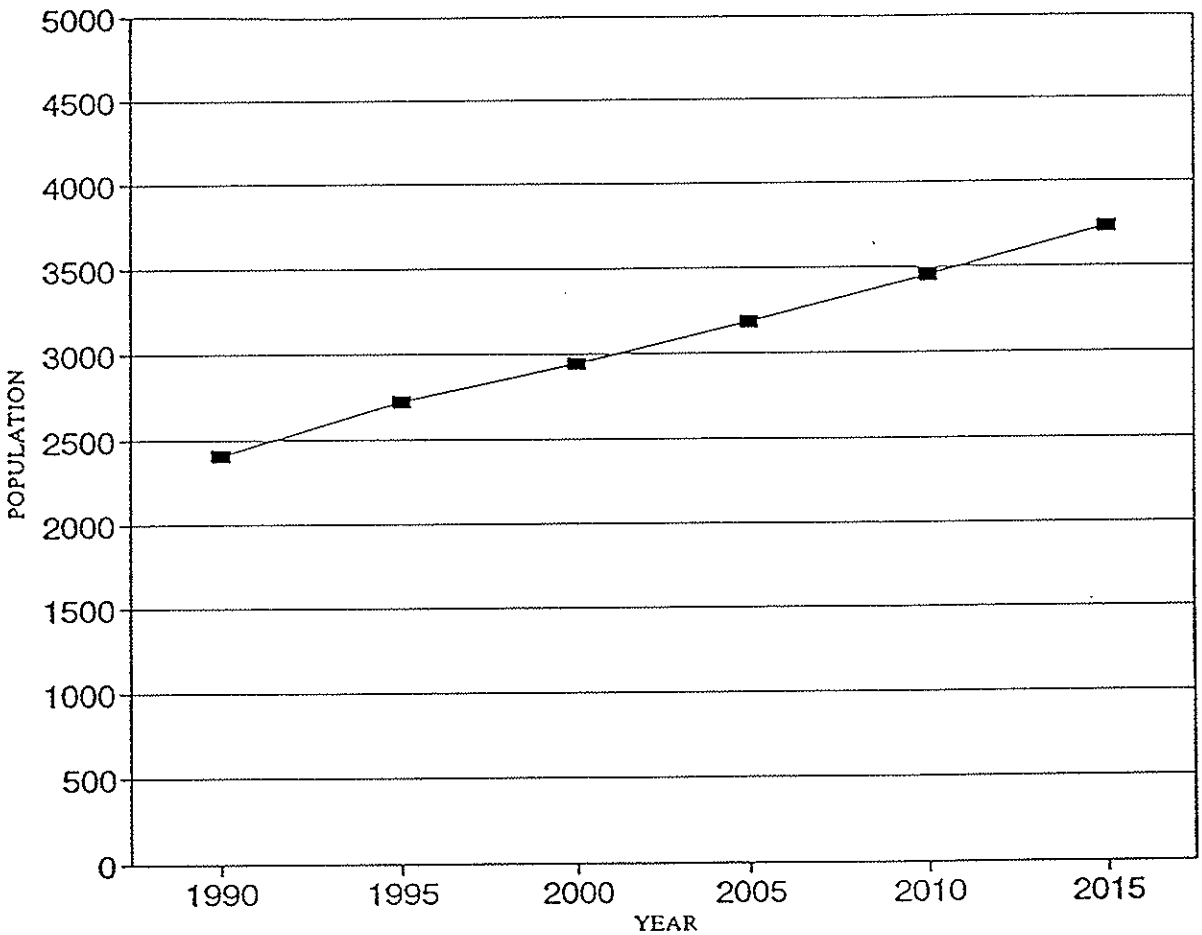


Figure 2-8 Population Data

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EXISTING SUPPLY SYSTEM

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Well Station No. 2 3-3
Liberty Grove Sanitary District No. 1 Booster Pump Station 3-3
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CHAPTER 3

EXISTING SUPPLY SYSTEM

The development of a long-range protection program must also evaluate the existing facilities in terms of their present conditions. From utility planning, the most important reason for the study of the existing system is to create a basis for the design of a protection area and evaluation of sites for a third well. This chapter is devoted to a discussion of the components of the existing water supply works.

SUPPLY SYSTEM

The Sister Bay water supply system is based entirely on the use of groundwater. The system consists of two well stations, two booster stations, and one storage standpipe, as shown in Figure 3-1. The water system is divided into an upper zone and a lower zone. Both well pumps discharge directly into the lower pressure zone. The two booster pump stations draw water from the lower pressure zone and discharge to the upper pressure zone.

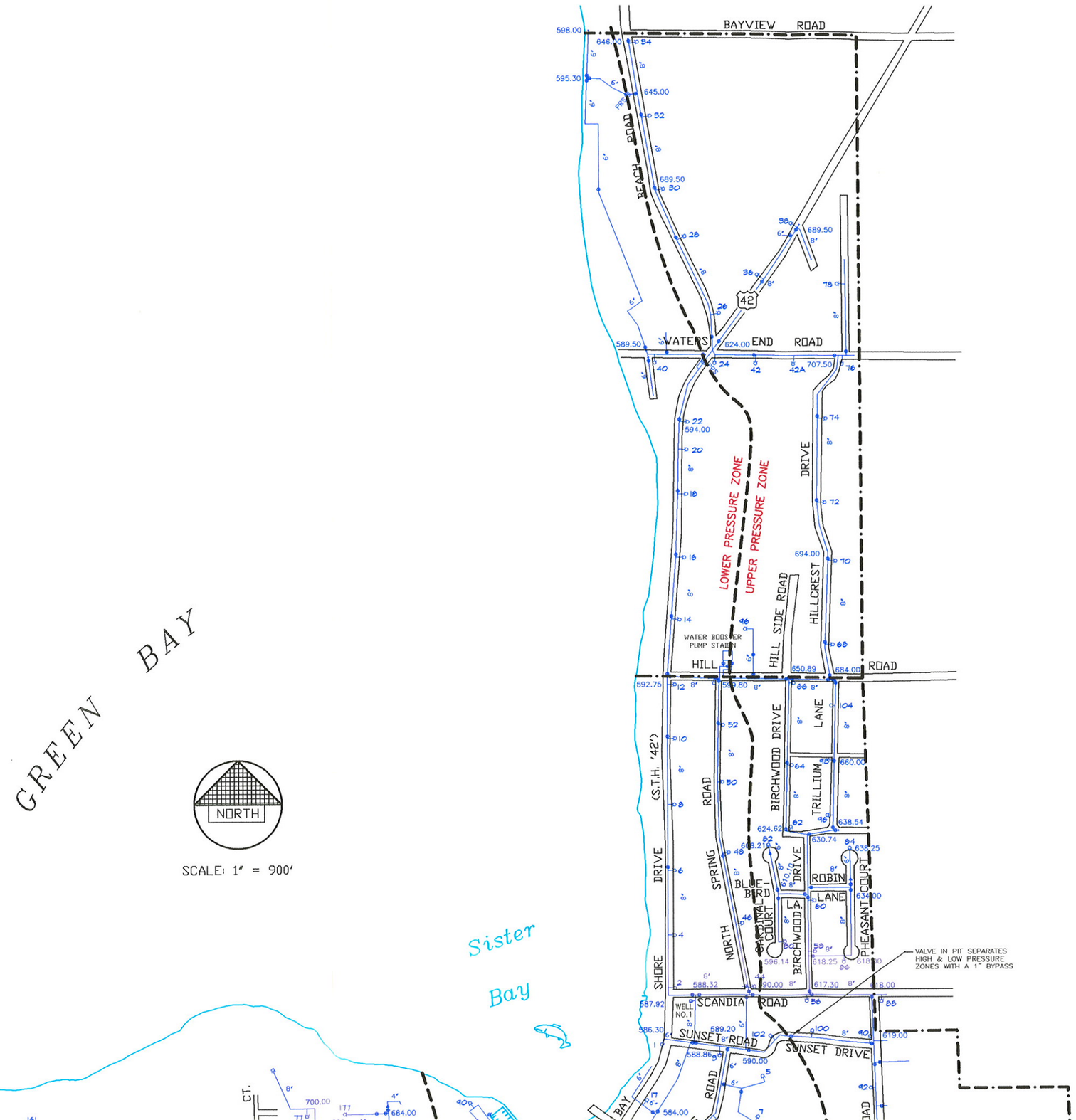
The well pumps can be controlled manually or automatically. In the automatic control, the well pumps are operated in response to the water elevation in the standpipe. Control signals for the well pumps are transmitted over telephone lines. Well No. 1 and well No. 2 pumps are manually alternated in the lead and the lag positions.

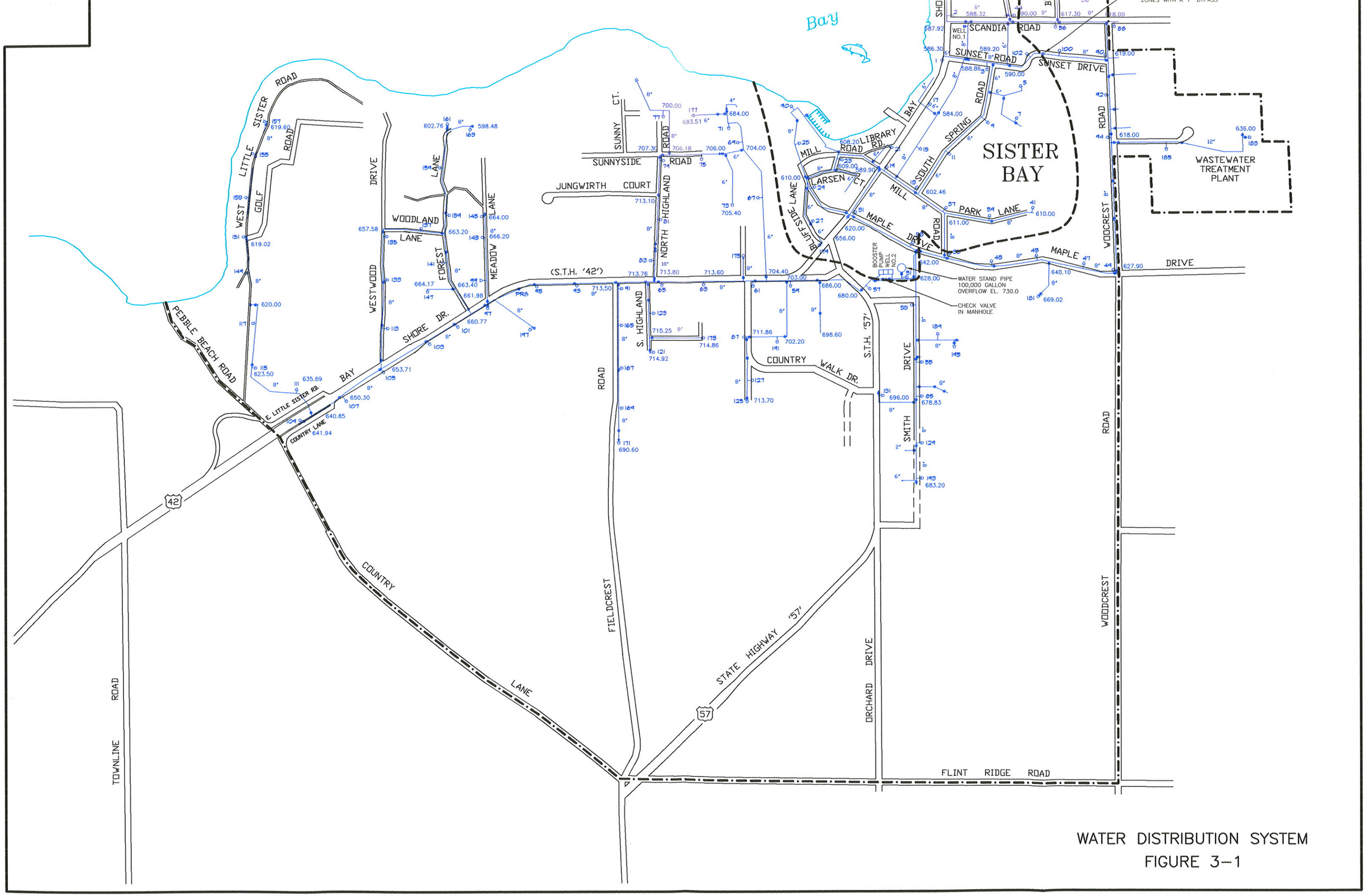
Chlorine solution is added for disinfection as the water from the well pumps enters the distribution system. Currently, no other chemicals are added to the water system.

Principal features of the existing supply and storage system are summarized in Table 3-1. Additional information regarding each of the well stations is presented in the following sections.

Well Station No. 1

Well station No. 1 is located along Scandia Road east of STH '42'. The well was originally constructed in 1972 to a depth of 208 feet. The well consists of a 10-inch diameter pipe grouted in place from the surface to a depth of 138 feet, and a 10-inch diameter open limestone borehole from 138 feet to the bottom of the well. The specific capacity of the well is 4.8 gallons per minute per foot of drawdown. The static water is at the ground surface and the well is currently pumped at 400 gallons per minute (gpm).


BAYVIEW ROAD
BEACH ROAD
WATERS END ROAD
42
LOWER PRESSURE ZONE
UPPER PRESSURE ZONE
DRIVE
HILLCREST
HILL SIDE ROAD
WATER BOOSTER PUMP STATION
HILL ROAD
BIRCHWOOD DRIVE
LANE
TRILLIUM
(S.T.H. '42')
SHORE DRIVE
SPRING ROAD
NORTH
BLUE-BIRD COURT
CARDINAL COURT
BIRCHWOOD L.P.
ROBIN LANE
PHEASANT COURT
VALVE IN PIT SEPARATES HIGH & LOW PRESSURE ZONES WITH A 1" BYPASS
SCANDIA ROAD
WELL NO.1
SUNSET ROAD
SUNSET DRIVE
GREEN BAY
Sister Bay
NORTH
SCALE: 1" = 900'



WATER DISTRIBUTION SYSTEM
FIGURE 3–1

Table 3-1 Principal Features of Existing Supply Facilities

Characteristic	Value
Well Station No. 1:	
Well	
Year Drilled	1972
Ground Elevation	590 USGS
Depth, ft.	208
Static Water Level, ft.	Flowing
Specific Capacity, gpm/ft	4.80
Well Pump	
Capacity, gpm	485-510
TDH, ft.	250
Setting, ft.	120
Well Station No. 2:	
Well	
Year Drilled	1972
Ground Elevation	685 USGS
Depth, ft.	305
Static Water Level, ft.	92
Specific Capacity, gpm/ft.	6.90
Well Pump	
Capacity, gpm	445-460
TDH, ft.	215
Setting, ft.	160

Well Station No. 2

Well station No. 2 is located along Smith Drive east of STH '57'. Well No. 2 was constructed in 1972 to a depth of 305 feet. The well consists of a 10-inch diameter pipe grouted in place from the surface to a depth of 171 feet, and a 10-inch diameter open limestone borehole from 171 feet to the bottom of the well. The specific capacity of the well is 6.9 gallons per minute per foot of drawdown. The static water level in the well is at 92 feet and the well is currently being pumped at 400 gpm.

Liberty Grove Sanitary District No. 1 Booster Pump Station

The Liberty Grove Sanitary District No. 1 booster station is located near the intersection of Hill Road and North Spring Road. The sanitary district booster station includes two Weinman pumps with a rated capacity of 100 gpm driven by 5 horsepower constant speed drives. The sanitary district booster station also includes a 600 gpm diesel engine pump used to meet fire flows. The booster pumps are controlled by system pressure within the upper pressure zone. As system pressure in the upper zone decreases, the pumps operate to meet the required water demand.

The village and sanitary district booster pump stations can be manually alternated in the lead and lag positions. If the lead booster station cannot provide adequate pumping capacity to meet required demands, the lag booster station is brought on-line to meet required flows. One booster pump station is provided with an emergency back-up generator, whereas, the other is provided with a direct drive engine.

Standpipe

The standpipe was built in 1972 by the Brown Minneapolis Tank Company. The tank has a capacity of 100,000 gallons. The tank is 19 feet in diameter and 48 feet high. The standpipe is located adjacent to well station No. 2. The high water level of the standpipe is elevation 730 USGS. The low water level is 700 USGS. Pressure in the lower zone is maintained by the standpipe.

Elevated Storage Tank

In April 1995, a water system study was completed by Robert E. Lee & Associates for the village of Sister Bay. One of the recommendations of the study was to increase the water system storage capacity.

Plans were made to construct a 150,000 gallon elevated storage tank. The proposed tank location is on Jungwirth Court, 550 feet west of North Highland Drive. Construction on the tank will start in the spring of 1996, with an estimated completion date of November 1, 1996.

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WATER USE

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CHAPTER 4

WATER USE

Basic to the development of groundwater protection programs for water supply systems is the analysis of present and past water use and the projection of water use trends into the future. This information, when applied to the land use and population data defined in Chapter 2, determines water requirements at various stages of development in the study area. These projections form a basis for the water supply protection area that is illustrated in subsequent chapters.

In April 1995, a water study report was prepared by Robert E. Lee & Associates for the village of Sister Bay. This report examined past and present water use information, and projected future water use rates. Water use information and projections pertinent to the development of a wellhead protection program are reproduced in this report. To be conservative and ensure the most complete protection possible, the future average day water use must be determined.

For convenience, the pertinent portions of the water study which evaluate water use are reproduced below.

PAST AND PRESENT WATER USE

The water use factor which is of the highest concern in a study of the Sister Bay system is the future average use. The future average day use must be determined to designate a wellhead protection area that is conservative enough to ensure complete protection yet reasonable to allow for future development that will not pose a threat to the public health, safety, and welfare of the people.

Average water production information for the water system for the year 1990 to 1994 was obtained from village monthly pumping records and is shown in Table 4-1. Average water production was evaluated for wintertime and summertime because of the wide variation in water usage as a result of seasonal population. Present annual average water use is about 237,071 gallons per day (gpd) during the months beginning in early summer through mid-fall, equivalent to a gross per capita consumption of about 87 gpd.

The Sister Bay water system is completely metered. Water use for each service in the village is separated into residential, commercial, industrial, and public uses. Water use data for the various categories from the 1991 to 1994 village records is presented in Table 4-2.

This data can be used to develop per capita unit consumption values. The per capita unit consumption values are necessary to determine future water requirements for design a sufficient wellhead protection area.

Table 4-1 Annual Total and Average Monthly Production

WINTER/SPRING MONTHS:							
Year	Thousand Gallons of Water Pumped						
	Jan	Feb	Mar	Apr	Nov	Dec	Total
1990	2,579	2,286	2,294	2,823	2,709	2,538	15,229
1991	2,467	2,298	2,500	2,855	3,131	2,937	16,188
1992	3,033	2,874	2,859	3,032	3,434	3,778	19,010
1993	3,764	3,122	3,324	3,269	4,343	4,038	21,860
1994	4,277	4,646	4,172	4,992	3,734	3,806	25,627
Ave.	3,224	3,045	3,030	3,394	3,470	3,419	19,583
SUMMER/FALL MONTHS:							
Year	Thousand Gallons of Water Pumped						
	May	June	July	Aug	Sept	Oct	Total
1990	4,539	5,727	8,589	7,672	5,426	5,035	36,988
1991	4,600	6,203	9,000	8,597	5,799	5,245	39,444
1992	11,689	7,961	8,965	10,650	6,234	5,948	51,447
1993	5,361	7,093	9,334	9,769	6,845	6,539	44,941
1994	7,045	6,405	10,451	11,116	8,681	7,410	45,285
Ave.	6,647	6,678	9,268	8,396	6,597	6,035	43,621

Total annual water use by residential, commercial, industrial, and public customers for 1991-1994 were obtained from village records and is shown in Table 4-2. The column titled "total metered" is the sum of the individual meter readings. The column titled "total supplied" is the amount of water metered at the pump station. The difference between the two figures is the amount of water that is unaccounted. For the period from 1990 to 1994, the village of Sister Bay, on the average, accounted for 16 percent of its water.

The unaccounted water represents inaccurate meters and leaks. Whenever the amount of unaccounted water exceeds 20 to 25 percent, the losses are excessive and the situation should be investigated. Acceptable values would be in the 10 to 15 percent range.

Table 4-2 Water Sold, 1990-1994

Year	Water Sold, gpd					
	Residential	Commercial	Industrial	Public	Total Metered	Total Supplied
1990	42,395	64,449	—	17,334	124,178	140,814
1991	48,986	69,726	—	19,800	138,512	149,923
1992	47,351	67,699	—	19,707	134,756	170,337
1993	48,222	72,477	—	20,778	141,477	178,063
1994	54,340	80,792	—	23,326	158,458	189,748

Water usage on a per capita basis is shown in Table 4-3. Summer/fall water use values are used due to the fact water usage is highest during these months. Residential water use includes single-family homes and duplexes. Residential water use was determined for 1992-1994 using metered residential water use and extrapolated population estimates.

Table 4-3 Per Capita Water Use, Summer/Fall (July-October)

Year	Water Use, gpcd				
	Population	Residential	Commercial	Public	Total
1991	2,472	35.5	62.0	2.2	99.7
1992	2,533	37.1	61.5	2.0	100.9

FUTURE WATER REQUIREMENTS

Water consumption data for Sister Bay provides the basis for estimates of future water needs within the study area. From this data, design factors are applied to population to obtain the estimated average and maximum rates of water use at any future time in any portion of the study area.

Design factors developed from analysis of water use are summarized in Table 4-4.

Table 4-4 Design Unit Consumption Values

Water Use	Unit Consumption Value Per Capita, gpcd
Residential	35
Commercial	60
Public Use	5
Combined Value	100

The principal factors influencing water use in residential areas include density of dwelling units, economic levels of the consumers, and water rates charged. As the population density increases, residential water use tends to decrease due to a decrease in irrigation and a shift to commercial water using services such as laundering and car washing. As the economic level of the customers increases, the water use increases due to an increase in water consuming appliances. Increasing water rates or sewage rates appear to have little influence on basic household uses, but have quite a significant influence on irrigation and other outdoor uses. This normally appears as a lower peak rate of use rather than a noticeable drop in overall use.

Considering all of the previous factors and the apparent constant residential water use noted over the past three years and the trend for water conservation, it is unlikely there will be a substantial increase in use in the future. A value of 35 gpcd appears to be a reasonable value for residential water use.

A value of 60 gpcd was selected as an appropriate unit consumption rate for predicting future commercial water requirements. This value represents a small increase in existing use to account for shifting uses from residential to commercial use as discussed previously.

A value of 5 gpcd was selected as an appropriate unit consumption rate for predicting future public water use. This value represents an increase over existing use, but is still within reasonable values.

Future demand rate variations are expected to remain similar to those mentioned previously in this chapter.

Future amounts of unaccounted water are expected to decrease to a maximum value of 15 percent (85 percent accounted). With the high cost of capital, energy and labor, reductions in leakage and changes to improve accountability should prove cost-effective.

Water requirements for the entire water system were determined for the year 2015. The results of these calculations are summarized in Table 4-5.

Table 4-5 Projected Average Daily and Maximum Day Water Use for the Year 2015

Water Use	Population	Unit Consumption Per Capita, gpcd	Average Day Demand, gpd
Residential	3,735	35	130,725
Commercial	3,735	60	224,100
Public	3,735	5	18,675
Sub-total			373,500
Unaccounted-for water at 15% of total			56,025
TOTAL			429,525

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WELL STATION NO. 3

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CHAPTER 5

WELL STATION NO. 3

In April of 1995, a water system study was completed by Robert E. Lee & Associates for the village of Sister Bay. This evaluation of the current operating water supply, distribution, and storage system offered several recommended improvements, one of which was the construction of a third well station. As mentioned in that report, a third well station would greatly increase the reliability of the water system and provide for more uniform distribution of water throughout the system.

SERVICE STANDARDS

Service standards establish minimum requirements for water quality, quantity and pressure, and determine the degree of fire protection and reliability the system should provide. In Wisconsin, the minimum standards are set forth in administrative rules and regulations established by the Wisconsin Department of Natural Resources (WDNR). Other more restrictive standards for various phases of water supply have been set by the American Water Works Association (AWWA) and the Insurance Services Office (ISO).

Most of these standards were discussed in detail in the water system study report. The standards of concern in this chapter are those that relate directly to the quantity and quality of the water supply system.

Water Quantity and Quality

With regard to water quantity, construction of a third well is guided by two basic premises. These are, first, that a water supply system should be capable of meeting all demands during the period of maximum use without reducing pressure below an acceptable limit, and second, that no water rationing or other customer limitations are compatible with high standards of service.

Desirable water quality implies water which is clear, tasteless, odorless, and free of bacteriological contamination. The WDNR has established minimum standards in Chapter NR 109 for mineral content, physical characteristics, and bacterial content of water to ensure its quality. The construction of a third well is designed to meet these requirements.

Supply and Storage Facilities

A municipal water system should be capable of meeting all demands expected to be imposed on the system. To achieve this goal requires a combination of wells and storage facilities. As a minimum, the wells must have a capacity equal to the maximum daily demand, and storage must be provided for equalizing peak hourly demands and to provide a reserve. As a maximum, the wells could have a capacity equal to the maximum hourly demand plus design fire flow.

ALTERNATIVE SITES FOR WELL NO. 3

Three locations were considered as a potential site for the third well station. Because of the existing agreement between the village of Sister Bay and the town of Liberty Grove Sanitary District No. 1 regarding the sharing of a municipal water distribution system, lands within the town of Liberty Grove were also under consideration for the future well site.

Alternative 'A' — Town of Liberty Grove Sanitary District No. 1 Booster Pump Station

Alternative 'A' is located at the town of Liberty Grove Sanitary District No. 1 booster pump station. The potential site is located in the SE 1/4 of Section 32 of Township 32 North, and Range 28 East.

Alternative 'B' — Southeast Section of the Village of Sister Bay

Alternative 'B' is located in the southeast portion of the village. This site is located in Section 8 of Township 31 North, and Range 28 East.

Alternative 'C' — Southwest Section of the Village of Sister Bay

Alternative 'C' is located in the southwest portion of the village. This site is located in Section 9 of Township 31 North and Range 28 East.

EVALUATION OF ALTERNATIVES

A present worth analysis was not completed for the three alternative sites. There was not expected to be a significant difference between the present worth values of each alternative. Non-economic factors were considered more important in evaluating which well site should be recommended. These non-economic factors included, equalization of water supply to the distribution system, groundwater flow direction, the extent of the wellhead protection area, and existing and future potential sources of contamination within that area.

One important consideration was to recommend a location for well No. 3 such that the recharge area for this well would be separate from the recharge areas of the other two wells. Separate recharge areas would increase the water system reliability by reducing the potential for a contamination event to affect more than one well.

Alternative 'A'

Alternative 'A' is located in LGSD No. 1. A benefit of this location is the close proximity to a watershed boundary that may function as a barrier protecting against potential contaminants. A well and pumping station in the north section of the service area would better equalize the distribution of water throughout the entire system. This area, under current zoning for the town of Liberty Grove shown in Figure 2-7, is categorized as single family residential which defines construction of this sort as acceptable.

Immediate concerns regarding this site are legal issues associated with the construction of a pumping station to be owned by the village of Sister Bay in the town of Liberty Grove. Some soils in this area create a problem in that they exhibit low to very low soil pollution attenuation potential as mapped on the Groundwater Pollution Potential and Pollution Attenuation Potential in Door County, Wisconsin maps by the WDNR.

Alternative 'B'

Alternative 'B' is located in the southeast portion of the village. This area lies in close proximity to a watershed boundary. A benefit to locating the well within the village limits is more direct control.

This site lies in an area of soils characterized as having low to very low pollution attenuation potential. In addition, the surface exhibits many fracture traces. These fracture traces indicate the potential for direct contact with subsurface fractures that would be tapped for an abundant groundwater supply. This creates a danger for contamination of the groundwater contained in the aquifer below the wellfield. This area is also currently zoned as agricultural and open space under the village's zoning ordinance. Farming activities are detrimental to the quality of a groundwater supply and contradictory to the goals identified in this wellhead protection plan. With wells Nos. 1 and 2 located in close vicinity with respect to the entire service district, there is no great benefit of equalization throughout the distribution system. This site would result in overlapping recharge areas for well No. 3 and well No. 2.

Alternative 'C'

Alternative 'C' is located in the southwest portion of the village. This alternative also demonstrates the benefit of better control because of its location within the village limit boundaries. There are soils in the area that exhibit good pollution attenuation potential. This portion of the village is relatively free of fracture traces and exposed bedrock.

There is no immediate watershed boundary in this area to act as a potential shield for the groundwater captured in a well here from potential surface contaminants. This area, like Alternative 'B', is zoned for agricultural uses and the preservation of open space which causes a problem with regard to wellhead protection. The location does not provide for any great benefit of equalization for the distribution system as a whole. The recharge area for a well at alternative site No. 3 would overlap the recharge system for well No. 2.

RECOMMENDED SITE

The obstacles encountered by choosing Alternative 'A' are easily overcome. The town of Liberty Grove not only holds an agreement with the village regarding sharing of the public water system, but also because the town will recognize direct benefits such as flow equalization from the new well. With proper soil tests and the guidance of the WDNR maps, a site near the watershed boundary will be identifiable as feasible for the construction of a new well.

The problems associated with Alternatives 'B' and 'C' are similar and would require amending the zoning ordinance to provide for adequate protection of the public water supply. The natural features limiting the groundwater protection at these sites cannot be altered.

Therefore, the recommended site for the third well is Alternative 'A', located in the town of Liberty Grove Sanitary District No. 1. This site is used in the development of a wellhead protection area.

DESIGN PARAMETERS

The estimated design parameters for the proposed well station No. 3 is outlined in Table 5-1. These parameters are based on the existing two wells and may change when the well is constructed.

Table 5-1 Estimated Design Parameters for Well Station No. 3

Characteristic	Value
Well	
Year Drilled	To Be Determined
Depth, ft.	210
Estimated Static Water Level, ft.	Surface
Estimated Pumping Water Level	85
Well Pump	
Capacity, gpm	400
TDH, ft.	300
Setting, ft.	160

CAPITAL COST ESTIMATE

The estimated capital cost for the construction of well station No. 3 is detailed in Table 5-2 below.

Table 5-2 Capital Cost Estimate for Well Station No. 3

Item	Estimated Cost
Site Work	$ 8,000
Drill and Test New Well	75,000
Well Pump	20,000
Piping	15,000
Pump and Generator Building	60,000
Disinfection Equipment	11,000
Electrical	15,000
Standby Generator	48,000
Subtotal	$252,000
Contingency and Engineering	76,000
TOTAL	$328,000

6

BASIS OF WELLHEAD PROTECTION PLANNING

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CHAPTER 6

BASIS OF WELLHEAD PROTECTION PLANNING

This chapter contains the procedures used to determine the wellhead protection area. The wellhead protection area is conservatively designed to provide the most feasible protection for the groundwater supply of the village of Sister Bay and the LGSD No. 1. An inventory of potential contamination sources within the protection area was prepared. Stringent restrictions will be developed for activities within the wellhead protection area to protect the public health.

WELLHEAD PROTECTION AREA

The wellhead protection area is defined for the purposes of this report as the surface and subsurface area surrounding well No. 1, well No. 2, and future well No. 3; through which contaminants are reasonably likely to move toward and reach these wells in a minimum time period of five years. Five years is used because it is required as a minimum in NR 811.16, and because it is considered a reasonable amount of time to plan for and initiate clean-up efforts or well replacement in the event of a major contaminant spill. Several factors must be considered in order to account for all influences on groundwater contamination. Conservative design values are assumed for the purposes of this study to provide protection against groundwater contamination.

Development of the wellhead protection area began with determining the direction of groundwater flow to each well. Information about the regional groundwater flow and geology were used to estimate the recharge area for each well. Aquifer properties estimated from literature sources. The authors are not aware of any regional hydrogeological work beyond those references consulted. Therefore, the information presented in these references was used, essentially unchanged in the development of the wellhead protection areas. This assured that hydrogeologic conditions at the present are not significantly different than those observed in the references. Because of this lack of concrete information, the wellhead protection area boundaries were conservatively set.

The references consulted during the development of the wellhead protection area are included in Appendix A.

The mathematical models used to calculate the protection area were developed for use in a porous media. The use of these models in this report required the assumption that the fractured bedrock aquifer behaved as a porous medium at the scale of the problem. The presence of major unknown fractures can result in groundwater movement in unexpected directions. For example, significant rainfall events have been observed to cause a noticeable rise in the static water level of well No. 2 shortly after occurrence. Also, it has been observed that the groundwater level in a monitoring well at a site near Well No. 2 has dropped significantly.

Because of this change, there is a concern that there might be an underground connection between Well No. 2 and the monitoring well. This monitoring well is located at a leaking underground gasoline storage tank site (Voight's Automotive). It should be noted that gasoline compounds have not been detected in Well No. 2. Verification of this connection is beyond the scope of this report, but it points out the need for a conservative approach to delineating the protection area.

Groundwater Flow Direction

Regional groundwater flow directions were determined from water table contours. The water table contours developed in Figure 2-5 by the USGS were analyzed using the computer software package "Terramodel," by Plus III Software, Inc. of Atlanta, Georgia. This software is used to develop stormwater runoff volumes based on the area topography. Because of the physical similarities, it can also be used to determine groundwater flow direction.

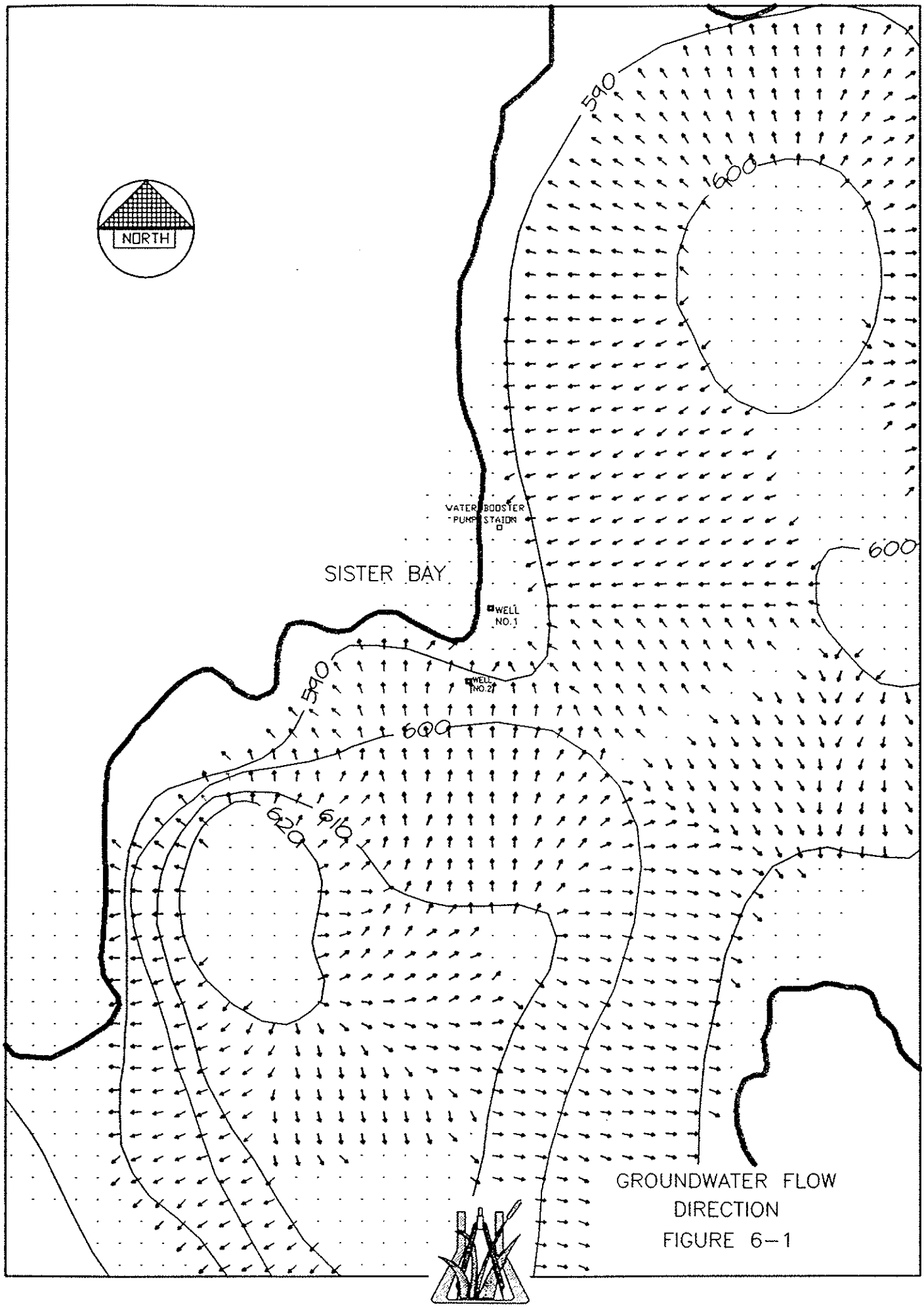
The software constructs a three-dimensional grid from the groundwater contour data. The grid elevations between contours are interpolated. The software package calculates a slope for each grid based on the grid corner elevations. The model output is shown in Figure 6-1. The slope direction is shown by arrows with the head pointing downslope. In the locations where there is no slope, the model generates a dot. The groundwater flow direction was taken as the slope direction.

The groundwater flow to well No. 1 varies between the east and the southeast. The groundwater flow to well No. 2 is from the south. At the proposed well No. 3 location, the groundwater flows from the east.

These groundwater flow directions are valid for October 1971, the year the groundwater levels were measured. The year 1971 was an average precipitation year. Based on this and the regional geology, the groundwater flow directions are not expected to vary significantly from year to year.

Recharge Area

The recharge area for a well is considered to be the area from which water reaches the aquifer by surface infiltration and eventually reaches the well. The recharge area is determined by examining the local soils and aquifer properties. An examination of the groundwater flow directions developed in Figure 6-1 will show the presence of a groundwater divide running up the middle of the peninsula. The groundwater divide will form one edge of the recharge area. The width of the recharge area depends on the aquifer properties and is determined below.



GROUNDWATER FLOW DIRECTION
FIGURE 6-1

Zones of Influence

A "zone of influence" is defined as the land area above the cone of depression. The cone of depression is defined as the lowering of the groundwater table which develops around a well when water is withdrawn. The lowering of the water table develops the shape of an inverted cone. The cone of depression enlarges with time until a steady state condition is reached. The dimensions of the cone of depression depend on the pumping rate and the aquifer properties.

The zone of influence is determined by calculating the limits of the cone of depression developed after 30 days. The limit is defined as that point where the drawdown is 0.1 feet. The zone of influence represents the area of the most concern because any contaminant released in this area would be immediately captured by the pumping well and released to the distribution system. Extensive field work would be required to determine the necessary aquifer properties to enable use of conventional distance-drawdown calculations. Therefore, two alternate methods were used to calculate the zone of influence.

The first method, the Volumetric Flow Equation, estimates the volume of water removed from the aquifer after 30 days of pumping at the maximum rate. To be conservative, no aquifer recharge is included. The only aquifer property needed with this method is an estimate of the porosity. The aquifer parameters are given in Table 6-1. The calculations are shown in Appendix C. The zone of influence for each well is shown in Table 6-2.

Table 6-1 Parameters for Zone of Influence Calculations

Characteristic	Value
Design Maximum Well Pumping Rate, gpm	400
Time Period	30 days
Estimated Aquifer Porosity	0.10
Saturated Thickness, ft.	
Well No. 1	125
Well No. 2	150
Well No. 3 — estimated	125

The second method uses a computer modeling program developed by the EPA. The software code, WHPA, uses aquifer properties and pumping rates to determine the horizontal extent of groundwater "captured" by the well. The extents are determined by a time period selected by the program user and the average groundwater velocity calculated by the software. In this case, the selected time period is 30 days. The model input data and output are shown in Appendix C. The zone of influence for each well is shown in Table 6-2.

Table 6-2 Zone of Influence Radius

Well	Volumetric Flow, ft.	WHPA, ft.	Proposed, ft.
Well No. 1	242	280	300
Well No. 2	217	273	300
Well No. 3	242	260	300

The most conservative zone of influence is that calculated by the WHPA code. This zone is shown on Figure 6-2. The zone radius is rounded to 300 feet for field convenience.

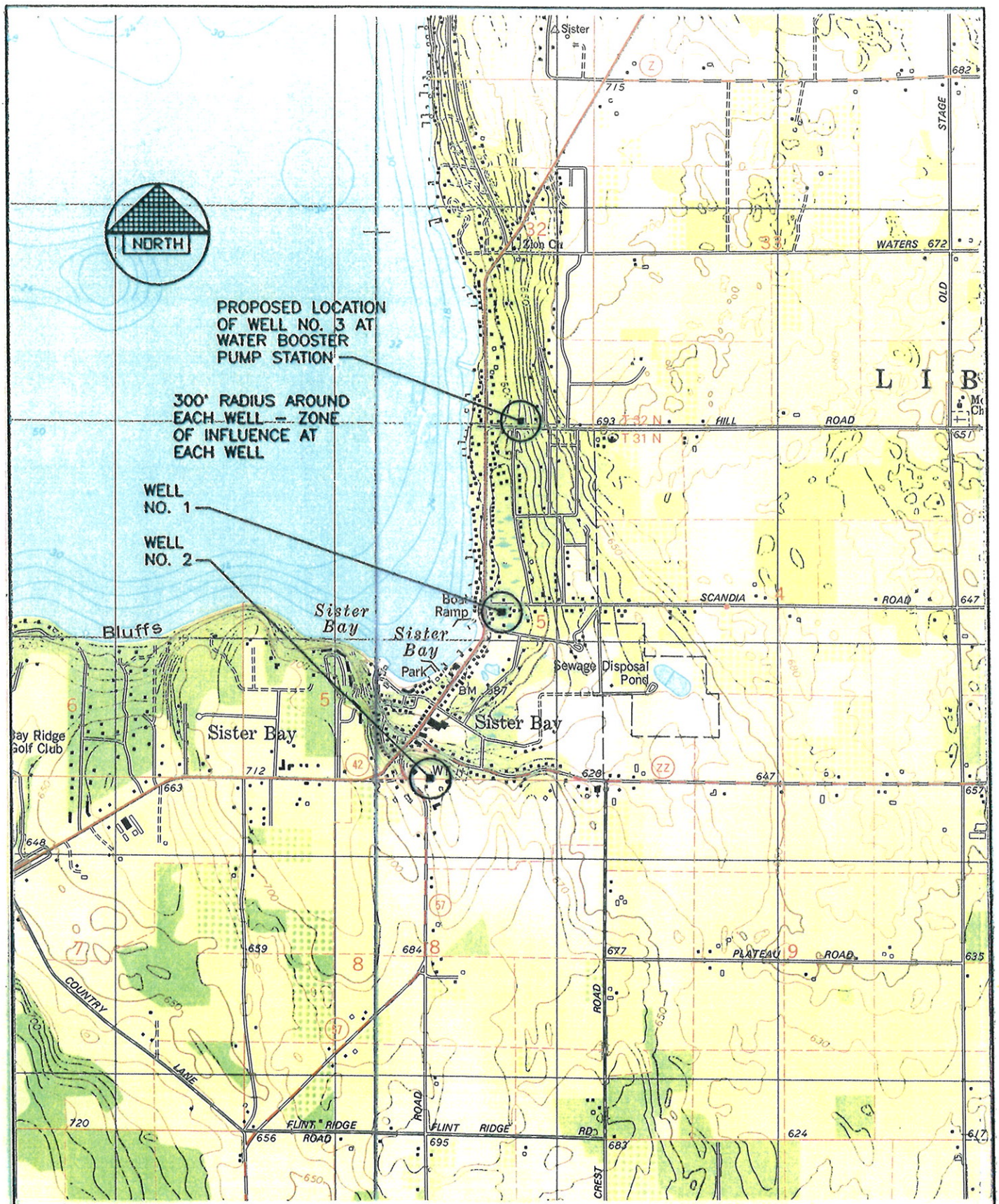
A soil pollution attenuation potential map was developed in "A Nonpoint Source Control Plan for Upper Door Priority Watershed Project." Soils in Door County were rated in their potential to attenuate or "clean" surface water as it moves through the soil to the groundwater. A rating of very low indicated very little potential to "clean" pollutants from water, whereas a good rating means the soil has the best potential to attenuate pollution of the soils in the area. This map contained in the aforementioned report shows that the soils overlying the zones of influence have low to very low attenuation potential.

Zones of Contribution

The "zone of contribution" is defined as that area from which groundwater will reach the well after a certain period of time. The zone extent depends on the aquifer properties, the pumping rate, and the time period selected. The zone of contribution includes part of the recharge areas and the downgradient portion of the cone of depression.

The time period selected for calculating the zone of contribution is five years. Two methods were used to develop the areal extent of the zone for each well; the uniform flow method and a computer groundwater flow model.

Uniform Flow Method. This is a mathematical method of determining a probable Zone of Contribution to a well using aquifer properties and well pumping rates. A summary of the parameters used in calculations can be found in Table 6-3. A larger saturated thickness is used for the zone of contribution than the zone of influence because the effects of drawdown can be safely ignored due to the longer time period involved. This method typically delineates an area larger than necessary due to the fact that it ignores limiting geologic features. It should not be used alone in cases located in Door County because of the fractured dolomite aquifer that does not exhibit uniform consistency and therefore does not produce uniform groundwater flows. The areas produced by these calculations are shown on Figure 6-3. The upgradient limit is defined by the groundwater divide. The calculations for this method can be found in Appendix D.



U.S.G.S. 7.5 Minute Quad.
Ephroim 1982
Sister Bay 1982

ZONES OF INFLUENCE
FIGURE 6-2

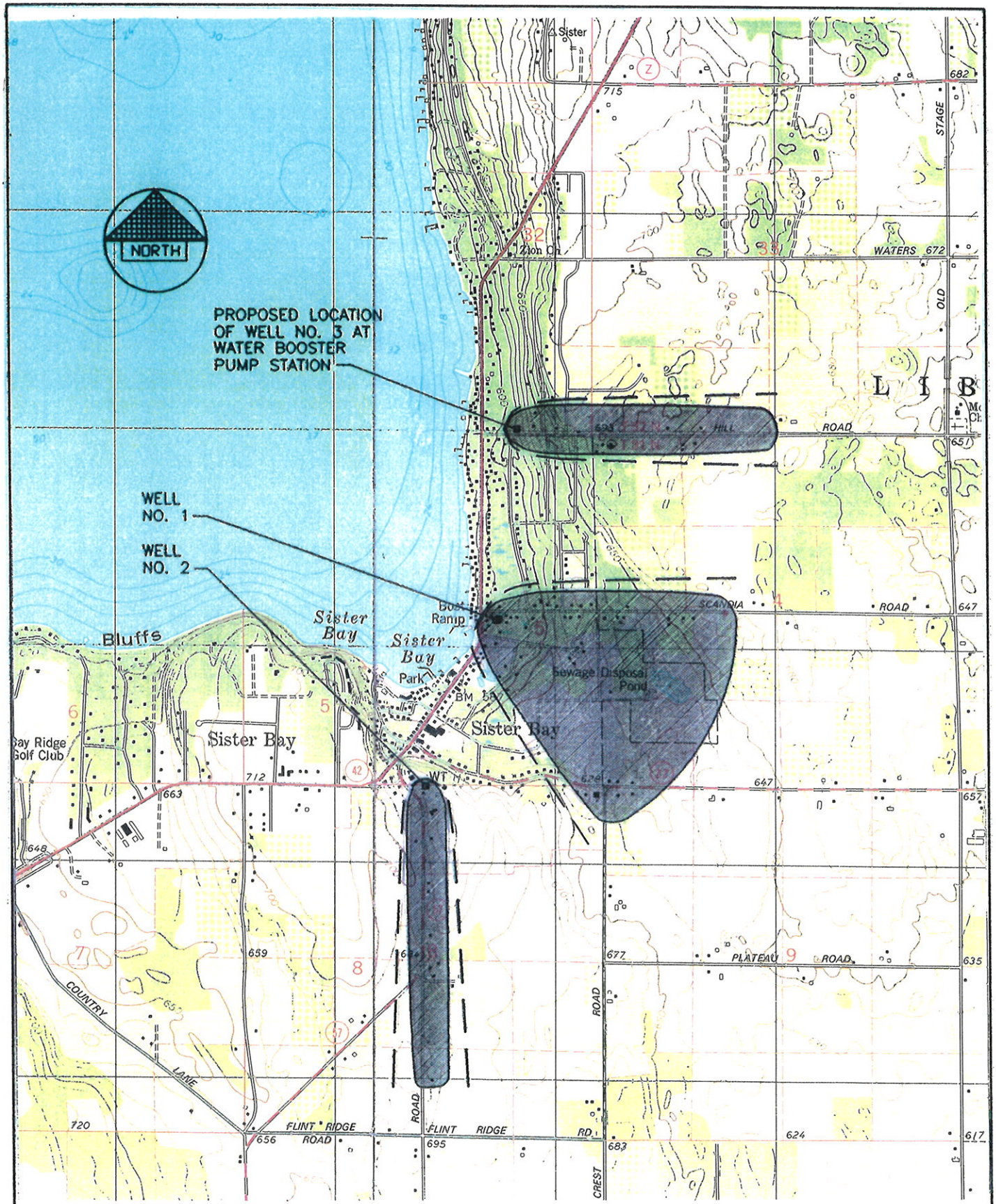
Table 6-3 Parameters for Uniform Method

Parameter	Value
Average Well Pumping Rate, ft^3/day	28,740 (215,000 gpd)
Hydraulic Conductivity, ft/day	30
Saturated Thickness, ft.	
Well No. 1	167
Well No. 2	184
Well No. 3 — estimated	167
Hydraulic Gradient, ft/ft	
Well No. 1	0.004
Well No. 2	0.0067
Well No. 3	0.005

Computer Modeling. A computer modeling program was also used in refining the wellhead protection area. The program, the WHPA CODE, uses various aquifer and pumping performance conditions to develop a suitable wellhead protection area. The program has several sub-programs which can account for different situations such as stream barriers, geologic barriers, and multiple wells. The program was created for confined aquifer systems; but is used to verify areas calculated by other methods. The sub-program MWCAP was used to determine the zone of contribution. The values used for the model are identified in Table 6-4. Actual printouts from the modeling procedure can be found in Appendix E. The area defined by the program is shown on Figure 6-3.

Table 6-4 Aquifer Parameters for WHPA CODE Computer Model

Characteristic	Value
Transmissivity, ft^2/day	6,200
Hydraulic Gradient, ft/ft	
Well No. 1	0.004
Well No. 2	0.0067
Well No. 3	0.005
Porosity, dimensionless	0.10
Aquifer Thickness, ft.	
Well No. 1	167
Well No. 2	184
Well No. 3	167
Angle of Ambient Flow, degrees (Groundwater Flow Direction)	
Well No. 1	180
Well No. 2	90
Well No. 3	180
Time Period	
Zone of Influence	30 days
Zone of Contribution	5 years



LEGEND

— — UNIFORM FLOW METHOD

WHPA MODEL

U.S.G.S. 7.5 Minute Quad.
Ephraim 1982
Sister Bay 1982

ZONES OF CONTRIBUTION
FIGURE 6-3

The zone of contribution calculated by the uniform flow method is a parabolic shaped area. The long axis is parallel with the groundwater flow direction. The distance from the well to the downgradient limit and the width of the zone are listed in Table 6-5. The upgradient limit is defined by the groundwater divide.

Table 6-5 Calculated Zone of Contribution Dimensions

Uniform Flow Method	Well No. 1	Well No. 2	Well No. 3
Downgradient Limit, ft.	230	130	180
Zone Width, ft.	1,440	780	1,140
Upgradient Limit, ft.	N/A — extends to groundwater divide		
WHPA Method	Well No. 1	Well No. 2	Well No. 3
Downgradient Length, ft.	170	100	150
Zone Width, ft.	900	600	750
Upgradient Length, ft. (Based on 5-Year Time of Travel)	3,330	4,500	3,800

The zone of contribution calculated by the WHPA computer model is oval shaped. The length is determined by the five-year time of travel period. The width of the zone and the downgradient limit are less than those determined using the uniform flow method. These dimensions are given in Table 6-5.

The groundwater flow directions at wells No. 2 and 3 are fairly well defined; from the south at well No. 2 and from the east at well No. 3. However, at well No. 1, the groundwater flow direction varies. Probable directions range from the east to the southeast (see Figure 6-1). The zone centerline is therefore rotated through an arc which corresponds to the different groundwater flow directions to determine the zone of contribution.

The soils overlying the zone of contribution have varying pollution attenuation potential. At well No. 1 and the proposed well No. 3, the soils closest to the well have low attenuation potential. From the village limits eastward, the soil has good attenuation potential. The soils at well No. 2 have differing pollution attenuation potential; some are rated good and some are rated low.

This discussion regarding soil pollution attenuation potential is meant to alert village officials that any surface spills of contaminants within the wellhead protection zone should be cleaned up thoroughly as soon as possible. The village cannot rely on the soils of the area to buffer the effects of a spill and allow a delayed cleanup effort.

Composite Wellhead Protection Area

Due to the nonuniformity of the aquifer in the Sister Bay area, all of the methods previously mentioned have been used to create a composite wellhead protection area. This area is broken down into zones with various levels of protection. These areas are shown on Figure 6-4.

Primary Protection Zones. The primary protection zones are the zones of influence for each of the three wells in the village's public water supply system. The primary protection zone is a 300-foot radius circle centered on the well. This is where strictest protection will be enforced to ensure maximum protection against immediate contamination to the water supply from potential surface and subsurface pollutant sources.

Management Zone No. 1. Management zone No. 1 is a segment of a circle which extends from the boundary of the primary protection zone outward to the limit of the zone of contribution. The boundaries of the management zone were chosen to correspond with probable groundwater flow directions or easily identified geographical features. The next level of protection is present in management zone No. 1.

Management Zone No. 2. Management zone No. 2 begins at the boundaries of the management zone No. 1 and extends outward to encompass the entire area one mile from each of the wells or the village limits, whichever distance is greater. The lowest level of protection is present in this zone.

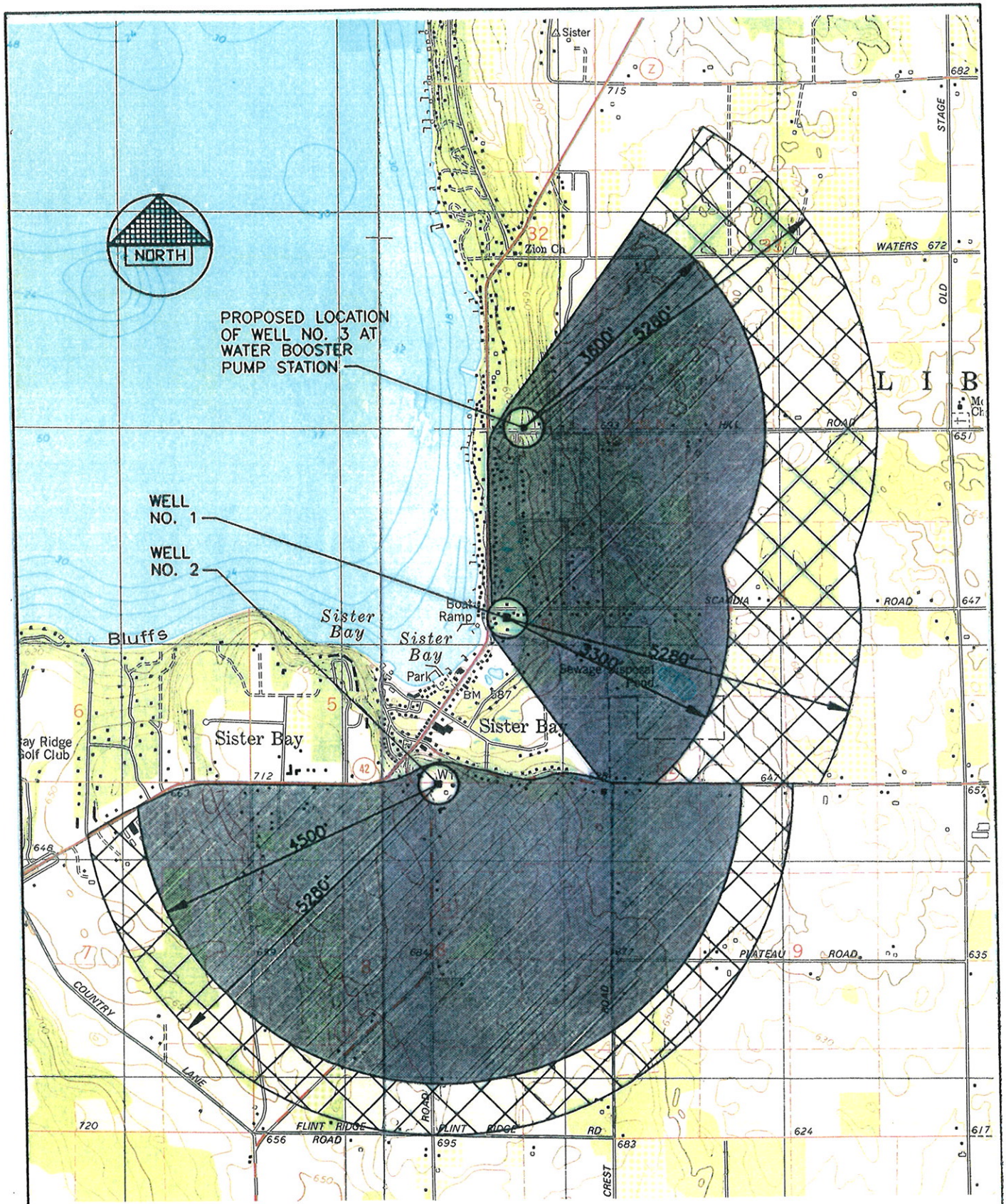
CONTAMINATION SOURCE INVENTORY

One component essential to wellhead protection planning is an inventory of existing potential contamination sources. It is also important to evaluate and eliminate the possibility of future potential sources of contamination to the groundwater.

Existing Potential Sources of Contamination

Existing potential sources of groundwater contamination include any activity that endangers groundwater quality. Potential sources of contamination include the following activities.

Agricultural Sources. Agricultural sources of contamination are mainly found in the southern and eastern parts of the village. Possible sources include operations involving feedlots, dairies, manure spreading and storage, crops and orchards, and pesticide mixing. Contamination can result from nitrates, pesticides, bacteria, and automotive wastes associated with these practices.



LEGEND

- PRIMARY PROTECTION ZONE
- MANAGEMENT ZONE NO. 1
- MANAGEMENT ZONE NO. 2

U.S.G.S. 7.5 Minute Quad.
Ephraim 1982
Sister Bay 1982

WELLHEAD PROTECTION AREA
FIGURE 6-4

Commercial Sources. Commercial sources are located along STHs '42' and '57', as well as along the coastline of the bay. Sources evaluated include but are not limited to auto repair shops and service stations, barber shops and beauty salons, cemeteries, golf courses, laundromats, and photo processing facilities. Groundwater contamination can result from a large spillage of chemicals associated with these businesses.

Municipal Sources. Municipal sources include salt storage facilities, underground storage tanks, public recreational facilities, and governmental/institutional office buildings. Contamination can result from leaking underground tanks, fertilizer for parks and lawns, and the infiltration of dissolved road de-icing salt.

Residential Sources. Residential sources of contamination come from household cleaning products, improper handling or storage of toxic substances, on-site wastewater treatment and disposal systems, and leaking underground fuel storage tanks.

An inventory was compiled that lists several potential contamination sources within the primary protection zones and the management zone No. 1. A summary of this inventory is shown in Table 6-6. The approximate locations of these sources relative to the primary protection zone are identified on Figure 6-5.

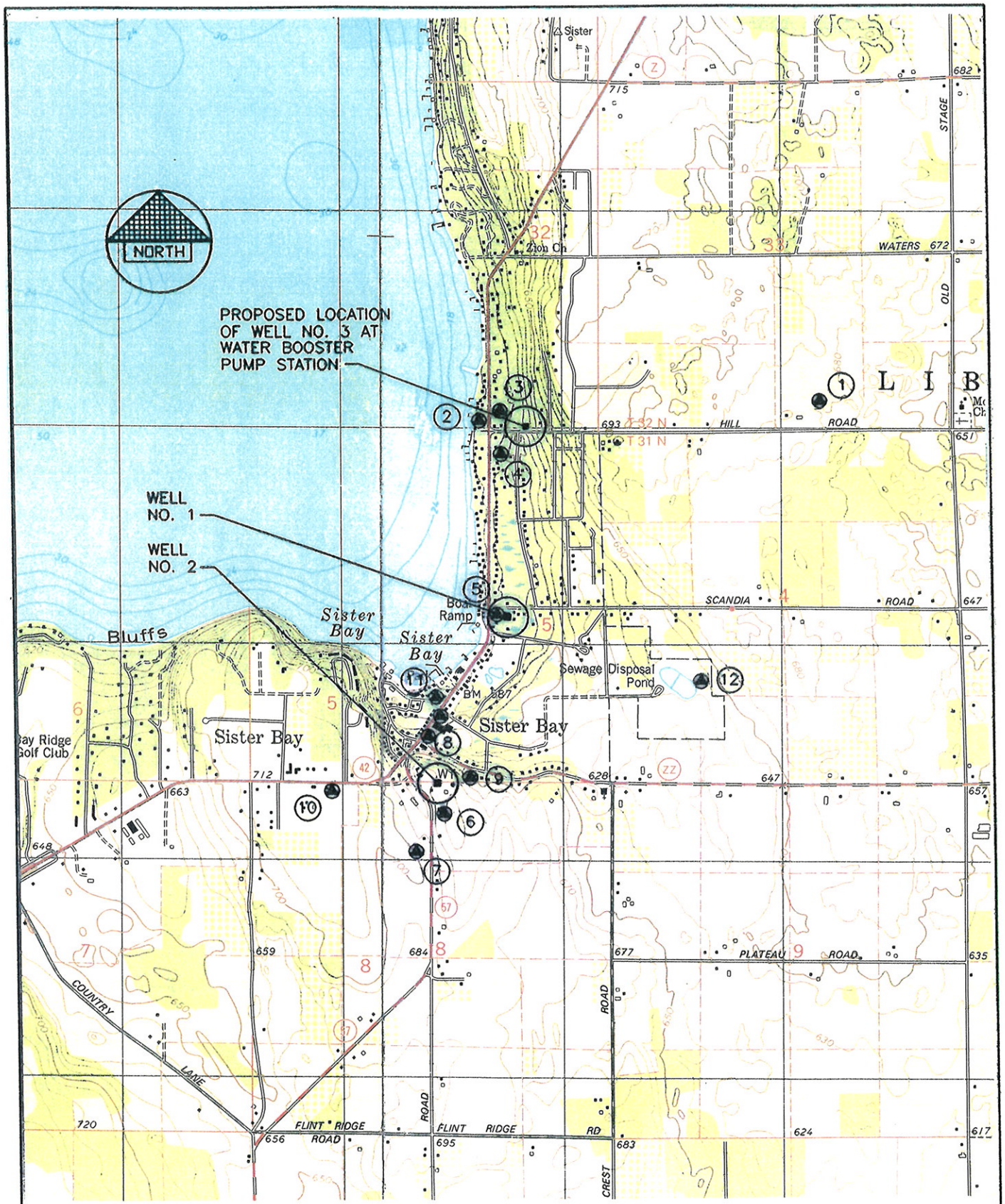
Table 6-6 Existing Potential Contamination Source Summary

Location	Description
1	Pesticide Mixing Site
2	Active Gas Station
3	Former Town Shop
4	Former Gas Station — USTs Removed
5	Active Gas Station
6	Telephone Company Shop — UST Removed
7	Former Oil Bulk Plant — Storage Tanks Removed
8	Hardware Store Warehouse
9	Cemetery
10	Active Gas Station — LUST Site
11	Former Gas Stations
12	Wastewater Treatment Plant — Note: Lagoon system has been replaced by a mechanical plant.

Not all potential contamination sources are listed in Table 6-6. For example, it is possible that many homes and businesses in Sister Bay have or had underground heating oil tanks. It is not possible to show all of them in the table. There are several residences east and south of Sister Bay that are outside the sewer service area and within the management zone No. 1 which utilize on-site wastewater treatment and disposal systems. There are several small farming operations within the zone of contribution. Because of their small size, these locations are not included.

Elimination of Future Potential Sources of Contamination

In order to ensure protection of the groundwater supply into the future, measures must be taken to discourage future activities detrimental to the preservation of groundwater quality. Action to prevent future potential contamination sources from being built in the primary protection zones or the management zones has been initiated in the form of a Wellhead Protection Ordinance discussed in Chapter 9.



EXISTING POTENTIAL SOURCES OF CONTAMINATION
FIGURE 6-5

U.S.G.S. 7.5 Minute Quad.
Ephroim 1982
Sister Bay 1982

7

PUBLIC EDUCATION PROGRAM

Page

PUBLIC HEARING 7-1
GROUNDWATER BROCHURE 7-1

CHAPTER 7

PUBLIC EDUCATION PROGRAM

One required component of the Wisconsin Department of Natural Resources Wellhead Protection Plan Program is a means to educate the public affected by the plan. This is especially important in Sister Bay due to the fractured dolomite aquifer supplying the area and the high potential for aquifer contamination.

PUBLIC HEARING

A public hearing is required for the adoption of any village ordinance. This time should be taken advantage of as an opportunity to better inform the people about their groundwater supply. Groundwater experts from the WDNR and Wisconsin Rural Water Association can be reserved to speak at this event. Appendix F includes a list of additional resources for this purpose.

GROUNDWATER BROCHURE

There are a number of brochures available which discuss the importance of groundwater and the need to protect this fragile resource. These brochures can be purchased in bulk at a reasonable cost and distributed to the public as part of the education program. Brochures are available from the Wisconsin Rural Water Association, the WDNR and the American Water Works Association. The addresses and telephone numbers of these organizations are given in Appendix F.

8

WATER CONSERVATION PROGRAM

CHAPTER 8

WATER CONSERVATION PROGRAM

The Sister Bay Water and Sewer Department should have a water conservation program. The objective of the water conservation program is two fold. The first is to slow the rate of increase in water consumption. As the population increases and technological advances require more water use, the utility will be called upon to produce more and more water. By reducing the rate of increase and the peak demand through conservation, the department can reduce or delay the capital expenditures necessary to increase the supply capacity. Water conservation will also reduce the rate at which groundwater is withdrawn from the aquifer. This, in turn, reduces the potential for contaminants to reach the well.

Water conservation can be encouraged by requiring the use of water saving fixtures in new construction, enacting a sprinkling ban to reduce peak water use and educating consumers on methods to reduce water use in their home or business. Educational water conservation brochures are available from the American Water Works Association and the Wisconsin Rural Water Association. The sprinkling ban is described in Appendix G. With the exception of the use of water saving fixtures in new construction, compliance with the program would be voluntary.

The second objective of the water conservation program is an emergency conservation plan. This part of the plan would be implemented in the event of a major water supply emergency. A water supply emergency would include such events as a major fire, a national disaster; like a tornado, a major pollutant spill which requires one or more supply wells to be shut down, or a mechanical failure of an important component of the distribution system.

Development of the emergency conservation plan would include identifying the major water consumers and asking them to develop their own emergency conservation plan. This plan would be implemented upon notice by water department personnel. The emergency conservation plan would include a prohibition on any outdoor water use not necessary to preserve life or property; for example, fire fighting would not be prohibited but washing driveways would. The eight largest water users are listed in Table 8-1 below. These consumers would be contacted first in the event emergency conservation measures are required.

Table 8-1 Major Water Consumers

Anderson-Door County Laundry
Al Johnson Restaurant
Scandia Nursing Home
Krist's Final Rinse
Open Hearth Lodge
Church-Hill Inn
Helm's Four Seasons Motel
Pheasant Park Condominiums

9

MANAGEMENT PLAN

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Primary Protection Zones.....9-1
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CONTINGENCY PLAN.....9-2
ZONING RESOLUTION.....9-2

CHAPTER 9

MANAGEMENT PLAN

In planning for the protection of the public water supply, a means of enforcement must be established. The management plan discussed in the following section is comprised of a Wellhead Protection Ordinance, included in this report as Appendix H; a contingency plan, included as Appendix I; and a Zoning Resolution, included as Appendix J.

WELLHEAD PROTECTION ORDINANCE

The Ordinance to be adopted by the Village Board of Sister Bay, Wisconsin addressing the subject of wellhead protection for the two existing wells and a third future well supplying the community water system outlines and establishes enforceable regulations regarding activities contradictory to the preservation and improvement of groundwater quality. The Ordinance illustrates three levels of enforcement.

Primary Protection Zones

The primary protection zones outlined previously in Chapter 6 require the strictest regulation of activities due to the possibility of immediate capture of contaminants into the groundwater supply. A number of activities and conditions are prohibited in the primary protection zone. These activities and conditions are based on experience elsewhere known to have the potential for release of contamination into the groundwater. Prohibited activities include gas stations, landfills, dry cleaning, feedlots, bulk pesticide storage and use, septic tanks, drainfields and stormwater infiltration basins and drainfields. A complete list is found in the Wellhead Protection Ordinance included in Appendix H. The ordinance provides an allowance for existing facilities which include prohibited activities, however, these facilities will be required to upgrade equipment to minimize contaminant release and to develop plans to deal with a release in the event one occurs.

Management Zone No. 1

Management zone No. 1 employs similar regulations to those of the primary protection zone to a lesser degree. This zone remains a critical area for groundwater protection. The distance from the outer boundary to the wells allows a longer reaction time in the event of an emergency.

The list of prohibited activities in management zone No. 1 is similar to that included in the primary protection zone. One important difference is that herbicide and pesticide use is allowed in the management zone No. 2, provided that best management practices are used and the use of such substances does not pose a serious threat to the groundwater.

Management Zone No. 2

Because of the distance to the well, activities in management zone No. 2 are not enforced by means of regulations. Public education regarding the need for groundwater protection is promoted in this area. Portions of this zone are located beyond the village limit boundaries. In these areas, public education is extended to the town of Liberty Grove whether or not the residents of this area are customers of Sister Bay's community water supply system.

CONTINGENCY PLAN

A contingency plan is essential in the event of an emergency jeopardizing the water supply. This plan summarizes an order of action to be taken. It includes names and phone numbers of people to be notified in such a situation as well as measures to continue service to the district without putting public in danger. The contingency plan is included as Appendix I. Institutions whose activities could pose a major threat to the public groundwater supply will be required, with the adoption of the Wellhead Protection Ordinance, to devise individual contingency plans to be followed in the event of an emergency.

ZONING RESOLUTION

A Resolution has been proposed to the town of Liberty Grove, the Wisconsin Department of Natural Resources, and Door County to accommodate for future development in the wellhead protection area out of the control of the village. It is a request for cooperation on the part of these agencies in recognizing the established areas as being in need of protection from certain activities and taking this knowledge into account when making future decisions regarding proposed uses for the area. The Resolution is included as Appendix J.

A

APPENDIX A

REFERENCES

REFERENCES

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   Publ WR 325-92
   Jay Payton, WDNR Program Planner
   March, 1993

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   Publ WR 313-92
   Maureen Muldoon, WGNHS Hydrogeologist
   Jay Payton, WDNR
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3. Delineation of Wellhead Protection Areas in Fractured Rocks
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4. Wellhead Protection Plans for New Municipal Wells-A Template
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   May, 1994

5. National Rural Water Association: Wellhead Protection Program, Case Studies
   GWTG-01, 1992
   Clem Wethington
   Tom Taylor
   Chet Fleming
   Bob Carroll

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   Geological Survey Water-Supply Paper 2047, WDNR
   M.G. Sherrill, 1978

8. Water Resources of Wisconsin-Lake Michigan Basin
   Hydrologic Investigations Atlas, HA-432
   Earl L. Skinner
   Ronald G. Borman
   1973

9. A Nonpoint Source Control Plan for the Upper Door Priority Watershed Project
   Publ. WR-195-87
   WDNR
   February 1987

B

APPENDIX B

CONTACT LIST FOR FUTURE REFERENCE

CONTACT LIST FOR FUTURE REFERENCE

1. DNR New Well/Wellhead Protection Coordinator
   Attn: Lee Boushon
   Public Water Supply Section
   P. O. Box 7921
   Madison, WI 53707-7921
   (608) 266-0857

2. DNR Statewide Wellhead Protection Coordinator
   Attn: Jay Payton
   Bureau of Water Resources Management
   P. O. Box 7921
   Madison, WI 53707-7921
   101 South Webster Street
   Madison, WI 53703
   (608) 267-9659

3. DNR District Water Supply Specialists
   Attn: Cheryl Bougie
   Lake Michigan District
   P. O. Box 10448
   Green Bay, WI 54307-0488
   1789 Shawano Avenue
   Green Bay, WI 54303
   (414) 492-5885

4. Wisconsin Geological and Natural History Survey
   University of Wisconsin-Extension
   Attn: Ken Bradbury, Hydrogeologist
   3817 Mineral Point Road
   Madison, WI 53705-5100
   (608) 262-1705

C

APPENDIX C

ZONE OF INFLUENCE CALCULATIONS — VOLUMETRIC FLOW AND COMPUTER MODEL

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¤                     1 = feet and days                                ¤
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¤                    Number of Wells for which                         ¤
¤                    Capture-Zones are desired:  1  <= Should be 1 if  ¤
¤                                                     plotting heads! ¤
¤                         Minimum X-Coordinate:                        ¤
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¤                         Minimum Y-Coordinate:                        ¤
¤                         Maximum Y-Coordinate:  500.0                 ¤
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¤                  Maximum Spatial Step Length:  50.0                  ¤
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¤          AQUIFER PROPERTIES AND LOCATION FOR WELL # 1                ¤
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¤                         X Coordinate (ft): 250.0                     ¤
¤                         Y Coordinate (ft): 250.0                     ¤
¤             Well Discharge Rate (ft**3/d): 77000.0                   ¤
¤                  Transmissivity (ft**2/d): 6200.0                    ¤
¤        Hydraulic Gradient (dimensionless): 0.004000                  ¤
¤           Angle of Ambient Flow (degrees): 180.00                    ¤
¤          Aquifer Porosity (dimensionless): 0.10                      ¤
¤                    Aquifer Thickness (ft): 125.00                    ¤
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¤                          Boundary Type:  0                          ¤
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¤               CAPTURE-ZONE TYPE OPTION FOR WELL # 1                 ¤
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 <Enter> = select value   <Esc> = options menu   <F1> = DOS shell
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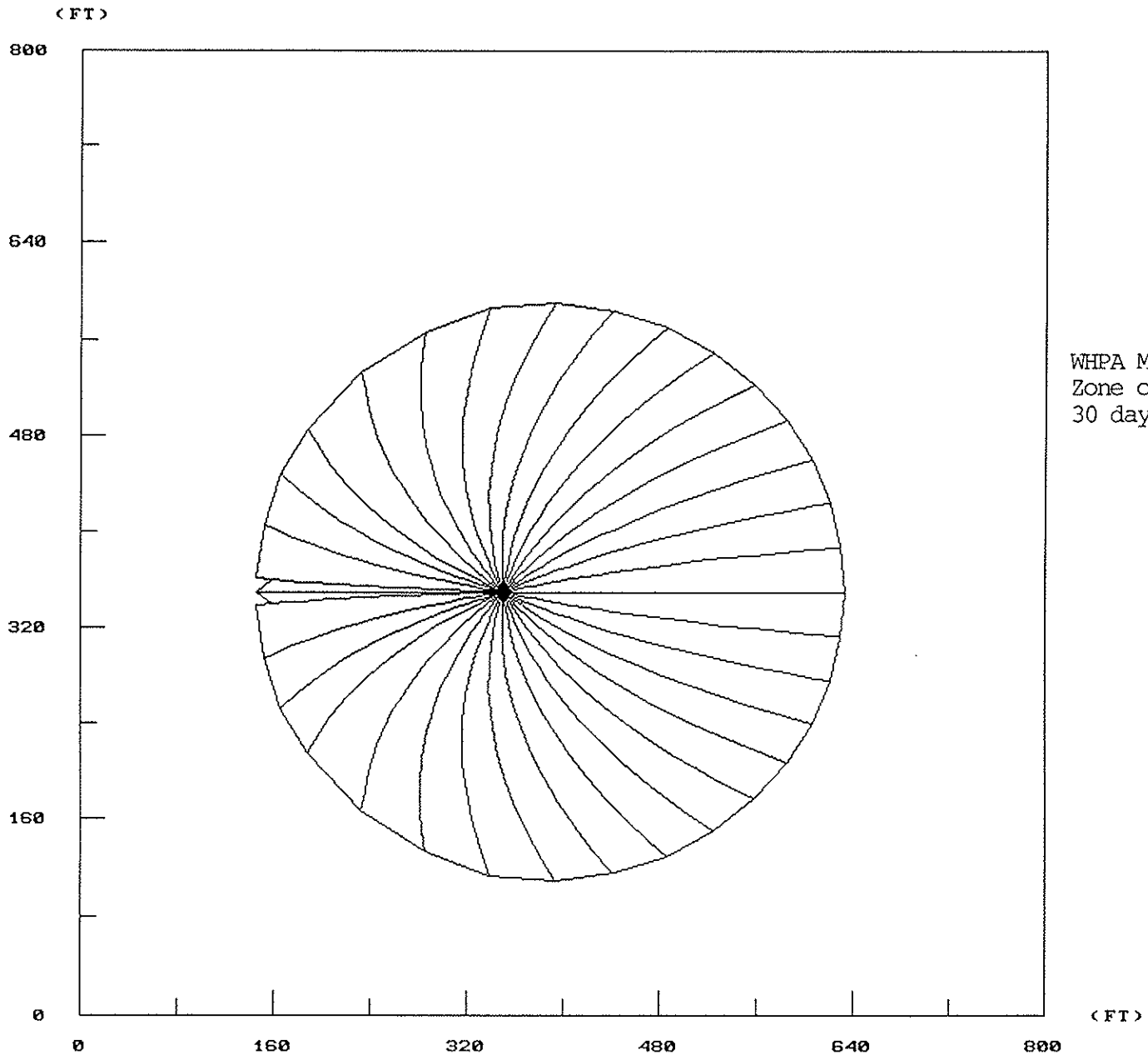
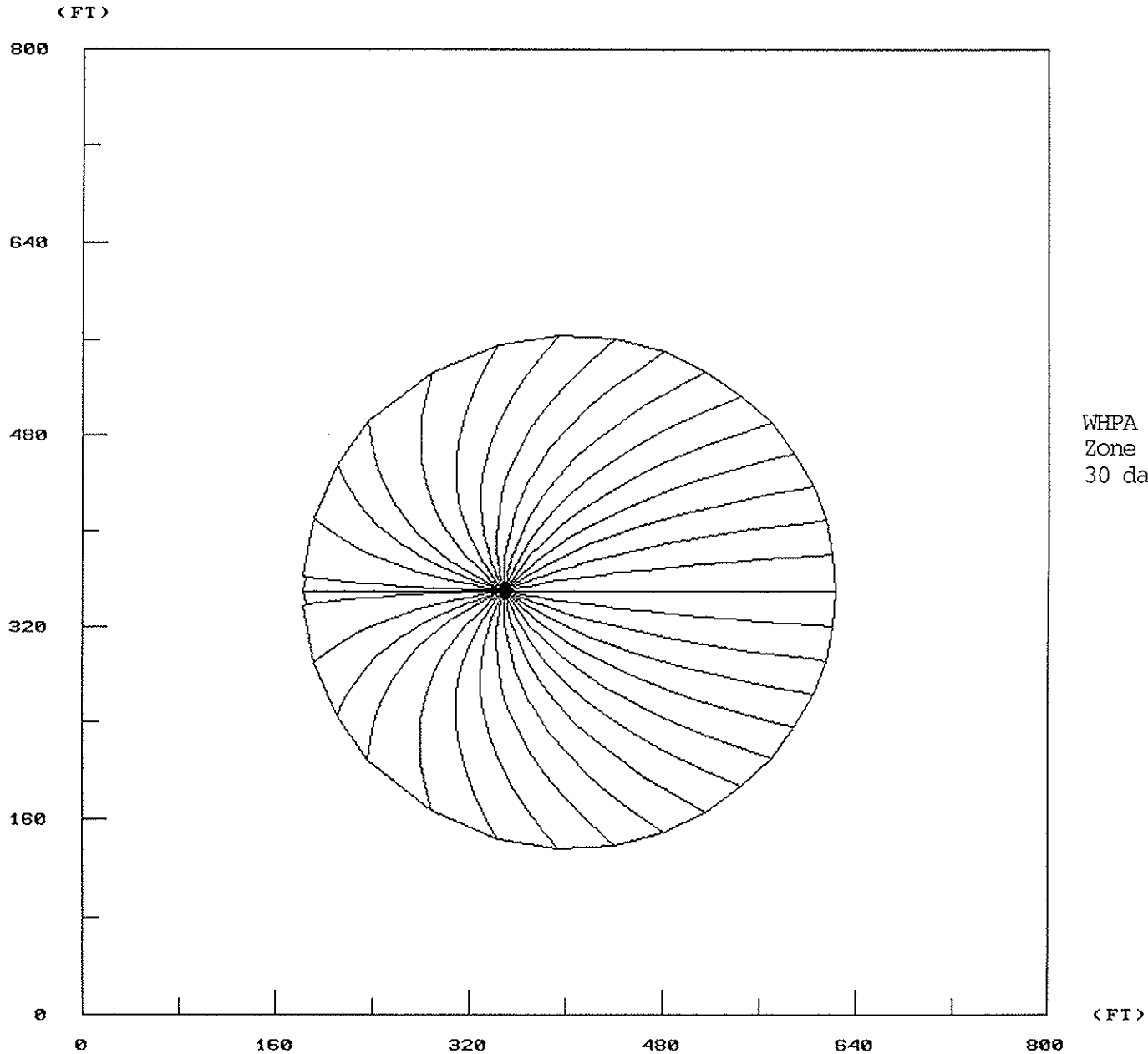
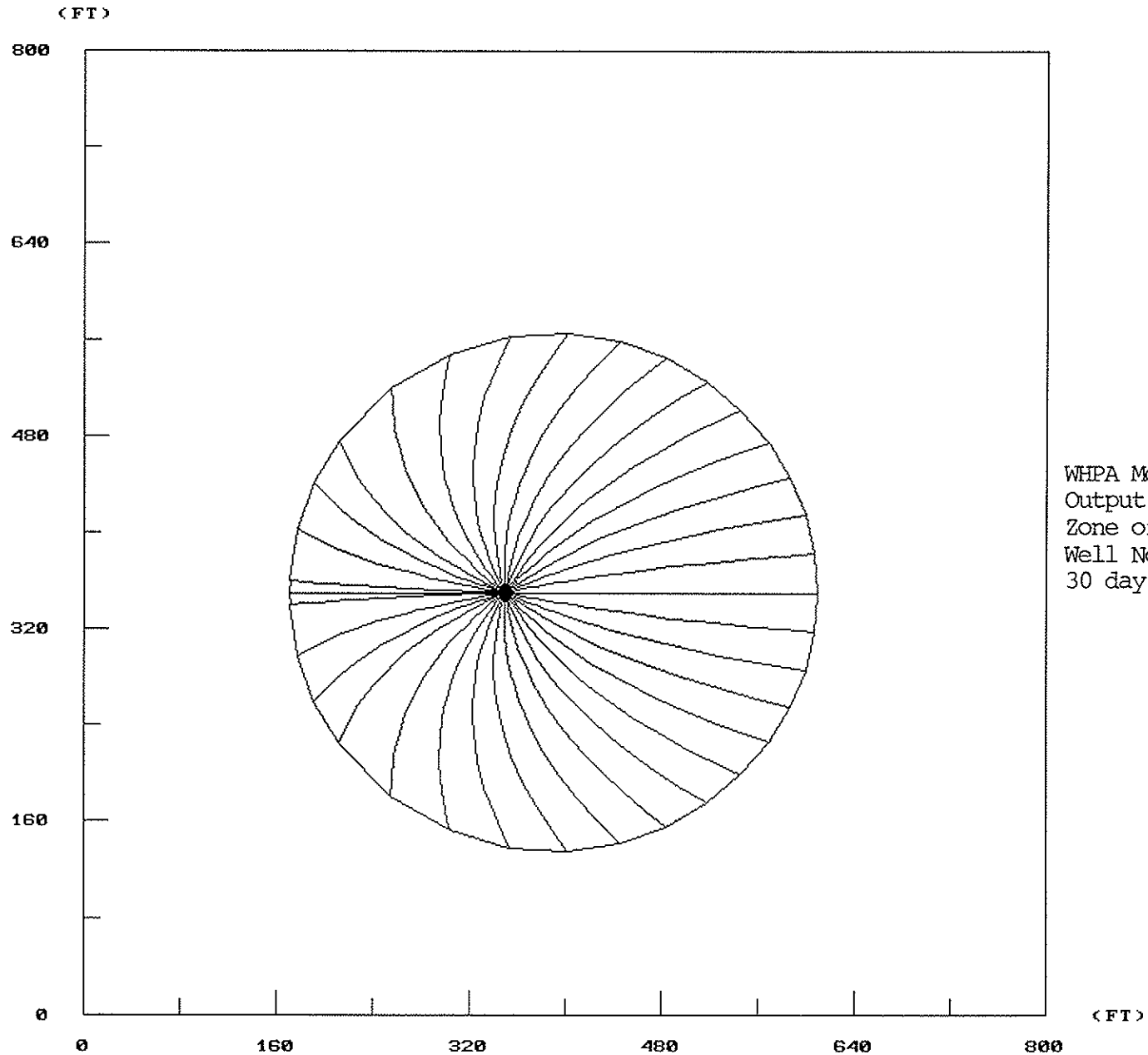


WHPA Model Graphical Output
Zone of Influence Well No. 1
30 day time of travel

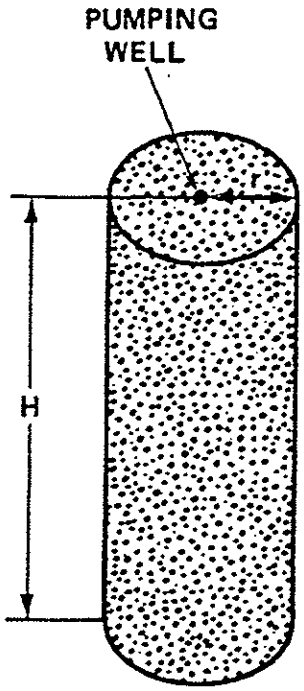


WHPA Model Graphical Output
Zone of Influence Well No. 2
30 day time of travel



WHPA Model Graphical Output
Zone of Influence
Well No. 3
30 day time of travel

Figure 4
WHPA Delineation Using Volumetric Flow Equation
(Calculated Fixed Radius)



$$r = \sqrt{\frac{Q\,t}{\pi\, n\, H}} = 1138 \text{ ft}$$

WHERE
Q = Pumping Rate of Well = 694.4 gpm = 48,793,668 ft^3/yr
n = Aquifer Porosity = 0.2
H = Open Interval or Length of Well Screen = 300 ft
t = Travel Time to Well (5 Years)

(Any consistent system of units may be used.)

$$\underbrace{Q\,t}_{\text{VOLUME PUMPED}} = \underbrace{n\,\pi\,H\,r^2}_{\text{VOLUME OF CYLINDER}}$$

(From EPA June, 1987)

Robert E. Lee & Associates, Inc.
Engineering, Surveying, Laboratory Services
2625 S. Webster Ave • PO Box 2100 • Green Bay, WI 54306-2100 • 414/336-6335 • FAX 414/336-9141

SUBJECT			
SISTER BAY WELL HEAD PROTECTION			
JOB NO.	DATE 1/19/96	BY DWH	SHEET 1

I. WELL No. 1 + WELL No. 3

PARAMETERS

$Q = 400$ gpm $= 77005$ ft^3/day
$n = 0.10$
$H = 125$ ft
$t = 30$ days

$$r = \sqrt{\frac{77005 \text{ ft}^3/\text{day} * 30 \text{ day}}{\pi * 0.10 * 125 \text{ ft}}}$$

$r = 242$ ft

II WELL No. 2

PARAMETERS

$Q = 400$ gpm $= 77005$ ft^3/day
$n = 0.10$
$H = 155$ ft
$t = 30$ day

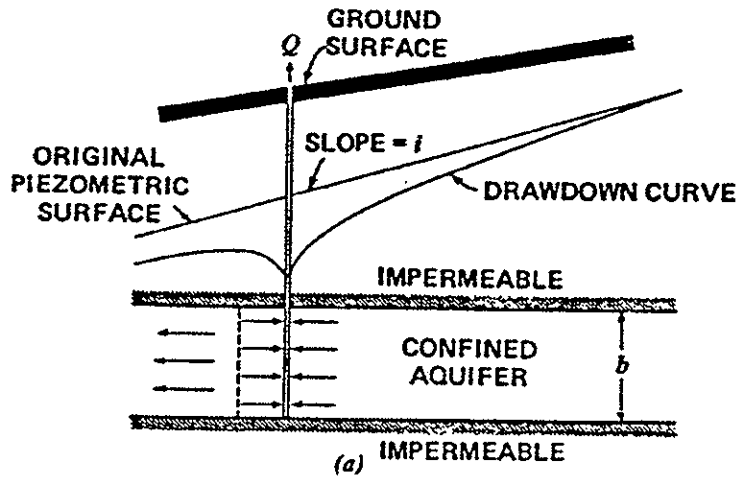
$r = 217$ ft

D

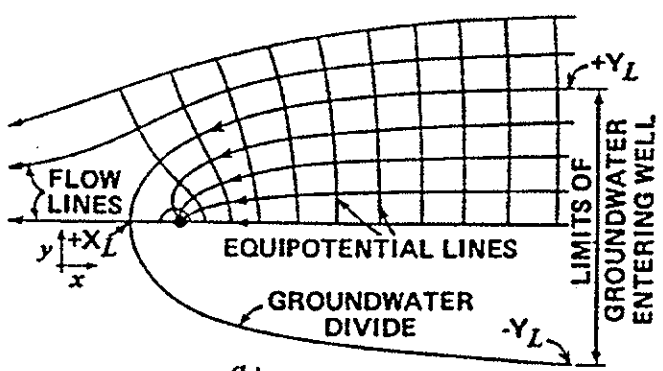
APPENDIX D

UNIFORM FLOW METHOD CALCULATIONS

Figure 6
WHPA Delineation Using the
Uniform Flow Equation



(a)



(b)

$$-\frac{Y}{X} = \tan\left(\frac{2\pi Kbi}{Q}\,Y\right)$$

UNIFORM-FLOW EQUATION

$$X_L = -\frac{Q}{2\pi Kbi}$$

DISTANCE TO DOWN-GRADIENT NULL POINT

$$Y_L = \pm\frac{Q}{2Kbi}$$

BOUNDARY LIMIT

LEGEND:

- Pumping Well

Where:
Q = Well Pumping Rate
K = Hydraulic Conductivity
b = Saturated Thickness
i = Hydraulic Gradient
π = 3.1416

SOURCE: Todd, 1980
(From EPA June, 1987)

NOT TO SCALE

II. Well No. 2

PARAMETERS

$Q = 149$ gpm $= 28740$ ft^3/day
$b = 184$ ft
$K = 30$ ft/day
$i = 0.0067$

$X_L = 130$ ft $\qquad Y_L = 390$ ft

III. Well No. 3

PARAMETERS

$Q = 149$ gpm $= 28740$ ft^3/day
$b = 167$ ft
$K = 30$ ft/day
$i = 0.005$ ft/ft

$X_L = 180$ ft $\qquad Y_L = 570$ ft

Robert E. Lee & Associates, Inc.
Engineering, Surveying, Laboratory Services
2525 S. Webster Ave. • P.O. Box 2100 • Green Bay, WI 54306-2100 • 414/336-6338 • FAX 414/336-9141

SUBJECT			
SISTER BAY WELLHEAD PROTECTION			
JOB NO.	DATE 1/19/96	BY DWH	SHEET 1

I. WELL No. 2

A. PARAMETERS

$Q = 149$ gpm $= 28740$ ft^3/day
$b = 167$ feet
$K = 30$ ft/day
$i = 0.004$ ft/ft

$$X_L = \frac{Q}{2\pi K b i} = \frac{28740 \text{ ft}^3/\text{day}}{2\pi \times 30 \text{ ft/day} \times 167 \text{ ft} \times 0.004 \text{ ft/ft}}$$

$$X_L = 230 \text{ ft}$$

$$Y_L = \frac{Q}{2 K b i} = \frac{28740 \text{ ft}^3/\text{day}}{2 \times 30 \text{ ft/day} \times 167 \text{ ft} \times 0.004 \text{ ft/ft}}$$

$$Y_L = 720 \text{ ft}$$

E

APPENDIX E

COMPUTER MODELING DATA

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¤                                                                          ¤
¤         Run Title: BASIC MODEL WITH 3 WELLS                              ¤
¤                                                                          ¤
¤             Units to use for Current Problem:  1                         ¤
¤                    0 = meters and days                                   ¤
¤                    1 = feet and days                                     ¤
¤                                                                          ¤
¤                    Number of Wells for which                             ¤
¤                    Capture-Zones are desired:  3  <= Should be 1 if      ¤
¤                                                     plotting heads!      ¤
¤                         Minimum X-Coordinate:                            ¤
¤                         Maximum X-Coordinate:  12000.0                   ¤
¤                         Minimum Y-Coordinate:                            ¤
¤                         Maximum Y-Coordinate:  12000.0                   ¤
¤                                                                          ¤
¤                Maximum Spatial Step Length:  100.0                       ¤
¤                                                                          ¤
¤          Perform Hydraulic Head Calculation:  0                          ¤
¤                         (1 = yes, 0 = no)                                ¤
¤                                                                          ¤
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¤          AQUIFER PROPERTIES AND LOCATION FOR WELL # 1                    ¤
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¤                                                                          ¤
¤                         X Coordinate (ft): 1790.0                        ¤
¤                         Y Coordinate (ft): 7000.0                        ¤
¤             Well Discharge Rate (ft**3/d): 28700.0                       ¤
¤                  Transmissivity (ft**2/d): 6200.0                        ¤
¤       Hydraulic Gradient (dimensionless): 0.004000                       ¤
¤          Angle of Ambient Flow (degrees): 180.00                         ¤
¤         Aquifer Porosity (dimensionless): 0.10                           ¤
¤                   Aquifer Thickness (ft): 167.00                         ¤
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¤               BOUNDARY CONDITION INPUT FOR WELL # 1                      ¤
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¤                              Boundary Type:   0                          ¤
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¤                    0 = no boundary                                      ¤
¤                    1 = stream boundary                                  ¤
¤                    2 = barrier boundary                                 ¤
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¤                 CAPTURE-ZONE TYPE OPTION FOR WELL # 1                   ¤
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¤                                                                         ¤
¤                    Capture-Zone Type Option:   2                        ¤
¤                                                                         ¤
¤                      0 = steady-state                                   ¤
¤                      1 = hybrid                                         ¤
¤                      2 = time-related                                   ¤
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 <Enter> = select value   <Esc> = options menu   <F1> = DOS shell


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¤          AQUIFER PROPERTIES AND LOCATION FOR WELL # 2                   ¤
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¤                                                                         ¤
¤                        X Coordinate (ft): 780.0                         ¤
¤                        Y Coordinate (ft): 4500.0                        ¤
¤            Well Discharge Rate (ft**3/d): 28700.0                       ¤
¤                 Transmissivity (ft**2/d): 6200.0                        ¤
```

```
¤       Hydraulic Gradient (dimensionless): 0.006700                    ¤
¤          Angle of Ambient Flow (degrees): 90.00                       ¤
¤        Aquifer Porosity (dimensionless): 0.10                         ¤
¤                  Aquifer Thickness (ft): 184.00                       ¤
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¤               BOUNDARY CONDITION INPUT FOR WELL # 2                   ¤
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¤                            Boundary Type:  0                          ¤
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¤                     0 = no boundary                                   ¤
¤                     1 = stream boundary                               ¤
¤                     2 = barrier boundary                              ¤
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¤               CAPTURE-ZONE TYPE OPTION FOR WELL # 2                   ¤
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¤                    Capture-Zone Type Option:  2                       ¤
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¤                      0 = steady-state                                 ¤
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¤          AQUIFER PROPERTIES AND LOCATION FOR WELL # 3                ¤
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¤                        X Coordinate (ft): 2100.0                     ¤
¤                        Y Coordinate (ft): 9890.0                     ¤
¤            Well Discharge Rate (ft**3/d): 28700.0                    ¤
¤                 Transmissivity (ft**2/d): 6200.0                     ¤
¤       Hydraulic Gradient (dimensionless): 0.005000                   ¤
¤          Angle of Ambient Flow (degrees): 180.00                     ¤
¤         Aquifer Porosity (dimensionless): 0.10                       ¤
¤                  Aquifer Thickness (ft): 167.00                      ¤
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¤               BOUNDARY CONDITION INPUT FOR WELL # 3                  ¤
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¤                             Boundary Type:  0                        ¤
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¤                   0 = no boundary                                    ¤
¤                   1 = stream boundary                                ¤
¤                   2 = barrier boundary                               ¤
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 <Enter> = select value   <Esc> = options menu   <F1> = DOS shell


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¤                CAPTURE-ZONE TYPE OPTION FOR WELL # 3                 ¤
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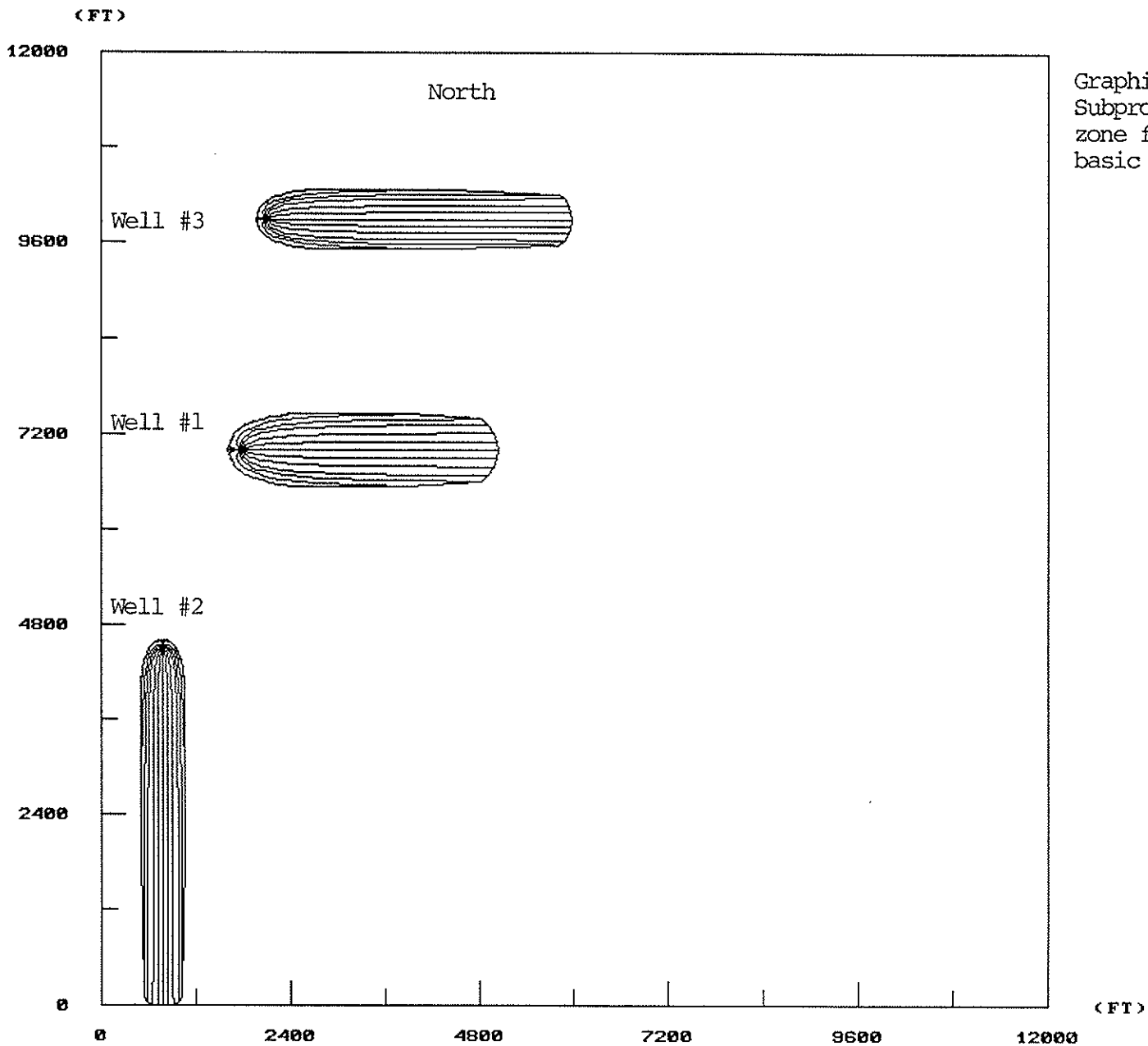

Graphical output WHPA Model Subprogram: MWCAP capture zone for 10 year time of travel basic model with 3 wells.

F

APPENDIX F

ADDITIONAL PUBLIC EDUCATION SOURCES

ADDITIONAL PUBLIC EDUCATION SOURCES

University of Wisconsin System:

1. George Kraft, Hydrogeologist, Central Wisconsin Groundwater Center (CWGC)
   (715) 346-4270

2. Chris Mechenich, Education Specialist, CWGC
   (715) 346-4270

3. Jim Peterson, Water Resources Specialist, Environmental Resources Center
   (608) 262-3799

4. Ron Hennings, Hydrogeologist, WI Geological & Natural History Survey
   (608) 263-7395

5. Albert Dicks, Geologist, UW-Superior
   (715) 394-8311

6. Ron Stieglitz, Geologist Education, UW-Green Bay
   (414) 465-2267

Department of Natural Resources:

1. Bureau of Water Resources Management
   (608) 267-7610

2. Bureau of Water Supply
   (608) 266-0821

3. Cathy Cliff, Education Section Chief, Bureau of Information and Education
   (608) 267-7529

4. Kevin Kessler, Chief Groundwater Management Section, Bureau of Water Resources
   (608) 267-9350

Wisconsin Rural Water Association
350 Wake Way, Plover, WI 54467
(715) 344-7778

American Water Works Association
6666 W Quincy Avenue, Denver, CO 80235
(800) 926-7337

G

APPENDIX G

SPRINKLING BAN

SPRINKLING BAN

WATER USE RESTRICTED: EMERGENCY SHORTAGE

Declaring Bans. Whenever the Water Department superintendent shall advise the Village Administrator in writing that the water supply of the village's water utility is being depleted and that normal levels of supply are not foreseen, or that a situation exists with respect to the village's water supply system requiring curtailed water use, the Village Administrator may declare a "Water Shortage Emergency" in the village and direct a ban on the use of water supplied by such facility for non-essential uses including, but not limited to, the watering of lawns, gardens, shrubbery and other domestic plant life. The Village Administrator may use discretion in determining the extent of the restrictions based upon the seriousness of the supply depletion or system problem, and may direct a ban between specific dates or between the hours of 7:00 A.M. and 7:00 P.M.; may direct an alternating ban based on odd/even days of the month and property addresses; or may direct a ban composed of combinations of the foregoing restrictions. Any ban so imposed by the Village Administrator shall remain in effect until such time as the Village Administrator is advised that water supplies are sufficient to allow for cessation of such ban, whereupon he shall direct that the ban is ceased. If the Village Administrator declines to direct the cessation of such ban after having been advised by the water utility, in writing, that the cause for such ban no longer exists, the Council may consider the matter at any meeting thereof upon the request of any member and may, by resolution, declare the cessation of such ban.

Notice to Residents. The Village Administrator, upon declaring a "Water Shortage Emergency" shall notify local newspapers, radio and other news media and may request that such media advise residents thereof as a public service announcement. Thereafter the Police Department or Village Water Department shall personally notify any resident violating the restrictions so imposed of such restrictions and order of said resident to refrain from further violation.

Violation of Ban; Penalty. Any person who, after being notified by the Police Department or the Water Department that they are in violation of the conditions of such shortage emergency ban, shall continue to use water supplied by the Village in violation of such ban shall forfeit not less than $1.00, nor more than $200.00 for each violation hereof. Each time a resident, upon notice as required herein, refuses to comply with the restrictions of said ban shall be considered a separate offense.

SPRINKLING BAN

WATER USE RESTRICTED: EMERGENCY SHORTAGE

Declaring Bans. Whenever the Water Department superintendent shall advise the Village Administrator in writing that the water supply of the village's water utility is being depleted and that normal levels of supply are not foreseen, or that a situation exists with respect to the village's water supply system requiring curtailed water use, the Village Administrator may declare a "Water Shortage Emergency" in the village and direct a ban on the use of water supplied by such facility for non-essential uses including, but not limited to, the watering of lawns, gardens, shrubbery and other domestic plant life. The Village Administrator may use discretion in determining the extent of the restrictions based upon the seriousness of the supply depletion or system problem, and may direct a ban between specific dates or between the hours of 7:00 A.M. and 7:00 P.M.; may direct an alternating ban based on odd/even days of the month and property addresses; or may direct a ban composed of combinations of the foregoing restrictions. Any ban so imposed by the Village Administrator shall remain in effect until such time as the Village Administrator is advised that water supplies are sufficient to allow for cessation of such ban, whereupon he shall direct that the ban is ceased. If the Village Administrator declines to direct the cessation of such ban after having been advised by the water utility, in writing, that the cause for such ban no longer exists, the Council may consider the matter at any meeting thereof upon the request of any member and may, by resolution, declare the cessation of such ban.

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Violation of Ban; Penalty. Any person who, after being notified by the Police Department or the Water Department that they are in violation of the conditions of such shortage emergency ban, shall continue to use water supplied by the Village in violation of such ban shall forfeit not less than $1.00, nor more than $200.00 for each violation hereof. Each time a resident, upon notice as required herein, refuses to comply with the restrictions of said ban shall be considered a separate offense.

H

APPENDIX H

WELLHEAD PROTECTION ORDINANCE

WELLHEAD PROTECTION ORDINANCE

VILLAGE OF SISTER BAY
DOOR COUNTY, WISCONSIN

WHEREAS, the Village of Sister Bay derive their public water supply from ground wells, and

WHEREAS, the aquifers need to be protected from contamination by activities of mankind, and

WHEREAS, the Village of Sister Bay desires to assume and maintain a leadership role in the protection of its drinking water resources through its own efforts and in cooperation with other local governments and state and federal agencies,

NOW THEREFORE, BE IT ORDAINED by the Village Board of Sister Bay, Door County, Wisconsin, (hereafter Village) in Council duly assembled and it is hereby ordained by the authority of the same that the following Ordinance known as the Wellhead Protection Ordinance is adopted and made a part of the Code of Ordinance of the Village of Sister Bay, to wit:

SECTION 1 SHORT TITLE.

This Ordinance shall be known and cited as the "Wellhead Protection Ordinance" (hereafter Ordinance).

SECTION 2 PURPOSE AND AUTHORITY.

The purpose of this Ordinance is to promote the public health, safety, and general welfare by insuring the provision of a safe and sanitary drinking water supply for the Village by the establishment of a Wellhead Protection Area surrounding the wellheads for all wells which are the supply sources for the Village water system and by the designation and regulation of property uses and conditions which may be maintained within such zones to minimize public and private losses due to contamination of the public water supply.

These regulations are established pursuant to the authority granted by the Wisconsin Legislature in 1983, Wisconsin Act 410 (effective May 11, 1984), which specifically added groundwater protection to the statutory authorization for municipal planning and zoning in order to protect the public health, safety, and welfare.

SECTION 3 DEFINITIONS.

When used in this Ordinance the following words and phrases shall have the meanings given in this Section:

(a) AQUIFER — a geologic formation, group of formations, or part of a formation that contains sufficient saturated, permeable material to yield significant quantities of water to wells and springs.

(b) COMMUNITY WATER SYSTEM — a public water system that serves at least fifteen service connections used by year-round residents or regularly serves at least twenty-five year-round residents.

(c) CONE OF DEPRESSION — a depression in the water table that occurs when a pumping well withdraws water at a rate faster than the aquifer can supply water to the well.

(d) FACILITY — a building or buildings, appurtenant structures, and surrounding land used by a single business, private entity, or governmental unit or sub-unit at a single location or site.

(e) FIVE-YEAR TIME OF TRAVEL (TOT) — the five-year time of travel is the recharge area upgradient of the cone of depression, the outer boundary of which it is determined or estimated that groundwater and potential contaminants will take five years to reach a pumping well.

(f) GROUNDWATER — the water in a saturated zone or stratum beneath the surface of land or water, whether or not it is flowing through known and definite channels.

(g) GROUNDWATER DIVIDE — a ridge in the water table, or potentiometric surface, from which groundwater moves away at right angles in both directions. Line of highest hydraulic head in the water table or potentiometric surface.

(h) HAZARDOUS SUBSTANCE — any waste or material which because of its quantity, concentration or physical, chemical or infectious characteristics may:

(1) Cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness; or

(2) Pose a substantial present or potential hazard to human health or to the environment when improperly treated, stored, transported, disposed of or otherwise managed.

(i) MANAGEMENT ZONES — a zone or zones established to provide protection to the area surrounding a well or well field from potential contaminant sources. Management options may include limits on certain activities, more stringent design and operating standards, strict monitoring of potential pollution sources, promoting best management practices, and/or implementing education programs. Multiple protection zones may be established for different management strategies based on proximity to the well field.

(j) PETROLEUM PRODUCT — any fuels (gasoline, diesel fuel, kerosene, and mixtures of these products), lubricating oils, motor oils, hydraulic fluids, and other similar products.

(k) POTABLE WATER — any water that is satisfactory for drinking, culinary, and domestic purposes meeting current State and Federal drinking water standards.

(l) PRIMARY CONTAINMENT — the first level of product tight containment, i.e., the inside portion of that container which comes into immediate contact on its inner surface with the hazardous material being contained.

(m) PRIMARY PROTECTION ZONE — an area calculated as the zone of influence characteristic to each individual well supplying potable water to any community water system.

(n) PUBLIC UTILITY — any utility (gas, water, sewer, electrical, telephone, cable television, etc.) whether publicly owned or privately owned.

(o) RECHARGE AREA — an area in which water reaches the zone of saturation by surface infiltration and encompasses all areas or features that supply groundwater recharge to a well.

(p) REGULATORY AGENCY — any governmental agency with jurisdiction over hazardous waste as defined herein.

(q) SANITARY LANDFILL — a disposal site where solid wastes, including putrescible wastes, or hazardous wastes, are disposed of on land by placing earth cover thereon.

(r) SEASONAL AVERAGE — the average for design parameters over the period from June to August is considered due to the drastically fluctuating population of the Village at this time as compared to the remainder of the year, in order to insure maximum protection.

(s) SECONDARY CONTAINMENT — the level of product tight containment external to and separate from the primary containment. Secondary containment shall consist of leak-proof trays under containers, floor curbing or other containment systems and shall be of adequate state-approved size and design to handle all spills, leaks, overflows, specific design and election of materials shall be sufficient to preclude any substance loss. Containment systems shall be sheltered so that the intrusion of precipitation is effectively prevented.

(t) WELL — any excavation that is drilled, cored, bored, washed, driven, dug, jetted, or otherwise constructed when the intended use of such excavation is to conduct groundwater from an aquifer system to the surface by pumping or natural flow, or to monitor the characteristics of groundwater within an aquifer system.

(u) WELLHEAD — the upper terminal of a well, including adapters, ports, seals, valves, and other attachments.

(v) WELLHEAD PROTECTION AREA — the surface or subsurface area surrounding a water well or well field, supplying a public water system, an area through which contaminants are reasonably likely to move toward and reach such water well or well field.

(w) ZONE OF CONTRIBUTION — the land area over which water can infiltrate and move toward the well.

(x) ZONE OF INFLUENCE — the land area above the cone of depression that results after thirty days of continuous pumping of a well.

SECTION 4 ESTABLISHMENT OF WELLHEAD PROTECTION AREA.

There is hereby established a use district to be known as a Wellhead Protection Area, identified and described as all the areas including those of the cone of depression due to the average seasonal pumping capacity of the wells, the areas encompassing the zone of contribution for a five year time of travel to the wells, and the recharge areas influencing the wells.

The area(s) designated as the Zone of Influence for the well(s) is hereby known as the Primary Protection Zone(s). It begins at the wellhead and extends radially outward a distance of 300 feet from the well.

Additional protection beyond the Primary Protection Zone shall be accomplished by the establishment of Management Zones.

The boundaries of Management Zone One (1) shall begin at a point or points along the outer perimeter of the Primary Protection Zone and extend outward to all points within and including the designated Zone of Contribution for the five year time of travel to each of the wells. Furthermore, as the average seasonal or yearly average (whichever is greater) pumping capacity of the wells is changed, the Management Zone One (1) boundaries shall be changed in like manner and simultaneously.

The boundaries of Management Zone Two (2) shall include all the area extending between the Management Zone One (1) outer perimeter and a minimum of one (1) mile radially or the Village Limit boundaries (whichever is greater) from any well supplying water to the aforementioned community water system.

Subsequent and additional Management Zones may be established whenever it is found that the Wellhead Protection Zone needs to be expanded to provide adequate protection for the groundwater within and/or adjacent to the Wellhead Protection Area.

SECTION 5 SUBSTANCES REGULATED.

The materials regulated by this ordinance shall consist of the following:

(a) Petroleum products as defined in Section 3, Definitions.

(b) Substances listed in the Federal Hazardous Waste List.

(c) Substances other than those listed on the Federal Hazardous Waste List that are determined by State or Federal agencies to pose a significant threat to any community water supply well or well field.

SECTION 6 RESTRICTIONS WITHIN THE WELLHEAD PROTECTION AREA.

Restrictions within each Zone of the Wellhead Protection Area shall be determined by the Village Board or their appointee. The Board or their appointee shall conduct a survey of the Wellhead Area and identify the potential sources of contamination therein. After assessing the local groundwater protection needs, the method or combination of management methods shall be submitted for approval.

The restrictions within each Zone may be modified periodically to provide additional protection or to prevent future contamination.

The area within Management Zone Two (2) shall be managed by conducting a public education program to inform the property owners of the need for and methods of wellhead protection. If additional management methods are necessary, the appropriate governing bodies with jurisdiction over the area within the Management Zone Two (2) shall be notified.

The following uses or conditions shall be and are hereby prohibited within the Management Zone One (1). Restrictions are in effect for all protection zones whether or not such use or condition may otherwise be ordinarily included as a part of a use permitted under Section 10 of this Ordinance unless such uses are approved or permitted by State and Federal regulatory agencies.

(a) Agricultural activities;

(b) Feedlots or other concentrated animal facilities;

(c) Gas stations;

(d) Vehicle repair establishments, including auto body repair;

(e) Junk yards or auto salvage yards;

(f) Bus or truck terminals;

(g) Impervious surfaces other than roofs of buildings, and streets, parking lots, driveways and walks serving buildings permitted under Section 10 of this Ordinance;

(h) Dry cleaning businesses;

(i) Any manufacturing or industrial business;

(j) Electroplating facilities;

(k) Exterminating businesses;

(l) Sanitary landfills;

(m) Sanitary sewer lines within 100 feet of a wellhead;

(n) Animal waste spreading;

(o) Septic tanks or drain fields appurtenant thereto;

(p) Stormwater infiltration basins;

(q) Hazardous waste disposal sites;

(r) Surface use or storage of hazardous material, including commercial use of agricultural pesticides;

(s) Underground or basement storage tanks;

(t) Salt storage.

All of the previously mentioned uses or conditions as well as the following situations shall be and are hereby prohibited within the Primary Protection Zone:

(a) Bulk herbicide and/or pesticide storage and use.

SECTION 7 EXEMPTIONS.

Individuals and/or Facilities may request the Village to permit additional land uses in the Wellhead Protection Area. All requests shall be in writing either on or in substantial compliance with forms to be provided by the Village and shall include an environmental assessment report prepared by a licensed environmental engineer. Said report shall be forwarded to the Village Engineer and/or designee(s) for recommendation and final decision by the Village Board. The Individual/Facility shall reimburse the Village for all consultant fees associated with this review at the invoiced amount plus administrative costs. Any permitted uses shall be conditional and may include required environmental and safety monitoring consistent with local, state, and federal requirements, and/or bonds and/or sureties satisfactory to the Village.

The following activities or uses are exempt from the provision of this Ordinance:

(a) The transportation of any hazardous substance through the wellhead protection area, provided the transporting vehicle provides adequate primary and secondary containment and is in-transit.

(b) The use of herbicides and pesticides is allowed within the Management Zones, provided best management practices are used or it is determined that the use of such herbicides and pesticides does not pose a serious threat to the groundwater.

(c) The use of any hazardous substance solely as fuel in a vehicle fuel tank or as a lubricant in a vehicle.

(d) Fire, police, emergency medical services, emergency management center facilities, or public utility transmission facilities.

(e) Retail sales establishments that store and handle hazardous substances for resale in their original unopened containers.

(f) Consumer products limited to use at a facility solely for janitorial or minor maintenance purposes.

(g) Consumer products located in the home which are used for personal, family or household purposes.

(h) The storage and use of hazardous substances as fuel or lubricant to provide auxiliary power for emergency use to the well field, provided an enclosed secondary containment system is provided for the substance.

(i) Any water treatment chemicals connected with the operation of the wells.

(j) Stormwater retention ponds constructed in a manner approved by the Village and/or Village Engineer may be placed in the management zone. Blasting to remove bedrock during pond construction is prohibited. The soil beneath the retention pond shall have a low rate of water transmission, less than 0.15 inches per hour.

SECTION 8 REQUIREMENTS FOR EXISTING FACILITIES.

The following requirements are to be met by existing facilities wishing to continue with practices questionable to groundwater protection:

(a) Facilities shall provide copies of all federal, state, and local operation approvals or certificate and on-going environmental monitoring results to the Village.

(b) Facilities shall provide additional environmental or safety structures/monitoring as deemed necessary by the Village, which may include but are not limited to stormwater runoff management and monitoring.

(c) Facilities shall replace equipment or expand in a manner that improves the existing environmental and safety technologies already in existence.

(d) Facilities shall have the responsibility of devising and filing with the Village a contingency plan satisfactory to the Village for the immediate notification of Village officials in the event of an emergency.

SECTION 9 PENALTIES.

In the event of the release of any contaminants which endanger the Wellhead Protection Area, the activity causing said release shall immediately cease and a cleanup satisfactory to the Village shall occur.

The Individual/Facility participating in such activity shall be responsible for all costs of cleanup, Village consultant fees at the invoice amount plus administrative costs for oversight, review, and documentation. These costs may include but are not limited to:

(a) The cost of Village employees' time associated in any way with the cleanup based on the hourly rate paid to the employee multiplied by a factor determined by the Village representing the Village's cost for expenses, benefits, insurance, sick leave, holidays, overtime, vacation, and similar benefits.

(b) The cost of Village equipment employed.

(c) The cost of mileage reimbursed to Village employees attributed to the cleanup.

Any violation of this Ordinance occurring within the Primary Protection Zone or Management Zone One (1) shall be punishable by imprisonment of the said violator(s) in the County jail for up to 12 months and/or by a fine of not less than $100.00 nor more than $500.00, plus the costs of prosecution for each separate violation hereof. Each day a violation exists or continues shall constitute a separate offense. For any corporation committing any violation of this Ordinance within Management Zone One (1) shall be punished by a fine of not more than $10,000 or double the defendant's gain, whichever is greater.

SECTION 10 MAPS & DETAILS AVAILABLE AT VILLAGE HALL.

Complete details of this Ordinance as well as maps illustrating the areas referred to herein may be inspected at the Village of Sister Bay Building and copies may be obtained at a reasonable charge for copying.

SECTION 11 CONFLICT AND SEVERABILITY.

Conflict with other Ordinances: In case of a conflict between this Ordinance, or any part thereof, and the whole or part of any existing or future Ordinances, the provisions of the most restrictive shall apply.

Severability: If any word, clause, phrase, portion, or provision of this Ordinance is held invalid or unconstitutional by any duly authorized court in the State of Wisconsin, such a decision shall no affect the remainder or any other provision of this Ordinance.

This Ordinance shall be effective as of _____. All Ordinances and parts of Ordinances in conflict herewith shall not be and the same are hereby repealed.

ENACTED AND ADOPTED this _____ day of 1996.

_____
Village President

Attest: _____
Village Clerk

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APPENDIX I

PUBLIC WATER SUPPLY CONTINGENCY PLAN

VILLAGE OF SISTER BAY
DOOR COUNTY, WISCONSIN

PUBLIC WATER SUPPLY CONTINGENCY PLAN

The purpose of the Public Water Supply Contingency Plan for the village of Sister Bay, Wisconsin is to establish, provide, and keep updated certain emergency response procedures which may become necessary in the event of a partial or total loss of public water supply service as a result of natural disasters, chemical contamination, or civil disorders. This contingency plan is the procedural guide for responding to such emergencies.

Assessment. The village currently is served by two wells. Well No. 1 is currently pumped at 400 gallons per minute (576,000 gallons per day). Well No. 2 is also pumped at 400 gpm. The average daily demand for the entire year, 1994 was 194,279 gpd and the seasonal, May through October, average daily demand for 1994 was 246,114 gpd. The village has an existing 100,000 gallon standpipe and is currently constructing additional elevated storage with a design capacity of 150,000 gallons.

In addition to the construction of the new elevated storage tank, the village will be constructing a third pumping station. This station is designed for a capacity of 400 gpm. With the construction of the elevated storage and a new well station, the village will be equipped to operate under emergency conditions involving the need to remove a well station from the system due to contamination or mechanical failure.

Priority List. In the event of a disruption in water service due to an emergency situation in the village, available water must be distributed according to a priority of needs. Those users considered to be high priorities are the fire fighting system, households, nursing homes, and schools. Those users to be contacted for use reduction are listed in Chapter 8. Other users to be contacted would include landscaping operations, commercial establishments and resort and tourism activities.

Emergency Contact Numbers. In the event of an emergency, certain individuals and agencies need to be notified. There should be one person designated to make the appropriate contacts to ensure all of the necessary people/agencies are informed of the situation. The following people/agencies are to be notified:

Agency/Name	Telephone Number
Steve Jacobson, Water System Superintendent	854-2246
Sheriff Department	868-3237
Fire Department	854-4021
County Emergency Response Person	743-5461
Electric Utility (WPS)	743-6212
Local Department of Natural Resources Water Supply Contact (Gus Glaser)	414-492-5890
Wisconsin Rural Water Association	715-344-7778
Well Driller and Pump Installer (Bernie Nooyen, CTW Corp.)	414-866-9044
Pump Installer	
Hazardous Materials Spill Response Team (DNR)	414-492-5800 or 800-943-0003
Carl Fischer, Village President	854-9641
Ron Kane, Village Administrator	854-4118

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APPENDIX J

ZONING RESOLUTION

RESOLUTION NO. _____

VILLAGE OF SISTER BAY
DOOR COUNTY, WISCONSIN

A RESOLUTION OF THE VILLAGE OF SISTER BAY TO DOOR COUNTY, THE TOWN OF LIBERTY GROVE AND TO THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES, REQUESTING THAT WELLHEAD PROTECTION AND GROUNDWATER PROTECTION CONSIDERATIONS BE WEIGHED IN MAKING PERMITS AND ZONING, SUBDIVISION, AND OTHER RELATED LAND USE ORDINANCES, REGULATIONS, OR DECISIONS.

WHEREAS, it is within the responsibility of the Village of Sister Bay, as a public water supplier, to consider the health, safety, and welfare of its customer; and

WHEREAS, groundwater contamination can and does occur as a consequence of a variety of land use activities; and

WHEREAS, it is desirable to preserve and protect the quantity and quality of our groundwater resources to assure a continued safe, adequate, and usable supply, now and in the future; and

WHEREAS, protection of current and potential future sources of groundwater is worthwhile from the standpoint of resource protection;

NOW, THEREFORE, BE IT RESOLVED by the Village Board of Sister Bay, that we do respectfully ask that Door County, the Town of Liberty Grove, and the Wisconsin Department of Natural Resources consider wellhead and groundwater protection in making permits, zoning, subdivision, and other related land use ordinances, regulations, or decisions for areas possibly affecting the wells of the Village of Sister Bay

ADOPTED this the day of _____, 1996, by the Village Board of Sister Bay, by unanimous vote.

Village of Sister Bay
Official Signature

_____
President

ATTEST: _____
Clerk