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Water Division

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Environmental Report

Middle Door County, Wisconsin
Wastewater Treatment Facilities

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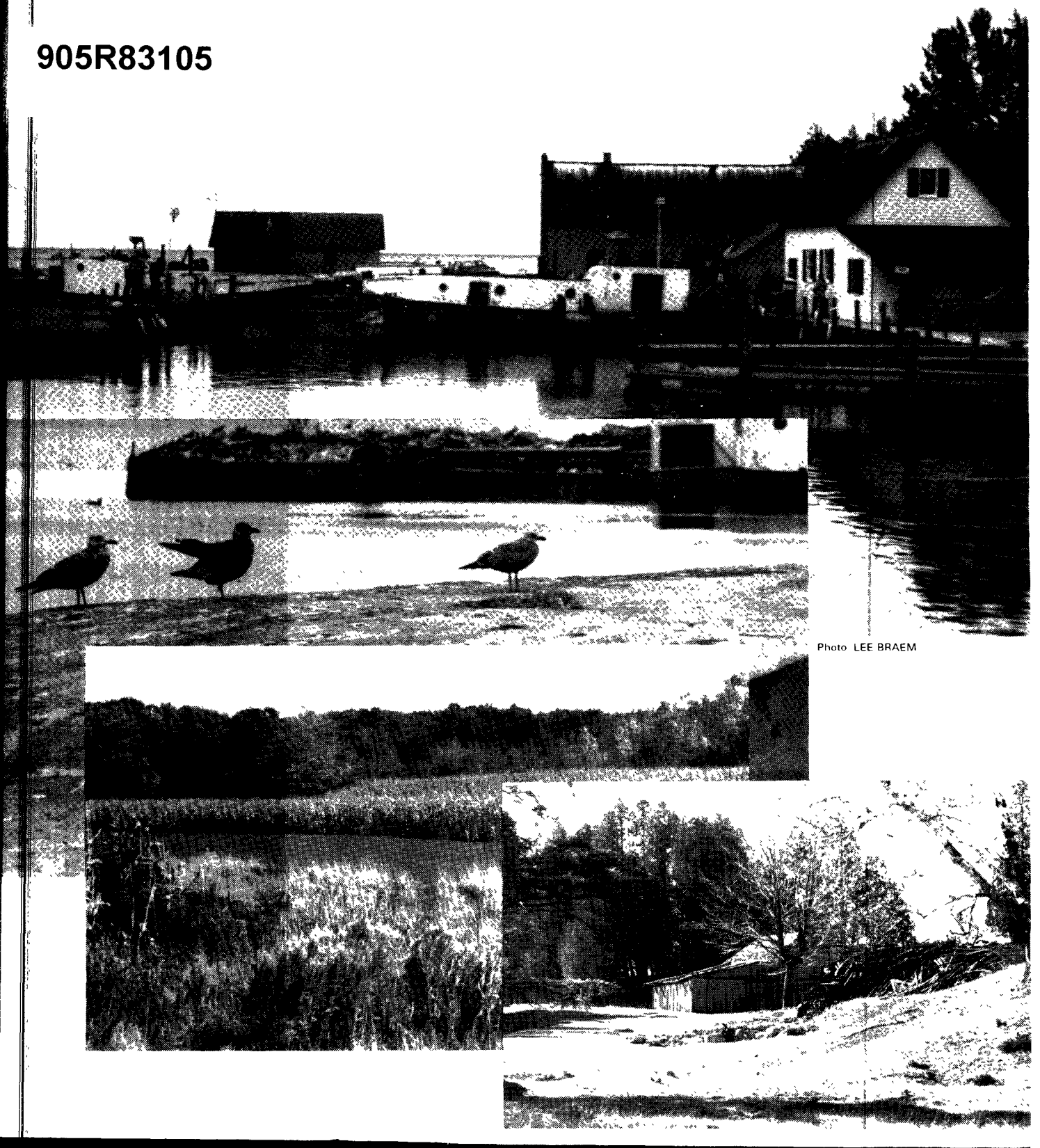

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Final Environmental Report

Middle Door County, Wisconsin
Wastewater Treatment Facilities

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Environmental Impact Section
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EXECUTIVE SUMMARY

Purpose of and Need for Action

This Environmental Report (ER) is a resource document which provides information concerning wastewater treatment system alternatives, including an analysis of cost-effectiveness and environmental impact, for the communities of Egg Harbor, Fish Creek, Ephraim and Baileys Harbor in middle Door County, Wisconsin (Figure 1). Because this document is an ER, the evaluation of alternatives is intended to provide guidance on the types of wastewater treatment options that appear to be favorable based on cost-effectiveness and associated environmental impacts.

Because of unique geological conditions and high water tables in many parts of the middle Door County area, there has been concern that existing onsite wastewater treatment systems may be contributing to the contamination of ground and surface waters. In 1978, the Town of Gilbraltar (including Fish Creek), acting on behalf of the Town of Baileys Harbor and the Villages of Egg Harbor and Ephraim, received a planning grant (Step 1) from the United States Environmental Protection Agency (USEPA) through the Wisconsin Department of Natural Resources (WDNR). This grant provided funding for the preparation of a Facilities Plan for the four communities. The individual jurisdictions contracted with three engineering firms to prepare the Facilities Plan. At that time, USEPA determined that an Environmental Impact Statement (EIS) would be needed because of the sensitive natural resources present in the project area and the potential for improved wastewater facilities to induce development and population growth. The EIS was to be prepared concurrently with the Facilities Plan.

In October 1980, the Facilities Planners submitted the Facilities Plan to the local communities for their review. The Facilities Plan addressed the wastewater treatment needs of the four communities and concluded that a combination of onsite systems and centralized wastewater treatment systems would be most cost-effective. The Facilities Plan also concluded that

individual treatment plants would be the most cost-effective alternative for each community. The Middle Door County Facilities Plan was submitted to WDNR and USEPA in October 1980 for review. A review of the Facilities Plan indicated several areas where additional information was needed before it could be approved by WDNR or USEPA.

Fish Creek currently is the only community that is proceeding with the additional work necessary to produce an approvable Facilities Plan. It formed a Sanitary District that included the most densely populated areas of Fish Creek and hired a consultant to prepare an Addendum to the original Facilities Plan for the Sanitary District. The Addendum was submitted to WDNR for review. Approval of the Addendum is pending.

The EIS cannot be completed until the other communities (Egg Harbor, Ephraim, and Baileys Harbor) have completed their portions of the Facilities Plan. It is not known whether the remaining communities intend to complete the Facilities Plan, or what the schedule would be for its completion. Because the entire Middle Door County Facilities Plan may never be finished, or funded by USEPA, the completion of the EIS on wastewater treatment needs for the four communities is doubtful.

In order to adjust to the changing scope of the project, to help resolve outstanding environmental concerns, and to provide interim guidance for environmentally sensitive wastewater treatment alternatives, USEPA initiated the preparation of this Environmental Report. The ER is intended to serve as a guide to the four communities, their facilities planners, government agencies, and citizens by outlining environmentally sensitive solutions to the wastewater treatment problems of the communities.

The ER evaluates the wastewater management alternatives presented in the 1980 Facilities Plan and the 1982 Addendum, plus several additional alternatives for each commmunity, for cost-effectiveness and environmental impacts. Significant issues discussed in the ER are the potential for groundwater contamination by existing onsite systems, and the potential for centralized wastewater facilities to induce population growth and cause secondary impacts on the environment in the project area. Other issues

that are discussed include impacts to wetlands, prime farmlands, threatened or endangered species, and archaeological or historical sites; economic impacts on local residences; the ability of local governments to finance improvements; and secondary impacts.

Existing Conditions in the Natural and Manmade Environment

Natural Environment

The ER presents information on the natural environment in the project area including: air quality, geology, soils, surface water, groundwater, and terrestrial and aquatic biota. The major elements of the natural environment that will affect decisions concerning continued use of onsite systems - or the need for centralized wastewater collection and treatment systems - are the geology, groundwater, and surface water.

The geology of the project area is characterized by dolomite bedrock overlain by shallow unconsolidated glacial deposits. The bedrock slopes from the ridge of the Niagra escarpment along the Green Bay coast to the Lake Michigan shore, with outcrops at numerous locations. The shallow bedrock has a major impact on excavation costs. The surface bedrock is primarily Niagaran dolomite with many natural crevices, fissures and, joints at the surface. The soils and bedrock are moderately permeabable and most precipitation percolates to the groundwater aquifers in the dolomite bedrock.

Approximately 26 percent of the soils in the project area are underlain by dolomite bedrock at an approximate depth of 3.5 feet and in general have a depth to bedrock of less than 5 feet. The surficial deposits overlaying the shallow bedrock consist of dolomite fragments, silt or clay. Other surficial deposits include alluvium, marsh and lake deposits consisting of silt, clay and organic matter; outwash, beach deposits and sand dunes consisting of well-sorted sand and gravel; and ground moraines, end moraines and drumlins consisting of till (intermixed clay, silt, sand, gravel, and boulders).

In general, the soils in the project area exhibit considerable variability in composition and characteristics. The depth to the water table ranges from zero to greater than 6 feet, and the slope ranges from zero to 18 percent. The SCS has given many of the soils in the project area a "severe" rating for soil absorption systems. The primary limitations are near surface bedrock, high water table, and steep slopes.

The primary water supply source for the project area is groundwater from private wells. Most of the wells drain from the surficial unconsolidated materials and the dolomite bedrock. The principal water bearing zones are in vertical and bedding plane joints in the dolomite bedrock. The dolomite aquifer has a high contamination potential because of the shallow soils cover, the permeability of the soils, and the fractured condition of the bedrock.

The surface waters of concern in the ER are the coastal bays and harbors along Green Bay and Lake Michigan. Existing water quality information for these areas is unavailable but general information indicates that Lake Michigan is slightly eutrophic. Green Bay is more variable in alkalinity, pH and ionic composition. In many locations the Lake Michigan shoreline is characterized by a slight bottom gradient, rock shoals and considerable bottom deposition. In contrast, the Green Bay coast has a sharp bottom gradient along the escarpment.

Manmade Environment

The ER presents information on the manmade environment of the project area including land use, population, economic conditions, recreation and tourism, personal and governmental finances, and cultural resources. One of the major elements of the manmade environment that will affect decisions concerning wastewater management is the existing and projected populations of the four communities.

For several decades prior to 1970 the population of Door County and the project area had been declining. Between 1970 and 1980, however, the population in the project area increased by 26.1 percent. This population

increase is consistant with recent national trends of net migration from urban areas to rural areas. The current trend of population increase is expected to continue because of the recreational attraction of Door County and its popularity as a retirement area.

Population projections for the year 2000 were made for permanent, seasonal, and seasonally transient populations. Projections for the permanent population were based on historical population statistics and the fertility rate. The permanent population is expected to continue to grow, but at a decreasing rate. The seasonal population is expected to continue to grow at a substantial rate based on the 1970-1980 increase in seasonal housing units. The 1982 seasonally transient population was estimated based on the number of cottages, motel units and campsites available in the project area. The seasonally transient population was assumed to remain constant over the planning period because the limited information available precluded the identification of trends. Population projections for the four communities are presented in Table 1.

Table 1. Population projections for Egg Harbor, Fish Creek, Ephraim and Baileys Harbor.

	1980			2000		
	Permanent	Seasonal	Seasonal Transient[b]	Permanent	Seasonal	Seasonal Transient[b]
Egg Harbor Village	238	606	473	369	802	473
Fish Creek Community	224[a]	375[a]	540	278	610	540
Ephraim Village	319	1,029	728	466	1,505	728
Baileys Harbor Community	313[a]	78[a]	473	536	212	473

[a] 1979

[b] 1982 estimated cottage, motel and campsite population.

Needs Documentation

Onsite systems are the predominant means of wastewater treatment in the project area. Most of the onsite systems utilize soil absorption of septic tank effluent, or holding tanks.

Onsite systems that fail to function properly can cause backups in household plumbing, ponding of effluent on the ground surface, groundwater contamination that may affect water supplies, and/or excessive nutrients and coliform levels in surface water. USEPA Guidance requires that documented pollution problems be identified and traced back to the causal factors. Projects may receive USEPA grants only where a significant proportion of residences can be documented as having or causing problems. Eligibility for USEPA grants is limited to those systems for which there is direct evidence that indicates they are causing pollution, or those systems that are virtually identical in environmental constraints and in usage patterns to documented failing systems.

Information on existing systems was gathered from Door County Health Department records. Interviews with Health Department personnel also were useful in assessing environmental conditions in the project area and the suitability of septic tank and soil absorption systems for treating wastewater. A septic leachate detector survey, color infrared aerial photography, and a mailed questionnaire alsc were used to assess the effectiveness of the existing treatment systems and to document direct evidence of onsite system problems.

The results of these investigations indicate that certain areas exhibit a combination of site limitations, history of replacements, and documented water quality problems that appear to require offsite treatment. In general, these areas encompass the downtowns of the four communities. They have concentrations of commercial uses, small lots, and constraints for soil absorption systems, such as shallow depth to bedrock, cobble, or water table. These areas have a concentration of holding tanks both for

new structures and as replacements for septic tank and soil absorption systems.

Several well sampling programs have been conducted in the project area and contaminated wells have been documented. However, in most cases the contamination was found to be the result of insufficient well casing, inadequate grouting, or some other feature of the installation or operation of the well. Similarly, the septic leachate detector may have identified some groundwater plumes containing nutrient concentrations above background levels, but the origin of the plumes could not be determined. As yet, no documented evidence exists which links contaminated groundwater in the project area with failing onsite systems. The potential for such contamination is clear, because of the shallow soil cover and fractured bedrock, but direct evidence of groundwater contaminated by onsite systems is lacking.

Wastewater Management Alternatives

The project alternatives considered in the ER serve all the subareas identified in the Facilities Plan for the four communities. For each community a no action alternative, several alternatives utilizing centralized collection and treatment (including alternatives equivalent to those recommended in the Facilities Plan), and an alternative utilizing only onsite systems for the entire service area were evaluated.

The No Action Alternative

The No Action Alternative implies that neither USEPA nor WDNR (except through the Wisconsin Fund where eligible individual systems can be funded for upgrades through NR 128.30) would provide funds for wastewater treatment systems. Wastewater would be treated in existing onsite systems and no few facilities would be built except on an individual basis to replace obviously failed systems.

The need for improved wastewater management in each community is not well documented. The cost of pumping existing holding tanks appears to be

a major impetus for centralized collection and treatment systems. The number of onsite systems experiencing failures or backups is small. The potential impact of onsite systems on groundwater quality is a major concern but problems with properly constructed wells appear to be minimal and have not been traced specifically to onsite systems.

The No Action Alternative was rejected for all four communities because it does not provide an administrative mechanism or funding to provide adequate inspection of existing onsite systems unless there are obvious problems. As a result, there is a potential that environmental problems associated with existing onsite systems would persist and result in groundwater pollution. Furthermore, no project would be instituted to mitigate the high cost for businesses to pump holding tanks. The result would be an increasing number of holding tanks that have high operational costs.

The Build Alternatives

The service area for each community was divided into a sewer service area and an onsite service area for alternatives providing centralized collection and treatment. In each community, two sewer service alternatives were evaluated; one with sewers with the same extent as that recommended in the Facilities Plan and another with a more limited extent. The smaller sewer service areas primarily include the downtown areas and are based on primary inferred evidence from the needs documentation.

Upgrading of onsite systems was evaluated using available information. The onsite technologies considered were septic tanks, seepage beds, mounds, and holding tanks, although other technologies may be appropriate on a limited basis. The number of systems to be upgraded was estimated conservatively. The systems that were not obviously causing a direct effluent flow to the bedrock were not included in the estimate of the number of systems to be upgraded. Compliance with Wisconsin code was not used as a criterion for estimating the number of systems to be upgraded. It was assumed that the district or village will assume management and maintenance responsibilties for the onsite systems within the service areas.

Collection systems evaluated for the sewer service areas include conventional gravity, septic tank effluent (STE) gravity, and STE pressure sewers. In general, conventional gravity systems were the least costly. STE gravity sewers were used in conjunction with alternatives including treatment systems utilizing treatment and disposal of septic tank effluent.

The centralized treatment and disposal alternatives included WWTPs with bay or lake discharge for all four communities, WWTPs with land or wetland disposal, and cluster drainfields or cluster mounds for individual communities where appropriate and technically feasible. Cluster drain fields are seepage soil absorption systems designed to serve more than one home. Cluster mounds are similar to cluster drainfields except that the seepage system is constructed in a raised bed (mound) to overcome limitations of shallow soil depth and a shallow water table. WWTP treatment alternatives evaluated for each community included the treatment process recommended in the Facilities Plan as well as an aerated lagoon.

For the alternatives with bay or lake discharge, the outfall from the WWTP would discharge at a minimum depth of 25 to 30 feet, as recommended by the US Fish and Wildlife Service, to minimize the impact on fish spawning areas.

Village of Egg Harbor Alternatives

Alternatives considered for the Village of Egg Harbor include: the no action alternative (Alternative 1), three alternatives for the larger sewer service area (Alternatives 2A, 2B and 3), three alternatives for the smaller sewer service area (Alternatives 4, 5 and 6), and onsite system upgrades for the entire service area (Alternative 7). A description and ranking of the total estimated present worth costs for each alternative are presented in Table 2.

The least cost alternative for Egg Harbor is Alternative 7, upgraded onsite systems for the entire service area. Alternative 2B (conventional gravity collection in the larger sewer service area, a rotating biological contactor (RBC) WWTP, discharge to Green Bay, and upgraded onsite systems

Table 2. Summary of estimated present worth costs for Egg Harbor alternatives (December 1981, $1000).

Alternative	Collection and transmission	Treatment	Disposal	Onsite Component	Total	Average annual equivalent cost[1]	Ranking
1. No Action							
2A. Conventional gravity collection system for Subarea 1A, 1B, and 2A, transmission to aerated lagoon WWTP in Sec. 24 T30N R26E, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.	866.7	490.3	132.5	678.3	2,167.6	214.6	5
2B. Conventional gravity collection system for Subarea 1A, 1B, and 2A, transmission to RBC WWTP in Sec. 24 T30N R26E, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.	867.7	873.2	132.5	678.3	2,550.7	252.5	6
3. STE gravity collection system for Subareas 1A, 1B, and 2A, transmission to site in Sec. 31 T30N R27E and treatment and disposal in cluster soil absorption system; upgraded onsite systems for remainder of subareas.	885.2	-	484.2	678.3	2,047.7	202.8	4
4. Conventional gravity collection system for Subareas 1AN, 1BS, and 2AS, transmission to aerated lagoon WWTP in Sec. 24 T30N R26E, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.	410.7	400.1	132.5	929.0	1,872.3	185.4	3
5. STE gravity collection system for subareas 1AN, 1BS, and 2AS, transmission to site in Sec. 31 T30N R27E, and treatment and disposal in cluster soil absorption system; upgraded onsite systems for remainder of subareas.	561.7	-	303.0	929.0	1,793.7	178.0	2
6. Conventional gravity collection systems for Subareas 1AN, 1BS, and 2AS, transmission to and treatment at land application site in Sec. 31 T30N R27E; upgraded onsite systems for remainder of subareas.	516.2	400.1	202.3	929.0	2,047.6	202.8	4
7. Upgraded onsite systems for all subareas.	-	-	-	1,670.1	1,670.1	165.4	1

[1] Amortized at 7.625% over 20 years.

in the remainder of the service area) is equivalent to the recommended alternative in the Facilities Plan and is the most expensive of the build alternatives.

Treatment plant locations were selected based on the site recommended in the Facilities Plan (Sec. 24 T3ON R26E) and a general area (Sec. 31 T3ON R27E) where a cluster drainfield or a land application system would be feasible. An aerated lagoon and a RBC WWTP were evaluated for both sewer service areas. The RBC system was recommended in the Facilities Plan although the aerated lagoon was less costly. In this analysis, the aerated lagoon was deemed to be technically feasible and the least cost system. The aerated lagoon also was utilized as the treatment process for the land application system option.

Community of Fish Creek Alternatives

Alternatives considered for the Community of Fish Creek included: the no action alternative (Alternative 1), one alternative for the larger sewer service area (Alternative 2), four alternatives for the smaller sewer service area (Alternatives 3, 4, 5 and 6), and onsite systems upgrades for the entire service area (Alternative 7). A description and ranking of the total estimated present worth costs for each alternative are presented in Table 3.

The treatment plant locations that were evaluated were the recommended site of the Facilities Plan Addendum (NENW Sec. 33), the site investigated in the Addendum for a cluster mound (SWNE Sec. 32), and a general site where a cluster drainfield or land application system may be feasible (Sec. 3). Because the Facilities Plan Addendum for Fish Creek recommended an aerated lagoon, this analysis included only the aerated lagoon for wastewater treatment options that require surface discharge.

The least cost alternative for Fish Creek is Alternative 4, STE gravity sewer for the smaller sewer service area with treatment and disposal in a cluster mound, and onsite upgrades for the remainder of the service area. Alternative 2 (conventional gravity sewers for the larger sewer ser-

Table 3. Summary of estimated present worth costs for Fish Creek alternatives (December 1981, $1000x).

Alternatives	Collection	Treatment	Transmission and discharge	Onsite component	Total	Average annual equivalent cost[1]	Ranking
1. No Action							
2. Conventional gravity collection system for subareas 2, 3A, and 3B, transmission to aerated lagoon WWTP in NENW Sec. 33, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.	1,017.2	833.2	567.1	496.2	2,913.7	288.5	4
3. Conventional gravity collection system for Subareas 2 and 3A, transmission to aerated lagoon WWTP in NENW Sec. 33, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.	941.7	833.2	567.1	563.8	2,905.8	287.8	3
4. STE gravity collection system for subareas 2 and 3A, transmission to site in SWNE Sec. 32, and treatment and disposal in cluster mound; upgraded onsite systems for remainder of subareas.	1,108.7	-	936.8	563.8	2,609.3	258.4	1
5. STE gravity collection system for Subareas 2 and 3A, transmission to site in Sec. 3 treatment and disposal in cluster drainfield; upgraded onsite systems in remainder of subareas.	1,108.7	-	1,102.7	563.8	2,775.2	274.8	2
6. Conventional gravity collection system for Subareas 2 and 3A and transmission to and treatment at a land application site in Sec. 3; upgraded onsite systems in remainder of subareas.	941.7	833.2	642.8	563.8	2,981.5	295.2	5
7. Upgraded onsite systems for all subareas.				3,276.8	3,276.8	324.5	6

[1] Amortized at 7.625% over 20 years.

vice area, aerated lagoon WWTP, discharge to Green Bay, and onsite upgrades for the remainder of the service area) is equivalent to the recommended alternative presented in the Facilities Plan Addendum, and is ranked 4 of the 6 build alternatives.

Village of Ephraim Alternatives

Alternatives considered for the Village of Ephraim included: the no action alternative (Alternative 1), one alternative for the large sewer service area (Alternative 2), three alternatives for the smaller sewer service area (Alternatives 3, 4, and 5) and onsite systems upgrades for the entire service area (Alternative 7). A description and ranking of the total estimated present worth cost of each alternative are presented in Table 4.

The treatment plant location was based on the Facilities Plan recommended site (Sec. 24). The wastewater treatment option recommended in the Facilities Plan, an aerated lagoon, also was evaluated. The locations of the discharge or disposal sites are slightly different from the Facilities Plan. The Green Bay outfall was extended to the 30-foot depth and this necessitated re-routing the outfall force main considerably north of the location presented in the Facilities Plan in order to keep the underwater outfall length as short as possible. An alternative wetland discharge site was evaluated near the center of Sec. 25. A new alternative includes a cluster drainfield located on a site in Sec. 24 where the soils and hydrogeologic conditions appear to be suitable.

The least cost alternative for Ephraim is Alternative 6, onsite upgrades for the entire service area. Alternative 2 (conventional gravity sewers for the larger sewer service area, aerated lagoon WWTP, discharge to Green Bay, and onsite upgrades for the remainder of the service area) is equivalent to the recommended alternative in the Facilities Plan and is the most expensive of the build alternatives.

Table 4. Summary of estimated present worth costs for Ephraim alternatives (December 1981, $1,000x).

Alternatives	Collection and Conveyance	Treatment	Disposal	Onsite Component	Total	Average annual equivalent cost[1]	Ranking
1. No Action							
2. Conventional gravity collection system for all subareas except Subarea 4, transmission to aerated lagoon WWTP in Sec. 24, and discharge to Green Bay; upgraded onsite systems for Subarea 4.	3,741.7	749.9	467.9[2]	959.3	5,918.9	586.1	5
3. Conventional gravity collection system for Subarea 1A, 1B, and 2, transmission to aerated lagoon WWTP in Sec. 24, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.	1,301.6	670.5	822.9[2]	1,167.6	3,962.6	392.4	4
4. Conventional gravity collection system for Subareas 1A, 1B, and 2, transmission to aerated lagoon WWTP in Sec. 24, and discharge to wetlands; upgraded onsite systems for remainder of subareas.	1,301.6	670.5	514.4	1,167.6	3,654.1	361.9	3
5. STE gravity collection system for Subareas 1A, 1B, and 2, transmission to site in Sec. 24, and treatment and disposal in cluster drainfield; upgraded onsite systems in remainder of subareas.	1,325.6	-	890.6	1,167.6	3,383.9	335.1	2
6. Upgraded onsite systems for all subareas.	-	-	-	2,938.5	2,938.5	291.0	1

[1] Amortized at 7.625% over 20 years.

[2] A more northerly location of the WWTP would reduce outfall costs significantly.

Community of Baileys Harbor Alternatives

Alternatives for the Community of Baileys Harbor include: the no action alternative (Alternative 1), three alternatives for the larger sewer service area (Alternatives 2A, 2B, and 3), two alternatives for the smaller sewer service area (Alternatives 4 and 5), and upgraded onsite systems for the entire service area (Alternative 6). A description and ranking of the total estimated present worth costs for each alternative are presented in Table 5.

Treatment plant locations were selected based on the recommended site in the Facilities Plan (Sec. 17) and sites near the proposed discharge areas (Secs. 7 and 8). Because the recirculating sand filter was the treatment alternative recommended in the Facilities Plan, this analysis includes the sand filter as an alternative component, in addition to the aerated lagoon WWTP. An outfall to Baileys Harbor was presumed to be unacceptable, based on contacts with the US Fish and Wildlife Service and WDNR. For that reason, the outfall was extended to Lake Michigan. Soils that are potentially suitable for a cluster drainfield or a land application system are located only at a considerable distance from the community. Thus, no alternatives that incorporate these components were developed. Two wetland discharge locations were considered. One site in Sec. 8 was recommended in the Facilities Plan but that site is adjacent to the Mud Lake and Ridges Sanctuary National Natural Landmarks and has the potential to adversely impact these areas. Therefore, a second discharge site was considered in Sec. 7.

Alternative 6, upgraded onsite systems for the entire service area, is the least cost alternative for Baileys Harbor. Alternative 2B (conventional gravity sewers serving the larger sewer service area, recirculating sand filter WWTP discharging to a wetland site in Sec. 8, and upgraded onsite systems for the remainder of the service area) is equivalent to the recommended alternative in the Facilities Plan and is the most expensive alternative.

Table 5. Summary of estimated present worth costs for Baileys Harbor alternatives (December 1981, $1,000x).

Alternatives	Off-site component				On-site Component	Total	Average annual equivalent cost[1]	Ranking
	Collection	Conveyanace	Treatment	Discharge				
1. No Action								
2A. Conventional gravity collection system for subareas 3 and 6, transmission to aerated lagoon WWTP and discharge to wetland in Sec. 8; upgraded onsite systems for remainder of subareas.	1,295.6	269.1	543.7	335.4	1,793.9	4,237.7	419.6	3
2B. Conventional gravity for Subareas 3 and 6, transmission to recirculating sand filter WWTP and discharge to wetland in Sec. 8; upgraded onsite systems for remainder of subareas.	1,295.6	269.1	843.3	335.4	1,793.9	4,537.3	449.3	5
3. Conventional gravity collection system for Subareas 3 and 6, transmission to aerated lagoon WWTP and discharge to wetland in Sec. 7; upgraded onsite systems for remainder of subareas.	1,295.6	375.4	543.7	335.4	1,793.9	4,344.0	430.2	4
4. Conventional gravity collection system for Subarea 3, transmission to aerated lagoon in Sec. 17, and discharge to Lake Michigan; upgraded onsite systems for remainder of subareas.	981.8	109.3	490.1	920.1	1,973.6	4,474.9	443.1	6
5. Conventional gravity collection system for Subarea 3, transmission to aerated lagoon WWTP and discharge to wetland in Sec. 7; upgraded onsite systems for remainder of subarea.	981.8	875.4	490.1	349.0	1,973.6	4,169.9	412.9	2
6. Upgraded onsite systems for all subareas.					3,648.5	3,648.5	351.3	1

Septage and Holding Tank Waste Disposal

In 1981, an estimated volume of 225,000 gallons of septage and 10 millon gallons of holding tank wastes from within the study area were disposed of by land application. Nearly 9 million gallons of holding tank wastes were from institutions and businesses, primarily restaurants, motels, cottages and condominiums. The remainder of the holding tank wastes and the septage were from the permanent and seasonal residences.

The different wastewater management alternatives presented in the ER would produce varied volumes and proportions of septage and holding tank wastes. If the alternatives that feature continued use of onsite systems for all subareas were implemented, 275,500 gallons per year of septage and 30 million gallons per year of holding tank wastes would be generated. If the alternatives that feature conventional gravity sewers for the larger sewer service areas were implemented, 182,000 gallons per year of septage and 7 million gallons of holding tank wastes would be generated. Other combinations of alternatives would generate volumes of liquid wastes that range between these quantities. If all the communities were to have septic tank effluent gravity or pressure sewers, the volume of septage produced would be slightly greater than that shown for the full onsite alternatives.

Safe land application rates for septage and holding tank waste disposal are based on total nitrogen loadings. The nitrogen loading criterion used in this study to estimate the land area required was 300 pounds per acre per year. The resulting land application area requirements for the range of alternatives are:

Alternative	Septage	Holding tank wastes	Total
Existing onsite systems	4.8 ac	45 ac	50 ac
All onsite systems for planning period	5.2 ac	131 ac	136 ac
All centralized gravity	3.4 ac	30 ac	34 ac

There is considerable area suitable for land application of septage and holding tank wastes within the study area. No problems are anticipated in identifying suitable land application sites.

Environmental Consequences

The ER discusses the construction, operational, and secondary environmental impacts associated with implementation of the alternatives, and presents mitigative measures that can be applied to eliminate or reduce the environmental impacts.

Construction and Operational Impacts

The construction of centralized collection facilities would have considerable impacts on the right-of-ways where the sewers are located. Construction would be difficult because the extensive shallow bedrock requires blasting and because many right-of-ways are narrow and tree lined. Dewatering and blasting for deep sewer excavation and pump stations could affect shallow wells in the vicinity of the construction zone.

Construction of a lake or bay outfall would have construction impacts similar to those for collection systems, except that, additionally, the lake or bay environment would be temporarily disturbed resulting in an increase in turbidity, decreases in dissolved oxygen, and possibly some fish mortality.

The treatment facilities discharging to the lake or bay would be required to meet the effluent requirements established by WDNR. Water quality would be altered, but not seriously degraded.

Treatment plant effluent that is discharged to land application sites or wetlands also would be required to meet the effluent requirements established by WDNR. Both should result in minimal operational impacts because the effluent should be of relatively high quality. Possible operational impacts from land application are mounding of groundwater under the site and nitrate buildup in the groundwater. The possible operational impacts of concern with wetlands are alterations to the existing flora and fauna regimes due to changes in the hydrologic conditions of the site, and flushing of solids into surface waters in the spring and fall. Changes in the vegetative and hydrologic regimes of the wetland sites could represent a

significant impact because of their species diversity, uniqueness, and local and regional significance.

The centralized collection, treatment and disposal facilities, and/or the onsite upgrades would have a positive effect on groundwater quality by eliminating existing onsite systems that could be contaminating the groundwater. Onsite upgrades and management of onsite systems would replace inadequate onsite systems with appropriate new systems or holding tanks.

Financial and Economic Impacts

The costs of implementing a project in one of the project area communities could be apportioned between the State of Wisconsin and local residents. Grants of up to 60 percent of the eligible costs of implementing a wastewater improvement action could be available from the Wisconsin Fund. Because of their position on the State priority list, it is unlikely that the communities in the project area will be eligible for any Federal funding under Section 201 of the Federal Water Pollution Control Act for construction of wastewater treatment facilities. The local construction costs and the entire costs of the system operation and maintenance would be borne entirely by the system users.

Even with State grants, many of the project alternatives could have an adverse financial impact on community residents, as measured by their ability to afford the estimated average annual user costs. The capital costs of some of the alternatives also could have a significant negative impact on the financial condition of the individual communities. The financial burden imposed by the additional debt that would be incurred could limit the ability of each community to engage in other capital improvement projects and potentially could impact their ability to provide other public services (e.g., police and fire protection) at a level consistent with that which is currently being provided.

Secondary Demographic Impacts

Facilities planning in the middle Door County project area has not been based on the underlying assumption that sewers may be needed to accom-

modate projected growth, but that there may be a need to correct an existing problem; i.e., the potential for groundwater contamination as a result of inadequate onsite systems.

The proposed sewer service areas in each of the communities essentially are "built-out." Some additional infill development could take place, but it cannot be concluded that the absence of sewer systems is inhibiting growth from taking place. However, the availability of sewer systems could possibly increase the attraction of the communities for year-round residences.

If sewers are constructed in a community, it is possible that the sewered area might "capture" some of the projected growth at the expense of unsewered areas. However, it also is possible that because of the density of existing development within the proposed sewer service areas, the limited amount of buildable land within the sewer service areas, and the fundamental attraction of the area as a recreational and retirement area, the sewered areas might not offer any particular competitive advantage over unsewered areas. It also is possible that induced growth could be an important factor in one community, for a variety of reasons, and of little consequence in another community.

As discussed previously, high population growth rates were experienced in each of the four communities between 1970 and 1980 in spite of the lack of centralized wastewater collection and treatment facilities. Continued high growth rates are projected for the area over the next twenty years. The major factors influencing continued growth include favorable land costs, site and locational amenities, and variations in demand between permanent and seasonal dwellings. The construction of wastewater collection and treatment facilities in the project area communities could lead to additional growth in excess of that which is all ready projected, but the factors outlined above probably will have a greater affect on population growth.

Conclusion

The least cost alternative for each community from both an economic and environmental impact perspective is as follows:

- Egg Harbor: Alternative 7 - Upgraded onsite systems for the entire service area.
- Fish Creek: Alternative 4 - Septic tank effluent gravity collection for the smaller sewer service area, transmission to site in SWNE Sec. 32, and treatment and disposal in cluster mound; upgraded onsite systems for the remainder of the service area.
- Ephraim: Alternative 6 - Upgraded onsite systems for the entire service area.
- Baileys Harbor: Alternative 6 - Upgraded onsite systems for the entire service area.

These alternatives are the least cost based on the population projections and available needs documentation. For Fish Creek, the year 2000 population projection used in the ER is less than that used by the Facilities Planner (Foth and Van Dyke and Associates, Inc. 1982). The use of a larger year 2000 population projection could result in the least cost alternative for Fish Creek (Alternative 4) becoming technically unfeasible. In that case, Alternative 5, STE gravity collection system with treatment and disposal in a cluster drainfield in Sec. 3, appears to be the least costly, technically feasible alternative.

The cost estimates for onsite system upgrading for Egg Harbor, Ephraim, and Baileys Harbor are highly sensitive to the number of holding tanks required. The need for a holding tank is based on the soil condition of each individual property at the location of the onsite system. The assumptions contained in the ER concerning soil condition were based on limited information. When soil data becomes available for each lot, the number of holding tanks required may be greater than estimated here, and a collection and treatment alternative for Egg Harbor, Ephraim and/or Baileys Harbor could then be the least cost alternative. Should this be the case, the alternatives that are the most likely to be the least costly are as follows:

- Egg Harbor: Alternative 5 - STE gravity collection system for the smaller sewer service area, transmission to site in Sec. 31 T30N R27E, and treatment and disposal in cluster soil absorption system; upgraded systems for the remainder of the service area.

- Ephraim: Alternative 5 - STE gravity collection system for the smaller sewer service area, transmission to site in Sec. 24, and treatment and disposal in cluster drainfield; upgraded onsite systems for the remainder of the service area.

- Baileys Harbor: Alternative 5 - Conventional gravity collection system for the smaller sewer service area, transmission to aerated lagoon WWTP, and discharge to wetland in Sec. 7; upgraded onsite systems for the remainder of the service area.

CONCLUSION

The ER reviews in detail the existing information about the natural and manmade environment in middle Door County, Wisconsin that is pertinent to evaluating the adequacy of existing onsite treatment systems and alternative wastewater treatment systems. The shallow soil cover, high groundwater table and fractured bedrock indicate that there is a potential for groundwater contamination from inadequate septic systems. However, a review of the available groundwater test data from wells in the area cannot show an undisputable connection between groundwater contamination and existing onsite systems. A review of available information on installation and replacement of onsite systems indicates that outside of the downtown areas of the four communities, few residential onsite systems have required replacement or appear to be experiencing problems. However, the downtown areas have concentrations of commercial uses and small lots, and as a result have a concentration of holding tanks both for new structures and as replacement onsite systems. The impetus for planning alternative wastewater management systems for these communities is derived from perceived problems concerning groundwater contamination and the cost of holding tank waste disposal, especially for commercial systems.

The ER reviews a number of wastewater management options for each community, including the recommended alternative presented in the Facilities Plan. Particular attention is given to management systems that

provide for upgrading existing onsite systems with obvious or potential problems. For Egg Harbor, Ephraim and Baileys Harbor, upgrading onsite systems and maintaining them with a management district is identified as the least costly alternative over 20 years. For Fish Creek, a centralized collection system with treatment in a cluster mound is identified as the least costly alternative, primarily because of the high number of commercial holding tanks in the downtown area.

The cost estimates and ranking of alternatives could change, though, depending on the number of new or replacement holding tanks that are required. Additional investigations are needed to refine these cost estimates and to determine if, in the case of the three communities where onsite system upgrade alternative are identified as most cost effective, such an approach can adequately provide for the wastewater treatment needs of the communities over the planning period.

FINAL ENVIRONMENTAL REPORT

MIDDLE DOOR COUNTY

WASTEWATER TREATMENT FACILITIES

DOOR COUNTY, WISCONSIN

Prepared by the

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION V

CHICAGO, ILLINOIS

and

WAPORA, INCORPORATED

CHICAGO, ILLINOIS

FEBRUARY 1983

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1.0. PURPOSE OF AND NEED FOR ACTION

1.1. Project History

The project area encompasses approximately 100 square miles in the central portion of the Door County, Wisconsin peninsula and includes the Towns of Baileys Harbor and Gibraltar, and the Villages of Egg Harbor and Ephraim (Figure 1-1). Portions of the Towns of Egg Harbor, Jacksonport, and Liberty Grove also are included. The Door County peninsula is characterized by an upland ridge of bedrock, the Niagaran escarpment, that extends the length of the Green Bay coastline. The project area contains numerous natural features and sensitive areas such as Kangaroo Lake, Baileys Harbor Swamp, Ephraim Swamp, the Ridges Sanctuary, and Peninsula State Park.

On-site systems are the predominant means of wastewater treatment in the project area; the only centralized wastewater treatment systems currently in use in the project area are at Peninsula State Park and the Baileys Harbor Yacht Club. The unique geologic conditions present in much of Door County generally are not conducive to on-site systems. Bedrock is present near the surface in many areas, high groundwater tables also are present, and fractures in the bedrock can result in direct percolation of wastewater into the aquifers that are used for water supply. Because there are no public water systems in the project area and area residents use wells to obtain their water, there has been concern that existing on-site wastewater treatment systems may be contributing to the contamination of ground and surface waters.

Until the 1960s, public control over septic tank system installation was nonexistent or only advisory. During the 1960s and 1970s, the State government and local health departments formulated and implemented procedures for preconstruction approval of septic tank systems. These procedures and standard design requirements have reduced the occurrence of surface malfunctions and plumbing backups for new systems. In 1971, the communities of Baileys Harbor, Egg Harbor, Ephraim, and Fish Creek each received an order from the Wisconsin Department of Natural Resources (WDNR)

to provide adequate wastewater disposal facilities to abate contamination of groundwater. The pollution abatement orders were issued following a well sampling program conducted during the summer of 1971. Well samples were taken from 460 wells in the project area and more than 15% (71) were found to be bacteriologically unsafe. Unsafe samples were found in each of the four communities. In 1972, Becher-Hoppe Engineers, Inc. completed the Door County Comprehensive Sewer and Water Plan which contained preliminary recommendations for wastewater collection and treatment alternatives in each area of Door County having significant population concentrations. The WDNR pollution abatement orders also required that each of the four communities prepare preliminary engineering reports. To achieve compliance with these orders the following reports were prepared:

Village of Ephraim Water and Wastewater Facilities. 1972. Owen Ayres and Associates, Inc.

Water Distribution System and Wastewater Collection and Treatment Facilities - Baileys Harbor, Wisconsin. 1973. Donohue and Associates, Inc.

A Preliminary Report on Sanitary Facilities to Serve the Communities of Egg Harbor and Fish Creek, Wisconsin. nd. Becher-Hoppe Engineers, Inc.

Because of a number of circumstances, including a lack of construction funds and differing recommendations within the preliminary reports concerning regional cooperation, no actions toward construction were taken. Although attempts were made to resolve the issues surrounding the preliminary reports, policy changes by the WDNR and US Environmental Protection Agency (USEPA) and changes in water quality laws rendered the preliminary reports inadequate for implementation. In 1977, the four communities and three engineering firms agreed to prepare a Facilities Plan for the middle Door County area on a cooperative basis. In 1978, the Town of Gibraltar (including Fish Creek), acting on behalf of the Town of Baileys Harbor and the Villages of Egg Harbor and Ephraim, received a planning grant (Step 1) from USEPA for the preparation of the Facilities Plan. At that time, USEPA determined that an Environmental Impact Statement (EIS) would be needed because of the sensitive natural resources present in the project area and the potential for improved wastewater facilities to induce development and population growth. The EIS was to be prepared concurrently with the Facilities Plan.

In October 1980, the Facilities Planners submitted the Facilities Plan to the local communities for their review. The Facilities Plan addressed the wastewater treatment needs of the four communities and concluded that a combination of on-site systems and centralized wastewater treatment systems would be most cost-effective. The Facilities Plan also concluded that individual treatment plants would be the most cost-effective alternative for each community. The Middle Door County Facilities Plan was submitted to WDNR and USEPA in October 1980 for review. The agencies' review indicated several areas where additional information was needed before it could be approved by WDNR or USEPA.

Fish Creek currently is the only community that is proceeding with the additional work necessary to produce an approvable Facilities Plan. It has formed a Sanitary District that includes the most densely populated areas of Fish Creek and has prepared an Addendum to the original Facilities Plan for the Sanitary District. The Addendum recommends constructing collector sewers within the Sanitary District and an aerated lagoon for wastewater treatment. Effluent from the aerated lagoons is proposed to be discharged into Green Bay. WDNR has reviewed the Addendum and provided the Sanitary District with comments concerning the recommended alternative. An application to the State for grant assistance from the Wisconsin Fund for the proposed project is pending. A public hearing on the Addendum was held in Fish Creek in August 1982.

1.2. Legal Basis For Action and Project Need

The National Environmental Policy Act of 1969 (NEPA) requires a Federal agency to prepare an EIS on "... major Federal actions significantly affecting the quality of the human environment ..." In addition, the Council on Environmental Quality (CEQ) has established regulations (40 CFR Part 1500-1508) to guide Federal agencies in determinations of whether Federal funds or Federal approvals would result in a project that would significantly affect the environment. USEPA has developed its own regulations (40 CFR Part 6) for the implementation of the EIS process. As noted above, USEPA Region V has determined that pursuant to these regulations, an EIS was required for the proposed Middle Door County project.

The State of Wisconsin has a similar statute, the Wisconsin Environmental Policy Act (WEPA; Section 1.11), which is patterned after NEPA. Under WEPA, state agencies must consider the environmental implications of all its proposals. Before proceeding with any major action significantly affecting the quality of the human environment, state agencies also must prepare a detailed statement concerning the environmental effects of the proposed action. If a proposed project includes both Federal and state involvement and has potential significant environmental impacts, a joint EIS can be prepared by the state and lead Federal agency to satisfy the requirements of both NEPA and WEPA.

The Federal Water Pollution Control Act of 1972 (FWPCA, Public Law 92-500), as amended in 1977 by the Clean Water Act (CWA, Public Law 95-217) establishes a uniform, nationwide water pollution control program according to which all water quality programs operate. WDNR has been delegated the responsibility and authority to administer this program in Wisconsin, subject to the approval of USEPA. However, the authority for determining whether proposed actions are subject to NEPA is retained by USEPA.

Federal funding for wastewater treatment projects is provided under Section 201 of the FWPCA. The USEPA will fund 75% of the grant eligible costs for conventional sewers and treatment. For alternative collection systems and treatment systems (e.g., pressure sewers, septic tank effluent sewers, septic tanks, and soil absorption systems), the funding level increases to 85% of the eligible costs. The costs for conventional sewers in which USEPA will not assist in funding are land and easement costs, sewers for which less than two-thirds of the planned flow originated before 28 October 1972, pipes in the street or easements for house connections, and building sewers for connection to the system. The costs for alternative systems that the USEPA will not assist in funding are easement costs and building sewers for connection to the septic tank. The grant eligibility of the on-site portions of alternative systems varies depending on their ownership and management. Publicly and privately owned systems constructed after 27 December 1977 are not eligible for Federal grants. Grants of up to 60 percent of the eligible costs of a pollution abatement program also are available from the Wisconsin Fund, a state program designed to assist in financing pollution abatement projects.

The dispersal of Federal funds to local applicants is made via the Municipal Wastewater Treatment Works Construction Grants Program administered by USEPA. Prior to the amendments of 1981, the program consisted of a three-step process: Step 1 included wastewater facilities planning; Step 2 involved the preparation of detailed engineering plans and specifications; and Step 3 covered construction for the pollution control system.

The Municipal Wastewater Treatment Construction Grants Amendments of 1981 became law (Public Law 97-217) on 29 December 1981, and significantly changed the procedural and administrative aspects of the municipal construction grants program. The changes reflected in these amendments have been incorporated into Construction Grants-1982 (CG-82) Municipal Wastewater Treatment (Draft - March 1982) and an interim final rule implementing the 1981 Amendments was issued by USEPA on 12 May 1982 (Federal Register (47) 92). Under the 1981 Amendments, separate Federal grants are no longer provided for facilities planning and design of projects. However, the previous designation of these activities as Step 1, facilities planning, and Step 2, design, are retained in the CG-82. The term Step 3 grant refers to the project for which grant assistance will be awarded. The Step 3 grant assistance includes an allowance for planning (Step 1) and design (Step 2) activities that is reimbursed to the community at the time of the grant award.

The CG-82 states that projects which received a Step 1 and/or Step 2 grant prior to the enactment of the 1981 Amendments should be completed in accordance with the terms and conditions of their grant agreement. Step 3 grant assistance will include an allowance for design of those projects which received a Step 1 grant prior to 29 December 1981. A municipality may be eligible, however, to receive an advance of the allowance for planning and/or design if the population of the community is under 25,000 and the state reviewing agency (WDNR) determines that the municipality otherwise would be unable to complete the facilities planning and design to qualify for grant assistance. The communities in the Middle Door County project area, excluding Fish Creek, currently are in Step 1. Fish Creek currently is proceeding with Step 2.

Communities also may choose to construct wastewater treatment facilities without financial support from the state or Federal governments. In such cases, the only state and Federal requirements are that the design be technically sound and that the WDNR is satisfied that the facility will meet discharge standards. Any applicable local ordinances would still have to be met.

If a community chooses to construct a wastewater collection and treatment system with USEPA grant assistance, the project must meet all requirements of the Grants Program. The CWA stresses that the most cost-effective alternative be identified and selected. USEPA defines the cost-effective alternative as the one that will result in minimum total resource costs over the life of the project, as well as meet Federal, state, and local requirements. Non-monetary costs also must be considered, including social and environmental factors. The cost-effective alternative is not necessarily the lowest cost proposal. The analysis for choosing the cost-effective alternative is based on both the capital costs and the operation and maintenance costs for a 20-year period, although only the capital costs are funded. The selection of the most cost-effective alternative also must consider the social and environmental implications of the alternative. An alternative that has low monetary costs but significant environmental impacts would not be preferred over an alternative with higher monetary costs but lesser social and environmental impacts.

Wisconsin was required by the Federal Clean Water Act (PL 92-500) to establish water quality standards for lakes and streams and effluent standards for discharge to them. Federal law stipulates that, at a minimum, discharges must meet secondary treatment requirements. In some cases, even stricter effluent standards are subject to USEPA approval and must conform to Federal guidelines.

A new wastewater treatment facility also is subject to the requirements of Section 402 of the FWPCA, which established the National Pollutant Discharge Elimination System (NPDES) permit program. Under the NPDES regulations, all wastewater discharges to surface waters require an NPDES permit and must meet the effluent standards identified in the permit. The USEPA has delegated the authority to establish effluent standards and to

issue discharge permits to the WDNR. The USEPA, however, maintains review authority. Any permit proposed for issuance may be subject to a state hearing, if requested by another agency, the applicant, or other groups and individuals. A hearing on an NPDES permit provides the public with the opportunity to comment on a proposed discharge, including the location of the discharge and the level of treatment.

Even when the Facilities Plan for Fish Creek is completed and approved, the EIS could not be completed until the other communities have completed their portions of the Facilities Plan. It is not known whether the remaining communities intend to complete their Facilities Plans, or what the schedule would be for their completion. In addition, because of their position on the state priority list, it seems unlikely that the communities in the project area will be eligible for any Federal funding for construction of wastewater treatment facilities. The level of funding currently available from the Wisconsin Fund is not known.

In order to adjust to the changing scope of the project, to help resolve environmental concerns, and to provide interim guidance for environmentally sensitive wastewater treatment alternatives, USEPA and its EIS consultant (WAPORA, Inc.) have prepared this Environmental Report (ER). The objective of the ER is to provide guidance to the agencies, facilities planners, and citizens by outlining environmentally sensitive solutions to their wastewater treatment problems.

This ER will also provide information and background material for the preparation of any future environmental documents for wastewater projects in this facilities planning area. At such time as the other communities decide to proceed with their facilities plans and depending upon the availability of Federal funding, USEPA will make a decision as to what type of environmental document should be prepared, e.g., an EIS or an Environmental Assessment. If the communities decide to complete facilities planning using the Wisconsin Fund, the WDNR will make the decision on the type of environmental document to be prepared. If the communities decide to complete their facilities planning without any Federal or state funding, the communities will be subject to any applicable local requirements as well as requirements of the NPDES permit program, etc.

1.3. Study Process and Public Participation

Participants in the wastewater planning process during the past four years have included: USEPA; WDNR; WAPORA, Inc. (EIS consultant); Becher-Hoppe Engineers, Inc., Donohue and Associates, Owen Ayres and Associates, Foth and Van Dyke and Associates, Inc. (facilities planners); Town of Gibraltar (grantee); Town of Baileys Harbor; Village of Egg Harbor; Village of Ephraim; and other Federal, State, local, and private agencies and organizations. USEPA sponsored three public meetings to facilitate public involvement during the preparation of the EIS and a Citizens Advisory Committee (CAC) was formed. Four informational newsletters also were prepared, not including the newsletter that was disseminated in conjunction with this Draft ER.

The major work efforts in the preparation of this Draft ER occurred during 1979, 1980, and 1982. Since 1979 when WAPORA, Inc. began work on this project, various interim reports have been submitted to USEPA, including the "Existing Conditions" chapter of the Middle Door County Environmental Statement (April 1980). The "Existing Conditions" report describes the features of natural and manmade environment in the project area that could affect, or be affected by, improvements in wastewater treatment. The interim reports previously submitted to USEPA have been incorporated into the ER.

1.4. Issues

Based on a review of USEPA's Notice of Intent (to prepare an EIS), the Directive of Work to WAPORA, Inc. (including subsequent modifications), and the Facilities Plan, the following issues have been determined to be significant and are addressed in the Environmental Report:

- Potential for wastewater treatment facilities to induce growth and to cause secondary impacts that could alter the highly valued and diverse recreational opportunities available in the project area
- Controversy over proposals that may stimulate development and increase the rate of population growth

- Potential impacts to the extensive, high quality wetlands and other natural areas present in the project area
- Possible effects on prime and unique farmlands, including large fruit orchards
- Potential impacts to threatened or endangered plant and animal species
- Possible disturbance of archaeological or historical sites
- Water quality and fisheries impacts from effluent discharges
- Documentation that existing onsite systems are, or have the potential to be, a health hazard
- Relationship between the performance of existing onsite systems and groundwater quality
- Cost-effectiveness of various methods of wastewater treatment, including alternative technologies
- Economic impact of the capital and monthly operating costs of wastewater treatment improvements on local residents
- Ability of local governments to finance the costs of improvement projects
- Type and extent of secondary impacts resulting from proposed treatment alternatives
- Examination and analysis of local zoning and subdivision ordinances, and land use regulations that could mitigate the negative impacts of improvement actions
- Commitment of resources including, but not limited to: construction materials, financial resources, and labor and energy resources.

2.0. DISCUSSION OF WASTEWATER TREATMENT ALTERNATIVES

2.1. Existing Wastewater Treatment Systems

Onsite systems are the predominant means of wastewater treatment in the project area. Most of the onsite systems utilize soil absorption of septic tank effluent or holding tanks. Information on existing systems was gathered from Door County Health Department records. Interviews with Health Department personnel also were useful in assessing the environmental conditions and suitability of septic tank and soil absorption systems for treating wastewater. A septic leachate detector survey (K-V Associates, Inc., 1980), color infrared aerial photography (USEPA 1979), and a mailed questionnaire (Becher-Hoppe Engineers, Inc. 1980) also were used to assess the effectiveness of the existing treatment systems.

2.1.1. Existing Onsite Systems

The majority of the structures within the project area use septic tank and soil absorption systems for wastewater treatment and disposal. The remainder rely on holding tanks, although a few prives remain in use. The Baileys Harbor Yacht Club utilizes a small sewage treatment plant. Septic tanks are constructed of either precast concrete or bitumastic-coated steel. Cast-in-place concrete is used for large septic tanks. Soil absorption systems are primarily seepage beds. Mounds and seepage trenches are also utilized. Some of the older systems use dry wells. Prior to 1970, the design and installation of onsite systems was not regulated. Since 1970, a permit has been required from the Health Department for the design of on-site systems. Until 1980, the onsite permit records did not indicate whether a system was inspected and installed according to the permit. In some cases inspections were made, but they were not routinely performed. Thus, accurate counts of what types of systems that have been installed, and their location, cannot be made. Since 1980, Wisconsin Administrative Code (WAC) has required counties to inspect onsite systems following installation.

Prior to 1980, the Department of Health and Social Services was responsible for the regulation of onsite systems. In 1980, this responsibility was shifted to the Department of Industry, Labor and Human Relations (DILHR). The Department is specifically responsible for reviewing and approving designs for large systems, for mounds, and for holding tanks. The Wisconsin Administrative Code Chapter H63 governs private sewage systems.

The "Wisconsin Fund" was authorized to assist in funding of onsite systems. Each county must become qualified to administer the monies and apply on behalf of the individual homeowner. Door County is qualified to administer the funds. Funding is available at a 60% level or a maximum of $3,000. The residence, in order to qualify, must be occupied more than 51% of the year. Participation in the program in Door County has been low, primarily due to lack of publicity and to the three month processing time for each application (Personal communication, John Teichtler, Acting Door County Sanitarian, to WAPORA, Inc., 12 April 1982).

Few failing onsite systems have been identified within the project area. Those that have experienced failure are usually old, inadequately sized systems. Most upgrades of existing systems occur when an inspection of the existing system is necessary for a building permit for remodelling projects. Most replacements have been for commercial structures, primarily restaurants and motels.

Within the project area, it is estimated that 50% of the systems installed under the permit program are holding tanks. About 30% are conventional seepage beds, and 20% are mound systems. The State directs that a soil absorption system be installed where it is feasible. Thus, the use of holding tanks illustrates the general unsuitability of the area for soil absorption systems. The Health Department is not authorized to issue permits for soil absorption systems that would require a variance from the State rules. For example, no credit is allowed for water conservation or seasonal use, and no variances for isolation distances from lot lines and structures are allowed. Holding tanks appear to be specified for seasonally occupied residences much more readily than other systems even though,

for example, a mound system or a soil absorption system that necessitates a variance may be installed. Because the certified soil tester is hired by the landowner and the county sanitarian may not inspect each lot, the homeowner has some latitude in system selection.

2.1.2. Summary of Data on Existing Systems

Data on existing onsite systems are fragmentary. A 100% sanitary survey would be necessary to fully characterize the systems in the project area. From an operational viewpoint, homeowners could provide data on regularity of pumping and overloading of the soil absorption system that results in surface breakout of effluent or backups in the residence. Data on the wastewater purification capability of the systems generally are not available except by way of the well water quality testing programs and individual sampling conducted over the last 12 years.

Four types of surveys for evidence of failures have been conducted: well sampling programs, a mailed questionnaire, a septic leachate detector survey, and an aerial photographic survey. Failure evidence is positively identified by backups in the dwelling resulting from inadequate seepage from the soil absorption system, surface breakout of septic tank effluent over the soil absorption system, or contamination of groundwaters or surface waters from inadequately treated effluent. These surveys are discussed in the following sections in addition to the discussion of the types of onsite systems that have been permitted within the project area since 1976. The Draft Facilities Plan also contains detailed information concerning existing onsite systems that will not be reproduced in its entirety in this report.

2.1.2.1. County Health Department Permit File Data

Information concerning recently installed systems (dating back to 1976) has been extracted from the permits filed with the County Health Department. Although general conclusions can be drawn from the permits, the information cannot be used to develop a definitive analysis of existing systems. Difficulties include standards revised over the period of time,

the lack of initial and final inspections, the recent availability of mound soil absorption systems, inadequate location descriptions, and the absence of information on the reasons for repairs and replacements. The information from the permit records was tabulated for the redefined subareas within the project area.

Egg Harbor

The permit records for Egg Harbor are summarized in Table 2-1 for single family residences and in Table 2-2 for commercial and multifamily structures. The subareas are shown in Figure 2-1. The records show that few systems have been replaced (2 systems for commercial structures). Of the 23 new systems for single family dwellings within the subareas, six have been holding tanks, fifteen have been septic tank and seepage bed systems, and two have been septic tank and mound systems. For multifamily and commercial structures, septic tanks and soil absorption systems also predominate.

Fish Creek

The permit records for Fish Creek are summarized in Table 2-3 for single family residences and in Table 2-4 for commercial and multifamily structures. The Fish Creek subareas are shown in Figure 2-2. The records show that numerous systems for commercial structures have been replaced since 1976, nearly all with holding tanks. Most have been replaced when applications for remodelling permits are filed, in which case an onsite system inspection is conducted by the County Sanitarian. Some systems, though, have been noted as failing when the replacement is installed. Thirteen new systems for single family residences have been permitted throughout the subareas. Of these, 11 have been holding tanks. Only two existing soil absorption systems have been replaced (with holding tanks) within the Fish Creek subareas.

Ephraim

The permit records for the Village of Ephraim are summarized in Table 2-3 for single family residences and in Table 2-4 for commercial and multi-

Table 2-1. New and replacement wastewater systems for single family residences, by subarea in Egg Harbor Village and Town and part of Jacksonport Town within the project area (Door County Health Department permit records).[a]

Subarea	SB/STr		LP + SB/STr		LP + M		ST only	HT		Total	
	New	Repl.	New	Repl.	New	Repl.	Repl.	New	Repl.	New	Repl.
Egg Harbor Village											
1A	2	0	0	0	0	0	0	0	0	2	0
1B	0	0	1	0	0	0	0	4	0	5	0
2A	0	0	0	0	0	0	0	0	0	0	0
2B	0	0	1	0	1	0	0	0	0	2	0
2C	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	1	0	1	0
4	3	0	1	0	0	0	0	1	0	5	0
5	6	0	1	0	1	0	0	0	0	8	0
Total	11	0	4	0	2	0	0	6	0	23	0
Egg Harbor Town											
T30 R26 Sec 13	0	0	2	0	1	0	0	3	1	6	1
T30 R27 Sec 19-33	14	1	0	1	2	0	0	6	1	22	3
T30 R26 Sec 25-36	9	1	0	0	0	0	0	1	0	10	1
T29 R26 Sec 1-3	3	0	0	0	0	0	0	0	0	3	0
Jacksonport Town											
T29 R27 Sec 4-6	0	0	0	0	0	0	0	1	0	1	0
Total	26	2	2	1	3	0	0	11	2	42	5

[a] Abbreviations: SB/STr - seepage bed/seepage trench; LP - lift pump; M - mound; ST - septic tank; HT - holding tank.

Table 2-2. New and replacement wastewater systems for multifamily and commercial structures in Egg Harbor Village and Town and part of Jacksonport Town within the project area (Door County Health Department permit records).[a]

Subarea	Structure	Business	New or Replacement System	System Permitted
Egg Harbor Village				
1A	Lena's Sip and Chat	Bar and restaurant	Repl.	(ST 2800 + LP 500) + SB 30x92
1B	Bank of Sturgeon Bay	Banking facility	New	ST 990 + LP 300 + SB 18x30
	Lull-Abi Motel	Motel (9 units) and residence	Repl.	(ST 750) + ST 2000 + LP + SB 30x75
	Hardware	Store and coffee shop	New	ST 1000 + LP + SB
	Harbor Bluff Condominiums	Condominiums	New	ST + LP + M
2A	Village park	Park toilet	New	HT 1000
	Whitecliff Condominium	Condominiums (9 units) and residence	New	HT 21,000
4	Rocky Shores Condominiums	Condominiums (18 units)	New	ST 6100 + ST 750 + ST550 + SB 50x180
		Condominiums (10 units)	New	ST 4000 + SB 50x100
		Condominiums (32 units)	New	ST 3600 + ST 3600 + ST 6100 + SB 80x 206
Egg Harbor Town				
T30 R27 Sec 19-33	Bachi Mfg. Co.	Industrial plant	New	ST 1625 + SB 20x60
	Birch Creek Farm	Music education camp	New	ST 7680 + SB 102x114
	Mitchell & Sollenberger	Mobile home park	New	ST 1725 + SB 1880 s.f.
	Stephen Wood	Commercial shops (3 units)	New	HT 1500 + HT 1500 + HT 1500 + HT 750 + HT 750
T30 R26 Sec 25-36	Sunset Prairie Village	Condominiums (6 units)	New	ST 4000 + LP 990 + STr 5x564
T29 R26 Sec 1-3	The Shallows	The Gate House (8 units)	New	HT 6000
	Ken Hemming	Shops	New	ST 1000 + SB 20x20
Jacksonport Town				
T29 R30 Sec 4-6	Frontier Wilderness	Campground	New	ST 2992 + LP + SB 32x50

[a]Abbreviations: ST- septic tank; LP - lift pump; SB/ST- seepage bed/seepage trench; HT - holding tank.

Table 2-3. New and replacement wastewater systems for single family residences by subarea in Fish Creek, Town of Gibraltar, and Village of Ephraim (Door County Health Department permit records).[a]

Subarea	SB/STr		LP + SB/STr		LP + M		ST only	HT		Total	
	New	Repl.	New	Repl.	New	Repl.	Repl.	New	Repl.	New	Repl.
Fish Creek											
1	0	0	0	0	0	0	0	2	0	2	0
2	0	0	0	0	0	0	3	2	2	2	5
3A	1	0	0	0	0	0	0	2	0	3	0
3B	0	0	0	0	0	0	0	2	0	2	0
4	0	0	0	0	0	0	0	1	0	1	0
5	0	0	0	0	0	0	0	1	0	1	0
6	1	0	0	0	0	0	0	1	0	2	0
Total	2	0	0	0	0	0	3	11	2	13	5
Gibraltar Town											
T30 R27 Sec 7-18	29	1	0	0	1	0	1	15	0	45	2
T30 R27 Sec 1-6	13	1	0	0	4	0	0	8	1	22	2
T31 R27 Sec 25-36	17	2	0	0	0	0	1	8	0	25	3
Total	59	4	0	0	5	0	2	31	1	95	7
Ephraim											
1A	0	0	0	0	0	0	0	1	0	1	0
1B	0	0	0	1	0	0	0	3	3	3	4
1C	1	0	0	0	0	0	0	0	0	1	0
2	1	0	0	0	0	0	0	1	1	2	1
3	6	1	0	0	1	0	0	2	0	9	1
4	4	0	0	0	0	1	0	3	0	7	1
5	0	0	0	0	0	0	0	0	0	0	0
6	0	1	0	0	0	0	0	1	0	1	1
Total	12	2	0	1	1	1	0	11	4	24	8
Sec 12	10	0	0	0	1	0	0	4	0	15	0
Sec 13	2	0	0	1	1	0	0	0	0	3	1
Sec 24	5	0	1	0	1	0	0	0	0	7	0
Sec 25-26	1	0	0	0	0	0	0	0	0	1	0
Total	18	0	1	1	3	0	0	4	0	26	1

[a] Abbreviations: SB/STr - seepage bed/seepage trench; LP - lift pump; M - mound; ST - septic tank; HT - holding tank.

Table 2-4. New and replacement wastewater systems for multifamily and commercial structures in Fish Creek, Town of Gibraltar, and Village of Ephraim (Door County Health Department permit records).[a]

Subarea	Structure	Business	New or Replacement System	System Permitted
Fish Creek				
2	White Gull Inn	Restaurant and lodge	Repl.	HT 14,860
	Cottage Inn Motel	Motel (9 units)	Repl.?	HT 5000 + HT 5000
	Fish Creek Motel	Motel (13 units)	New	HT 5000 + HT 2500
		Motel (12 units)	New	HT 6000
	C&C Club	Restaurant and bar	Repl.	HT 30,000
	Fish Creek Dock	Restrooms	Repl.	ST 990 + (SB)
	Cole's store and post office	Store, 2 apts, and house	Repl.	HT 5445
	The Galley	Restaurant and gift shop	Repl.	HT 2500
	Fish Creek Garage	Service bays	Repl.	HT 2550
	The Cookery	Restaurant	Repl.	HT 14,150
	Blue Willow	Restaurant	Repl.	ST 1250 + (SB)
	Gilster Realty	Realty and law offices	New	HT 2550
	Hidden Harbor Condominiums	Condominiums (84 units)	New	HT 100,000
3A	Homestead Motel	Motel (18 units)	New	HT 9000
	Murray's Irish House	Shop	New	HT 2500
3B	Nor Dor Motel	Motel (8 units)	New	HT 5000
Gibraltar Town				
T30 R27 Sec 1-6	Omnibus Ski	Shops	Repl.	ST 2200 + STr 5317 s.f.
T31 R27 Sec 25-36	English Inn	Restaurant	Repl.	HT 10,000
	Thumb Fun	Amusements	Repl.	(ST 990) + SB 24x68
	Beckstrom's shop	Shop	New	HT 975 + HT 975
	Forest View Motel	Motel (5 units)	New	ST 1250 + SB 18x55
Ephraim				
1A	Pine Grove Lodge and Cottages	Motel (20 units) and house	New	HT 13,168
	Ephraim Yacht Harbor Condominiums	Condominiums (20 Units)	New	HT 96,165
	Edgewater Motel and Restaurant	Assembly Hall	Repl.	HT 2,500
		Motel (10 units)	New	HT 5000
	Cedar St. Apartments	Apartments (8 units) and shops	New	HT 10,000
	Ephraim Shores Motel	Motel (28 units)	New	HT 15,000
	Wilson's Restaurant	Restaurant	New	HT 5,000
1B	Shorewood Cottages	Restaurant	New	HT 5,000
	Eagle Harbor Condominiums	Condominiums (7 units)	New	HT 15,000
1C	Knudson House Condominiums	Condominiums (12 units)	Repl.	HT 23,000
2	Anderson House Motel and Cottages	Motel (10 units)	New	HT 19,800
5	Len Surico's restaurant	Restaurant	New	HT 17,500
	Spud's Wood Turning Shop	Shop and restaurant	New	HT 2,000
	Door County Cheese Company	Shop and restaurant	New	ST 1000 + SB 26x40
	Len's Art Gallery	Shop	New	HT 1000
	The Gathering	Shops (6 units)	New	HT 5000
	Upland Townhouses	Duplex (2 units)	New	ST 1250 + SB 24x53
		Duplex (2 units)	New	ST 1250 + SB 24x53

[a] Abbreviations: SB/STr - seepage bed/seepage trench; LP - lift pump; ST-septic tank; HT-holding tank.

family structures. The subareas for Ephraim are displayed in Figure 2-3. The records show that within the "downtown" area, most of the new commercial and multifamily structures are on holding tanks. One condominium complex has replaced its septic tank and soil absorption system with a holding tank within the past 6 years. Eight new (or expansions of) motels, condominiums, and restaurants have been granted permits within the "downtown" area. Subarea 5 (STH 42 east of the "downtown" area) has experienced some commercial development in the past 5 years and permits for wastewater disposal have been issued for five new restaurant and shopping complexes and two duplexes. All except three of these were holding tank permits.

Within the subareas in Ephraim, 24 permits for wastewater disposal systems for single family residences have been issued. The majority of these permits have been for soil absorption systems on the bluff east of the downtown area. In addition to the permits for new systems, eight permits for replacement systems have been issued; these are equally divided between holding tanks and soil absorption systems.

The areas within the Village that are outside the numbered subareas (Figure 2-3) have had greater numbers of permits issued for single family residences than the numbered subareas. Most of these permits have been issued for Section 12, the area north of STH 42. Four permits for holding tanks have been issued; the remainder (23) have been for septic tank and soil absorption system.

Baileys Harbor

The permit records for the Town of Baileys Harbor and parts of the Towns of Liberty Grove and Jacksonport are summarized in Table 2-5 for single family residences and in Table 2-6 for commercial and multifamily structures. The subareas for Baileys Harbor are displayed in Figure 2-4 and Figure 2-5. The records indicate that the majority of permits within the subareas have been issued for the west shore of Kangaroo Lake and the north shore of Baileys Harbor. Septic tank and soil absorption systems predominate around Kangaroo Lake and holding tanks predominate around Baileys Harbor. Within Subarea 1, permits for 23 new septic tank and soil

Table 2-5. New and replacement wastewater systems for single family residences by subarea in the Town of Baileys Harbor and parts of the Towns of Liberty Grove and Jacksonport (Door County Health Department permit records).[a]

Subarea	SB/STr		LP + SB/STr		LP + M		ST only	HT		Total	
	New	Repl.	New	Repl.	New	Repl.	Repl.	New	Repl.	New	Repl.
Baileys Harbor											
1	20	0	3	1	0	0	0	1	3	24	4
2A	2	0	0	0	1	0	0	4	1	7	1
2B	0	0	0	0	0	0	0	2	0	2	0
3	0	0	0	0	0	0	1	4	3	4	4
4	0	0	0	0	0	0	3	2	0	2	3
5	1	0	0	0	0	0	0	3	0	4	0
6	2	0	0	0	0	0	0	3	1	5	1
7	0	1	0	0	0	0	0	1	0	1	1
8A	0	0	0	0	1	0	0	9	2	10	2
8B	0	0	0	0	0	0	0	0	0	0	0
Total	25	1	3	1	2	0	4	29	10	59	16
Liberty Grove Town											
T31 R28 Sec 7-30	18	1	1	0	1	0	0	6	0	26	1
Baileys Harbor Town											
T31 R28 Sec 31-35	4	0	0	0	1	0	0	7	0	12	0
T30 R28 Sec 1-14	6	0	0	0	4	0	0	23	1	33	1
T30 R28 Sec 18-19	8	1	0	0	0	0	0	4	0	12	1
T30 R28 Sec 30-32	4	0	0	0	0	0	0	1	0	5	0
T29 R28 Sec 6-7	3	0	0	0	0	0	0	2	0	5	0
T30 R27 Sec 22-36	6	1	0	0	0	1	0	2	1	8	3
Jacksonport Town											
T29 R27 Sec 1-3	0	0	0	0	0	0	0	0	0	0	0
Total	49	3	1	0	6	1	0	45	2	101	6

[a] Abbreviations: SB/STr - seepage bed/seepage trench; LP - lift pump; M - mound; ST - septic tank; HT - holding tank.

Table 2-6. New and replacement wastewater systems for multifamily and commercial structures in the Town of Baileys Harbor and parts of the Towns of Liberty Grove and Jacksonport within the project area (Door County Health Department permit records)[a].

Subarea	Structure	Business	New or Replacement System	System Permitted
Baileys Harbor				
1	Wallaby Lodge	Resort (3 units) and bar	Repl.	ST 2000 + LP + SB 35x90
2A	Kangaroo Lake Resort	Resort (7 units)	New and Repl.	HT 14,025
3	Estonian Inn (Petry Place)	Motel (40 units) and House	Repl.	HT 12,500
6	Sleeter's Motel	Motel (9 units)	New	ST 2000 + SB 50x60
	Kwaterskis Snowmobile Sales	Shop	New	ST 750 + LP500 + M 35x35
		RV court	New	HT 2500
	Turk's Products	Manufacturing	New	ST 1000 + SB 20x25
Liberty Grove Town				
T31 R28 Sec 7-30	Lundh Ford	Auto dealership	New	HT 2500
	Sister Bay Oil Co.	Gasoline station	New	HT 2550
	Aqualand Campground	Campground (150 sites)	New	ST 15,575 + LP + M 77x334
Baileys Harbor Town				
T30 R28 Sec 1-14	Reimer Cherry Plant	Processing plant	New	ST 1500 + SB 24x103
T30 R28 Sec 30-32	Town of Baileys Harbor	Recreation fields	New	Privy

[a]Abbreviations: SB - seepage bed; LP - lift pump; ST - septic tank; M - mound; HT - holding tank.

absorption systems have been issued. For that same area, only one holding tank permit has been issued for a new system and three have been issued for replacement systems.

In comparison with Fish Creek and Ephraim, few commercial and multifamily structures have been developed in Baileys Harbor Township. Within the subareas, seven commercial or multifamily structures have been issued wastewater disposal permits. Four of these were located on CTH F (Subarea 6) and three of these permits were for septic tank and soil absorption systems.

In the outlying areas of the Town of Baileys Harbor and the contiguous areas of the Towns of Liberty Grove and Jacksonport, permits have been about equally divided between septic tank and soil absorption systems, and holding tanks. Holding tank permits predominate along the shorelines of Lake Michigan, particularly for the shore areas of Moonlight Bay. The commercial and multifamily wastewater permits in these outlying areas have been minimal.

2.1.2.2. Mailed Questionnaire

A Wastewater Disposal Questionnaire (Appendix A) was distributed to all property owners in the participating communities (Towns of Gibraltar and Baileys Harbor, and Villages of Egg Harbor and Ephraim) by inclusion in the 1978 tax bills. Approximately 3,400 questionnaires were distributed and about 700 returned questionnaires were useable. The results of the questionnaire are presented and discussed in the Draft Middle Door County Facilities Plan and will be only highlighted within this section.

The responses are displayed in Table 2-7. Most respondents (90%) indicated that they utilize a septic tank that discharges to some kind of soil absorption system for wastewater treatment. Seepage beds or trenches dominated (73%), followed by drywell or tile line (10%), mound (less than 1%), and unknown (17%). Holding tanks constituted 7% of the wastewater systems (this percentage is increasing, based on recent permits issued). Privies were utilized by 2% and chemical or composting toilets by less than

Table 2-7. Individual wastewater treatment systems from the wastewater questionnaire responses.

Type of System	Village of Egg Harbor		Town of Gibraltar		Village of Ephraim		Town of Baileys Harbor		Sum of Areas		
	P	S	P	S	P	S	P	S	P	S	Total
Septic Tank	29	73	74	91	37	128	66	135	206	427	633
To Seepage Field	(21)	(43)	(60)	(67)	(28)	(94)	(53)	(92)	(163)	(296)	(459)
To Tile Line or Drywell	(6)	(5)	(8)	(8)	(5)	(11)	(9)	(13)	(28)	(37)	(65)
To Mound SAS	(0)	(1)	(1)	(0)	(2)	(0)	(0)	(0)	(3)	(1)	(4)
Unknown	(2)	(24)	(5)	(16)	(2)	(23)	(4)	(30)	(13)	(93)	(106)
Holding Tank	2	4	2	6	4	7	3	18	11	35	46
Privy	0	0	0	3	0	1	0	9	0	13	13
Direct Discharge	0	0	0	2	1	1	0	2	1	5	6
Chemical/Composting Toilet	0	0	0	0	0	0	0	3	0	3	3
Unknown	0	1	0	0	0	2	0	2	0	5	5
Total	31	78	76	102	42	139	69	169	218	488	706

P = Permanent residence
S = Seasonal residence

1%. "Direct discharge" was noted by 1% of the respondents as their disposal method. Another 1% did not know what method of disposal was utilized on their property.

A significant number of residents utilized ancillary methods of disposing of some household wastewaters through other than their primary disposal system. Laundry wash water constitutes the largest source with dishwater, lavatory basins, and water conditioner brine also discharged elsewhere. Water conditioner brine may bypass the disposal system as long as it does not cause a nuisance or hazard. The graywater sources (laundry and sink wash waters) must, by code, be disposed of in an environmentally acceptable manner. Discharges to the ground surface of these graywaters totaled 9 (out of a total of 628 systems). Permanent residences appear to have the majority of these discharges, which may be due to socioeconomic factors (where they live and their disposable income) rather than inadequacy of their primary disposal system. Also, a much smaller percentage of seasonal residences probably have laundry facilities.

The perceptions of the property owners concerning the adequacy of their disposal system was obtained in the questionnaire (Table 2-8). The question, "Does your disposal system satisfactorily serve your residence?" was answered positively by 95% of the respondents; 2% indicated that they experience problems, and 3% did not respond. The respondents indicated that their problems were seasonal or were satisfactorily handled by reducing water use. No one community had a greater concentration of problem systems than another.

Another questionnaire item attempted to discern whether the respondents perceived wastewater problems in their community. The question: "Are there any other wastewater problems in your community you think need correction?" can be misleading because many respondents may have one single problem in mind. In the open-ended comments accompaning the questionnaire, few specific problems with on-site systems were mentioned. Certain "problem areas" were mentioned (Appendix A); specifically the developed areas along the waterfront in Fish Creek and Ephraim, and the Main Street area of downtown Baileys Harbor. Land disposal of holding tank wastes and septage also was frequently mentioned as a perceived problem. Given these qualifications, the responses from the various communities are displayed in Table 2-9.

Table 2-8. Responses to wastewater questionnaire item No. 5: Does your system adequately serve your residence?

	Village of Egg Harbor			Town of Gibraltar			Village of Ephraim			Town of Baileys Harbor			Sum of Areas		
	P	S	Total	P	S	Total	P	S	Total	P	S	Total	P	S	Total
Yes (number)	30	34	99	73	96	169	37	133	170	68	154	222	208	452	660
(percent)	96.8	94.5	95.2	97.3	91.4	93.9	92.5	95.7	95.0	97.1	94.5	95.3	96.2	94.6	95.1
No (number)	0	0	0	0	3	3	1	4	5	2	5	7	3	12	15
(percent)	--	--	--	--	2.9	1.7	2.5	2.9	2.8	2.9	3.1	3.0	1.3	2.5	2.2
No Answer (number)	1	4	5	2	6	8	2	2	4	0	4	4	5	14	19
(percent)	3.2	5.5	4.8	2.6	5.7	4.4	5.0	1.4	2.2	--	2.5	1.7	2.3	2.9	2.7

P = Permanent residences
S = Seasonal residences

Table 2-9. Responses to wastewater questionnaire item No. 15: Are there any wastewater problems in your community you think need correction?

	Village of Egg Harbor			Town of Gibraltar			Village of Ephraim			Town of Baileys Harbor			Sum of Areas		
	P	S	Total	P	S	Total	P	S	Total	P	S	Total	P	S	Total
Yes (number)	0	2	2	8	18	26	15	23	38	7	12	19	30	55	85
(percent)	--	3.9	2.8	11.0	18.0	15.0	42.9	17.3	22.6	11.7	11.1	11.3	16.0	14.0	14.7
No (number)	15	38	53	36	53	89	12	64	76	44	80	124	107	235	342
(percent)	75.0	74.5	74.6	49.3	53.0	51.4	34.3	48.1	45.2	73.3	74.1	74.4	57.0	60.0	59.0
Don't Know (number)	5	11	16	29	29	58	8	46	54	9	16	25	51	102	153
(percent)	5.0	21.6	22.5	39.7	29.0	33.5	22.9	34.6	32.1	15.0	14.8	14.9	27.1	26.0	26.4

P = Permanent residences
S = Seasonal residences

Generally, the residents of the Village of Egg Harbor and the Town of Baileys Harbor have little perception of wastewater problems in their communities that need correction (3% and 11%, respectively). Greater percentages of the respondents from the Town of Gibraltar and Ephraim (15% and 23%, respectively) perceive a need for corrections to wastewater problems. These percentages indicate that few people perceive the current wastewater problems to be serious.

Another question dealt with the frequency of pumping of the septic tanks. The property owner was asked to identify how often in the previous five-year period the septic tank had been pumped. The required frequency of pumping varies greatly and depends upon the number of users, the organic loadings, the loading of refractory compounds, and the size of the septic tanks. Some septic tanks used seasonally and with small annual loadings may require pumping only once every 20 years. Other septic tanks for residences occupied year-round and subject to large organic loads may require annual pumping. The generally recognized guide for a four-person household (larger than average) is once every two to five years. Smaller households and seasonal residences could have much longer pumping intervals because the interval between organic decomposition and loading is greater. The questionnaire results are presented in Figure 2-6 for permanent and seasonal residences.

The percent of permanent residents who indicated that they have not pumped their septic tank in the last five years ranges from 16% to 25%. This indicates that these residents do not pump their septic tanks based on a regular, recommended interval but may rely on a clogged soil absorption system to indicate that the septic tank needs to be pumped. Between 55% and 65% have their septic tank pumped at regular intervals (one to four times during the five-year period). A somewhat higher percentage, between 12% and 24%, had their septic tank serviced five times or more in the 5-year period. No reasons were provided for the short pumping intervals, but it may be indicative of problems with the system.

For seasonal residences, 5% to 7% had pumped their septic tank five or more times within the 5-year period.

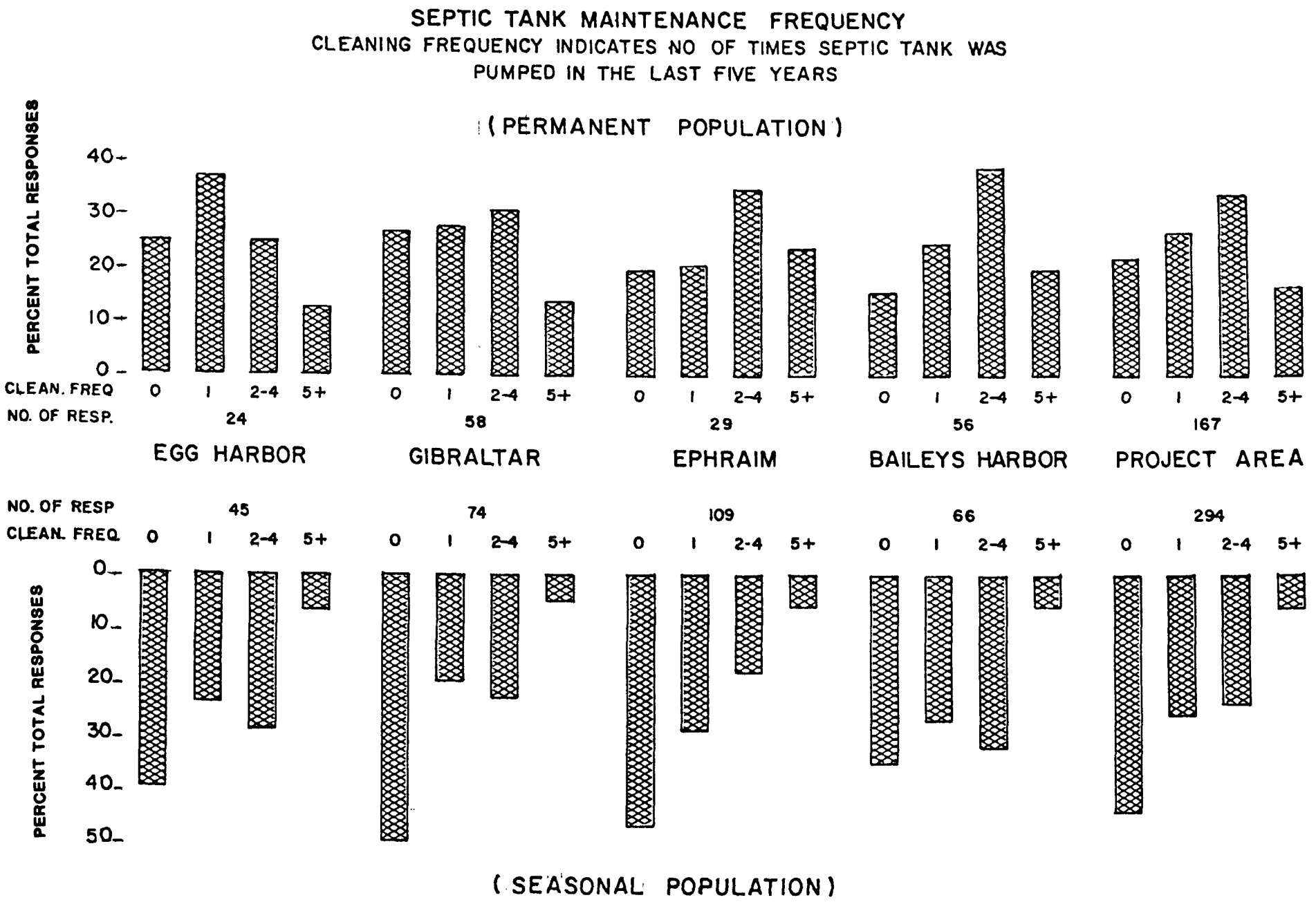


Figure 2-6. Septic tank maintenance frequency (adapted from Facilities Plan).

This is probably not indicative of any problems. Good preventive maintenance procedures would probably call for the septic tank to be inspected and pumped once every 5 years.

The Wastewater Disposal Questionnaire results were not tabulated by community subarea, thus, conclusions as to location of specific problem areas cannot be made. For this reason, the questionnaire does not support the need to construct collection and treatment facilities. In addition, it is not known whether multifamily and commercial structures are included within the questionnaire results or what bias these could have on the results.

2.1.2.3. Septic Leachate Survey

The Septic Leachate Survey was conducted by K-V Associates, Inc. (1980) and is included in Appendix B. The components of the survey included the continuous monitoring of the shoreline by the recording leachate instrument (Septic Snooper) and water quality analyses of identified stream or shore bottom plume sources for evidence of domestic wastewater breakthrough of excessive nutrients and coliform bacteria. The methodology and the results are presented in Appendix B. The survey covered shoreline areas in Egg Harbor, Fish Creek , Baileys Harbor, Eagle Harbor, Sister Bay, Moonlight Bay, North Bay, and Kangaroo Lake where the density of development would be most likely to result in significant pollution problems. Low-density, single unit development characterizes the more exposed, rocky coastline, while high-density cottages and business establishments characterize the sandy inner shores of the harbor areas.

A summary of the dormant and erupting groundwater plumes is given in Table 2-10. Erupting plumes dominated in all of the survey areas except in Kangaroo Lake where no groundwater plumes (either erupting or dormant) were identified. Although no discharges were observed along the periphery of Kangaroo Lake and all of the samples had low total phosphorus content, a problem situation could not be confirmed because of the late season survey of the shoreline. In addition, there were no dormant plumes identified at

Eagle Harbor, Fish Creek and Tennison Bay, or Sister Bay. It should be noted that throughout much of the project area, the fissured dolomite substrate causes an atypical transport, dilution, and attenuation of septic leachate and an atypical manifestation of plumes.

Table 2-10. Septic leachate survey groundwater plume identification (K-V Associates, Inc., 1980).

Survey Location	Number of Groundwater Plumes	
	Erupting	Dormant
Baileys Harbor	5	4
Eagle Harbor (Ephraim)	4	0
Egg Harbor	3	1
Fish Creek and Tennison Bay	4	0
Kangaroo Lake	0	0
Moonlight Bay	4	4
North Bay	4	1
Sister Bay	2	0

Plumes were tested for water quality parameters only. (The collection of groundwater flow direction and velocity data was limited by the bedrock and shallow soil conditions characteristic of the project area.) The water quality parameters that were analyzed were: nitrate nitrogen (as combined NO_3, NO_2, and N), ammonia nitrogen (NH_4-N), total phosphorus (TP), and conductivity (umhos/cm). In addition, water samples from stream outlets to harbor areas, drinking water wells, probable plume areas identified by the septic leachate detector, and several special sources such as the commercial laundry at Baileys Harbor were analyzed for fecal coliform count to confirm the presence of surface runoff or soil shortcircuiting from malfunctioning systems. Elevated nutrient levels were measured, but in few cases were the levels high enough to identify any strong breakthroughs of

nutrients from soil absorption systems. Elevated fecal coliform levels were measured at two locations in Baileys Harbor, one in Sister Bay, and one in Eagle Harbor.

The amount of phosphorus that actually enters the lake from septic tanks would depend on the ability of drainage field soils to immobilize the phosphorus. When subsurface disposal systems are built on proper soil and are located at proper distances from the receiving water body, there is nearly 100% removal of phosphorus from the septic tank effluent by the soil. However, when the distances between the disposal system and lake are limited or when the drainage field has failed, a high proportion of the phosphorus from the system moves into the groundwater, or into the lake or river. While this situation characterizes the traditional cause of septic system failures, this is not completely relevant to the situation in the project area. A major cause of septic system failure in the project area is the too-rapid drainage of the septic fields into the fissured bedrock. To better understand the nutrient contribution of septic tanks to shoreline areas, the comprehensive septic leachate survey was performed in October 1979 by K-V Associates, Inc. Water quality analysis of identified groundwater plumes detected by the septic snooper supplied evidence of some domestic wastewater infiltration into the shoreline area. Additionally, high bacterial populations were associated with a few of the plumes. Significant organic contamination was found to be associated with wetland discharges elsewhere in the project area. The following conclusions were drawn from the survey:

- A total of 39 locations exhibited noticeable effluent plume characteristics. Five of these related to surface streams draining wetlands and passing through populous areas. The fractured dolomite substrate tended to fragment plumes so that the individual peaks would not necessarily indicate singular sources.

- A general correlation existed between the frequency of confirmed wastewater plumes and the dissolved solids content of background surface water samples in harbor areas. For example, Eagle Harbor and Baileys Harbor with background conductivity over 270 umhos contained numerous fragmented plume sources compared to the low levels of incidence in Egg Harbor and Tennison Bay (ca. 250 umhos).

- The strongest effluent source plumes were associated with surface discharges in harbor areas, one in the rear of Fish Creek Harbor and at the least three in Eagle Harbor, while separate BOD discharges, such as observed with the Mud Creek inflow in Moonlight Bay, represent additional nonpoint sources of nutrients.

- A number of plumes were found with fecal coliform bacterial levels exceeding 200 colonies/100 ml of water, two locations at Baileys Harbor, one in Sister Bay, and one in Eagle Harbor.

- Due to the bedrock and shallow soil conditions, on-site groundwater flow measurements were not particularly instructive.

- Of 25 wells sampled, no significant nitrate contamination was recorded. Three wells tested for bacteria showed no evidence of coliform contamination.

2.1.2.4. Aerial Survey

The USEPA Environmental Monitoring Systems Laboratory acquired aerial color infrared photography and multispectral scanner imagery of the project area on 16 May 1979 (USEPA 1979). The photography was examined for apparent septic system drainfield malfunctions. The multispectral scanner imagery was computer-analyzed to assess the thermal patterns, turbidity, and current mixing zones in the shoreline waters of the project area.

The technique requires detection of variation in color tones of vegetation resulting from septic effluent rising to or near the surface. Because the survey was conducted during the mid-morning hours when there was a low sun angle, shadows were created around some structures which sometimes limited the aerial view of each residential lot. Also, because the survey was conducted in mid May, many of the summer seasonal residences would not show septic system failure characteristics.

The analysis categorized the discernable onsite septic systems and identified these systems on enlarged photographs. The category and number of systems are presented in Table 2-11. Only two systems were identified as probable failures and 63 discernable systems were identified as possible failures. During a field inspection, 25 of the identified systems were

inspected. Of these, two had definitely failed and 15 would require further testing and monitoring.

Surface breakouts of septic tank effluent from permanent residences occur rarely in the planning area since none were identified by the aerial photography. Those that do occur are repaired quickly. Because the photography that was analyzed was obtained in May, the study is much less conclusive concerning surface breakouts from seasonal residences and from older residences under tree canopies.

2.1.2.5. Water Well Information

Unsafe water from domestic and commercial wells has long been a matter of concern in Door County. The dolomite bedrock is creviced and fractured and has solution cavities that may extend great distances. In addition, the bedrock often has little or no glacial cover so that pollutants can easily enter these openings and travel great distances quickly and with little attenuation. Wells in bedrock are typically constructed with a casing that is seated in the rock and extends to the ground surface. Below the casing the hole is left open in the rock.

With bedrock wells of this type the primary problem is contaminated surface and near-surface water percolating down the casing and entering the well cavity. Thus, the quality of grout seal between the casing and rock is important for construction of a safe well. Also, percolating water can enter and contaminate the well unless the entire unsaturated section is sealed off by the casing.

Prior to 1951, sufficient casing to hold the hole open was installed; beginning in 1951 a minimum of 40 feet was required. In 1957, the code was again revised and specified a 100-foot casing requirement because the previous 40-foot casing requirement was insufficient to prevent wells from being contaminated. Variances from the 100-foot casing requirement were allowed if the water table was near the surface. Follow-up water quality surveys indicated that the well casing should extend at least 30 feet into the water table to prevent bacteriological contamination. Because the

Table 2-11. Numbers of soil absorption systems identified by aerial photography (USEPA 1979).

Political Jurisdiction	Subarea	Number of Identified Soil Absorption Systems
Egg Harbor Village	1A	1
	2C	1
	4	1
	Total	3
Egg Harbor Town		3
Jacksonport Town		1
Fish Creek	2	1
	4	2
	5	2
	Total	5
Gibraltar Town		20
Ephraim Village	1C	1
	3	1
	4	1
	5	4
	Total	7
	Outlying area	2
Liberty Grove Town		9
Baileys Harbor Town	1	2
	2A	1
	3	1
	4	3
	5	1
	6	2
	Total	10
	Outlying areas	15

depth to the water table can be as much as 140 feet in some areas, different casing requirements for parts of the county were instituted in 1971. The casing requirement for much of the upland portions of the project area is now 170 feet or 30 feet below the static water level (whichever is greater).

Numerous investigations of well water quality have been conducted over the years, many of them in response to specific health problems. These early surveys are detailed in the Facilities Plan and in the WDNR Private Water Supply Section report of the history of well regulations and investigations (Appendix C). These sampling programs are briefly summarized below:

- Wieniewski (1942) reported that more than 70% of the wells tested in the township 15 miles south of the project area were unsafe.

- A US Public Health Service water quality study was conducted in the summer of 1955. Samples of 27 private wells supplying water for public consumption (hotels, restaurants, and parks that were licensed by the Hotel and Restaurant Division of the State Board of Health) were tested weekly. Some wells that had tested safe in the spring were found to be unsafe at some point in the summer. Of the 273 samples collected, 20% (representing 52% of the wells) tested positive for the coliform group. Accurate details were not obtained nor was well construction correlated with unsafe samples.

- State Board of Health follow-up sampling was conducted in 1957. Two additional wells were tested and accurate construction details were obtained. Of the 310 samples collected, 13% (representing 18 wells) were bacteriologically unsafe. The survey showed that the unit chlorinators (specified for the "unsafe" wells) were not effective for a variety of mechanical and operational reasons. A strong correlation between bacteriological water quality and age of the well and its conformance to code was found. At that time, the 100-foot casing requirment for new wells was instituted.

- State Board of Health water quality surveys were conducted in 1959, 1960, and 1961 to evaluate the 100-foot casing requirement. A relatively high number of wells produced bacteriologically unsafe samples duirng the 1959 survey (9 of 45 wells). For wells with less than 100 feet of casing, 3 of 6 had unsafe samples. In 1960 and 1961, the proportion of unsafe samples was considerably smaller (14 of 180). This was attributed to increased surveillance of well drill-

ing, particularly the grouting procedures, by the Drilling Division of the State Board of Health. Of the 19 wells with less than 100 feet of casing, eight produced unsafe samples on one or more occasions.

- Migrant labor camp surveys were conducted by the Board of Health in the early 1960's. Several camps were closed because they had bacteriologically unsafe water supplies. Unsafe water supplies were discovered at other camps throughout the late 1960's.

- A Milwaukee Journal reporter collected 30 water samples (20 in August 1970 and 10 in March 1971) from public establishments. Of the 30 samples, 14 were bacteriologically unsafe.

- The DHSS and DNR undertook a cooperative water quality survey in the summer of 1971. The DHSS sampled wells at mobile home parks, and at establishments licensed by the Hotel and Restaurant Section. The DNR sampled quasi-public places, such as service stations, taverns, marinas, and airports. A total of 2,204 water well samples were tested and 15.5% were unsafe. The wells with less than 100 feet of casing, or an unknown casing length constructed prior to 1957, produced approximately double the percentage of unsafe samples as those with 100 feet or more casing or those with less than 100 feet of casing constructed since 1957 under the variance procedure. Frequently, wells that tested safe would at another time test unsafe. The sample results indicated that unsafe conditions were intermittent, although, as the summer progressed, it appeared that a greater number of the samples tested unsafe.

- The League of Women Voters also collected data on well water quality during the summer of 1971. It is not known whether this data represents a completely independent sampling or includes data from the previously described DHSS and DNR sampling program. Private well owners were encouraged to submit water samples for testing and provide information on the characteristics of the well. The results for 312 wells tested within the project area jurisdictions (out of a total of 764) are reported below.

Project area jurisdiction	Total tested	Unsafe	Percent unsafe
Baileys Harbor	85	17	20%
Gibraltar	29	1	4
Egg Harbor	76	10	13
Ephraim	90	13	14
Fish Creek	32	9	28

Because the samples were collected by the homeowners themselves, it could be anticipated that some were contaminated

during sampling. Also, the sampling results probably demonstrate well construction problems as much as groundwater contamination. The League report also stated that of the 228 wells with more than 100 feet of casing, 31 were reported as unsafe.

- Sherrill (1978) reported on aquifer tests conducted in 1972 and 1973, including detailed data on certain wells within the County. One of the wells was located in Peninsula State Park about 350 feet north and 750 feet east of the entrance at Fish Creek. Another was located in Baileys Harbor, although its exact location was not detailed. The Fish Creek well was pumped and sampled in an uncased condition on 28 September 1972. Fecal coliform tested low initially but rose to greater than 10 colonies per 100 ml after 5 hours of pumping (2 samples). No explanation as to the coliform source was proffered, although the nearest on-site systems were about 400 feet distant. The well was subsequently deepened and cased to 100 feet. During a 21-hour test, no appreciable fecal coliform were detected, indicating that the casing was effective in preventing entry of contaminated water into the well. Evidence that contaminants can move rapidly through bedrock fissures is also presented. Dye introduced in one well travelled to a pumping well in a matter of minutes. One conclusion of the report was that contaminants which enter the bedrock may travel rapidly to pumping wells unless the "zone of contamination" is cased off.

- The private Water Supply Section kept a record of the bacteriological quality of water from new wells from September 1971 to July 1978 (Appendix C). These samples are typically gathered by the well driller when the well is being tested. It is not unusual for bacteriological contamination of the well to occur during drilling and pump installation. The initial tests of 1,216 new wells showed that 79 (7%) were unsafe. Retest results of 42 of these unsafe wells indicated that 17 (29%) were still unsafe. Third tests on 7 previously unsafe wells showed 2 unsafe wells. These results demonstrate that the present casing requirements are successful in providing safe water for consumption.

- The 1975-1976 survey of 40 private wells serving the public in establishments licensed by the Hotel and Restaurant Section of the DHSS showed no unsafe water supplies and three major well code violations. In most cases these same wells had produced unsafe samples in 1971 but had major well code violations at that time.

- The 1977 survey of eleven additional private wells serving the public produced one unsafe well water sample that in a retest was safe.

- In 1978, the DNR undertook a sampling program of wells with less than 40 feet of casing that had been constructed between 1936 and 1950 for which construction reports were available (Appendix D). A total of 48 wells were sampled. In the initial testing in May and June, 6 produced unsafe samples (12%). After disinfection and resampling, one well continued to test unsafe (one unsafe well was not disinfected and resampled). The wells were resampled in August. Of the 41 resampled, 13 (32%) were unsafe. Many of the wells producing unsafe samples had major pump installation violations that could allow recontamination of the well after the initial sampling (Appendix D). Of the wells sampling during this survey five were in Baileys Harbor and all tested safe. Two were in Liberty Grove and both tested safe. Nine were in the Village of Ephraim, of which six tested safe on both sampling dates. Two of the wells tested safe initially and unsafe in August. One tested unsafe in May or June and then tested safe after disinfection and resampling in August. The other jurisdictions in the project area were not represented in the study.

- In conjunction with the septic leachate survey (Appendix B) 24 well water samples were collected and tested for conductivity, total phosphorus, ammonia (NH_4-N), and nitrate (NO_3-N). Well construction information was not included; thus whether groundwater contamination exists cannot be concluded. Ammonia levels did not exceed 0.3 mg/l and the greatest nitrate concentration measured was 2 mg/l. Other than the three Egg Harbor wells, no other wells tested within the project area had nitrate concentrations exceeding 1 mg/l.

Although no comprehensive sampling programs have been conducted in Door County since 1978, periodic sampling of private wells serving public places continues. Few samples with unsafe results are recorded. Most inspections of wells with unsafe samples reveal that well and pump installation codes are not met.

2.1.3. Problems Caused by Existing Systems

Onsite systems that fail to function properly can cause backups in household plumbing, ponding of effluent on the ground surface, groundwater contamination that may affect water supplies, and excessive nutrients and coliform levels in surface water. The USEPA Guidance and Program Requirements Memorandum (PRM) 78-9 and 79-8 in effect when this project was initiated requires that documented pollution problems be identified and traced

back to the causal factors. The USEPA Region V Guidance on Site Specific Needs Determination and Alternative Planning for Unsewered Areas provides guidance on how to satisfy these PRMs. Projects may be funded only where a significant proportion of residences can be documented as having or causing problems. USEPA Region V's interpretation of these regulations is that eligibility for USEPA grants is limited to those systems for which there is direct evidence that indicates they are causing pollution or those systems that are virtually identical in environmental constraints and in usage patterns to documented failing systems. Sections 2.1.3.1. through 2.1.3.4. discuss the types of direct evidence of onsite system failure that are eligible for funding under the above referenced guidance.

2.1.3.1. Backups

Backups of sewage in household plumbing constitutes direct evidence if it can be related directly to design or site problems. Plugged or broken pipes or full septic tanks would not constitute an evidence of need. No comprehensive information on backups within the project area has been collected as yet. Some suggestions of recurring backups may be inferred from the Wastewater Disposal Questionnaire for those respondents who indicated that they have pumped their septic tanks five times or more in the previous five-year period. Of the respondents with septic systems, 10% indicated that they are in the category of frequent pumping. Specific locations of these respondents were not identified.

2.1.3.2. Ponding

Ponding of effluent above or around the soil absorption systems constitutes direct evidence of failure. The aerial photography was intended to identify these systems. The photographic analysis did not identify any systems with effluent ponding on the ground surface. The location of wastewater disposal areas was identifiable on some lots but no conclusions could be made whether they constituted failures. The disposal areas were identified by the signature of lush vegetation over the beds or trenches, probably due to effluent rising to the soil surface. In Door County this signature could be caused by improper installation, hydraulic overload

(sized improperly), organic solids overload (inadequate maintenance), or intentional installation close to the surface in order to maximize the separation distance from bedrock or groundwater. Some systems under construction or recently completed also were identified. Groundwater ponding on the soil surface and effluent pipe discharges are presumed to be minor evidences of failures within the project area. The wastewater disposal permits rarely identified systems as failing. In addition, the Wastewater Disposal Questionnaire responses do not indicate problems with surface ponding.

2.1.3.3. Groundwater Contamination

Contamination of water supply wells constitutes direct evidence of soil absorption system failure where concentrations of nutrients greatly exceed the background levels of groundwaters in the area for primary drinking water quality standards. In order for well sampling data to qualify as direct evidence of failures, specific well information must be collected. This information includes the depth of the well, its orientation with respect to soil absorption systems, and the degree of protection from surface contaminants. Because the wells are located in fractured bedrock, and detailed well and water sampling data are incomplete, specific failures of on-site systems cannot be identified.

Bacteriologically unsafe water well samples can be attributed to improper well construction, improper pump installation, or groundwater contamination. Of the three, groundwater contamination seems to be the minor cause. Aside from the well water analyses conducted in conjunction with the septic leachate survey, few well samples have been tested for the constituents, primarily conductivity, chlorides, ammonia, and nitrates, that would aid in identifying whether septic tank effluent is adversely affecting well water quality.

Contamination of the groundwater most likely occurs where contaminated water has direct contact with bedrock fissures. These contact locations could be where bedrock is exposed directly to contaminated water or where a coarse aggregate is adjacent to bedrock.

Sources of bacterial contamination may be filtered septic tank effluent, surface runoff, or infiltration of animal wastes. Some soil absorption systems may be constructed within bedrock where the gravel envelope around the effluent distribution system contacts fissured bedrock. In some areas, particularly Fish Creek, the drain beds or dry wells may be installed in the cobble material that has direct contact with the bedrock. Usually, nearly all the bacteria and viruses are filtered from the effluent at the gravel and natural soil interface in a soil absorption system. Animal wastes may enter the bedrock through direct infiltration below cattle yards or through infiltration of surface runoff into fissured bedrock (Personal communication, Mr. Sam Hagedorn, District Conservationist, to WAPORA, Inc., 13 April 1982). Other contaminants, such as road salt, oil, gasoline, fertilizers, and a wide variety of wastes, (Sherrill 1978) may be affecting groundwater quality in localized areas.

2.1.3.4. Surface Water Quality Problems

Surface water quality problems directly attributable to onsite systems must be serious enough to warrant taking action. Problems with public health implications, that is, high fecal coliform counts, are serious enough to warrant attention. However, nutrient inputs must be analyzed in terms of their contribution to water quality degradation and whether water quality would be significantly improved by an improvement action. A variety of means for evaluating the contribution of septic tank effluent to water quality problems are available and have been applied within the project area.

The septic leachate detector survey (Section 2.1.2.3.; Appendix B) was conducted to locate and quantify the nutrient inputs from septic tank-soil absorption systems. When the septic leachate plumes were located, surface and groundwater samples were taken at that point. The results (Appendix B) indicate that most plumes of septic leachate had low levels of phosphorus and nitrate in them compared to the typical levels in unattenuated septic tank effluent. Coliform counts were rarely elevated; elevated counts were obtained only where surface flows from streams entered the bays or lakes. Fecal coliform in streams typically originates from animal sources.

The water quality analyses for Moonlight Bay indicate a difficulty in identifying pollution sources. The groundwater sample at the Mud Lake outlet stream contained ammonia-nitrogen concentrations of 23 mg/l. A groundwater sample at a plume location a short distance to the west had a concentration of 26 mg/l (typical levels measured in wells in the area are less than 0.1 mg/l; Appendix B). Thus, the source of the ammonia at the stream is probably decaying organic matter and it probably accounts for the high ammonia at the other plume location as well. A number of plumes in the project area may have elevated nutrient concentrations from marsh sources. This particularly could be the case for the plumes registered in Eagle Harbor.

Water quality concerns in surface water focus primarily on bacteriological contamination rather than nutrient enrichment. The bacteriological contribution to surface waters from on-site systems is minimal, according to the septic leachate detector sampling. The greatest contribution of coliform to surface waters was from stream discharges, the Baileys Harbor laundry, and the Baileys Harbor Yacht Club treatment plant.

Lush growth of macrophytes, algae, and zooplankton serve as indicators of nutrient enrichment. The septic leachate detector surveyors noted few places where evidence of nutrient enrichment was occurring. Mapping of aquatic biota provides a general indication of the level of nutrient availability but numerous sources may contribute to productivity. Specific connections between productive areas and septic tank effluent must be identified in order to determine the need for a project. None of the aquatic sampling programs have made those specific connections.

2.1.3.5. Indirect Evidence

Indirect evidence that correlates with known failures can be used as an initial screening device for locating areas where failures are probable. Site limitations that infer failures are:

- Seasonal or permanent high water table

- Lack of isolation distances for water wells (depending on well depth and presence or absence of hydraulically limiting layers)

- Documented groundwater flow from a soil absorption system to a water well

- Slowly permeable soils with percolation rates greater than 60 minutes per inch

- Bedrock proximity (within three feet of soil absorption system where bedrock is permeable)

- Rapidly permeable soil with percolation rates less than 0.1 minutes per inch

- Holding tanks, not in themselves, but as evidence that site limitations prevent installation of soil absorption systems

- Onsite treatment systems that do not conform to accepted practices or current sanitary codes including, but not limited to, cesspools, the "55 gallon drum" septic tank, and other inadequately sized components.

- Onsite systems in an area where local data indicate excessive failure rates or excessive maintenance costs.

These indirect evidences can be utilized to categorize residences as likely failures or as likely to be operating properly. Because this project commenced before the Region V Guidance was developed, the needs documentation relies heavily upon indirect evidence and past needs for replacement of drainfields for verification. Near surface bedrock is a primary factor in coliform from septic tank effluent reaching groundwater. Thus, bedrock proximity is a key determinant in establishing need. The use of holding tanks is another main indication that soil absorption systems cannot be installed in compliance with code.

2.1.4. Identification of Problem Areas

Certain areas exhibit a combination of site limitations, history of replacements, and documented water quality problems that appear to require offsite treatment. In general, these areas encompass the downtowns of the four communities. They have concentrations of commerical uses, small lots, and constraints for soil absorption systems, such as shallow depth to bedrock, cobble, or water table (as determined from Soil Conservation

Service data [SCS 1978] and soil borings along roadways presented in the Facilities Plan [Foth and Van Dyke 1982]). These areas have a concentration of holding tanks both for new structures and as replacements for septic tank and soil absorption systems. The septic leachate detector may have identified groundwater plumes and the associated water quality testing has likely identified somewhat elevated concentrations of nutrients in the groundwater.

Each subarea within the four communities is briefly described in the following sections. Figures 2-1 through 2-5 depict the subareas. The subareas presented herein are equivalent to the subareas in the Facilities Plan (and Addendum) for Egg Harbor, Fish Creek, Baileys Harbor, and Kangaroo Lake. The subareas presented for Ephraim encompass essentially the same area, but the boundaries have been slightly modified. In all communities, the subareas have been broken down further than in the Facilities Plan (i.e. Subarea 1A, 1B) to facilitate discussion of the problem areas and, in Section 2.3, the areas served by the collection systems.

Egg Harbor - Subarea 1A

This subarea encompasses the properties along STH 42 south of its intersection with CTH G. Numerous commercial structures are located in this subarea as well as a number of residences. Two new septic tank and soil absorption systems for residences have been installed since 1976. One replacement soil absorption system was constructed for a bar and restaurant. Depth to bedrock may preclude soil absorption systems on some lots.

Egg Harbor-Subarea 1B

This subarea encompasses the land along STH 42 north of its intersection with CTH G, and along Church St. One new soil absorption system has been constructed and four new holding tanks were installed for residences. Permits for one replacement and two new soil absorption systems for commerical structures have been issued. The dominant land use in this subarea is residential. Depth to bedrock is a major impediment for construction of soil absorption systems.

Egg Harbor-Subarea 2A

Subarea 2A includes the lakefront properties along Whitecliff Road up to CTH E. Two condominiums and a motel are included in this subarea; the remainder are residences. No wastewater permits for residences have been issued in recent years. Holding tank permits for the town park and a condominium have been issued. The septic leachate detector did not identify wastewater plumes along the shoreline. An occasional residential lot may be unsuitable for a soil absorption system because of shallow depth to bedrock.

Egg Harbor-Subarea 2B

This subarea encompasses the shoreline along Whitecliff Road north of CTH E almost to the village boundary. Only residences are located within this subarea. Two permits for soil absorption systems have been issued for new residences; one a lift pump and seepage bed permit and the other a lift pump and mound permit. No effluent plumes were identified by the septic leachate detector survey. Isolated individual lots may be unsuitable for soil absorption systems.

Egg Harbor-Subarea 2C

Subarea 2C encompasses the shoreline area along CTH G between Whitecliff Road and the Alpine Resort. Residential use is the only land use within this area. No wastewater permits have been issued since 1976. No wastewater plumes were identified within this area. An occasional individual lot may be unsuitable for soil absorption systems.

Egg Harbor-Subarea 3

The Alpine Resort and approximately three residences occupy this subarea at the southern shore of the bay. One holding tank permit for a residence has been issued for this area. The septic leachate detector survey identified three erupting plumes apparently related to wastewater directly adjacent to the Resort (Appendix B). Water quality analyses of

these plumes, though, did not reveal significantly elevated nutrient concentrations. The one holding tank permit was issued for an area where depth to bedrock is limiting. Most of the subarea should be suitable for soil absorption systems, although mound systems likely are required in some areas.

Egg Harbor-Subarea 4

This subarea consists of the North Point subdivision and the Rocky Shores Condominiums. Permits for four soil absorption systems (all within one area) and one holding tank have been issued for new residences. The Rocky Shores Condominiums have had soil absorption systems installed. Depth to bedrock in part of the North Point subdivision may limit on-site wastewater systems to holding tanks. One dormant plume was identified by the septic leachate detector.

Egg Harbor-Subarea 5

This subarea encompasses the shoreline along CTH G and Mariner Road and includes Alpen Lane. Residences and one resort are located within the subarea. No plumes were identifed along the shoreline. Permits for soil absorption systems for new residences totalled eight, including one mound. Shallow bedrock and excessive cobble in the soil may require holding tanks on some lots.

Egg Harbor-Outlying Areas

The Town of Egg Harbor exclusive of the Village of Egg Harbor has some shoreline on Green Bay north of Subarea 2B and south of Subarea 5. The remainder of the area consists primarily of agricultural land at the higher elevations. Permits for 40 soil absorption systems and 15 holding tanks have been issued. Along the shoreline, depth to bedrock has required installation of holding tanks for about one-half of the recent permits. On the bluff, depth to bedrock in some locations has prevented the issuance of permits for soil absorption systems.

Fish Creek-Subarea 1

Subarea 1 consists of the Cottage Row properties between the bluff and the shore. All the properties are in residential uses. Two permits for holding tanks for new residences have been issued. No plumes were identified by the septic leachate detector (nearly all the properties are occupied seasonally). Two well water samples did not reveal unusually high nutrients and the two "background" surface water quality samples also were typical. A few individual lots may not be suitable for soil absorption systems due to shallow bedrock and slopes.

Fish Creek-Subarea 2

This subarea encompasses the downtown area of Fish Creek from the creek west to the shore of Green Bay. It includes the Hidden Harbors Condominiums currently under construction. Permits for four holding tanks have been issued for residences, two are replacements for soil absorption systems. Three residences have had their septic tanks replaced with new ones. A large number of businesses (7) have had the septic tank and soil absorption system replaced by holding tanks. Of those seven, four are restaurants and two are motels. The one new motel has installed a holding tank. The current wastewater permit issued for the Hidden Harbors Condominium is a large holding tank. The septic leachate detector survey identified two erupting plumes and the water quality analysis performed on one of them showed considerable nutrient enrichment (total phosphorus - 1.19 ppm; ammonia-nitrogen - 5.8 ppm). In addition, the bacteriological analysis of the groundwater indicated coliform levels of 75 colonies per 100 ml. Another groundwater sample collected in the vicinity showed elevated nutrient concentrations (total phosphorus - 0.4 ppm; ammonia-nitrogen - 3.1 ppm). (Typical groundwater nutrient concentrations in wells for total phosphorus and ammonia-nitrogen are 0.01 ppm and 0.03 ppm., respectively; Appendix B.) The primary reason holding tanks have been installed is that insufficient area is available on-site for a soil absorption system. Some have been installed because the depth to bedrock or cobble is insufficient. Along the bay, the depth to the water table also is insufficient. Some soil absorption systems may be constructed within the water table, result-

ing in insufficient nutrient and bacteria removal (evidenced by erupting plumes). Some dry wells that permit direct passage of effluent to the cobble layer may be present within this subarea.

Fish Creek-Subarea 3A

This subarea encompasses the low-lying properties along STH 42 east of the creek and including the Gibraltar School. Numerous commercial properties and some residences are included. One new soil absorption system and two holding tanks for residences have been issued wastewater permits. Two commercial structures, including one motel, have holding tanks required in the permits. The water samples, surface and ground, taken in conjunction with the septic leachate detector survey in the mouth of the creek are inconclusive with respect to groundwater quality. Ammonia-nitrogen concentrations are somewhat elevated but the concentrations of phosphorus and nitrates are not. The source of the ammonia cannot be established. Insufficient lot area for soil absorption systems has been a factor in selection of holding tanks. In addition, much of the subarea has water table depths such that mounds would be required. Some of the older structures may have the soil absorption system constructed within the water table, resulting in inadequate purification of the effluent. A water sample taken from the well at the Edge of Park Cottages exhibited no elevated concentrations of nutrients. The USGS drilled and tested a well in the park to the north of this subarea (Sherrill 1978). Testing of the well showed that bacteriologically unsafe water was entering the well. The Gibraltar School currently utilizes a holding tank. Previously they operated a treatment plant on the property that discharged into the creek. Concern for contamination in the harbor resulted in abandonment of the treatment plant.

Fish Creek-Subarea 3B

Subarea 3B encompasses the intersection area of Spring Road, STH 42, CTH F, and Gibraltar Road. The structures are about evenly divided between residential and commercial uses. Two holding tanks for residences and one for a motel have been required on wastewater permits. Depth to bedrock is identified as the limitation that necessitates holding tanks. The soil

borings conducted for the sewers indicated that certain lots may have sufficient soils for soil absorption systems.

Fish Creek-Subarea 4

This subarea encompasses the properties along CTH F for one-half mile beyond the intersection with STH 42. Nearly all the parcels are occupied by residences. One new residence is served by a holding tank. Depth to bedrock is the major limitation that necessitates holding tanks. Nearly all of the older residences likely have soil absorption systems in an area of shallow, fissured bedrock. Some lots may have soil absorption systems that have a minimum of soil cover and may function satisfactorily.

Fish Creek-Subarea 5

The properties along Gibraltar Road for one-half mile east of the intersection with STH 42 constitute this subarea. The primary land use is residential. One new residence has a holding tank. Shallow depths to bedrock generally characterize the soils and preclude soil absorption systems. Soil absorption systems are likely the principal means of wastewater treatment for existing residences. Some of these systems are likely constructed in insufficient soil to prevent untreated effluent from entering the bedrock.

Fish Creek-Subarea 6

This subarea encompasses the properties along Spring Road for one-half mile south of the intersection with CTH F. The properties are primarily in residential use. Permits for one soil absorption system and one holding tank have been issued for new residences. The soil cover over bedrock is generally insufficient for soil absorption systems. Most of the residences are older and likely have soil absorption systems for wastewater treatment. Some may have insufficient soil thickness to prevent inadequately treated effluent from entering the bedrock.

Town of Gibraltar

The remainder of the Town has considerable shoreline development along Green Bay south of Fish Creek Subarea 1. Residences predominate over commercial structures. Most on-site systems for which permits have been issued have been soil absorption systems (68) while permits for 32 holding tanks have been issued. Permits for holding tanks have been issued primarily along the Green Bay shoreline and on the bluff overlooking the shoreline. Depth to bedrock is the primary limitation for soil absorption systems for the area where holding tanks are required. Away from the bluff, soil absorption systems are the predominant means of wastewater treatment.

Ephraim-Subarea 1A

This subarea encompasses the downtown area of Ephraim. Few single family residences are located within this subarea; motels, condominiums, restaurants, and shops predominate. One holding tank permit for a new residence has been issued. Six permits for holding tanks for new commerical developments have been issued. The septic leachate detector did not identify any plumes along the shoreline. Surface and groundwater samples at one location did not identify any elevated nutrient concentrations. Two well samples, collected in conjunction with the septic leachate detector survey, did not show elevated nutrient concentrations. The well sampling program conducted in 1978 on wells with less than 40 feet of casing included two wells in this subarea. Both wells tested bacteriologically safe on both sampling dates. While most of the new commercial structures are on holding tanks, many of the older structures are on septic tank and soil absorption systems with no apparent detrimental effect on groundwater quality. The soils are gravelly sandy loam in the surface and gravel below. Holding tanks are required because lot areas are insufficient for soil absorption systems.

Ephraim-Subarea 1B

This subarea encompasses the south shoreline of Eagle Harbor. The area includes the properties along STH 42 to German Road. Structures are a

mix between single family residences, rental cottages, condominiums, and some shops and restaurants. One replacement permit for a soil absorption system has been issued and six holding tank permits (including three replacements) have been issued for single family residences. Holding tank permits have also been issued for a condominium project and a restaurant. The septic leachate detector survey identified four erupting groundwater plumes within the subarea. Water quality analyses of these plumes showed slightly elevated phosphorus and ammonia concentrations. One groundwater sample contained 240 colonies per 100 ml fecal coliform. (Maximum drinking water level is 1 coliform bacteria per 100 ml Wisconsin code NR 109.30) The stream samples contained generally normal levels of fecal coliform, although one stream may be influenced by concentrated animal or human wastes. The two wells sampled in conjunction with the septic leachate survey revealed no elevated nutrient concentrations. One well that may be in this subarea was tested in the survey of wells with less than 40 feet of casing. The well tested bacteriologically safe in the first sampling period and unsafe in the second sampling period. Many wells were not sealed against surface contamination, although the ones that were not sealed are not noted. Thus, groundwater contamination is not definitely established at the location. The soils within the subarea are generally sands without limitations for soil absorption systems. Away from the bay, depth to water table may limit on-site systems to mounds. The residences between STH 42 and the bay are generally located on small lots that have insufficient area of suitable soils for a soil absorption system. Many of these residences have soil absorption systems near or within the water table and within a short distance of the bay.

Ephraim-Subarea 1C

Subarea 1C includes the shoreline along STH 42 below the bluff and borders of Subarea 1A on the south. Aside from an occasional commercial structure, residences dominate the land use. One new soil absorption system permit has been issued for a new residence and a replacement permit for a holding tank has been issued for a condominium. The septic leachate detector survey identified no plumes and no water samples were collected. The survey of wells with less than 40 feet of casing included one well in

this subarea that tested unsafe, safe, and safe in three respective tests. The soils of most of the subarea are deep and well drained and present minimal limitations to installation of soil absorption systems.

Ephraim-Subarea 2

This subarea encompasses the properties on the hillside to the east of the downtown and includes some shoreline along STH 42 between Subarea 1A and Subarea 1B. Single family residences predominate, although some motels and institutional structures are also included. One soil absorption system permit has been issued for a new residence. Two holding tank permits have been issued; one for a new residence and one as a replacement. A permit for a holding tank for a new motel also has been issued. The short shoreline section revealed no plumes and no water quality samples were taken. The survey of wells with less than 40 feet of casing tested one well that may be in this subarea; it tested safe in both samples. The properties along Moravia Street are characterized by exposed and shallow bedrock. The remainder of the subarea has bedrock at depths such that soil absorption systems, either seepage beds or mounds, could be permitted for a majority of the lots. Steep slopes, limited lot area, and shallow bedrock would likely preclude soil absorption systems on some lots.

Ephraim-Subarea 3

Subarea 3 encompasses the properties on the bluff between Orchard Road and the bluff. The subarea is nearly completely residential. Eight soil absorption systems have been issued permits (one is a replacement) and two holding tanks permits have been issued. The soils in most of the area are suitable for soil absorption systems, either mounds or conventional systems, where lot area is sufficiently large.

Ephraim-Subarea 4

The area on the bluff east of the downtown constitutes Subarea 4. Residences are the only wastewater producing structures within the subarea. Four soil absorption systems for new residences have received permits and

one replacement mound has been permitted. Three holding tank permits have been issued. Occasional lots may not have sufficient soil depth for a soil absorption system, although it is likely that soil depth is adequate for the majority of lots. Mound systems may be required on many of the lots due to depth to bedrock limitations.

Ephraim-Subarea 5

Subarea 5 encompasses the properties along STH 42 from Orchard Road to the Village boundary. Few residences are located in this subarea; the majority of structures are in commercial use. No permits for wastewater systems for single family residences have been issued. Permits for holding tanks for four new shops have been issued. One new shop and two duplexes have received permits for septic tank and soil absorption systems. Depth to bedrock is the limitation that requires that holding tank permits be issued. About 75% of the properties within this subarea may require holding tanks.

Ephraim-Subarea 6

This subarea encompasses the properties along STH 42 between the bay and Middle Road, along one-quarter mile of Middle Crossing Road, and along the shoreline west of STH 42. A few commercial properties are included but most are residential properties. One replacement soil absorption system permit and one holding tank permit for a new residence have been issued. The septic leachate detector did not identify any plumes along the shoreline. Three wells within or near this subarea were tested in the survey of wells with less than 40 feet of casing. All three tested bacteriologically safe at both sampling times. The soils on the shoreline lots appear to be suitable for soil absorption systems. Throughout the remainder of the subarea, depth to bedrock limitations may preclude construction of conventional soil absorption systems. In some areas mounds may be permitted; otherwise holding tanks may be required. The existing residences probably have soil absorption systems installed over shallow fissured bedrock. There is no evidence, though, of any environmental contamination from them.

Ephraim-Outlying areas

The outlying areas of Ephraim consist primarily of low density residential areas and open space. A total of 23 soil absorption permits have been issued and four holding tank permits were issued, all in Section 12. Limitations of depth to bedrock have necessitated the holding tank permits. Most areas are suitable for septic tank and soil absorption systems. Isolated individual lots may not be suitable where depth to bedrock is insufficient. One well was tested during the survey of wells with less than 40 feet of casing. The well tested safe in the initial sampling and unsafe in the follow-up sampling. Because the well was in an isolated location, it is unlikely that the groundwater in the area typically is unsafe.

Liberty Grove Town

The portion of the project area within the Town of Liberty Grove includes some shoreline area along North Bay and rural estates. The properties are, for the most part, on large parcels. A total of 21 soil absorption system permits have been issued, most of which were for seepage beds for new residences. Six holding tank permits have been issued for residences. Two businesses had holding tanks specified for them. One large campground had a septic tank and mound system installed for wastewater treatment. The septic leachate detector identified one dormant plume. Two locations were sampled for surface and groundwater. None of the water samples identified elevated nutrient concentrations. Four wells were sampled in conjunction with the septic survey and none showed elevated nutrient concentrations. Two wells with less than 40 feet of casing tested safe in both the May-June and August testing dates. About 50% of the area has depth to bedrock limitations that preclude soil absorption systems. The lots along North Bay are generally small and have water table depths that should require mound systems. Many of these properties probably have soil absorption systems constructed just above or within the water table, yet no evidence exists to show that environmental contamination is occurring.

Baileys Harbor-Subarea 1

Subarea 1 consists of the west shore properties of Kangaroo Lake. Nearly all structures are residences. Permits for on-site systems have been numerous; 28 have been issued since 1976. Permits for soil absorption systems have totalled 24, and four holding tank permits have been issued (three for replacements). The septic leachate detector survey identified no plumes. One groundwater sample from the lakeshore showed slightly elevated nitrate-nitrogen, although the source could not be identified. The well water tested in association with the leachate detector did not indicate significant concentrations of nutrients. Some individual lots do not have sufficient area of suitable soils for soil absorption systems. Most lots, though, have sufficient area of suitable soils for construction of soil absorption systems.

Baileys Harbor-Subarea 2A

This subarea encompasses the south and east shoreline of Kangaroo Lake south of North Kangaroo Lake Drive. Most lots are occupied by single family residences. Three resorts are also located within this subarea. Permits for three soil absorption systems and five holding tanks have been issued. In addition, a holding tank permit was issued for new units at one of the resorts. No plumes were identified by the septic leachate detector along the shoreline. One water sample of shallow groundwater had a slightly elevated ammonia concentration. Soil conditions on about 60% of the subarea are generally suitable for soil absorption systems. High groundwater and shallow bedrock are the principal limitations. Even where site limitations are severe, soil absorption systems have been installed in the past. Although no evidence exists to indicate that they are seriously affecting the lake, it is likely that they do have some effect on the lake as a result of nutrient input.

Baileys Harbor-Subarea 2B

This subarea includes the east shoreline of Kangaroo Lake between CTH E and North Kangaroo Lake Drive. One condominium development and a cottage

resort are located in this subarea and the majority of structures are single family residences. Two permits for holding tanks for new residences have been issued. No plumes were identified by the septic leachate detector. A shallow groundwater sample contained slightly elevated ammonia concentrations. In conjunction with the septic leachate survey, two wells were tested, but neither had elevated nutrients. Soil limitations to soil absorption systems are severe due to a high water table over about 75% of the subarea. Many of the residences have soil absorption systems that would not be expected to adequately treat the effluent, yet no evidence exists to demonstate that the lake or groundwater is adversely affected.

Baileys Harbor-Subarea 3

The downtown area of Baileys Harbor constitutes Subarea 3. It includes the area between the bluff and the shore, from the intersection of STH 57 and Ridges Road on the north to the intersection of STH 57 and Summit Road on the south. Most structures along STH 57 are in commerical use and include motels, shops, and restaurants. The back streets have residences located along them. No soil absorption system permits have been issued for this subarea. Holding tank permits for four new residential structures, including three on-site systems replacements, and one motel (a small holding tank was replaced) have been issued. In addition, another three businesses are known to have holding tanks. The septic leachate detector survey identified three erupting plumes and one dormant plume along the shoreline. One surface water sample at the Baileys Harbor Laundry holding tank had elevated phosphorus concentration and high bacteria count. Lush algae growth also was present in the area. The other surface and shallow groundwater samples did not have elevated nutrient concentrations. The two wells that were sampled with the leachate detector survey did not contain elevated nutrients. The 1978 survey of wells with less than 40 feet of casing included three wells that may be within this subarea. None of the wells had bacteriologically unsafe water at either sampling time. All three wells were on the western boundary of the subarea; thus, they may not be typical of the water quality at the shoreline. The water sample testing conducted for the non-community public water supplies has consistently produced safe samples. The subarea has shallow

bedrock, as mapped by the Soil Conservation Service. The bedrock depths should preclude soil absorption systems on most of the lots within the subarea. Many of the older structures do have soil absorption systems that, as they are upgraded, are replaced with holding tanks. Only one incident has been recorded where on-site system failure has been related to a public health problem (noted in the Facilities Plan) and that was a number of years ago.

Baileys Harbor-Subarea 4

This subarea is located on the shoreline of Baileys Harbor south of the downtown. It extends as far south as the Lawrence University facilities and extends west to STH 57. Aside from the University facilities, the structures are predominately residential. Two permits for holding tanks for new structures have been issued. Also, three septic tanks have been replaced. The University dormitories have recently constructed soil absorption beds. The septic leachate survey identified no plumes and no wate samples were taken. The 1973 survey of wells with less than 40 feet of casing included one well in this subarea. At both sampling dates the well was bacteriologically safe. The bedrock is shallow in this subarea and soil absorption systems would be precluded, according to Code requirements, on many of the lots. The majority of the structures have soil absorption systems, yet there is no evidence of bacteriological contamination.

Baileys Harbor-Subarea 5

Subarea 5 consists of the properties along Bluff Road west of the downtown. The area has residences on large lots. One permit for a soil absorption system and three permits for holding tanks have been issued for new residences. The soils map indicates that the entire area is characterized by shallow bedrock such that holding tanks are generally required. Individual lots may have sufficient area suitable for soil absorption systems, each soil absorption system would need to be examined to determine if sufficient soil material were present to preclude bacteriological contamination of the groundwater. The great depths to groundwater (more than 75 feet) virtually assures protection of the groundwater.

Baileys Harbor-Subarea 6

This subarea encompasses the properties along CTH F west of the downtown to its intersection with CTH EE and the properties south of CTH F. Several commerical structures are located along the north side of CTH F and residences are located throughout the remainder of the subarea. Permits for wastewater systems for residences include two soil absorption systems and four holding tanks. The soils map indicates that some areas, particularly north of CTH F, are suitable for soil absorption systems. Most of the subarea, though, is unsuitable for soil absorption systems because bedrock is found at shallow depths. Isolated lots do have adequate depths of soil as indicated by permits for soil absorption systems. No other information concerning operational and environmental hazards are available for this subarea.

Baileys Harbor-Subarea 7

Subarea 7 encompasses the properties along STH 57 and CTH Q from the intersection of Ridges Drive and STH 57 to approximately one mile north. Most properties have residences on them, although a few commerical structures are included. One permit for a holding tank for a new residence and one permit for a replacement soil absorption system have been issued. Generally, suitable areas for soil absorption systems may be found on most of the lots. Depth to bedrock limitations preclude soil absorption systems on some lots and depth to groundwater may require that holding tanks be installed on some other lots. Some of the existing soil absorption systems may not have sufficient thickness of soil between the seepage bed and bedrock or groundwater to ensure that no contaminated effluent reaches useable groundwater, although no evidence exists to indicate whether that is the case.

Baileys Harbor-Subarea 8A

The north shoreline of Baileys Harbor along Ridges Drive constitutes Subarea 8A. Only residences are located in this subarea. Nine holding tank permits for new residences and two holding tank permits for replace-

ments have been issued. One mound soil absorption system permit was issued. The septic leachate detector survey identified one erupting plume and three dormant plumes. A background water quality sample taken from the groundwater 100 feet from shore in the harbor had a slightly elevated ammonia concentration. The ammonia could be derived from drainage from the extensive marsh areas in the Ridges Sanctuary. This subarea occupies an old beach ridge that consists of sandy soil material. Depth to groundwater is the limitation that precludes utilization of conventional seepage beds. The shoreline lots have depths to groundwater that also preclude mounds. The older residences probably have soil absorption systems and the erupting plume likely derived from these systems. One failing soil absorption system was replaced by a holding tank in 1978 (the potential source of the erupting plume). The backlots (lots north of Ridges Drive) may or may not be suitable for mounds depending on the depth to groundwater.

Baileys Harbor-Subarea 8B

The eastern shoreline of Baileys Harbor constitutes this subarea. The Baileys Harbor Yacht Club resort and condominiums dominates the shoreline. Residences are located both north and south of the Yacht Club. No permits for wastewater disposal have been issued in this subarea since 1976. The Yacht Club has a sewage treatment plant that discharges to a small wetland that empties directly into the Harbor. The septic leachate survey identified one erupting plume along the shoreline where residences are located. The effluent from the Yacht Club treatment plant contained phosphorus concentrations of 2.5 ppm (no standard). The fecal coliform count in the effluent was 460 colonies per 100 ml (monitoring requirement only). Data from WDNR files indicates that the Yacht Club well produces consistently safe water. The shallow bedrock along nearly all of the shoreline precludes installation of conventional seepage beds. Some lots may have suitable soils for mound systems. The existing residences have soil absorption systems, most of which likely do not meet code requirements for depth to bedrock and depth to groundwater, yet little evidence has been assembled to show that contamination of groundwater and surface water is occuring.

Baileys Harbor Town

The Town of Baileys Harbor contains considerable shoreline along North Bay, Lake Michigan, Moonlight Bay, and Baileys Harbor in addition to considerable inland areas. The shoreline areas are generally characterized by shallow bedrock or by low beach ridges. Seasonal residences are common on these shorelines. Most permits for wastewater systems have been issued for these shoreline areas. A total of 49 permits for soil absorption systems for residences, and 41 permits for holding tanks have been issued. The holding tank permits predominate along the shoreline and soil absorption systems predominate inland. The septic leachate detector survey included the shoreline of North Bay and Moonlight Bay. No effluent plumes were noted on the North Bay shoreline in the Town of Baileys Harbor. In Moonlight Bay, four erupting plumes and four dormant plumes were identified. With the exception of one plume that was accompanied by Cladophora (a colonial form of alga), these plumes appear to be associated with marsh discharge through the groundwater. Ammonia-nitrogen concentrations of greater than 20 ppm and low phosphorus concentrations indicate this also. Soils within the town are generally unsuitable for soil absorption systems in the areas east of STH 57 due to limitations of depths to bedrock or groundwater.

2.1.5. Septage and Holding Tank Wastes Disposal Practices

Septic tanks and holding tanks are pumped when homeowners contract with septage haulers for service on a by-call basis. Several commercial and private septage haulers operate in the area. The haulers are licensed and inspected by the State Bureau of Solid Wastes under the provisions of Chapter NR 113 of the Wisconsin Administrative Code.

The number of holding tanks serving residences within the study area totals about 200 (the number of permits granted since 1976 totaled 162) for the entire study area. The businesses with holding tanks number approximately 48. The volume of holding tank wastes currently pumped within the study area is approximately 6,000 gallons per residence per year for a total of 1.0 million gallons from residences and approximately 9 million

gallons from businesses. The commercial haulers must submit monthly reports detailing what holding tanks they have pumped and what volume they have pumped from each one. The private haulers who handle up to one-third of the total pumped volume must submit quarterly reports.

Septage volumes are difficult to determine because each residence produces septage at considerably different rates. The rule of thumb for a permanent residence is 65 to 70 gallons per capita per year (USEPA 1977b). The annual septage production from seasonal residences is assumed to be 15 gallons per capita per year. From residences, approximately 240,000 gallons per year of septage is produced from the study area. The volume of septage pumped from businesses is relatively small in comparison, estimated as 15,500 gallons per year.

The haulers dispose of holding tank wastes and septage on land or at sewage treatment plants. The haulers each have inspected sites where they may apply the wastes to the land. The Bureau of Solid Wastes has statutory authority over these licensed disposal sites. The option of local control over the land disposal sites has been exercised by the towns of Liberty Grove and Gibraltar. The County Health Department performs periodic inspections on the disposal sites in these towns. In the other towns within the study area the Bureau of Solid Wastes inspects the site for the initial licensing but does not inspect subsequent operations. The land disposal sites are distributed throughout the study area but most lie between the communities of Baileys Harbor and Ephraim. The septage and holding tank wastes are surface-applied to the land throughout the year. The regulations specify that no surface spreading of these liquid wastes may occur within 1,000 feet of a residence (500 feet if the homeowner grants permission), it must be spread on lands with at least 36 inches of soil, it must satisfy the separation distances from drainageways and wells, and it must be applied at a rate of less than 30 gallons per 100 square feet per day. During the winter some haulers periodically dispose of the liquid wastes at either the Sister Bay or Valmy sewage treatment plants. The Gibraltar school hauls all its holding tank wastes to the Sister Bay treatment plant.

Disposal of the holding tank wastes and septage have been the subject of concerns raised by residents near the disposal sites. The files of WDNR contain several complaint letters (telephone complaints are not recorded) from nearby residents (Personal interview (Mr. Terry Hegeman, Bureau of Solid Wastes, to WAPORA, Inc., 21 April 1982). Most complaint calls are directed to the Door County Health Department (Personal interview, Mr. John Teichter, Door County Health Department, to WAPORA, Inc., 12 April 1982), although they have authority for inspection in the Towns of Liberty Grove and Gibraltar. Most frequently the complaint letters address spreading of wastes too close to residences. Other concerns have been odors, cattle on the site, and potential groundwater contamination. The files indicate no complaints or concerns from runoff from the sites. Also, while groundwater contamination is a concern, no contamination of groundwater has been shown (no sampling programs specifically targeted to these sites has been conducted).

While local residents have raised concerns about spreading these wastes on the approved sites, no contamination of groundwater or surface water has been shown. Each hauler has approved land disposal sites for the volume of wastes that are spread on the sites. Occassional problems at the respective sites are generally related to operational deficiencies (Personal interview, Mr. John Teichtler, Door County Health Department, to WAPORA, Inc., 12 April 1982).

2.2. Identification of Wastewater Treatment System Options

2.2.1. Design Factors

Three categories of factors must be considered in the design of a wastewater treatment system: the present and projected wastewater flows in the study area, the effluent requirements established by Federal and State authorities, and economic cost criteria (duration of the planning period, interest rate, service factor, and service life of facilities and equipment). Each of these factors is discussed in the following sections.

2.2.1.1. Wastewater Load Factors

Wastewater flow projections for the Middle Door County proposed sewer service areas were developed based on a projected year 2000 design population (Section 3.2.2.4.), an average daily base flow (ADBF) of 70 gallons per capita per day (gpcd) (which includes residential and commercial flows) and design infiltration of 10 gpcd. A determination of the design flow to the year 2000 is shown in Table 2-12.

The organic loads were projected on the basis of the accepted design values of 0.17 pounds of BOD_5 per capita per day and 0.20 pounds of suspended solids (SS) per capita per day (GLUMRB 1978). These values were applied to the projected year 2000 population. The BOD_5 and SS influent wastewater loading and influent wastewater concentrations are summarized in Table 2-12.

2.2.1.2. Effluent Requirements

The effluent limits for municipal wastewater discharge to Green Bay and Lake Michigan in Door County are as follows (By telephone, Mr. Edward Lynch, WDNR to WAPORA, Inc., 21 October 1982):

• Carbonaceous BOD_5	30 mg/l as a 30 day average
• Total suspended solids	30 mg/l as a 30 day average
• pH	6.0 to 9.0
• Total chlorine residual	0.5 mg/l
• Fecal coliform bacteria	monitored only
• Total phosphorus as P	1.0 mg/l for flows with a volume greater than 2500 population equivalent (no limit for smaller communities)

Wisconsin is currently evaluating the prospect of replacing the 2500 population equivalent with a 1 mgd flow. Variations from these requirements for discharge to land application and wetlands are discussed in Section 2.2.2.4.2. and 2.2.2.4.3. respectively.

2.2.1.3. Economic Factors

The economic cost criteria consist of an amortization or planning period from the present to the year 2000, or approximately 20 years; an

Table 2-12. Wastewater load factors projected for Fish Creek, Egg Harbor, Baileys Harbor and Ephraim, for the year 2000.

Parameters	Units	Larger Service Area			Smaller Service Area		
		Permanent	Seasonal[1]	Total	Permanent	Seasonal[1]	Total
Fish Creek							
Subareas served	----	------	2,3A,3B	-----	-----	2,3A	-----
Design year population	----	127	1079	1206	115	1046	1161
Average daily design flow[2]	mgd	0.010	0.086	0.096	0.009	0.084	0.093
Peak flow[3]	mgd	0.033	0.281	0.313	0.030	0.272	0.302
BOD_5 design loading[4]	lb/d	21.6	183.4	205.0	19.6	177.8	197.4
BOD_5 influent concentration	mg/l	255	255	255	255	255	255
SS design loading[5]	lb/d	25.4	215.8	241.2	23.0	209.2	232.2
SS influent concentration	mg/l	300	300	300	300	300	300
Egg Harbor							
Subareas served	----	-----	1A,1B,2A	-----	-----	1AN,1BS,2AS	-----
Design year population	----	145	465	610	65	187	252
Average daily design flow[2]	mgd	0.012	0.037	0.049	0.005	0.015	0.020
Peak flow[3]	mgd	0.038	0.121	0.159	0.017	0.049	0.066
BOD_5 design loading[4]	lb/d	24.6	79.1	103.7	11.1	31.8	42.8
BOD_5 influent concentration	mg/l	255	255	255	255	255	255
SS design loading[5]	lb/d	29.0	93.0	122.0	13.0	374	50.4
SS influent concentration	mg/l	300	300	300	300	300	300
Baileys Harbor							
Subareas served	----	-----	3,6	-----	-----	3	-----
Design year population	----	316	457	773	259	319	578
Average daily design flow[2]	mgd	0.025	0.037	0.062	0.021	0.026	0.046
Peak flow[3]	mgd	0.082	0.119	0.201	0.067	0.083	0.150
BOD_5 design loading[4]	lb/d	53.7	77.7	131.4	44.0	54.2	98.2
BOD_5 influent concentration	mg/l	255	255	255	255	255	255
SS design loading[5]	lb/d	63.2	91.4	154.6	51.8	63.8	115.6
SS influent concentration	mg/l	300	300	300	300	300	300
Ephraim							
Subareas served	----	--1A,1B,1C,2,3,5,6-		-----	-----	1A,1B,2	-----
Design year population	----	271	1952	2,223	126	1352	1478
Average daily design flow[2]	mgd	0.022	0.156	0.178	0.010	0.108	0.118
Peak flow[3]	mgd	0.070	0.508	0.578	0.032	0.352	0.384
BOD_5 design loading[4]	lb/d	46.1	331.8	377.9	21.4	229.8	251.2
BOD_5 influent concentration	mg/l	255	255	255	255	255	255
SS design loading[5]	lb/d	54.2	390.4	444.6	25.2	270.4	295.6
SS influent concentration	mg/l	300	300	300	300	300	300

Notes:

1. Seasonal residents plus seasonal transients.
2. 80 gpcd - based on average daily base flow 70 gpcd plus design infiltration 10 gpcd (based on maximum permissible infiltration rate of 200 gal/inch - diameter/mile/day.)
3. Peak factor 3.25. Based on accepted design values (GLUMRB 1978)
4. 0.17 lb/c/d.
5. 0.20 lb/c/d.

interest rate of 7.625%, and service lives of 20 years for treatment and pumping equipment, 40 years for structures, and 50 years for conveyance facilities. Salvage values were estimated using straight-line depreciation for items that could be used at the end of the 20-year planning period. An annual appreciation rate of 3% over the planning period was used to calculate the salvage value of the land. Operation and maintenance (O&M) costs include labor, materials, and utilities (power). Costs associated with the treatment works, pumping stations, solids handling and disposal processes, conveyance facilities, and on-site systems are based on prevailing rates. Annual revenue-producing benefits, such as lease of land application sites for crop production, are subtracted from O&M costs.

Costs are based on the USEPA STP Construction Cost Index of 411.6, the USEPA Complete Urban Sewer System (CUSS) Construction Cost Index of 226, and the Engineering News Record (ENR) Construction Cost Index of 3,725 for the fourth quarter of 1981 (December 1981). The total capital cost includes the initial construction cost plus a service factor. The service factor includes costs for engineering, contingencies, legal and administrative, and financing. The service factors used for different alternative components are summarized in Table 2-13. The economic cost criteria are summarized in Table 2-14.

Table 2-13. Service factor[a].

Item	Conventional Collection and Treatment System	Pressure Sewer, Cluster, and Onsite Systems (%)
Contingencies	10	15
Engineering	10	13
Legal & Administrative	3	3
Financing	4	4
Total	27	35

[a] A service factor is applied to the construction cost to compute the capital cost. Interest during construction is not included.

Table 2-14. Economic cost criteria.

Item	Units	Value
Amortization period	years	20
Interest (discount) rate	%	7-5/8
STP construction cost index - Chicago, December 1981	-	411.6
Sewer (CUSS) construction cost index - Chicago, December 1981	-	226
ENR - construction cost index, December 1981	-	3,725
Service Life		
Equipment	years	20
Structures	years	40
Conveyance facilities	years	50
Land	years	
Permanent		
Salvage value		
Equipment	%	0
Structures	%	50
Conveyance structures	%	60
Land	%	103

2.2.2. System Components

2.2.2.1. Flow and Waste Reduction

Economy in the construction and operation of sewage collection, treatment, and disposal facilities can be achieved in many localities by controlling waste flows or the amounts of impurities carried in the sewage. This economy is generally recognized in the short-term monetary savings that result from the reduced design capacities of facilities or from the long-term savings realized when facility expansion or replacement is rendered unnecessary. Other savings can be achieved throughout the life of the facilities by a reduction in operational costs. In addition, mitigation of some of the environmental impacts may be achievable through waste reduction measures. Methods of flow and waste reduction considered for use in the study area include water conservation measures, waste segregation, and a detergent phosphorus ban.

2.2.2.1.1. Water Conservation Measures

Clean water for many years has been taken for granted. Concerns over water supply and wastewater disposal and an increasing recognition of the benefits that may accrue through water conservation are serving to greatly stimulate the development and application of water conservation practices. The diverse array of water conservation practices may, in general, be divided into these major categories:

- Elimination of non-functional water use
- Water-saving devices, fixtures, and appliances
- Wastewater recycle/reuse system.

Elimination of Non-functional Water Use

Non-functional water use is typically the result of the following:

- Wasteful water-use habits such as using a toilet flush to dispose of a cigarette butt, allowing the water to run while brushing teeth or shaving, or operating a clotheswasher or dishwasher with only a partial load
- Excessive water supply pressure - for most dwellings a water supply pressure of 40 pounds per square inch (psi) is adequate and a pressure in excess of this can result in unnecessary water use and wastewater generation, especially with wasteful water use habits
- Inadequate plumbing and appliance maintenance - unseen or apparently insignificant leaks from household fixtures and appliances can waste large volumes of water and generate similar quantities of wastewater. Most notable in this regard are leaking toilets and dripping faucets. For example, even a pinhole leak which may appear as a dripping faucet can waste up to 170 gallons per day at a pressure of 40 psi. More severe leaks can generate even more massive quantities of wastewater.

Water-Saving Devices, Fixtures, and Appliances

The quantity of water traditionally used by household fixtures or appliances often is considerably greater than actually needed. Typically, toilet flushing, bathing, and clotheswashing collectively account for more

than more than 70% of the interior water use and waste flow volume of a household (Siegrist, Woltanski, and Waldorf 1978). Thus, efforts to accomplish major reductions in the wastewater flow volume, as well as its pollutant mass, have been directed toward toilet flushing, bathing, and clotheswashing. Some selected water conservation/waste load reduction devices and systems developed for these household activities include:

- Toilet devices and systems
  - Toilet tank inserts - such as water filled and weighted plastic bottles, flexible panels, or dams
  - Dual-flush toilet devices
  - Shallow-trap toilets
  - Very low volume flush toilets
  - Non-water carriage toilets

- Bathing devices and systems
  - Shower flow control devices
  - Reduced-flow shower fixtures

- Clotheswashing devices and systems
  - Waste flow reduction may be accomplished through use of a front loading machine which requires less water or a clotheswasher with a suds-saver attachment. The selection of suds-saver cycle when washing provides for storage of the washwater from the wash cycle for subsequent use as the wash water for the next wash load. The rinse cycle remains unchanged.

Wastewater Recycle/Reuse Systems

These systems provide for the collection and processing of all household wastewater or the fractions produced by certain activities for subsequent reuse. A system which has received a majority of development efforts includes the recycling of bathing and laundry wastewater for flushing water-carriage toilets or for outside irrigation.

Other Water Conservation Measures

One possible method for reduction of sewage flow is the adjustment of the price of water to control consumption. This method normally is used to reduce water demand in areas with water shortages. It probably would not be effective in reducing sanitary sewer flows because much of its impact is usually on luxury water usage, such as lawn sprinkling or car washing.

None of the luxury uses impose a load on a sanitary sewerage system and on onsite systems. Therefore, the use of price control probably would not be effective in significantly reducing wastewater flows. In addition, because all the residents in the project area obtain their water from individual wells, the only cost savings associated with reduced water use would be as a result of lower power costs for pumping and less chemical use for conditioning or treatment of the water by the individual homeowner.

Other measures include educational campaigns on water conservation in everyday living and the installation of pressure-reduction valves in areas where the water pressure is excessive (greater than 60 pounds per square inch). Educational campaigns usually take the form of spot television and radio commercials, and the distribution of leaflets with water and sewer bills. Water saving devices must continue to be used and maintained for flow reduction to be effective.

Results of Water Conservation Measures

Wastewater flows on the order of 15 to 30 gpcd can be achieved by installation of combinations of the following devices and systems:

- Replace standard toilets with dual cycle or low volume toilets
- Reduce shower water use by installing thermostatic mixing valves and flow control shower heads. Use of showers should be encouraged rather than baths whenever possible
- Replace older clotheswashing machines with those equipped with water-level controls or with front-loading machines
- Eliminate water-carried toilet wastes by use of in-house composting toilets
- Use recycled bath and laundry wastewaters to sprinkle lawns in summer
- Recycle bath and laundry wastewaters for toilet flushing. Filtration and disinfection of bath and laundry wastes for this purpose has been shown to be feasible and aesthetically acceptable in pilot studies (Cohen and Wallman 1974; McLaughlin 1968). This is an alternative to in-house composting toilets that could achieve the same level of wastewater flow reduction

- Commercially available air-assisted toilets and shower heads using a common air compressor of small horsepower would reduce sewage volume from these two largest household sources up to 90%.

Impact of Water Conservation Measures on Wastewater Treatment Systems

Methods that reduce the flow or pollutant loads can provide the following benefits to a wastewater management program:

- Reduce the sizes and capital costs of new sewage collection and treatment facilities
- Delay the time when future expansion or replacement facilities will be needed
- Reduce the operational costs of pumping and treatment
- Mitigate the sludge and effluent disposal impacts
- May extend the life of the existing soil absorption system that is currently functioning satisfactorily
- May reduce the wastewater load sufficiently to remedy a failing soil absorption system in which the effluent is surfacing or causing backups
- May reduce the size of the soil disposal field in the case of new onsite systems.

The pretreatment process of the onsite systems should be maintained at full-size to provide the necessary capacity to treat and attenuate peak flows. Potential benefits to the community of flow reduction, as well as the usefulness of methods, analysis procedures, and examples are provided in the document entitled Flow Reduction (USEPA 1981a).

2.2.2.1.2. Waste Segregation

Various methods for the treatment and the disposal of domestic wastes involve separation of toilet wastes from other liquid waste. Several toilet systems can be used to provide for segregation and separate handling of human excreta (often referred to as blackwater), and, in some cases, garbage wastes. Removal of human excreta from the wastewater serves to eliminate significant quantities of pollutants, particularly suspended solids, nitrogen, and pathogenic organisms (USEPA 1980a).

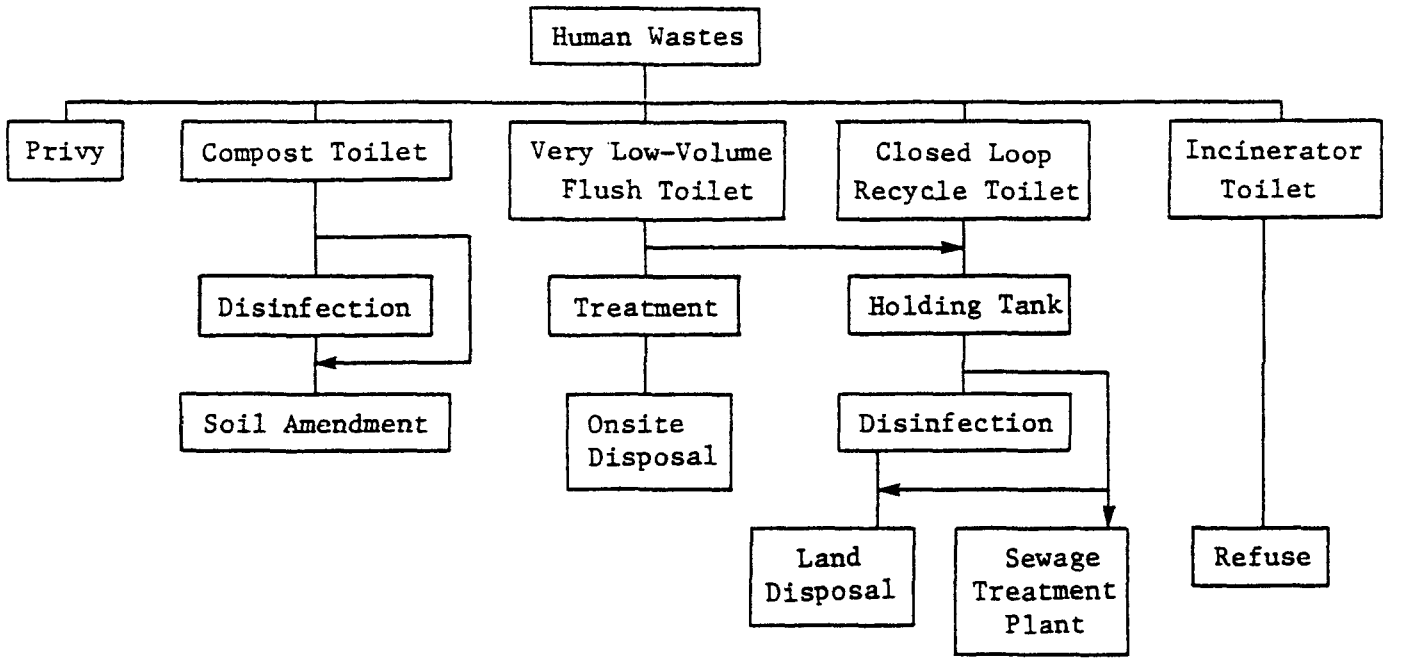
Wastewaters generated by fixtures other than toilets are often referred to collectively as graywater. Characterization studies have demonstrated that typical graywater contains appreciable quantities of organic matter, suspended solids, phosphorus, and grease. The organic materials in graywater appear to degrade at a rate not significantly different from those in combined residential water. Microbiological studies have demonstrated that significant concentrations of pathogenic organisms such as total and fecal coliforms, are typically found in graywater (USEPA 1980a).

Although residential graywater does contain pollutants and must be properly managed, graywater may be more simple to manage than total residential wastewater due to a reduced flow volume. A number of potential strategies for management of segregated human excreta (blackwater) and graywater are presented in Figure 2-7.

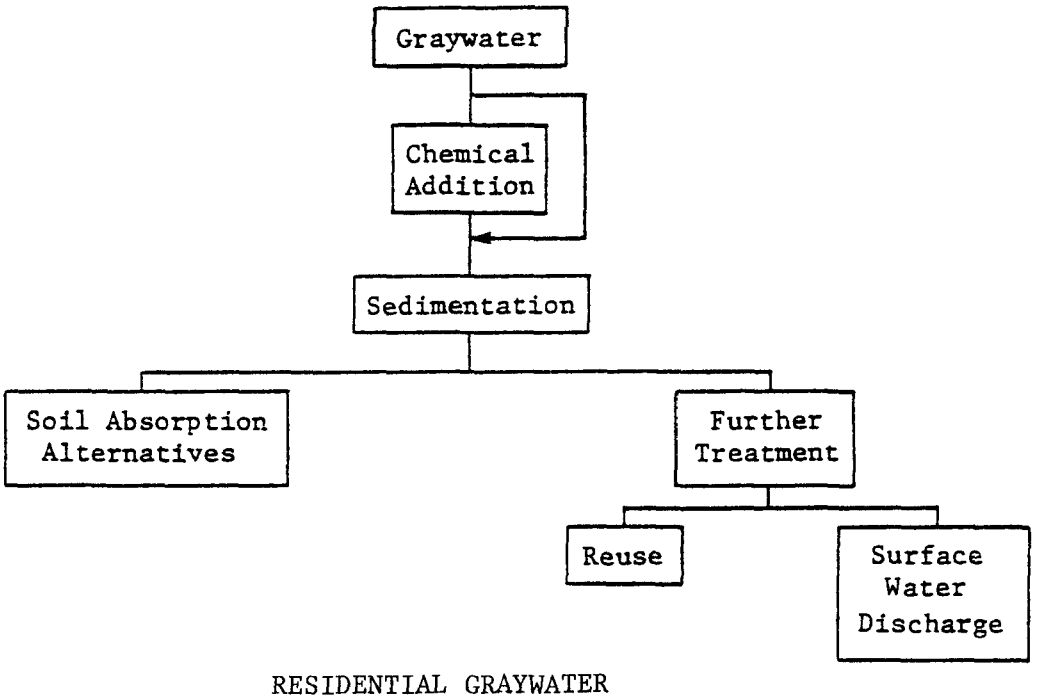
2.2.2.1.3. Wisconsin Ban on Phosphorus

Phosphorus is frequently the nutrient that controls algal growth in surface waters and is, therefore, an important influence on lake or stream eutrophication. Enrichment of the waters with nutrients encourages the growth of algae and other microscopic plant life. Decay of the plants increases biochemical oxygen demand and lowers the amount of dissolved oxygen in the water. The addition of nutrients encourages higher forms of plant life, thereby hastening the aging process by which a lake evolves into a bog or marsh. Normally, eutrophication is a natural process that proceeds slowly over thousands of years. However, human activity can greatly accelerate it. Phosphorus and other nutrients contributed to surface waters by human wastes, laundry detergents, and agricultural runoff often result in over-fertilization, over-productivity of plant matter, and "choking" of a body of water within a few years.

To reduce phosphorus concentrations in wastewater, Wisconsin legislature had banned the use and sale of domestic laundry detergents containing more than 0.5% phosphorus by weight, although the ban has expired as of the summer of 1982. The ban appears to have had a positive impact on surface water quality in the Great Lakes Basin, primarily by reducing phosphorus



SEGREGATED HUMAN WASTES



RESIDENTIAL GRAYWATER

Figure 2-7. Example strategies for management of segregated human wastes and residential graywater.

levels and algae in tributary and near-shore waters (Hartig and Horvath 1982). The preliminary assessment of the effects of the ban concluded that:

- Based on a survey of 58 major wastewater treatment plants in Michigan, influent and effluent total phosphorus concentrations decreased by 23% and 25%, respectively
- The phosphorus detergent ban resulted in a 20% reduction in total phosphorus loadings to the Great Lakes.

There would be no cost savings or cost increase for onsite systems if there were a phosphorus ban. It is possible, although not confirmed or quantified by previous research, that a reduction in phosphorus discharged to soil absorption systems would result in a considerable reduction in the amount of phosphorus transported by groundwater from the soil disposal system.

2.2.2.1.4. Summary

To reduce the waste loads (flow volume and/or pollutant contributions) generated by a typical household, an extensive array of techniques, devices, and systems are available. Because the amounts of water estimated (approximately 70 gpcd) for the centralized treatment alternatives are relatively small, and the current population of different sewer service areas is less than 10,000, water conservation measures would be marginally effective in reducing wastewater flows. Because the efficacy of water conservation is complex and must be determined on a case-by-case basis, a comprehensive water conservation alternative is not proposed in this document. However, residents with holding tanks under the onsite component of the system alternatives proposed in Section 2.3 would realize operation and maintenance cost savings if water conservation measures were used.

2.2.2.2. Collection System

Two types of collection and conveyance sewer systems are proposed: a gravity sewer system and a pressure sewer system. Both types of collection systems are briefly described in the following sections.

2.2.2.2.1. Gravity Sewer System

The gravity sewer system generally consists of gravity sewers, pumping stations, and force mains. Usually it will also carry whatever industrial wastes are produced in the area that it serves. A gravity sanitary sewer carries wastewater by gravity (downslope) only.

Apart from pumping facilities sometimes required at sewage treatment plants, the principal conditions and factors necessitating the use of pumping stations in the sewage collection system are as follows:

- The elevation of the area to be serviced is too low to be drained by gravity to existing or proposed trunk sewers
- Service is required for areas that are outside the natural drainage area, but within the sewage or drainage district
- Omission of pumping, although possible, would require excessive construction costs because of the deep cuts required for the installation of a trunk sewer to drain the area.

The pumping station pumps wastewater under pressure through a pipeline known as a force main. For the sake of economy, the force main profiles generally conform to existing ground elevations.

Gravity sewers that carry raw sewage are termed conventional gravity sewers in this report. In these sewers, sewage should flow with sufficient velocity to prevent the settlement of solid matter. The usual practice is to design the sewers so that the slope is sufficient to ensure a minimum velocity of 2 feet per second (fps) with flow at one-half full or full depth. Pumping stations within the conventional gravity sewer system must be designed to handle the solids in raw sewage, either by grinding them or by screening larger material and passing smaller material through the pump. Force mains are generally designed with adequate velocity to prevent deposition of solids at minimum flow. Solids will not settle out at a velocity of 2.0 fps, but solids that settle out when no flow occurs (pumps are operating discontinuously) require a velocity of 3.5 fps to resuspend them.

Gravity sewers that carry septic tank effluent are called septic tank effluent gravity sewers in this report (Figure 2-8). Other terms commonly applied to them are Australian sewers and small diameter sewers. Because only clear effluent from septic tanks is carried, a minimum velocity of 1.5 fps can be designed. Also, a minimum pipe size of 4-inch diameter is sufficient. Cleanouts, rather than manholes, are recommended so that less dirt enters the pipes (Otis 1979). Pipes do not need to be laid at a constant slope nor in a straight line (Simmons and Newman 1979). Other advantages of using septic tank effluent gravity sewers are that pumping equipment does not need solids handling equipment and force mains do not have minimum velocity requirements. Because septic tank effluent is odorous, special measures must be taken to ensure that odorous gases are not allowed to escape to the atmosphere near residences.

2.2.2.2.2. Pressure Sewer System

Essentially, a pressure sewer system is the reverse of a water distribution system. The latter employs a single inlet pressurization point and a number of user outlets, while the pressure sewer embodies a number of pressurizing inlet points and a single outlet, as shown in Figure 2-9. The pressure main follows a generally direct route to a treatment facility or to a gravity sewer, depending on the application.

There are two major types of pressure sewer systems: the grinder pump (GP) system and the septic tank effluent pump (STEP) system. As shown in Figure 2-10, the major differences between the alternative systems are in the onsite equipment and layout. There are also some subtle differences in the pressure main design methods and in the treatment systems required to reduce the pollutants in the collected wastewater to an environmentally acceptable level. Neither pressure sewer system alternative requires the modification of household plumbing, although neither precludes it if such modifications are deemed desirable.

The advantages of pressure sewers are primarily related to installation costs and inherent system characteristics. Because these systems use small diameter plastic pipes buried just below the frost penetration depth,

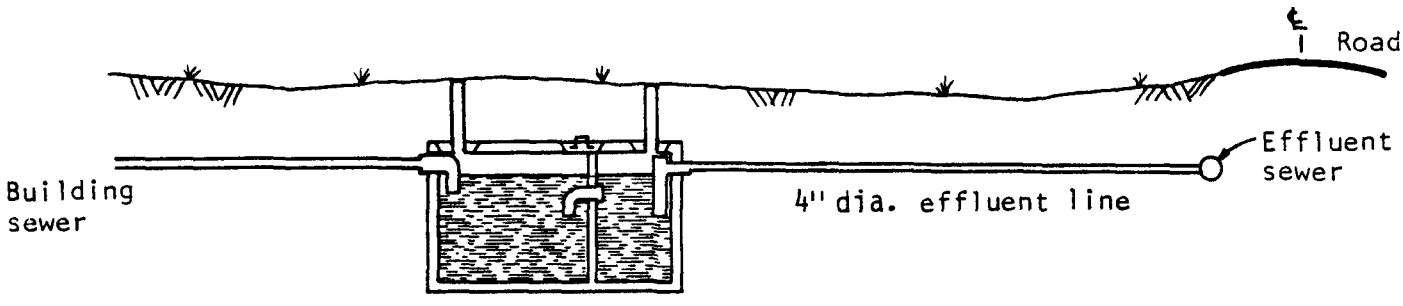


Figure 2-8. Septic tank effluent gravity sewer layout.

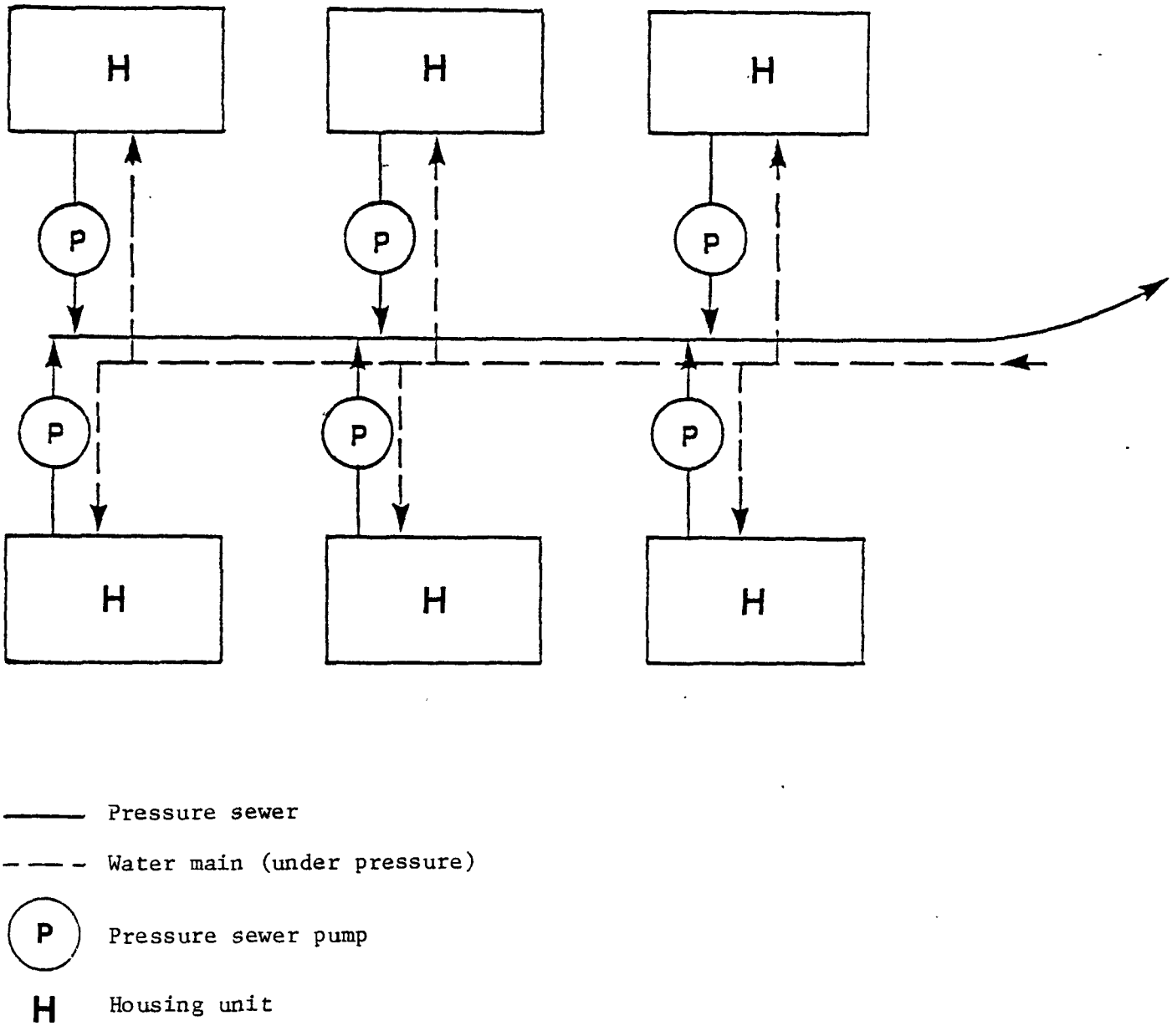
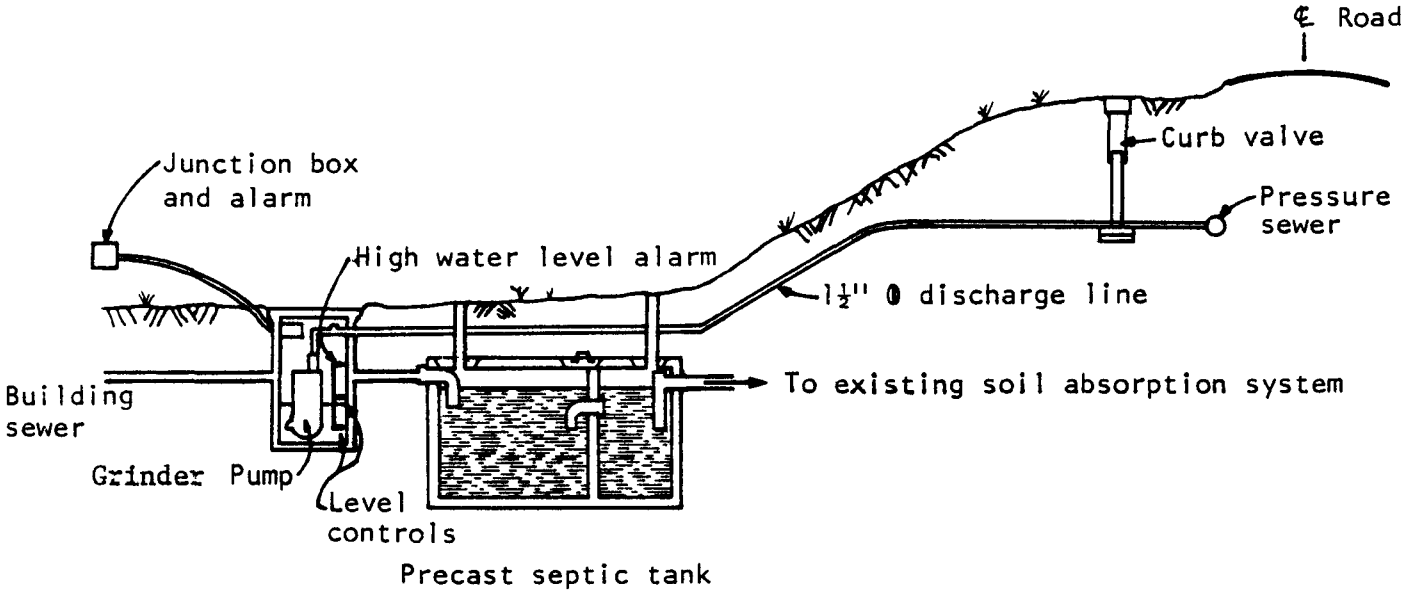
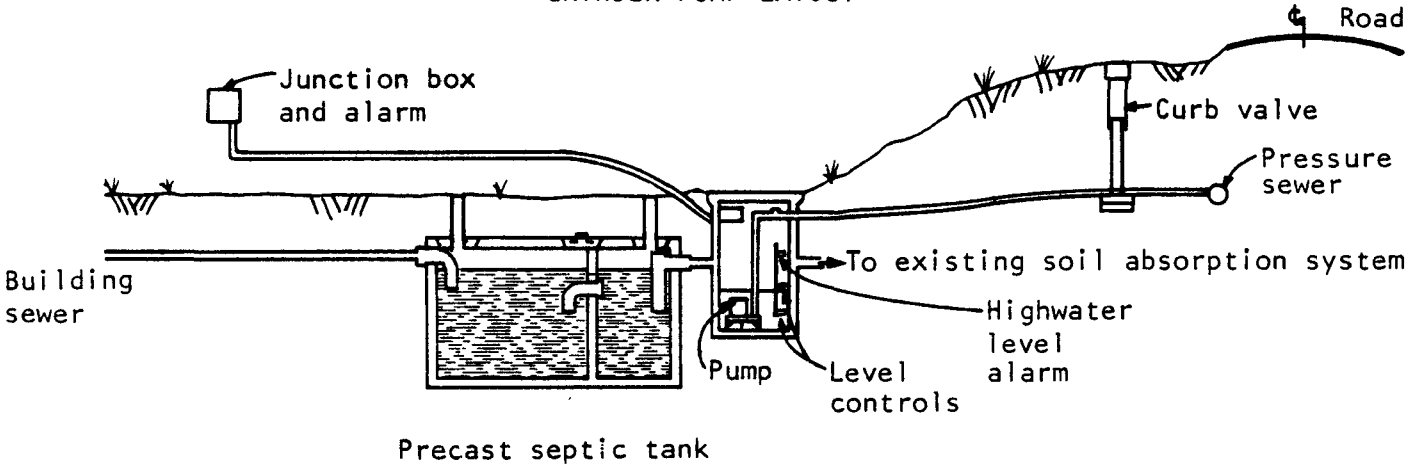


Figure 2-9. Pressure sewer versus water main.



GRINDER PUMP LAYOUT



SEPTIC TANK EFFLUENT PUMP LAYOUT

Figure 2-10. Types of pressure sewer systems.

their installation costs can be quite low compared to conventional gravity systems in low-density areas. Other site conditions that enhance this cost differential include hilly terrain, rock outcropping, and high water tables. Because pressure sewers are sealed conduits, there should be no opportunity for infiltration. The sewers can be designed to handle only the domestic sewage generated in the houses serviced, which excludes the infiltration that occurs in most gravity systems. The high operation and maintenance costs for the use of mechanical equipment at each point of entry to the system are the major disadvantage of a pressure sewer system.

Most of the dwellings in the study area have existing septic tanks. Therefore, the septic tank effluent pump (STEP) system is proposed for the collection system alternatives described in this document.

2.2.2.3. Wastewater Treatment Processes

A variety of treatment options were considered in the facilities plan. In general, wastewater treatment options include conventional physical, biological, and chemical processes and land treatment. The conventional options utilize preliminary treatment, primary sedimentation, and secondary treatment. These unit processes are followed by disinfection prior to effluent disposal. Land treatment processes include lagoons, slow-rate infiltration or irrigation, overland flow, and rapid infiltration.

The degree of treatment required is dependent on the effluent disposal option selected (Section 2.2.2.4.). Where disposal of treated wastewater is by effluent discharge to surface waters, effluent quality limitations determined by WDNR establish the required level of treatment (Section 2.2.1.2.).

2.2.2.4. Effluent Disposal Methods

Four effluent disposal options are available: discharge to receiving waters, discharge to wetlands, disposal on land, and reuse.

2.2.2.4.1. Bay Discharge

WDNR permits effluent discharge to Green Bay and Lake Michigan from secondary treatment plants meeting the effluent limitations presented in Section 2.2.1.2. The outfall discharge point must be at a 30 foot water depth to avoid any negative impacts on lake whitefish and lake trout spawning areas (By letter Mr. Ronald G. Spry, Acting Field Supervisor, U.S. Department of Interior, Fish and Wildlife Service, Green Bay, to Mr. Joe Magdol, Municipal Wastewater Section, WDNR, 20 January 1981).

2.2.2.4.2. Land Application

Land application or land treatment of wastewater utilizes natural physical, chemical, and biological processes in vegetation, soils, and underlying formations to renovate and dispose of domestic wastewater. Land application methods have been practiced in the United States for more than 100 years and presently are being used by hundreds of communities throughout the nation (Pound and Crites 1973).

In addition to wastewater treatment, the benefits of land application may include nutrient recycling, timely water applications, groundwater recharge, and soil improvement. These benefits accrue to a greater extent in arid and semi-arid areas, but are also applicable to humid areas. Secondary benefits include preservation of open space and summer augmentation of streamflow.

The components of a land application system include a centralized collection and conveyance system, some level of primary treatment, possible secondary treatment, possible storage and disinfection, and the land application site and equipment. In addition, collection of the treated water may be included in the system design along with discharge or reuse of the collected water. The optional components may be necessary to meet state requirements or to make the system operate properly.

Land application of municipal wastewater encompasses a wide variety of

possible treatment processes or methods of application. The three principal processes utilized in land treatment of wastewater are:

- Overland flow
- Slow-rate or crop irrigation
- Rapid infiltration.

In the overland flow process, the wastewater is allowed to flow over a sloping surface and is collected at the bottom of the slope. This type of land application requires a stream for final disposal. Overland flow generally results in an effluent with an average phosphorus concentration of 4 mg/l. Phosphorus removals usually range from 40% to 60% on a concentration basis (USEPA 1981b).

In the slow-rate method partially treated wastewater is applied to the land to enhance the growth of vegetation. The vegetation performs a major role in removing nutrients through vegetative growth. Water is applied at rates that may range from 0.8 to 3.1 inches per week. The upper 2 to 4 feet of soil is where the major removals of organic matter, nutrients, and pathogens occur. Some processes involved are filtration, chemical precipitation, and adsorption by the soil. The applied wastewater is either lost to the atmosphere by evapotranspiration or percolates to the water table. The water table must be naturally low or be maintained at a reasonable depth by wells or tile drainage. The surface soil must be kept aerobic for optimum conditions for removals to occur.

The rapid infiltration method involves high rates (4 to 120 inches per week) of application to rapidly permeable soils such as sands and loamy sands. Although vegetative cover may be present, it is not an integral part of the system. Cleansing of wastewater occurs within the first few feet of soil by filtration, adsorption, precipitation, and other geochemical reactions. In most cases, SS, BOD, and fecal coliform are removed almost completely. Phosphorus removal can range from 70% to 99%, depending on the physical and chemical properties of the soils. Nitrogen removal, however, generally is less significant, unless specific procedures are established to maximize denitrification (USEPA 1981b).

In rapid infiltration systems, there is little or no consumptive use of wastewater by plants, and only minor evaporation occurs. Because most of the wastewater infiltrates the soil, groundwater quality may be affected. To minimize the potential for groundwater contamination, the minimum depth to the water table should be 10 feet. Due to rapid rates of percolation, the permeability of the underlying aquifer must be high to insure that the water table will not mound significantly and limit the usefulness of the site.

Land Suitability

Limited areas of land are suitable for slow-rate irrigation of effluent. Some areas may be suitable for rapid infiltration, although concern about non-degradation of groundwater would effectively rule it out. Overland flow treatment can have adverse groundwater impacts if the permeability of the soils is greater than that of clays. Few areas in the Middle Door County study area have soils of low permeability necessary for an overland flow system.

The site screening for slow-rate irrigation areas was based on criteria such as depth to bedrock or water table greater than 5 feet, sufficient area of nearly level to level soils, high percentage of cropland and proximity to the communities. In the vicinity of Egg Harbor about 100 acres are likely to be suitable for land application based on SCS soils maps in Sections 30 and 31 T30N R27E. In the vicinity of Fish Creek about 180 acres in four areas may be suitable for land application in Sections 3 and 4. The Ephraim area has no land areas of cropland that are readily apparent as suitable for land application. Soils that are mapped as sufficiently deep for the depth to bedrock and groundwater requirements are present in Section 24 but this area is steeply sloping and has an extensive tree cover. Forest irrigation may be feasible in this area although runoff would likely be a problem. Because it is unlikely that a suitable system could be constructed in that area, no land application alternative will be developed for Ephraim. In the vicinity of the community of Baileys Harbor only small, irregularly shaped areas of suitable soils are mapped. Thus, no land application alternative will be designed and costed for Baileys Harbor.

Extensive testing of the soils in these areas would be required in order to establish that these sites are indeed suitable, and to determine actual design criteria for the irrigation system and groundwater collection system, if necessary. Because groundwater contamination concerns are issues in the study area, it is anticipated that complete hydrogeological reports on the sites would be required if the land application appears to be cost-effective.

The discharge limitations to the land disposal system are given in the Wisconsin Administrative Code, Section NR 214.07. The applicable discharge limitations are summarized as follows:

- There shall be no discharge to a land disposal system except after treatment in a sewage treatment system that includes a secondary treatment system
- The BOD_5 concentration in the discharge to the land disposal system shall not exceed 50 mg/l in more than 20% of the monitoring samples that are required during a calendar quarter
- The discharge shall be alternately distributed to individual sections of the disposal system in a manner to allow sufficient resting periods to maintain the absorptive capacity of the soil
- The geometric mean of the fecal coliform bacteria counts for effluent samples taken during a calendar quarter, or such other period as may be specified in the permit for the discharge, shall not exceed 200 per 100 ml.

Treatment of Wastewater by Land Irrigation

Treatment of wastewater by the land irrigation process requires a relatively small area of active cropland soils that have a moderate permeability. Excellent removals of all pollutants, except highly soluble salts, can be expected (BOD_5 and SS, 99%; phosphorus 95% to 99%; and nitrogen 70% to 90%). Based on an application rate of 2.0 inches per week and an annual application period of 17 weeks, the Egg Harbor land application area would need approximately 10 acres of irrigated area, and the Fish Creek land application area would need approximately 20 acres of irrigated area.

The principal soils characteristics required for an acceptable application site is a permeability that will allow reasonable drain tile spacing and still dewater the site. Under these conditions, farm equipment can be operated on the site within one day of irrigation without traction or compaction problems. In addition, it is essential that the application site does not have a slope that will erode as a result of effluent applications. The acceptable slope varies according to the existing plant cover and the rate of infiltration. For example, cropland irrigation would be limited by slopes exceeding 6%, whereas forest irrigation would be feasible on slopes of up to 20% (Powers 1978).

Artificial drainage may be required on all sites unless the water table is naturally low. Artificial drainage can be advantageous because it allows control of the applied effluent. The outlet point can be designed to minimize any excess seepage.

During the winter effluent would be stored. Some land irrigation projects in northern climates are operated throughout the winter but the operational difficulties are considerable. Generally, it is recognized that inclement weather storage is necessary (USEPA 1981b). The storage ponds should be located on naturally fine-textured material to minimize seepage. Soil surveys conducted in the area have not identified any soils that could function as a natural sealant. A pond constructed in this area would need to be artificially sealed.

2.2.2.4.3. Wetlands Discharge

Wetlands, which constitute approximately 3% of the land area of the continental US (USEPA 1977a), are hydrologically intermediate areas. Wetlands usually have too many plants and too little water to be called lakes, yet have enough water to prevent most agricultural or forestry uses. The use of wetlands to receive and satisfactorily treat wastewater effluent is a relatively new and experimental concept. In wetland application systems, wastewater is renovated by soil, plants, and microorganisms as it moves through and over the soil profile. Wetland systems are somewhat similar to overland flow systems in that most of the water flows over the soil surface

and the renovation action is more dependent on microbial and plant activity than on soil chemistry.

The wetlands application option is included in the systems alternatives for Ephraim and Baileys Harbor because extensive wetlands are near the communities and because lengthy outfalls for bay discharges would be required in both communities. A detailed investigation of wetlands discharge proposed in the Facilities Plan for Baileys Harbor was conducted as part of this study. The alternate locations for Baileys Harbor and the Ephraim wetlands discharge have not been investigated with respect to the assimilative capacity of these wetlands to treat wastewater. However the large areas available indicate that the available wetlands have sufficient capacity to accept treated effluent from the respective communities.

The discharge limitations for a wetlands disposal system for the State of Wisconsin were obtained from WDNR (By telephone, Mr. Steve Skavroneck, Water Quality Planning Section, WDNR, to WAPORA, Inc., June 1979) and are summarized as follows:

- The concentrations of BOD_5 and suspended solids (SS) in discharge to the wetlands disposal system shall not exceed 20 mg/l
- Disinfection is required prior to discharge to the wetlands disposal system
- Storage shall be provided to store the treated effluent from the WWTP for the winter months.

2.2.2.4.4. Reuse

Wastewater management techniques included under the category of treated effluent reuse may be identified as:

- Public water supply
- Groundwater recharge
- Industrial process uses or cooling tower makeup

- Energy production
- Recreational turf irrigation
- Fish and wildlife enhancement.

Reuse of treatment plant effluent as a public water supply or for groundwater recharge could present potential public health concerns. There are no major industries in the area that require cooling water. The availability of good quality surface water and groundwater and the abundant rainfall limit the demand for the use of treated wastewater for recreational turf irrigation. Organic contamination concentrations also are potential problems. Direct reuse would require very costly advanced wastewater treatment (AWT), and a sufficient economic incentive is not available to justify the expense. Thus, the reuse of treated effluent currently is not a feasible management technique for the study area.

2.2.2.5. Sludge Treatment and Disposal

Some of the wastewater treatment processes considered will generate sludge. The amount of sludge generated will vary considerably, depending on the process. A typical sludge management program would involve interrelated processes for reducing the volume of the sludge (which is mostly water) and final disposal.

Volume reduction depends on the reduction of both the water and the organic content of the sludge. Organic material can be reduced through the use of digestion, incineration, or wet-oxidation processes. Moisture reduction is attainable through concentration, conditioning, dewatering, and/or drying processes. The mode of final disposal selected determines the processes that are required.

Aerobic digestion and land application of the liquid sludge to farm land are the processes suitable for this project because of the small total volume under consideration.

In the case of aerated lagoons, the long detention time would result in a high degree of decomposition of the organic solids. Inert solids that

are not biologically decomposed would remain in the lagoons and may require cleanout and removal once every 10 to 20 years.

2.2.2.6. Onsite Systems

The onsite systems proposed for use in the study area are those that are being utilized at the present time. Some modifications of the existing designs are suggested to improve the operation of onsite systems. The presently utilized systems are described in detail in Section 2.1.1.

The septic tanks presently being installed in the area are considered adequate both in terms of construction and capacity. The continued use of 750-gallon tanks for small residences and 1,000- and 1,500-gallon tanks for larger residences are recommended. Septic tanks should have an exposed manhole or inspection port to monitor the contents of the tank. If, during pumpouts and inspections, certain septic tanks are found to be faulty or seriously undersized, these tanks would then be repaired or replaced. The number of these would be expected to be a small percentage based on septic tanks that have been replaced since 1976.

The seepage beds and seepage trenches (Figure 2-11) currently being installed in the County have a 20 year design life, although they would likely function satisfactorily for a considerably longer period. The seepage beds commonly installed range from 250 square feet (sf) to 1,000 sf for single family residences. The size is dictated by Wisconsin Code based on the number of bedrooms and water using appliances and soil permeability. No changes in the design procedures are anticipated as necessary to provide adequate sewage treatment. At the present time no reduction in the area of the seepage bed is allowed even though water conservation appliances may be installed. Existing residences that have failing soil absorption systems may receive a permit for a replacement soil absorption system only if variances for water conservation practices are allowed. A variation on the standard seepage bed is the seepage bed installed in a filled area. Over bedrock, the natural soil must be at least 30 inches thick. The seepage bed is then installed in the natural ground and partially in the fill. Although a number of filled systems are reportedly installed within the study

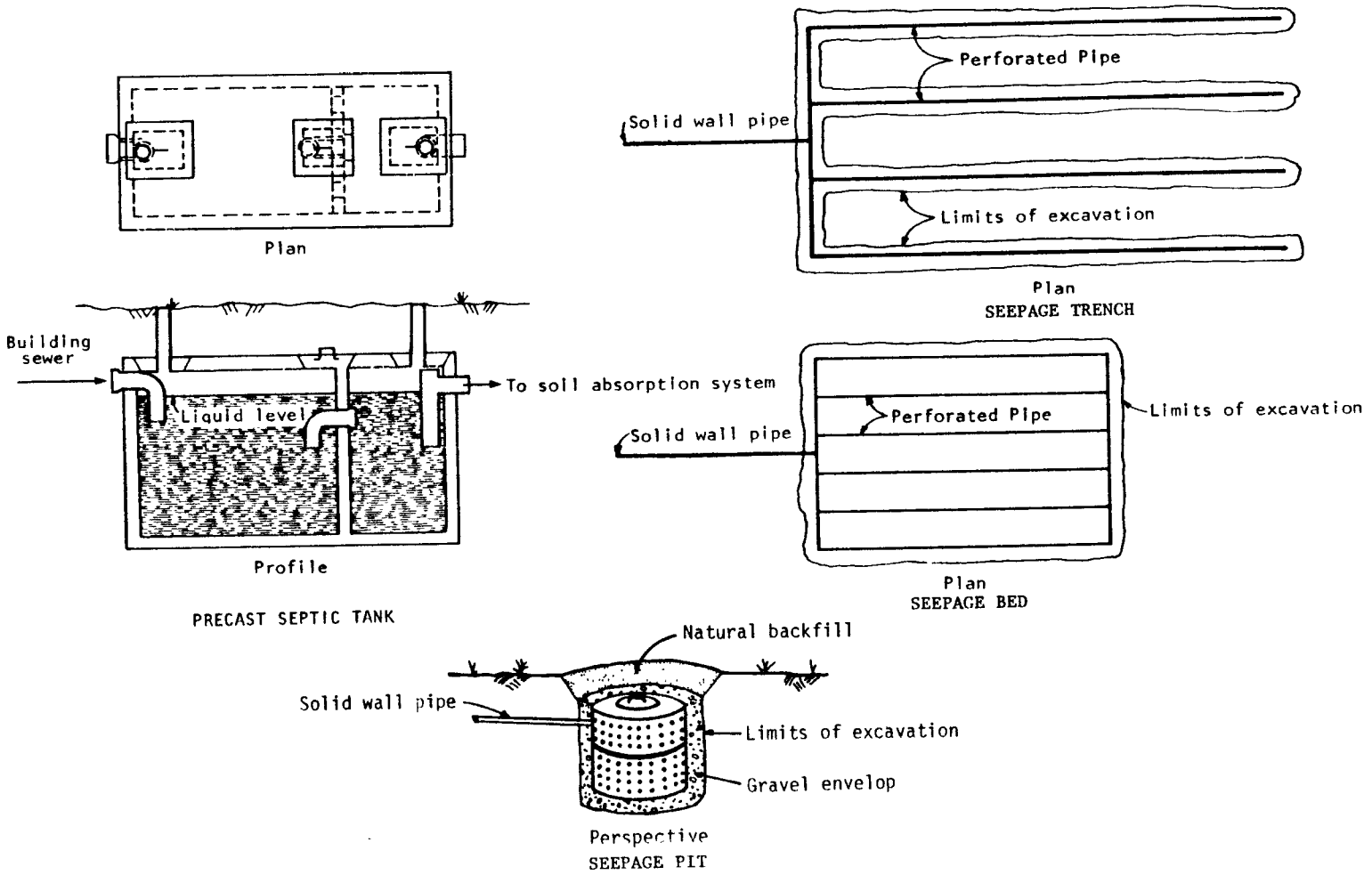


Figure 2-11. Septic tank - soil absorption systems.

area, the permit records do not clearly designate which systems are fill systems.

The mound soil absorption systems (Figure 2-12) are constructed according to detailed design standards given in the Code to overcome limitations of primarily shallow depth of soil over bedrock but also shallow water table. Mound systems have pressure distribution systems that must be supplied by pumps. The design standards incorporate flow rates that are consistent with the flow rates for seepage beds. The number of mound systems permitted for existing residences are not limited but for new residences the number is limited by court order. In the meantime, holding tanks are utilized for those residences that are on the waiting list.

The dry well soil absorption system (Figure 2-11) is currently in use for some structures and may have very limited application on some lots. No dry wells have been installed within the study area over the past six years. Depth of unsaturated permeable material must be sufficiently great so as to provide separation from bedrock and the water table. Dry wells may be installed only where insufficient area is available for a seepage bed.

Holding tanks do not strictly constitute onsite treatment because the treatment of the wastes must occur away from the site. Holding tanks are utilized where soil absorption systems cannot be installed because of site limitations. Since holding tanks for seasonal residences often are pumped three or fewer times per year, they can be the most cost-effective on-lot system. Holding tanks must have capacity to store the volume of sewage from five days. For residences the required volume is about 2,000 gallons. They are equipped with pumping connections and high water alarms. Approximately 50% of the onsite systems that have been installed under the permit program have been holding tanks within the Middle Door County study area.

Blackwater holding tanks may be appropriate for existing residences with soil absorption systems that fail because the absorption beds lack sufficient area. Components of the system include a low-flow toilet (2.5 gallons per flush or less), the holding tank for toilet wastes only, and

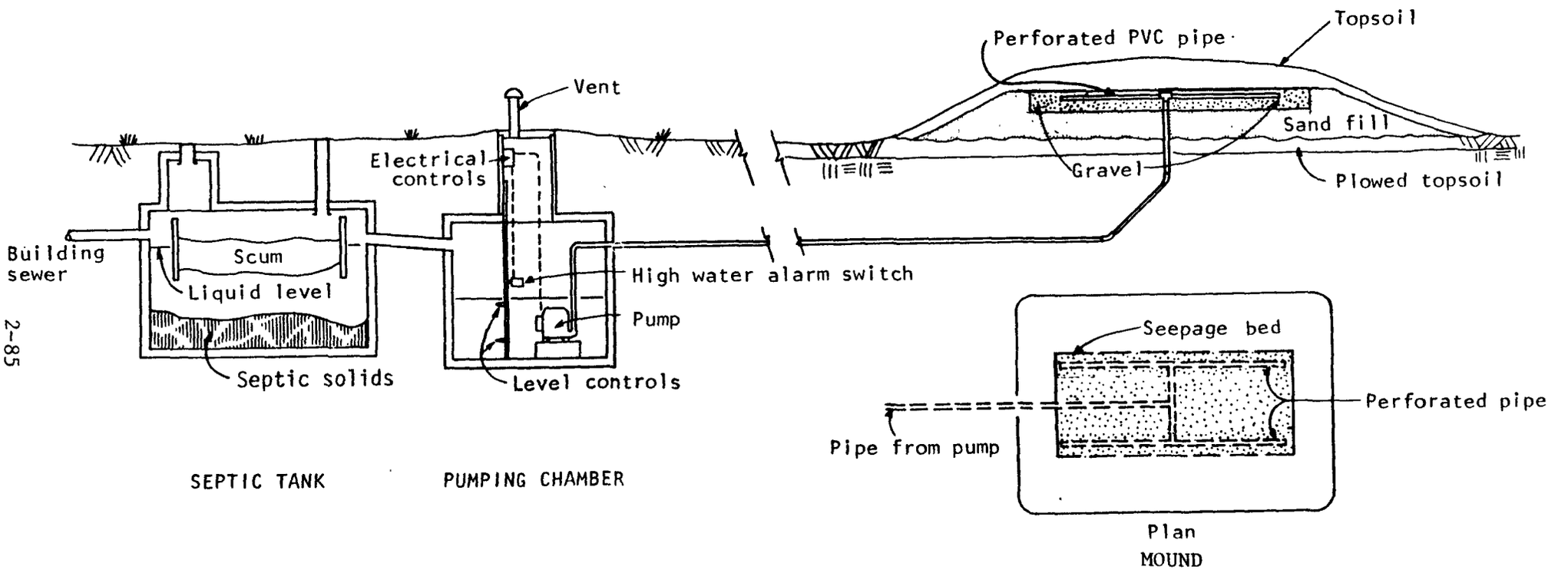


Figure 2-12. Septic tank - lift pump-mound.

the existing septic tank-soil absorption system for the remainder of the wastes. These systems are appropriate only where sufficient soil is available to protect the groundwater from pathogenic organisms in the septic tank effluent. When the toilet wastes are diverted from the septic tank - soil absorption system, that system has an opportunity to function properly and considerably reduced loading to groundwater would occur. Significant reductions of organic loads, 20 to 40% reductions in phosphorus loadings, and 80% reduction in nitrogen loadings to the septic tank-soil absorption system occur when toilet wastes are excluded. Blackwater holding tanks are recommended if the lot has insufficient area for any other soil absorption system. While blackwater holding tanks may be appropriate for numerous residences, the existing information was insufficient for a reasonable estimation. Therefore, standard holding tanks were estimated where blackwater holding tanks may be applicable. The Wisconsin Code has no regular provision for them and approval must be obtained from the Department (H63.09 (2)b). With a 1,000 gallon tank, pumping may be necessary following each month of occupancy.

2.2.2.7. Cluster System

The cluster system designates a common soil absorption system and the treatment and collection facilities for a group of residences. The common soil absorption system is used because the individual lots are unsuitable for onsite soil absorption systems. An area of soils suitable for a common soil absorption system must be available in order to consider this option. In the vicinity of the four communities only a small percentage of the area would be suitable for cluster soil absorption systems. Thus, where offsite treatment is required, cluster soil absorption systems may be feasible.

It was assumed that the existing septic tanks, with some replacements, are adequate for pretreatment. Septic tank effluent could be conveyed by small-diameter gravity sewers or pressure sewers to the soil absorption system sites. A cost-effectiveness analysis could establish which collection system to use for a particular area. A dosing system is typically required on large drain fields in order to achieve good distribution in the

field. Where the collection system uses pressure sewers, a separate accumulator tank and lift station is required. The wet well and lift station on the septic tank effluent gravity sewers can perform that function.

Cluster soil absorption systems are usually designed as three or more seepage beds, trenches, or mounds. One would be rested for a one-year period while the others would be dosed alternately. The soil absorption systems must be designed based on the requirements of the Wisconsin Code. The trench bottom or bed area requirements are sized in a manner comparable to single family residences.

Although the present soils information and topography indicate that cluster soil absorption systems may be feasible for Egg Harbor and Fish Creek, further field investigations would be needed before final designs could proceed. The depth of permeable material must be determined in order to show that groundwater mounding into the soil absorption system would not occur. Also, the characteristics of the proposed site soils must be examined sufficiently enough to verify the soil mapping of the SCS at a more detailed level than the present mapping.

The operation and maintenance requirements of the system are minimal. Periodic inspections of the lift stations and the soil absorption systems are essentially all that is necessary. The septic tanks and the lift station wet wells would require occasional pumping of solids. Maintenance of the collection piping is expected to be minimal (Otis 1979). Once a year the rested soil absorption system would be rotated back into use and another one rested. Blockages of the collection systems should occur only rarely because of the use of clear effluent. Lift stations are entirely dependent on a reliable power supply. Thus, only community power outages will affect operation of the system. Since wastewater generation is also dependent on power for pumping well water, the potential for serious environmental effects are somewhat mitigated.

2.2.2.8. Septage and Holding Tank Wastes Disposal

The use of a septic system requires periodic maintenance (3 to 5 years) that includes pumping out the accumulated scum and sludge, which is

called septage. Septage is a highly variable anaerobic slurry that contains large quantities of grit and grease; a highly offensive odor; the ability to foam; poor settling and dewatering characteristics; high solids and organic content; and a minor accumulation of heavy metals. Typical concentration values for constituents of septage are as follows (USEPA 1980b):

Total solids	38,800 mg/l
BOD_5	5,000 mg/l
COD	42,900 mg/l
TKN	680 mg/l
NH_3	160 mg/l
Total P	250 mg/l

Holding tank wastes are relatively dilute as compared to septage but is about twice as concentrated as raw sewage primarily from water conservation and from no infiltration in sewers. The extended detention times would cause the wastes to become anaerobic and odorous. Assuming that holding tank wastes have double the concentration of raw sewage, typical concentration values would be as follows:

Total solids	625 mg/l
BOD_5	540 mg/l
COD	1500 mg/l
TKN	160 mg/l
NH_3	90 mg/l
Total P	35 mg/l

Septage and holding tank wastes disposal regulations have been established mainly in states with areas that have a concentration of septic tanks. Wisconsin has established rules regarding disposal of liquid wastes particularly concerning the wastes to be disposed of on land. The general methods of septage and holding tank wastes disposal are:

- Land disposal
- Biological and physical treatment
- Chemical treatment
- Treatment in a wastewater treatment plant.

Land Disposal

The two basic types of land disposal are:

- Methods which optimize nutrient recovery such as application of the liquid wastes to cropland and pastures
- Methods of land application in which there is no concern for the recovery of nutrients in the liquid wastes such as landfills.

Septage can be considered a form of fertilizer because of its nutrient value when applied to the soil. Nitrogen, phosphorus, and micronutrients are contained in septage. The septage application rate is usually dependent upon the amount of nitrogen available to the crop. The die-off of pathogens in septage which is surface spread is quicker than that of pathogens in septage injected into the soil. Where septage is incorporated into the top 3 inches of the soil, generally 99% of all pathogens will die off within one month (Brown and White 1977).

The advantages of direct cropland application of septage and holding tank wastes are: the recycling of nitrogen and phosphorus; the low technology, maintenance, and cost of the systems; and the hostile environment which the sun and soil create for pathogens and parasites. Disadvantages include possible odor or water quality problems if the wastes are not spread properly and a possible inability to apply wastes when the ground is very wet.

Spreading septage and holding tank wastes on the land surface should be accomplished according to the requirements of the State of Wisconsin. The potential amount applied, though, should distinguish between septage and holding tank wastes because the concentrations of constituents in septage is about five times those of holding tank wastes. The nuisance conditions that are attributed to surface spreading can be minimized by subsurface injection. A summary of the regulations on surface spreading of liquid wastes on soils follows:

- Depth to bedrock or high groundwater must be at least 36 inches

- Disposal is not permitted on land used during the current growing season for pasturing livestock or for vegetables intended for human consumption, or on land used for growing forage crops during the eight weeks preceding harvest
- Disposal is not permitted on land with greater than 12% slopes
- Disposal on land with 6 to 12% slopes is limited to areas greater than 500 feet upgrade from a drainageway
- Disposal on land with 0 to 6% slopes is limited to areas greater than 200 feet upgrade from a drainageway
- Disposal is limited to areas greater than 50 feet from any property line
- Disposal is limited to areas greater than 200 feet from a potable water well or reservoir
- Disposal is limited to areas greater than 1,000 feet from a residence or area frequented by the public (500 feet if written permission is obtained from the owner)
- The rate of disposal shall not exceed 30 gallons per 100 square feet per day.

The regulations are slightly different if the liquid wastes are immediately plowed or knifed in. The distances from a residence may be 500 feet and from a drainageway may be 100 feet on land with 0 to 6% slopes.

Direct septage disposal on land may not be possible during certain times of the year. During period of heavy rainfall field access may not be possible on heavy soils. Heavy snow cover or frozen ground can also prevent field application. Some haulers dispose of the wastes at the Sister Bay or Valmy treatment plants during these periods.

The Wisconsin regulations virtually prohibit application of septage and holding tank wastes to active farmland by the length of the period prior to harvest that application may take place. Nearly all application sites are abandoned farmlands that do not have the nutrient removal capabilities of cropland. The greatest volume of liquid wastes are produced during late summer subsequent to the period when application to farmlands would be permitted.

Extensive acreages are suitable for application of liquid wastes in the Middle Door County study area. Many of these areas, though, are currently farmed and are thus unavailable for land application during the peak tourist season.

Biological and Physical Treatment of Septage

Septage may be treated biologically in anaerobic lagoons, aerobic lagoons, or digesters. Some advantages of aerobic treatment are that it reduces the offensive odor of the septage, produces a sludge with good dewatering characteristics, and produces a supernatant with a lower BOD_5 than anaerobic supernatants. The major disadvantage of aerobic treatment compared to anaerobic treatment is the higher operation and maintenance cost. Advantages of anaerobic treatment systems are that the waste undergoes stabilization of organic solids and they have relatively low operating and maintenance costs. A disadvantage of anaerobic treatment is the high BOD_5 of the effluent and the potential for nuisance odors.

Chemical Treatment of Septage

Treatment of septage involving the addition of a chemical is used to improve the dewaterability, reduce the odor, or kill the pathogens. Chemical treatment processes include addition of coagulants, rapid chemical oxidation, or lime stabilization.

Some of the advantages associated with the chemical treatment of septage are:

- Good reduction of the pollutant concentration can be achieved
- Dewaterability of septage is improved so the waste can be dewatered on sand beds
- Effective control of the pathogenic organisms is possible.

Disadvantages of chemical treatment of septage are:

- High costs are usually associated with chemical treatment and in many instances these alternatives are only feasible where relatively large quantities of septage are produced

- Large quantities of chemicals are needed
- Relatively high level of technology is needed.

Wastewater Treatment Plant

Holding tank wastes can be disposed of in any kind of sewage treatment plant since the characteristics of the wastewaters are similar. Special care must be exercised during discharge of the holding tank wastes into the waste stream because they are anaerobic and odorous.

Septage can be adequately treated at a properly operated WWTP. Both the activated sludge or the fixed media type plants are used to treat septage. Septage could be discharged into the liquid stream or sludge stream. Since septage is handled as a slurry, the possible addition points at a WWTP are the upstream sewer, the bar screen, the grit chamber, the primary settling tank, or the aeration tank. Discharge into the upstream sewer allows solids to settle out in the sewer, particularly at periods of low flow.

Septage can be treated easily at WWTPs that feature long detention times, such as facultative lagoons, aerated lagoons, or oxidation ditches. These plants are less susceptible to upsets from shock loadings and could easily accomodate septage as long as the additional organic load was included in the plant design.

The septage addition points in the sludge handling processes are the aerobic or anaerobic digester, the sludge conditioning process, or the sand drying beds. Septage added to a WWTP at 2% or less of the total flow will have little impact on the treatment processes.

The advantages of treating septage in a WWTP are:

- Septage is diluted with wastewater and treated
- Few aesthetic problems are associated with this type of septage handling

- Skilled personnel are present at the plant site.

The disadvantages of septage disposal at a WWTP are:

- A shock effect can occur in the unit processes of the WWTP if a septage is not properly entered into the wastewater flow
- The waste should undergo separation, degritting, and equilization before treatment, hence requiring additional equipment and facilities.

Summary

The septage disposal alternatives are probably limited to land application because the potential of upsetting the sewage or sludge treatment processes within a treatment plant is considerable. Holding tank wastes, on the other hand, can safely be treated within a sewage treatment plant. Thus, the option of treating holding tank wastes at the various sewage treatment plants should be investigated further. The selection of treatment and disposal options is discussed further in Section 2.5.

2.2.3. Centralized Collection System Alternatives

Each community was analyzed individually with respect to what type of collection system was most cost-effective. The three collections systems considered were conventional gravity, pump stations, and force mains; septic tank effluent gravity, pump stations, and force mains; and septic tank effluent pumps and pressure sewers. The conventional gravity sewers were not considered for alternatives with cluster soil absorption systems in Egg Harbor and Fish Creek. Because conventional gravity sewers were costed out as most cost effective in the Facilities Plan and addendum 1, one alternative with conventional gravity sewers serving an area similar to that in the Facilities Plan was prepared. The design of the sewers is based on the year-2000 populations. The layouts utilized were similar to those provided in the Facilities Plan and Addendum 1. A cost-effectiveness analysis was performed for the three alternative centralized collection systems. The detailed cost estimate for each alternative considered includes the costs for construction of the sewer system, the estimated salvage value after 20 years of use, and the estimated average annual opera-

tion and maintenance (O&M) costs. A detailed cost estimate for the various components of the collection alternatives is presented in Appendix E.

The conclusions concerning sewer service areas provided in the Facilities Plan and Addendum 1 were used as starting points for the analyses conducted in this document. In each community, reduced sewer service areas were investigated for determining the most cost-effective collection alternative for each community.

2.2.4. Centralized Wastewater Treatment Plant Alternatives

Different wastewater treatment processes appropriate for centralized WWTPs designed to meet the secondary treatment requirements in Section 2.2.1.2. were evaluated in the Facilities Plan (Becher-Hoppe Engineers, Inc. 1980). The cost effective analysis included in the Facilities Plan showed that aerated lagoon WWTPs were the most cost-effective for any regional or sub-regional alternative. However, in the analysis of alternatives the Facilities Plan and Addendum 1 recommended the following WWTPs based on site limitations, effluent limits more stringent than typical secondary treatment (wetland discharge) and cost considerations:

- Regional alternatives - WWTP not specified
- Sub regional alternatives
  - Egg Harbor - Rotating biological contactor
  - Fish Creek - Aerated lagoon (Foth and Van Dyke and Associates, Inc. 1982)
  - Ephraim - Aerated lagoon
  - Baileys Harbor - Recirculating sand filter

A comment made in the 26 August 1980 Public Hearing on the Draft Facilities Plan (Mr. Steven Jacobson) suggested comparison of the same WWTP alternative for each sub-regional project alternative. In this report rotating biological contactor WWTPs were used for screening proposed regional alternatives; for the sub-regional alternatives, an aerated lagoon WWTP and the WWTP recommended in the Facilities Plan and Addendum 1 (Becher-Hoppe Engineers, Inc. 1980, Foth and Van Dyke and Associates, Inc. 1982) were evaluated for each community.

The analysis for the regional alternatives is presented in Section 2.2.5. and for the sub-regional alternatives in Section 2.3.

2.2.5. Regional Treatment Alternatives

The analysis of regional treatment alternatives presented in the Facilities Plan concluded that the three communities along the Green Bay shore, Egg Harbor, Fish Creek, and Ephraim, should be considered on a regional basis but that Baileys Harbor on the Lake Michigan shore should be considered separately. Based on this conclusion a cost-effective analysis was made on the following regional treatment alternatives:

- Alternative 1 - Three separate WWTPs - one each for Egg Harbor, Fish Creek and Ephraim
- Alternative 2 - Two WWTPs - one for Egg Harbor, and one for Fish Creek and Ephrain at Fish Creek
- Alternative 3 - Two WWTPs - one for Egg Harbor, and Fish Creek in Section 6 (T30N,R27E) and a WWTP for Ephraim
- Alternative 4 - A regional WWTP for Egg Harbor, Fish Creek, and Ephraim in Section 6 (T30N,R27E)

The locations of the WWTPs and routes of the interceptor sewers are similar to the Facility Plan and are presented in Figures 2-13, 2-14, 2-15, and 2-16 for Alternatives 1, 2, 3, and 4, respectively.

A summary of the estimated costs for each alternative is presented in Table 2-15. Costs are based on rotating biological contactor WWTPs, interceptor sewers between communities, and outfalls to Green Bay for each WWTP. Collection sewer systems in each community are not included. Detailed costs are presented in Appendix E.

Alternative 1 has the least total present worth cost of $3,402,300 and is 18.5% less expensive than Alternative 2 which is the next least costly. Alternative 4 has the highest total present worth cost.

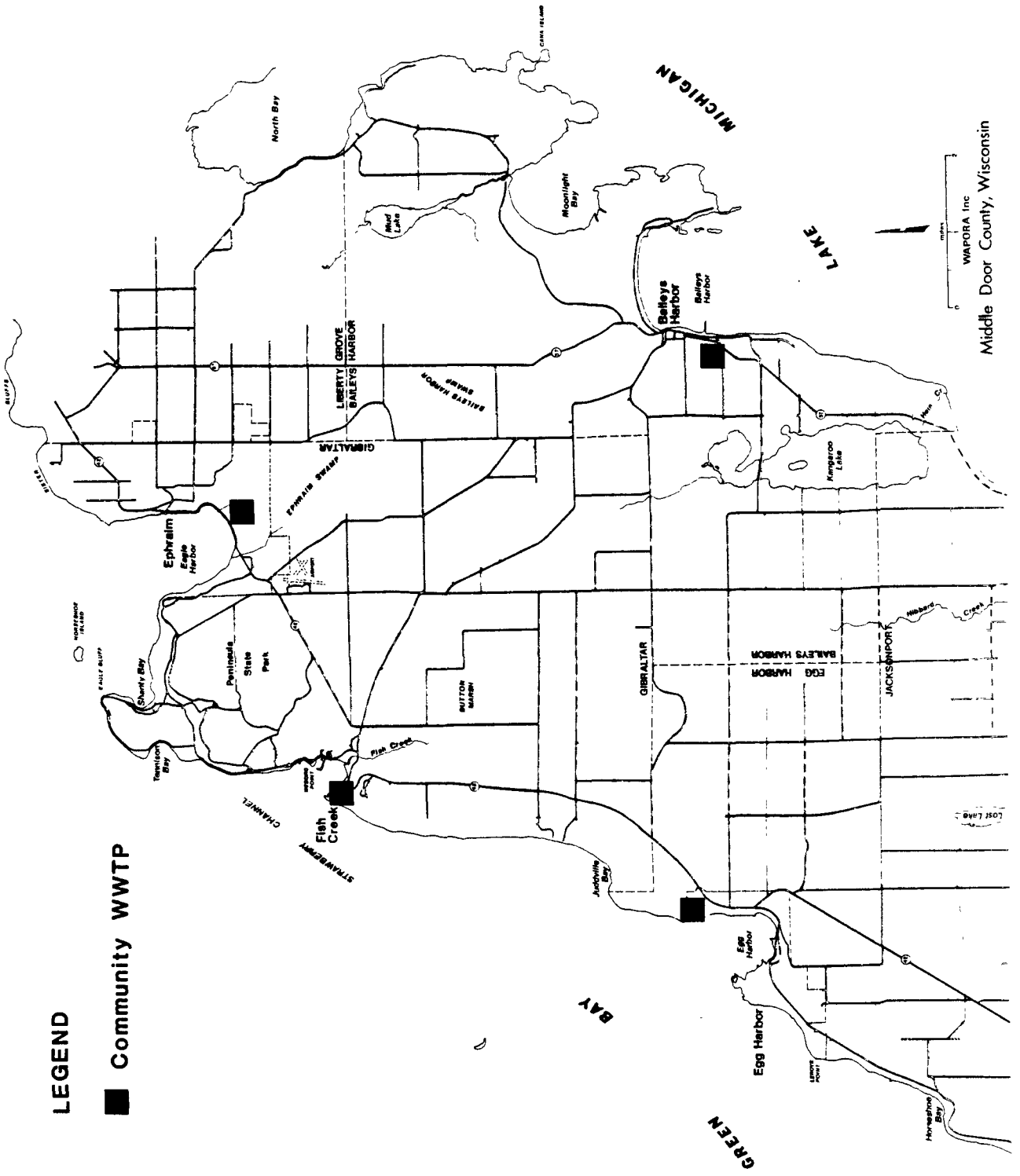


Figure 2-13. Regional treatment Alternative 1.

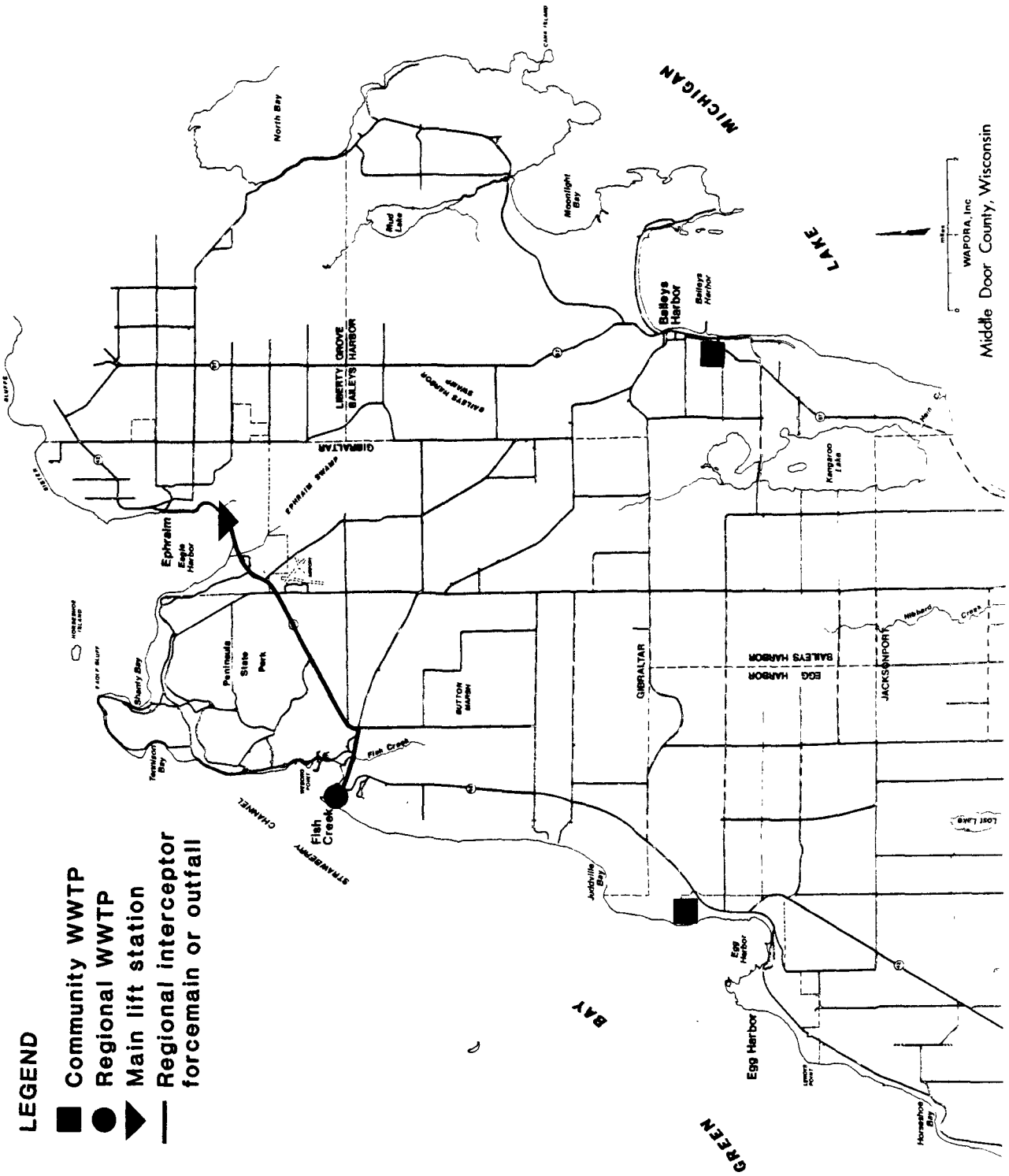


Figure 2-14. Regional treatment Alternative 2.

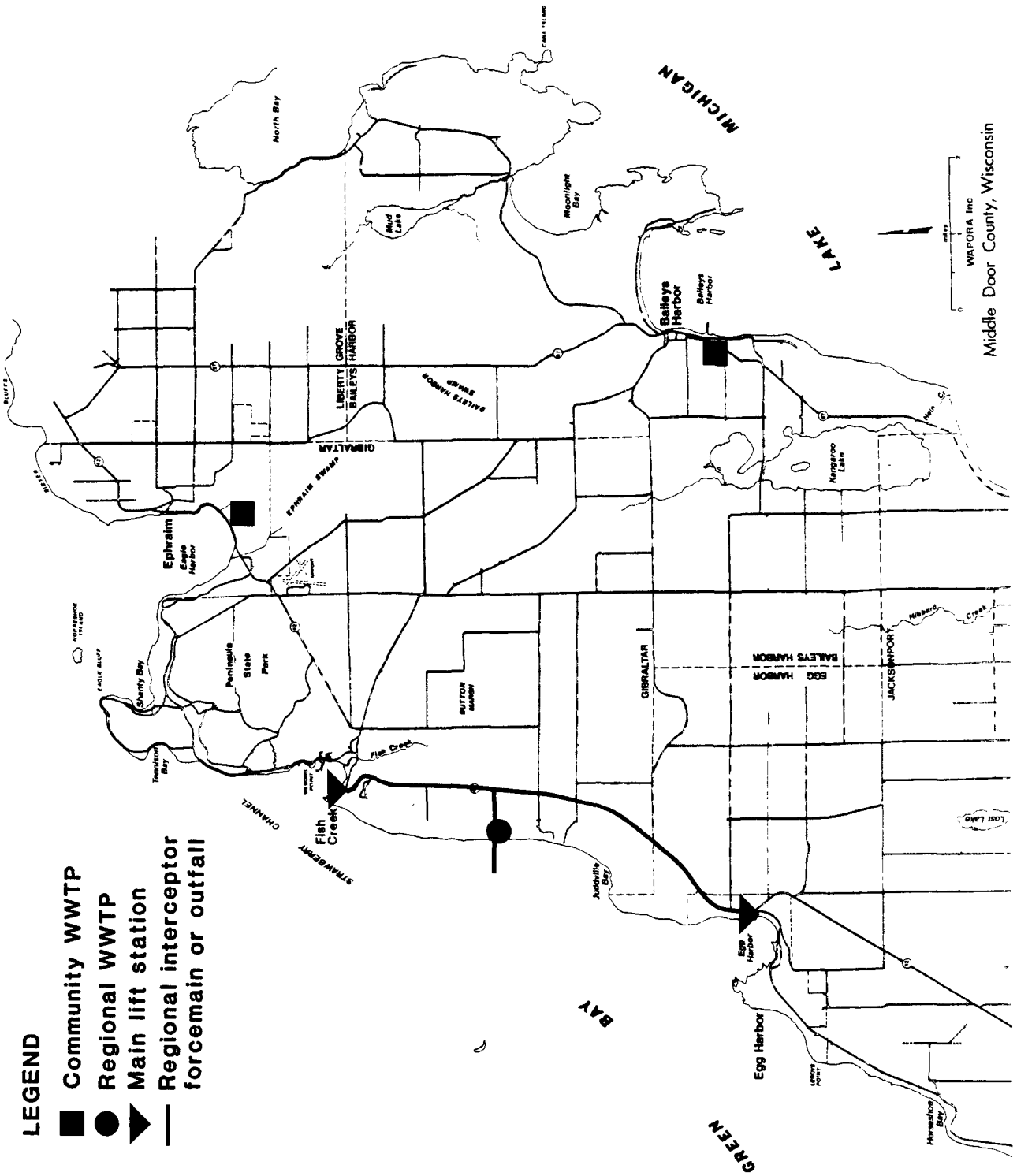


Figure 2-15. Regional treatment Alternative 3.

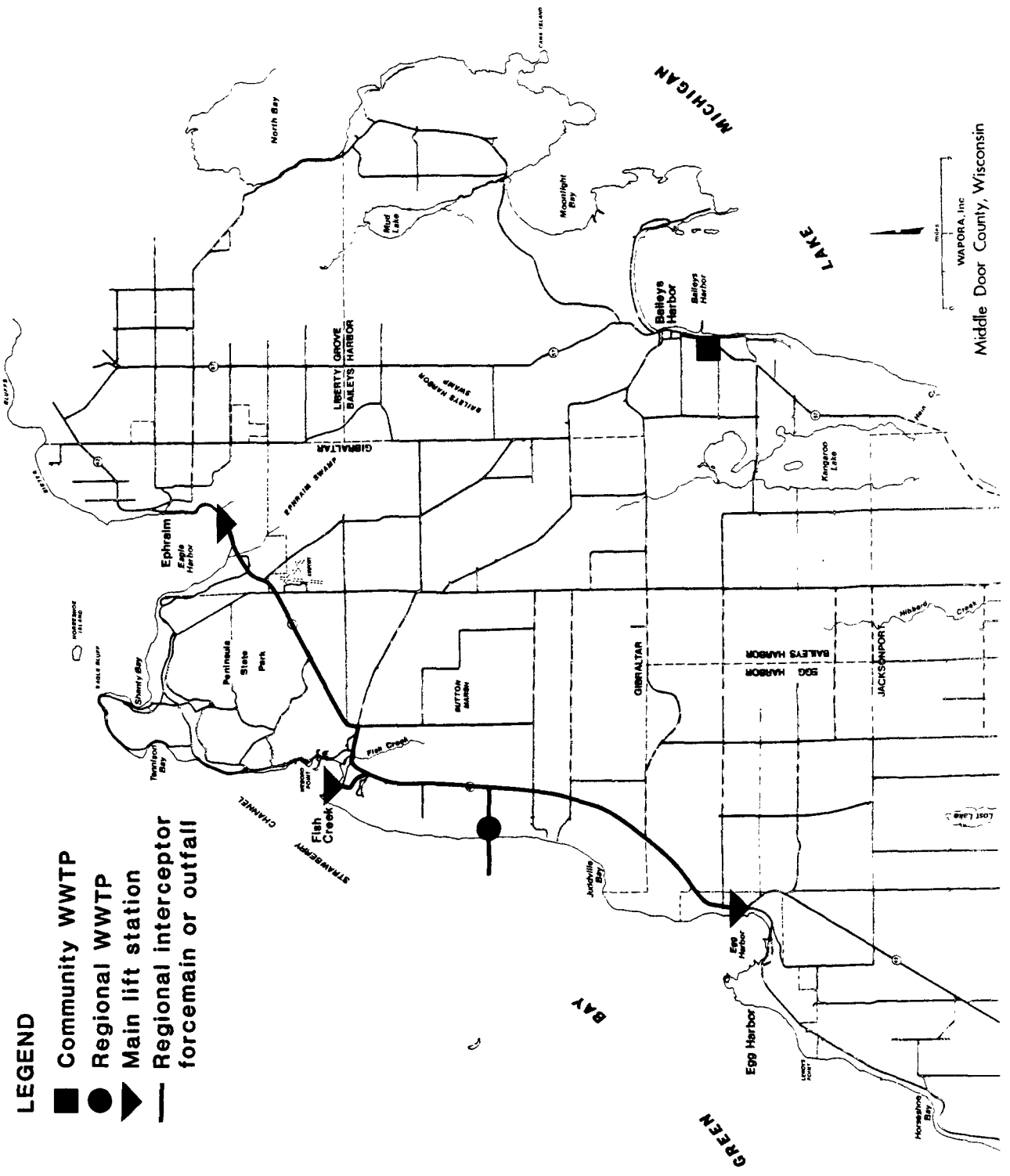


Figure 2-16. Regional treatment Alternative 4.

Table 2-15. Summary of all estimated treatment and transmission costs[3] of regional alternatives (December 1981 costs, in thousands of dollars).

Alternative Number and Title	Construction Cost	Salvage Value	O&M Cost	Present Worth			
				Capital[2]	O&M	Salvage	Total
1. Three separate WWTPs for Egg Harbor, Fish Creek, and Ephraim	1,603.3	479.7	146.2	2,036.2	1,476.4	(110.3)	3,402.3
2. Two WWTPs - a WWTP for Egg Harbor and one WWTP for Fish Creek and Ephraim at Fish Creek	2,430.4	994.2	116.4	3,086.6	1,175.4	(228.7)	4,033.3
3. Two WWTPs - a WWTP for Egg Harbor and Fish Creek in Section 6 (T30N, R27E) and a WWTP for Ephraim	3,0561.1	1,321.0	113.4	3,881.2	1,145.1	(303.8)	4,722.5
4. A regional WWTP for Egg Harbor, Fish Creek, and Ephraim in Section 6 (T30N, R27E)	3,918.4	1,852.8	83.3	4,975.3	841.2	(426.1)	5,390.4

[1] Present worth is computed from 20 years at 7-5/8% interest

[2] Includes construction cost plus 27% for engineering, administration, and legal, financing and contingencies.

[3] Collection sewer systems in each community are not included.

2.3. System Alternatives

Feasible and compatible sets of component options were combined into system alternatives. The system alternatives represent combinations of conveyance options for various wastewater flows, different treatment processes, siting options, effluent disposal options, sludge processing and disposal options, and onsite system options. The alternatives include no action, independent treatment systems for each community with discharge to either land or bay, and onsite systems. The potential wastewater treatment alternatives were developed and evaluated for technical feasibility, cost-effectiveness, and environmental concerns. These alternatives, including the No Action Alternative, and costs associated with each one are described in the following sections. All cost data are based on December 1981 price levels.

2.3.1. Alternative 1 - No Action Alternative

The No Action Alternative implies that neither USEPA nor WDNR (except on an individual basis through the Wisconsin fund where eligible individual systems can be funded for upgrades through NR 128.30) would provide funds to build, upgrade, or expand existing wastewater treatment systems. Wastewater would be treated in existing onsite systems and no new facility would be built except to replace obviously failed systems. This report assumes, however, that the county health department would assume responsibility for improving existing systems because environmental problems associated with the onsite systems would persist and groundwater pollution may become a problem if no corrective action were taken.

The need for improved wastewater management in each community is not well documented. Cost of pumping existing holding tanks appears to be the major impetus for centralized collection and treatment systems. The number of onsite systems experiencing serious or recurrent surface failures or backups is small. The impact of onsite systems on groundwater quality is a major concern but bacterial problems with properly constructed wells appear to be minimal and are not traced specifically to onsite systems as compared

to other sources. Some onsite systems are affecting the water quality of the bays of Green Bay and Lake Michigan on a very localized basis, as observed by the water quality analyses conducted in conjunction with the septic leachate detector survey. With the No Action Alternative, the health authorities would not have adequate justification for inspecting individual onsite systems and ordering upgrades where no persistent surface breakout is occurring. They are unlikely to have the time, personnel, or monitoring capabilities to be able to identify and solve potential problems with onsite systems.

Furthermore, no project would be instituted to mitigate the high cost for businesses to pump holding tanks. The result would be an increasing number of holding tanks that have high operational costs. The number of systems to be upgraded, and the costs of upgrading, operating and maintaining the onsite systems have not been estimated because too little information has been gathered to project future upgrades. Information on the actual soil conditions in the more densely developed areas and past failure rates are not known. In addition, the attitudes of the regulatory agencies toward petitions of modifications for existing structures are not clearly perceived.

2.3.2. Village of Egg Harbor Alternatives

The alternatives for Egg Harbor include sewers and treatment plants or onsite systems for two service areas for the downtown and onsite systems for the remainder of the village. The needs documentation does not clearly establish that septic tank and soil absorption systems are causing groundwater or surface water contamination problems in the village. The inferred evidence, particularly depth to bedrock and small lot size, does show need for improved waste treatment systems, primarily in the downtown area and also in outlying areas. The areas for which sewers were investigated are shown in Figure 2-17 and 2-18. The larger area (Figure 2-17) is consistent with the area shown in the Facilities Plan and the smaller area (Figure 2-18) is based on inferred evidence from the needs documentation.

The collection systems considered for the larger area (Figure 2-17) were the conventional gravity and the STE gravity. For both treatment plant locations, Sec. 24 T30N R26E and Sec. 31 T30N R27E, the conventional gravity systems are the least costly (Appendix E; Table E-10). For the smaller area (Figure 2-18), the septic tank effluent pressure sewers were also considered for the Sec. 31 site. Conventional gravity systems are the least costly (Appendix E; Table E-10) for both treatment plant locations. (Note: In Figures 2-17 and 2-18 the layout is the same for conventional and STE gravity sewers.)

The treatment plant locations (Figure 2-19) were selected based on the recommended site of the Facilities Plan (Sec. 24 T30N R26E) and a general site (Sec. 31 T30N R27E) where a cluster drainfield or a land application system could likely be located. An aerated lagoon and a RBC WWTP were evaluated for both sewer service areas. The RBC system was recommended in the Facilities Plan although the aerated lagoon was least costly. In this analysis, the aerated lagoon was deemed to be technically feasible and the least cost system (Appendix E; Table E-20). The aerated lagoon also was utilized as the treatment process within the land application system. The cluster drainfield and land application options are located in Sec. 31 and 30, respectively, T30N R27E (Figure 2-19). The outfall from the WWTP would discharge to Green Bay at a depth of 25 to 30 feet.

Each alternative for Egg Harbor will include the continued use of onsite systems in some or all subareas. The estimated numbers and costs of onsite systems to be upgraded and future systems are given in Appendix E, Table E-29 through E-32.

Alternative 1 - No Action

The No Action Alternative is discussed in general in Section 2.3.1. The total present worth cost of the No Action Alternative would probably be considerably less (about one-half) than Alternative 7 - upgraded onsite systems for all subareas. This estimate is based on the assumption that few of the existing onsite systems would be replaced during the project period.

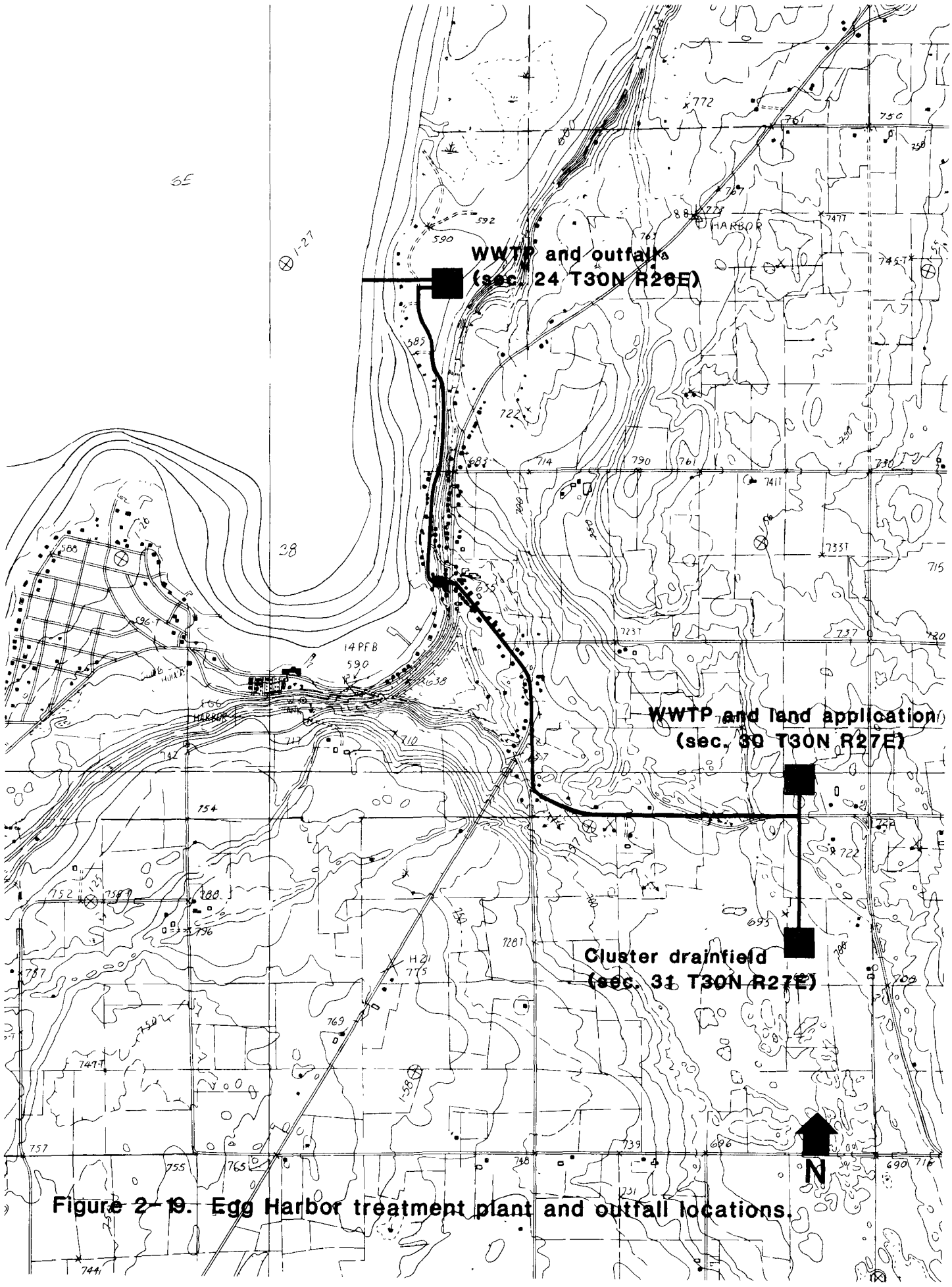


Figure 2-19. Egg Harbor treatment plant and outfall locations.

Table 2-16. Summary of estimated present worth costs for Egg Harbor alternatives (December 1981, $1000).

Alternative	Collection and transmission	Treatment	Disposal	Onsite Component	Total	Average annual equivalent cost[1]	Ranking
1. No Action							
2A. Conventional gravity collection system for Subarea 1A, 1B, and 2A, transmission to aerated lagoon WWTP in Sec. 24 T30N R26E, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.	866.7	490.3	132.5	678.3	2,167.6	214.6	5
2B. Conventional gravity collection system for Subarea 1A, 1B, and 2A, transmission to RBC WWTP in Sec. 24 T30N R26E, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.	867.7	873.2	132.5	678.3	2,550.7	252.5	6
3. STE gravity collection system for Subareas 1A, 1B, and 2A, transmission to site in Sec. 31 T30N R27E and treatment and disposal in cluster soil absorption system; upgraded onsite systems for remainder of subareas.	885.2	-	484.2	678.3	2,047.7	202.8	4
4. Conventional gravity collection system for Subareas 1AN, 1BS, and 2AS, transmission to aerated lagoon WWTP in Sec. 24 T30N R26E, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.	410.7	400.1	132.5	929.0	1,872.3	185.4	3
5. STE gravity collection system for subareas 1AN, 1BS, and 2AS, transmission to site in Sec. 31 T30N R27E, and treatment and disposal in cluster soil absorption system; upgraded onsite systems for remainder of subareas.	561.7	-	303.0	929.0	1,793.7	178.0	2
6. Conventional gravity collection systems for Subareas 1AN, 1BS, and 2AS, transmission to and treatment at land application site in Sec. 31 T30N R27E; upgraded onsite systems for remainder of subareas.	516.2	400.1	202.3	929.0	2,047.6	202.8	4
7. Upgraded onsite systems for all subareas.	-	-	-	1,670.1	1,670.1	165.4	1

[1] Amortized at 7.625% over 20 years.

Alternative 2A - Conventional gravity collection system for Subareas 1A, 1B, and 2A, transmission to aerated lagoon WWTP in Sec. 24 T30N R26E, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.

This alternative consists of the most cost-effective components for the large sewer service area and a bay discharge. The sewer service area and the aerated lagoon location are shown in Figure 2-17. The estimated present worth costs of the collection and transmission, treatment, discharge, and onsite system components are displayed in Table 2-16. The total present worth cost is estimated to be $2,167,600.

Alternative 2B - Conventional gravity collection system for Subareas 1A, 1B, and 2A, transmission to RBC WWTP in Sec. 24 T30N R26E, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.

This alternative is similar to the alternative recommended in the Facilities Plan. It consists of the most cost-effective collection system and the treatment system deemed to have the least siting problem in Sec. 24 (same WWTP site as for Alternative 2B). The sewer service area and the RBC WWTP location are shown in Figure 2-17. The estimated present worth costs of the collection and transmission, treatment, discharge, and onsite systems components are displayed in Table 2-16. The total present worth cost of the alternative is estimated to be $2,550,700.

Alternative 3 - STE gravity collection system for Subareas 1A, 1B, and 2A, transmission to site in Sec. 31 T30N R27E, and treatment and disposal in cluster soil absorption system; upgraded onsite systems in remainder of subareas.

This alternative consists of STE gravity sewers and a cluster drainfield. The assumption was made that most of the existing septic tanks would not be replaced and therefore it would be less costly to utilize them as compared to a community septic tank. The site identified for a possible cluster drainfield was selected based on the soil maps prepared by the SCS. No field inspection has been conducted. The sewer service area is shown in Figure 2-17 and the cluster drainfield site is shown in Figure 2-19. The estimated present worth costs of collection and transmission, disposal, and onsite systems components are displayed in Table 2-16. The total present worth cost of this alternative is estimated to be $2,047,700.

Alternative 4 - Conventional gravity collection systems for Subareas 1AN, 1BS, and 2AS, transmission to aerated lagoon WWTP in Sec. 24 T30N R26E, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.

This alternative features the reduced sewer service area and, in other respects, is similar to Alternative 2A. The sewer service area and the aerated lagoon location are shown in Figure 2-18. The estimated present worth costs of the collection and transmission, treatment, discharge, and onsite systems components are displayed in Table 2-16. The total present worth cost is estimated to be $1,872,300.

Alternative 5 - STE gravity collection system for Subareas 1AN, 1BS, and 2AS, transmission to site in Sec. 31 T30N R27E, and treatment and disposal in cluster soil absorption system; upgraded onsite systems for remainder of subareas.

This alternative is similar to Alternative 3, except the sewer service area is smaller. The sewer service area is shown in Figure 2-18 and the site for the cluster drainfield is shown in Figure 2-19. The estimated present worth costs of collection and transmission, disposal, and onsite systems components are displayed in Table 2-16. The total present worth cost is estimated to be $1,793,700.

Alternative 6 - Conventional gravity collection for Subareas 1AN, 1BS, and 2AS and transmission to and treatment at land application site in Sec. 30 T30N R27E; upgraded onsite systems for remainder of subareas.

This alternative features disposal on land by slow-rate irrigation using a permanent sprinkling system. The treatment prior to irrigation would utilize an aerated lagoon. A separate lagoon for winter storage of effluent was costed into the alternative, although a separate lagoon may not be necessary. Artificial drainage was not included in the preliminary design and costs. The sewer service area is shown in Figure 2-18 and the treatment and land application site in Figure 2-19. The estimated present worth costs of the collection and transmission, treatment, land application, and onsite systems components are displayed in Table 2-16. The total present worth cost is estimated to be $2,047,600.

Alternative 7 - Upgraded onsite systems for all subareas.

This alternative consists of upgraded onsite systems and future onsite systems in all subareas. The number of systems to be upgraded was estimated conservatively. The systems that are not obviously causing a direct effluent flow to the bedrock were not included in the estimate of the number of systems to be upgraded. Compliance with Wisconsin code was not used as a criterion for estimating the number of systems to be upgraded. The estimated total present worth of this alternative is $1,670,100.

2.3.3. Community of Fish Creek Alternatives

The alternatives for Fish Creek include sewers and treatment plants or onsite systems for three subareas that encompass the downtown and onsite systems for the remainder of the subareas of the community. The needs documentation does not clearly establish that septic tank and soil absorption systems are causing groundwater or surface water contamination problems except in a limited area along the shoreline. The inferred evidence, particularly, cobbly soils and limited depth to the water table, does show need for improved waste treatment systems within the commercialized downtown area. Depth to bedrock is severely limited within the subareas at the east end of the community. The high percentage of holding tanks that serve commercial establishments and their costly pumping requirements are apparently the impetus for sewering the area. The subareas for which sewers were investigated are shown in Figure 2-20. Subarea 3B was included within the sewer service area for one alternative and excluded for the others. The larger area is somewhat consistent with the Facilities Plan Addendum for Fish Creek.

The collection systems considered were the conventional gravity, STE gravity, and STE pressure sewers. For all WWTP locations, conventional gravity systems are the least costly (Appendix E; Table E-33).

The treatment plant locations (Figure 2-21) were selected based on the recommended site of the Facilities Plan Addendum (NENW Sec. 33), the site investigated for a cluster mound (SWNE Sec. 32), and a general site where a

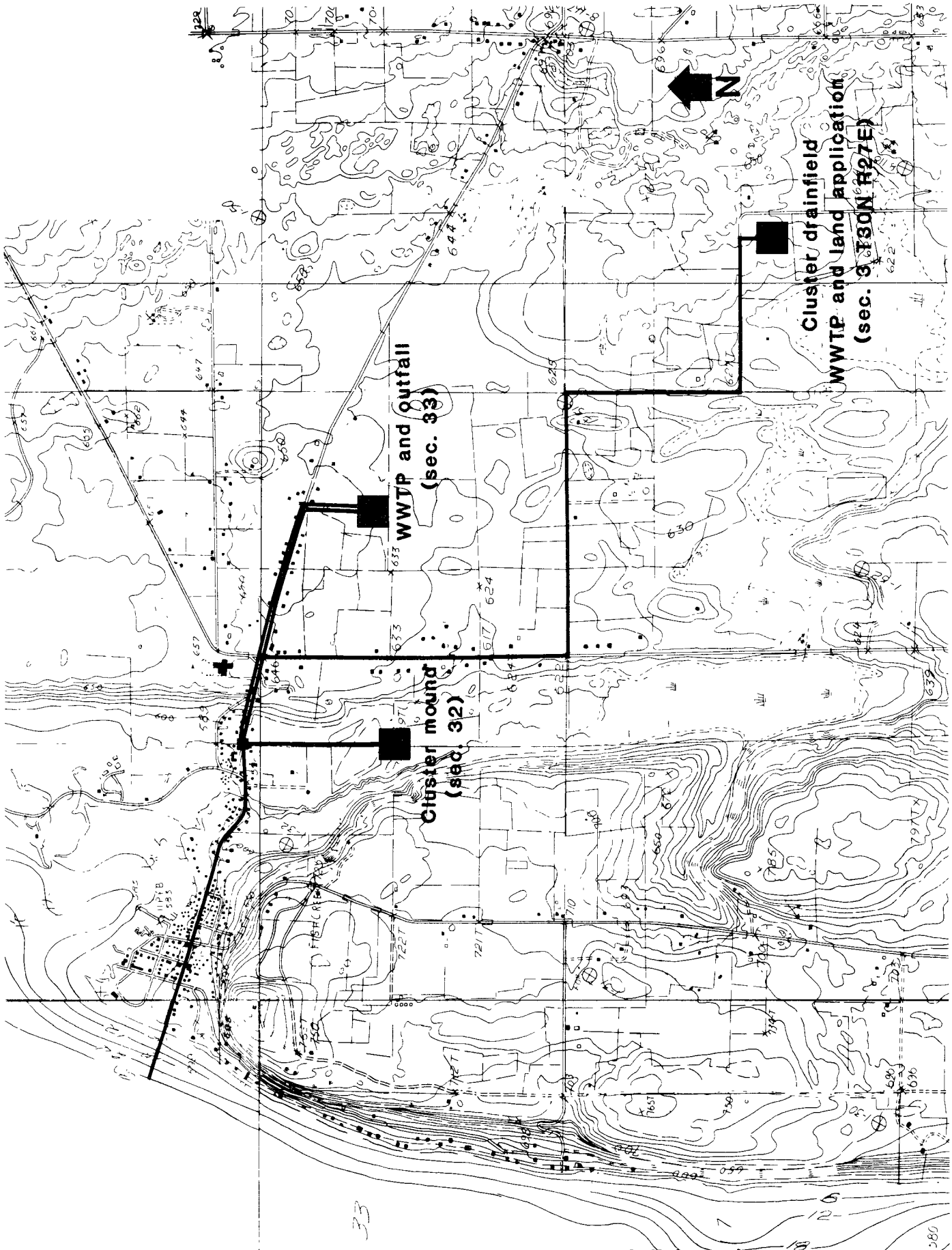


Figure 2-21. Fish Creek treatment plant and outfall locations.

cluster drainfield or land application system may be feasible (Sec. 3). Because the Facilities Plan Addendum for Fish Creek recommended an aerated lagoon, this analysis includes the aerated lagoon for wastewater treatment. The cluster mound was evaluated for the feasible location for limited flows (SWNE Sec. 32), and the cluster drainfield and land application options were evaluated for Sec. 3 (Figure 2-21). The outfall from the WWTP would discharge to Green Bay at a depth of 25 to 30 feet.

Each alternative for Fish Creek will include the continued use of on-site systems in some or all subareas. The estimated numbers and costs of onsite systems to be upgraded and future systems are given in Appendix E; Tables E-46 through E-49.

Alternative 1 - No Action

The No Action Alternative is discussed in general in Section 2.3.1. The total present worth cost of this alternative would be slightly less (approximately one-quarter) than Alternative 7 - upgraded onsite systems for all subareas. The estimated high cost is due to the large number of holding tanks currently being utilized by commercial properties that generate large volumes of wastes during the tourist season. Under the No Action Alternative, it was assumed that few existing systems would fail and would need to be replaced.

Alternative 2 - Conventional gravity collection system for Subareas 2, 3A, and 3B, transmission to aerated lagoon WWTP in NENW Sec. 33, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.

This alternative consists of conventional gravity sewers, the most cost-effective collection system for the larger sewer service area, and aerated lagoon located at NENW Sec. 33, and a discharge to Green Bay. It is similar to the recommended alternative of the Facilities Plan Addendum for Fish Creek. The sewer service area is shown in Figure 2-20 and the WWTP and outfall in Figure 2-21. The estimated present worth costs of the collection, treatment, transmission and discharge, and onsite systems components are displayed in Table 2-17. The total present worth cost is estimated to be $2,913,700.

Table 2-17. Summary of estimated present worth costs for Fish Creek alternatives (December 1981, $1000x).

Alternatives	Collection	Treatment	Transmission and discharge	Onsite component	Total	Average annual equivalent cost[1]	Ranking
1. No Action							
2. Conventional gravity collection system for subareas 2, 3A, and 3B, transmission to aerated lagoon WWTP in NENW Sec. 33, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.	1,017.2	833.2	567.1	496.2	2,913.7	288.5	4
3. Conventional gravity collection system for Subareas 2 and 3A, transmission to aerated lagoon WWTP in NENW Sec. 33, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.	941.7	833.2	567.1	563.8	2,905.8	287.8	3
4. STE gravity collection system for subareas 2 and 3A, transmission to site in SWNE Sec. 32, and treatment and disposal in cluster mound; upgraded onsite systems for remainder of subareas.	1,108.7	-	936.8	563.8	2,609.3	258.4	1
5. STE gravity collection system for Subareas 2 and 3A, transmission to site in Sec. 3 treatment and disposal in cluster drainfield; upgraded onsite systems in remainder of subareas.	1,108.7	-	1,102.7	563.8	2,775.2	274.8	2
6. Conventional gravity collection system for Subareas 2 and 3A and transmission to and treatment at a land application site in Sec. 3; upgraded onsite systems in remainder of subareas.	941.7	833.2	642.8	563.8	2,981.5	295.2	5
7. Upgraded onsite systems for all subareas.				3,276.8	3,276.8	324.5	6

[1] Amortized at 7.625% over 20 years.

Alternative 3 - Conventional gravity collection system for Subareas 2 and 3A, transmission to aerated lagoon WWTP in NENW Sec. 33, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.

This alternative is similar to Alternative 2 except Subarea 3B is excluded from the sewer service area. The sewer service area is shown in Figure 2-20 and the aerated lagoon and outfall location in Figure 2-21. The estimated present worth costs of the collection, treatment, transmission and discharge, and onsite systems components are displayed in Table 2-17. The total present worth cost of this alternative is estimated to be $2,905,800, somewhat less than Alternative 2 indicating that it is not cost-effective to provide sewer service to Subarea 3B.

Alternative 4 - STE gravity collection systems for Subarea 2 and 3A, transmission to site in SWNE Sec. 32, and treatment and disposal in cluster mound; upgraded onsite systems for remainder of subareas.

This alternative consists of STE gravity sewers and a cluster mound. The assumption was made that most of the existing septic tanks would not be replaced and holding tanks can be modified to operate as septic tanks and therefore it would be less costly to utilize them as compared to a community septic tank. The site identified for the community mound has been investigated extensively and is suitable for construction of a mound of limited area. The sewer service area and the cluster mound site are shown in Figures 2-20 and 2-21, respectively. The estimated present worth costs of collection, transmission and disposal, and onsite systems components are displayed in Table 2-17. The total present worth cost of this alternative is estimated to be $2,609,300.

Alternative 5 - STE gravity collection system for Subareas 2 and 3A, transmission to site in Sec. 3, treatment and disposal in cluster drainfield; upgraded onsite systems in remainder of subareas.

This alternative is similar to Alternative 4 except the soil absorption system is a community drainfield in Sec. 3. The general area identified for a cluster drainfield was selected based on the soil maps prepared by the SCS and no field inspection has been conducted. The sewer service area is shown in Figure 2-20 and the cluster drainfield is shown in Figure 2-21. The estimated present worth costs of collection, transmission and disposal, and onsite systems components are displayed in Table 2-17. The total present worth cost of this alternative is estimated to be $2,775,200.

Alternative 6 - Conventional gravity collection system for Subareas 2 and 3A and transmission to and treatment at land application site in Sec. 3; upgraded onsite systems for remainder of subareas.

This alternative proposes disposal on land by slow-rate irrigation using a permanent sprinkling system. The treatment prior to irrigation would utilize an aerated lagoon. A separate lagoon for winter storage of effluent was costed, although a separate lagoon may not be necessary. The additional fill that was included in the cost of the aerated lagoon in Alternatives 2 and 3 would not be necessary at this site although it was included in the costs. Artificial drainage of the application field was not included in the preliminary design and costs. The sewer service area is shown in Figure 2-20 and the treatment and land application site in Figure 2-21. The estimated present worth costs of the collection, treatment, disposal, and onsite systems components costs are shown in Table 2-17. The total present worth cost is estimated to be $2,981,500.

Alternative 7 - Upgraded onsite systems for all subareas.

This alternative consists of upgraded onsite systems and future onsite systems in all subareas. The number of systems to be upgraded was estimated conservatively. The systems that are not obviously causing a direct effluent flow to the bedrock were not included in the estimate of the number of systems to be upgraded. Compliance with the code was not used as a criterion for estimating the number of systems to be upgraded. The estimated total present worth cost of this alternative is estimated to be $3,276,800.

2.3.4. Village of Ephraim Alternatives

The alternatives for Ephraim include sewers and treatment plants or onsite systems for: 1) a service area of nearly the whole community, and 2) a service area of the downtown, with onsite systems for the remainder of the village. The needs documentation does not clearly establish that septic tank and soil absorption systems are causing groundwater contamination problems in the village. Elevated levels of nitrate and phosphorus were measured in surface water streams and shallow groundwater in Subarea

1B but the source may be the Ephraim Swamp. Other swamps in the study area exhibited similar elevated nutrient analyses. The inferred evidence, particularly depth to bedrock on the uplands, cobbly soil in the downtown, and depth to water table in Subarea 1B, does demonstrate that potential problems of groundwater contamination may be present. The large number of existing and proposed holding tanks in the downtown area indicates that a lower cost sewage treatment alternative could be developed. The areas for which sewers were investigated are shown in Figures 2-22 and 2-23. The larger area (Figure 2-22) is consistent with the sewer service area of the Facilities Plan. The reduced sewer service area (Figure 2-23) is based on inferred evidence from the needs documentation.

The collection systems considered were the conventional gravity and the STE gravity. The conventional gravity system was lowest cost for both sewer service areas (Appendix E; Table E-50).

The treatment plant location (Figure 2-24) was selected based on the recommended site and the recommended system, aerated lagoon, of the Facilities Plan (Sec. 24). The discharge or disposal locations are slightly different from the Facilities Plan. The Green Bay outfall was extended to the 30-foot depth and this necessitated routing the outfall forcemain to leave land considerably north of the location presented in the Facilities Plan in order to keep the underwater outfall length as short as possible. The discharge to the wetland was located near the center of Sec. 25. The cluster drainfield would be located on a site in Sec. 24 where the soils and hydrogeologic conditions appear to be suitable for a cluster drainfield.

Each alternative for Ephraim includes the continued use of onsite systems in some or all subareas. The estimated numbers and costs of onsite systems to be upgraded and future systems are given in Appendix E, Tables E-64 through E-66.

Alternative 1 - No Action.

The No Action Alternative is discussed in Section 2.3.1. The total present worth cost of this alternative would probably be about one-third

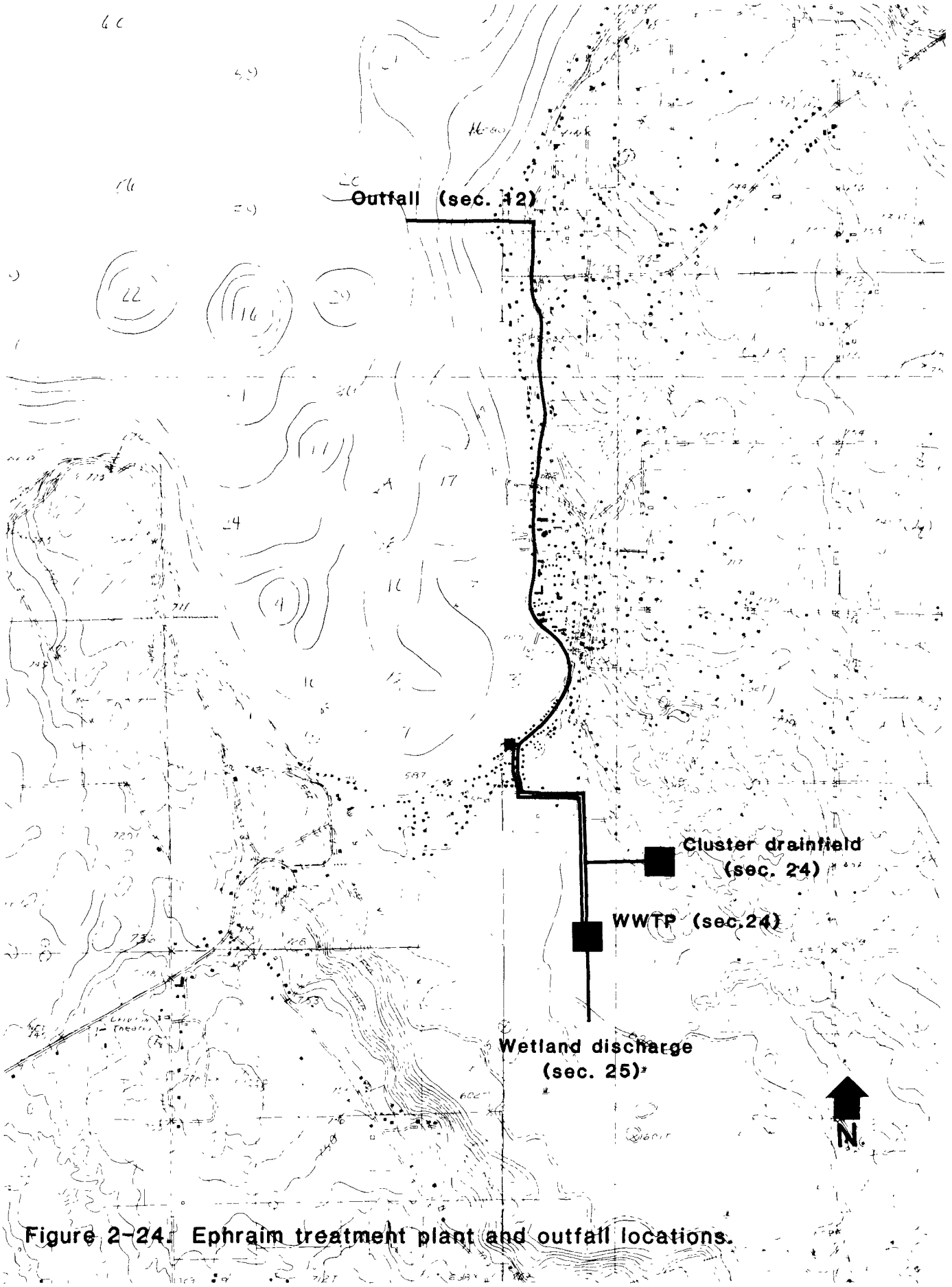


Figure 2-24. Ephraim treatment plant and outfall locations.

less than Alternative 6 - upgraded onsite systems for all subareas. This estimate is based on the assumption that few of the existing onsite systems would be replaced during the project period. The number of complete replacement systems has not been very high within the village, except where additions to structures have been constructed.

Alternative 2 - Conventional gravity collection system for Subareas 1, 2, 3, 5, and 6, transmission to aerated lagoon WWTP in Sec. 24, and discharge to Green Bay; upgraded onsite systems for Subarea 4.

This alternative consists of the most cost-effective components for the larger sewer service area and a bay discharge. The sewer service area (Figure 2-22), the aerated lagoon WWTP, and the bay discharge (Figure 2-24) are similar to the Facilities Plan. The estimated present worth costs of the collection and transmission, treatment, discharge, and onsite systems components are displayed in Table 2-18. The total present worth cost of this alternative was estimated to be $5,918,900.

If a more northerly WWTP location (such as in Sec. 13) would be feasible, the outfall costs for this alternative would be reduced. In this area it would be difficult to locate the plant a minimum of 750 feet from the nearest inhabited dwelling as required by the Wisconsin Code. It is estimated that the total present worth costs would be reduced by $570,000.

Alternative 3 - Conventional gravity collection system for Subareas 1A, 1B, and 2, transmission to aerated lagoon WWTP in Sec. 24, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.

This alternative is similar to Alternative 2 except the sewer service area is reduced considerably (Figure 2-23). The aerated lagoon and outfall locations are shown in Figure 2-24. The estimated present worth costs of collection and transmission, treatment, discharge, and onsite systems components are displayed in Table 2-18. The total present worth cost of this alternative is estimated to be $3,962,600.

Similar to Alternative 2, if a more northerly WWTP location was feasible, the total estimated present worth cost of this alternative could be reduced by $390,000.

Table 2-18. Summary of estimated present worth costs for Ephraim alternatives (December 1981, $1,000x).

Alternatives	Collection and Conveyance	Treatment	Disposal	Onsite Component	Total	Average annual equivalent cost[1]	Ranking
1. No Action							
2. Conventional gravity collection system for all subareas except Subarea 4, transmission to aerated lagoon WWTP in Sec. 24, and discharge to Green Bay; upgraded onsite systems for Subarea 4.	3,741.7	749.9	467.9[2]	959.3	5,918.9	586.1	5
3. Conventional gravity collection system for Subarea 1A, 1B, and 2, transmission to aerated lagoon WWTP in Sec. 24, and discharge to Green Bay; upgraded onsite systems for remainder of subareas.	1,301.6	670.5	822.9[2]	1,167.6	3,962.6	392.4	4
4. Conventional gravity collection system for Subareas 1A, 1B, and 2, transmission to aerated lagoon WWTP in Sec. 24, and discharge to wetlands; upgraded onsite systems for remainder of subareas.	1,301.6	670.5	514.4	1,167.6	3,654.1	361.9	3
5. STE gravity collection system for Subareas 1A, 1B, and 2, transmission to site in Sec. 24, and treatment and disposal in cluster drainfield; upgraded onsite systems in remainder of subareas.	1,325.6	-	890.6	1,167.6	3,383.9	335.1	2
6. Upgraded onsite systems for all subareas.	-	-	-	2,938.5	2,938.5	291.0	1

[1] Amortized at 7.625% over 20 years.

[2] A more northerly location of the WWTP would reduce outfall costs significantly.

Alternative 4 - Conventional gravity collection system for Subareas 1A, 1B, and 2, transmission to aerated lagoon WWTP in Sec. 24, and discharge to wetlands; upgraded onsite systems for remainder of subareas.

This alternative features disposal of the aerated lagoon effluent in the Ephraim Swamp in Sec. 25 (Figure 2-24). The effluent would be discharged along the edge of the wetland using multiple outlets so that the effluent discharge would dispersed over a broad area. The sewer service area is shown in Figure 2-23. The estimated present worth costs of collection and transmission, treatment, disposal, and onsite systems components are displayed in Table 2-18. The total present worth cost is estimated to be $3,654,100.

Alternative 5 - STE gravity collection systems for Subareas 1A, 1B, and 2, transmission to site in Sec. 24, and treatment and disposal in cluster drainfield; upgraded onsite systems in remainder of subareas.

This alternative consists of STE gravity sewers and a cluster drainfield. The assumption was made that most of the existing septic tanks would not be replaced and the holding tanks could be modified to perform as septic tanks and therefore it would be less costly to utilize them as compared to a community septic tank. The site identified for a possible cluster drainfield was selected based on the soil maps prepared by the SCS. No field inspections have been conducted. The slopes may necessitate some special design solutions that are more costly than that prepared for this document. The sewer service area is shown in Figure 2-23 and the generalized location of the cluster drainfield is shown in Figure 2-24. The estimated present worth costs of collection, treatment and disposal, and onsite systems components are displayed in Table 2-18. The total present worth cost of this alternative is estimated to be $3,383,900.

Alternative 6 - Upgraded onsite systems for all subareas.

This alternative consists of upgraded onsite systems and future onsite systems in all subareas. The number of systems to be upgraded was estimated conservatively considering systems should be upgraded only if there is strong suspicion that effluent is contaminating groundwater or surface water. The systems that are not obviously causing a direct effluent flow

to the bedrock or the ground water were not included in this estimate. Compliance with the code was not used as a criterion for estimating the number of systems to be upgraded. Future systems were estimated based on comparisons to the systems presently being installed in an area. The estimated total present worth cost of this alternative is $2,938,500.

2.3.5. Community of Baileys Harbor Alternatives

The alternatives for Baileys Harbor include sewers and treatment plants or onsite systems for two subareas that encompass the downtown and onsite systems for the remainder of the community. The needs documentation does not clearly establish that septic tank and soil absorption systems are causing contamination of groundwater or surface water. Some isolated failing systems were identified by the septic leachate detector. The inferred evidence, particularly depth to bedrock, does show a likelihood that less than fully treated effluent is reaching the bedrock. The number of holding tanks with high pumping costs serving downtown businesses may indicate that a sewer system could provide more cost-effective sewage treatment. The subareas for which sewer service was considered are similar to the Facilities Plan recommended sewer service area (Figure 2-25). Subarea 3 alone constitutes the second sewer service area (Figure 2-26).

The collection systems considered were the conventional gravity and the STE gravity for the larger sewer service area and the conventional gravity, STE gravity, and STE pressure for the smaller sewer service area. In both cases, the conventional gravity was least costly (Appendix E; Table E-67).

The treatment plant locations (Figure 2-27) were selected based on the recommended site within the Facilities Plan (Sec. 17) and sites near the proposed discharge areas (Sec. 7 and 8).

Because the recirculating sand filter was the treatment alternative recommended in the Facilities Plan, this analysis includes the filter as an alternative component along with the aerated lagoon WWTP. Soils that were potentially suitable for a cluster drainfield or a land application system

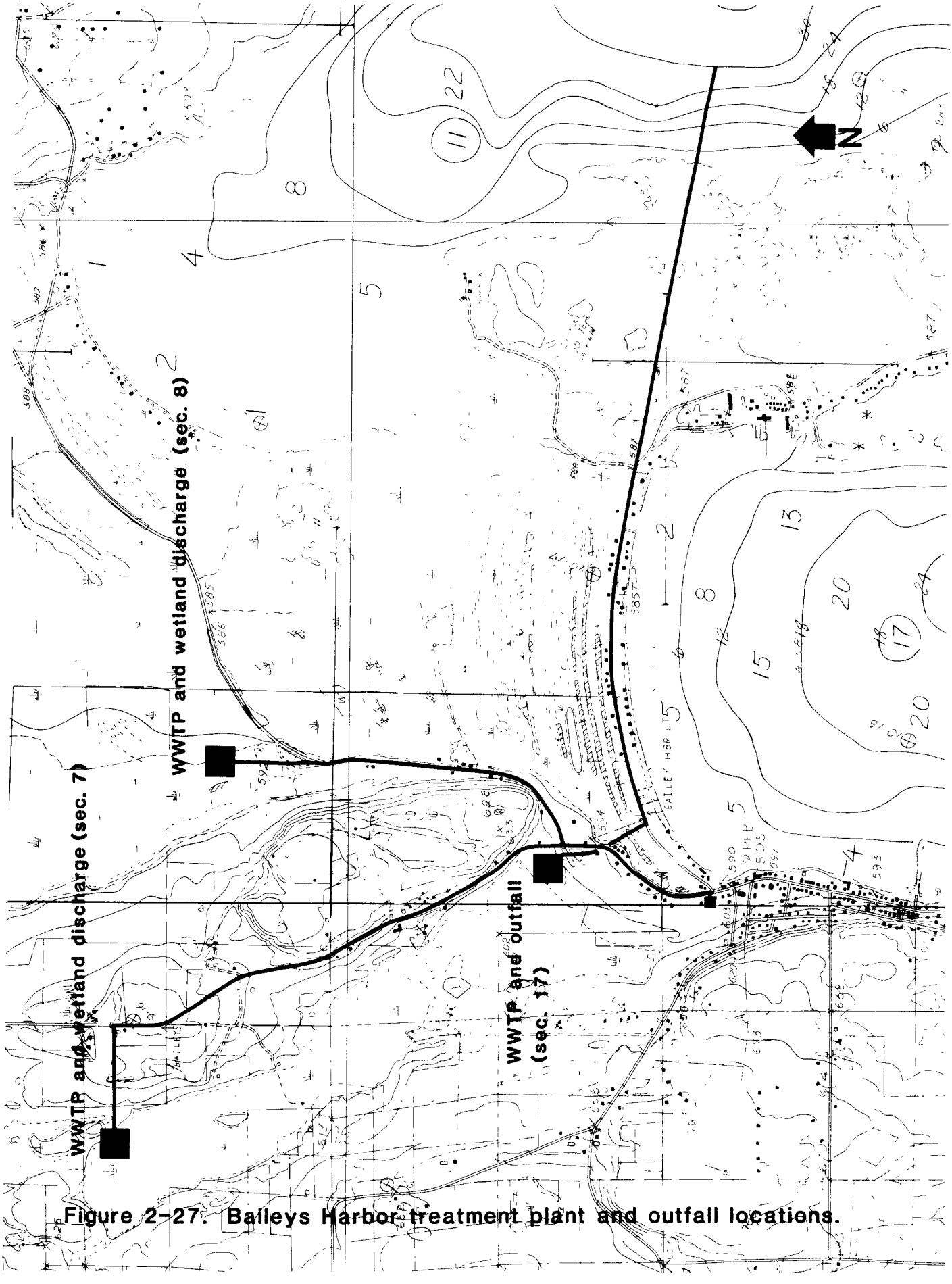


Figure 2-27. Baileys Harbor treatment plant and outfall locations.

were located only at a considerable distance from the community; thus, no alternatives that incorporate those components were developed. Two wetlands discharge locations were considered. One site in Sec. 8 was recommended in the Facilities Plan but that site is adjacent to the Mud Lake National Natural Landmark and this discharge has the potential to adversely impact this area. Therefore, a second discharge site was considered in Sec. 7. An outfall to Baileys Harbor was presumed to be unacceptable, based on contacts with the FWS and WDNR. For that reason, the outfall was extended to Lake Michigan east from the community.

Each alternative for Baileys Harbor will include the continued use of onsite systems in some or all subareas. The estimated numbers and costs of onsite systems to be upgraded and future systems are given in Appendix E; Tables E-82 through E-85.

Alternative 1 - No Action

The No Action Alternative is discussed in Section 2.3.1. The number of replacement systems in this alternative would probably not be very large, based on records of replacements at the Door County Sanitarian's office. The total present worth cost of this alternative would likely be between one-third to one-half less than Alternative 6 - upgraded onsite systems for all subareas. According to the best available information, a large number of onsite systems are currently constructed with too little clearance between the seepage bed and bedrock. Under this alternative, these would not be upgraded, thus the considerable cost savings.

Alternative 2A - Conventional gravity collection system for Subareas 3 and 6, transmission to aerated lagoon WWTP, and discharge to wetland in Sec. 8; upgraded onsite systems for remainder of subareas.

This alternative consists of conventional gravity sewers, the most cost-effective collection system, an aerated lagoon and the wetland discharge located at the site recommended in the Facilities Plan. The sewer service area is shown in Figure 2-25 and the aerated lagoon and discharge location is shown in Figure 2-27. The estimated present worth costs of the collection, conveyance, treatment, discharge, and onsite systems components

are displayed in Table 2-19. The total present worth cost is estimated to be $4,237,700.

Alternative 2B - Conventional gravity collection systems for Subareas 3 and 6, transmission to recirculating sand filter WWTP, and discharge to wetland in Sec. 8; upgraded onsite systems for remainder of subareas.

This alternative is similar to the recommended alternative in the Facilities Plan. It consists of the most cost-effective collection system combined with the treatment system considered by the Facilities Planners to be best suited to Baileys Harbor. The sewer service area is shown in Figure 2-25 and the recirculating sand filter and wetland discharge is shown in Figure 2-27. The estimated present worth costs of the collection, conveyance, treatment, disposal, and onsite systems components are displayed in Table 2-19. The total present worth cost of this alternative is estimated to be $4,537.300.

Alternative 3 - Conventional gravity collection system for Subareas 3 and 6, transmission to aerated lagoon WWTP and discharge to wetland in Sec. 7; upgraded onsite systems for remainder of subareas.

This alternative is similar to Alternative 2A except a less environmentally sensitive wetland would receive the discharge from the WWTP. The wetland in Sec. 7 appears to be hydrologically independent of the Ridges Sanctuary and the Mud Lake landmark. The sewer service area is shown in Figure 2-25 and the aerated lagoon and wetland discharge is shown in Figure 2-27. The estimated present worth costs of collection, conveyance, treatment, discharge, and onsite systems components are displayed in Table 2-19. The total present worth cost of this alternative is estimated to be $4,344.000.

Alternative 4 - Conventional gravity collection system for Subarea 3, transmission to aerated lagoon WWTP in Sec. 17, and discharge to Lake Michigan; upgraded onsite systems for remainder of subareas.

This alternative is the most feasible lake discharge option for Baileys Harbor. The discharge would be located in the lake directly east of Ridges Road along the section line. The WWTP would be located at the site at the intersection of CTH Q and STH 57 that the Facilities Planners had recommended (Figure 2-27). The sewer service area is shown in Figure

Table 2-19. Summary of estimated present worth costs for Baileys Harbor alternatives (December 1981, $1,000x).

Alternatives	Off-site component				On-site Component	Total	Average annual equivalent cost[1]	Ranking
	Collection	Conveyanace	Treatment	Discharge				
1. No Action								
2A. Conventional gravity collection system for subareas 3 and 6, transmission to aerated lagoon WWTP and discharge to wetland in Sec. 8; upgraded onsite systems for remainder of subareas.	1,295.6	269.1	543.7	335.4	1,793.9	4,237.7	419.6	3
2B. Conventional gravity for Subareas 3 and 6, transmission to recirculating sand filter WWTP and discharge to wetland in Sec. 8; upgraded onsite systems for remainder of subareas.	1,295.6	269.1	843.3	335.4	1,793.9	4,537.3	449.3	5
3. Conventional gravity collection system for Subareas 3 and 6, transmission to aerated lagoon WWTP and discharge to wetland in Sec. 7; upgraded onsite systems for remainder of subareas.	1,295.6	375.4	543.7	335.4	1,793.9	4,344.0	430.2	4
4. Conventional gravity collection system for Subarea 3, transmission to aerated lagoon in Sec. 17, and discharge to Lake Michigan; upgraded onsite systems for remainder of subareas.	981.8	109.3	490.1	920.1	1,973.6	4,474.9	443.1	6
5. Conventional gravity collection system for Subarea 3, transmission to aerated lagoon WWTP and discharge to wetland in Sec. 7; upgraded onsite systems for remainder of subarea.	981.8	875.4	490.1	349.0	1,973.6	4,169.9	412.9	2
6. Upgraded onsite systems for all subareas.					3,648.5	3,648.5	351.3	1

2-26 and includes Subarea 3 alone. The estimated present worth costs of collection, conveyance, treatment, discharge, and onsite systems components is displayed in Table 2-19. The total present worth cost is estimated to be $4,474,900.

Alternative 5 - Conventional gravity collection system for Subarea 3, transmission to aerated lagoon WWTP, and discharge to wetland in Sec. 7; upgraded onsite systems for remainder of subareas.

This alternative is similar to Alternative 3 except a reduced sewer service area (Figure 2-26) is involved. The wastewater would be conveyed to Sec. 7 where treatment in an aerated lagoon and discharge to the wetland would occur (Figure 2-27). The estimated present worth costs of collection, conveyance, treatment, discharge, and onsite systems components are displayed in Table 2-19. The total present worth cost of this alternative is $4,169,900.

Alternative 6 - Upgraded onsite systems for all subareas.

This alternative consists of upgraded onsite systems and future onsite systems in all subareas. The number of systems to be upgraded was estimated conservatively considering systems should be upgraded only if there is strong suspicion that effluent is contaminating groundwater or surface water. The systems that are not obviously causing a direct effluent flow to the bedrock or the groundwater were not included in this estimate. Compliance with the code was not used as a criterion for estimating the number of systems to be upgraded. Future systems were estimated based on comparisons to the systems currently being installed in an area. The estimated total present worth cost of this alternative is $3,648,500.

2.3.6. Septage and Holding Tank Wastes Disposal

The estimated volumes of septage and holding tank wastes currently produced are given in Section 2.1.5. Within the study area approximately 255,000 gallons of septage and 10 million gallons of holding tank wastes were disposed of in 1981. The septage estimates were derived from typical values of 65 gallons per capita per year for permanent residences and 15 gallons per capita per year for seasonal residences. Nearly 9 million

gallons per year of holding tank wastes are derived from institutions and businesses, primarily restaurants, motels, cottages, and condominiums. These volumes were summed from the records of the County Health Department. Permanent residences were expected to generate twelve pumpings per year and seasonal residences three pumpings per year at 2,000 gallons per pumping.

The range of alternatives presented in this document would produce varied volumes and proportions of septage and holding tank wastes from within the planning area. Under the alternatives that feature complete onsite systems, 275,500 gallons per year of septage and 30 million gallons per year of holding tank wastes would be generated. Under the alternatives that feature conventional gravity sewers for the larger service areas, 182,000 gallons per year of septage and 7 million gallons of holding tank wastes would be generated. The other alternatives and combinations of alternatives would generate volumes of liquid wastes that range between these numbers. If all the communities were to have septic tank effluent gravity or pressure sewers, the volume of septage produced would be slightly greater than that shown for the full onsite alternatives.

Safe application rates for septage and holding tank wastes are usually based on total nitrogen loadings. Other septage constituents of primary concern from a public health and water quality perspective are pathogens and phosphorus. Both are relatively immobile in typical soils. Nitrogen is the principal constituent of concern. The nitrogen loading criterion used in this study is 300 pounds per acre per year (USEPA 1980b). The current estimated septage production rate would require an area of 5 acres for disposal. Disposal of the existing holding tank wastes would require approximately 45 acres if the assumption concerning nitrogen concentration is correct.

Based on the previously listed volumes of septage and holding tank wastes and the safe nitrogen loading rates, the land application area requirements are:

Alternatives	Septage	Holding tank wastes	Total
Current	4.8 ac	44.5 ac	50 ac
All onsite	5.2 ac	131 ac	136 ac
All centralized gravity	3.4 ac	30 ac	34 ac

The greatest land area requirement is 136 acres for the full onsite alternatives (year 2000 condition). Considering the extensive land areas suitable for application of liquid wastes, no problem is anticipated in identifying sufficient suitable land. For example, the Reinhards, who dispose of the greatest volume of wastes, have 220 acres of land on CTH F between Fish Creek and Baileys Harbor. Approximately 60 acres of their land meets the 36 inch unsaturated soil depth and 500 foot isolation distance requirement. Thus, their land alone would suffice for disposal of all the septage and holding tank wastes of several of the alternatives. If the maximum application rate of 30 gallons per 100 square foot per day specified in the Wisconsin code were used and all the liquid wastes were to be disposed of in 4 months, all of the liquid wastes could be disposed of on 20 acres for the full onsite alternative.

The cost of treating holding tank wastes at the Fish Creek aerated lagoon was estimated to be $4.10 per 1000 gallons (By letter, Mr. James M. McDonald, Foth & Van Dyke and Associates, Inc. to Mr. Edward K. Lynch, WDNR Bureau of Wastewater Management, 23 June 1982). While the cost of applying these wastes to land cannot be compared directly to this cost, it is unlikely to be as great. Thus, unless the haulers are required by regulation to dispose of these wastes at the treatment plants, it is unlikely that they will. For the purpose of this document, the assumption was made that both septage and holding tank wastes will be disposed of on land.

2.4. Flexibility and Reliability of System Alternatives

2.4.1. Flexibility

Flexibility measures the ability of a system to accommodate future growth and depends on the ease with which a system can be upgraded or modified. The alternatives considered in this report include centralized collection sewer systems; wastewater treatment plants with bay, wetland, or land discharge; community mound and drainfield soil absorption systems; and various onsite systems. Because each alternative consists of a combination of components, flexibility is discussed on a component basis.

For gravity (conventional and septic tank effluent) and pressure sewer systems, the flexibility to accommodate future increases in flow greater than the original design flow is generally low. The interceptor sewers are generally designed for capacity beyond the planning period. To increase the capacity of collector sewers is a somewhat expensive process. In addition, the layout of the system depends upon the location of the treatment facility. The expansion of a sewer system is generally easy with the addition of new sewers but this option is expensive.

The ability to expand a conventional WWTP depends largely upon the processes being used, the layout of the facilities, and the availability of additional land for expansion. The expansion or upgrading of most of the treatment processes considered in the proposed WWTPs is relatively easy. With proper design of process components of the treatment plant and proper planning of the facility layout, the cost and effort required for expansion may be relatively small. Most conventional treatment processes also have good operational flexibility because operators can, to some extent, vary treatment parameters.

The ability to expand a wetland or land application discharge depends on the availability of additional land suitable for expansion. For the sites considered, additional suitable land is available. Flexibility for expansion of outfalls for bay discharge is similar to that of collection sewers and is somewhat limited and more costly in comparison with expansion of wetland and land application discharge facilities.

Onsite systems are flexible in that they are generally designed for each user. As long as spatial and environmental parameters are met, the type of system can be chosen according to individual requirements. Existing septic systems can be expanded by adding tank and drain field capacity, if suitable land is available. Flow can then be distributed to an added system with little disturbance of the existing one. In the case of mound systems, a second mound would be required; thus, future expansion may be difficult or impossible depending on the availability of a suitable area. Community systems treat wastewater from more than one house. The flexibility for design and expansion of such a system is somewhat less than for a standard septic system.

Based on the above discussion, it can be concluded that the majority of the alternatives considered in this report generally have similar flexibility for future growth and/or planning.

2.4.2. Reliability

Reliability measures the ability of a system or system components to operate without failure at its designed level of efficiency. It is particularly important to have dependable operation in situations where adverse environmental or economic impacts may result from failure of the system.

The gravity sewer is highly reliable when designed properly. Such systems require little maintenance, consume no energy, and have no mechanical components to malfunction. Gravity sewer problems can include clogged pipes that result in sewer backups; infiltration/inflow which increases the volume of flow beyond the design level; and broken or misaligned pipes. Major contributors to these problems are improperly jointed pipes and damage to manholes, especially where they are not located in paved roads. Where large sewers are used in order to achieve lower pipe slopes, problems with solids deposition can mean that frequent flushing with large volumes of water will be necessary.

Pump stations and force mains increase operation and maintenance requirements and decrease the system reliability. Backup pumps are installed in order to provide service in case one pump fails, and a backup power source is usually provided, either dual power lines, or stationary or portable emergency generators. Force mains are generally reliable; excessive solids deposition and burst pipes occur rarely. Leaking joints occur more frequently and can cause environmental damage.

Septic tank effluent pumps and pressure sewers generally are reliable means of conveying effluent to treatment. Because the solids have been removed in the septic tank, problems associated with solids deposition are avoided. The pump units themselves have been shown to be reliable; when failure or power outages do occur, storage of about 1.5 day's sewage volume

in the pump chamber and septic tank permits replacements to be made before backups occur. The pressure sewers themselves should be even more reliable than force mains because the pumped liquid is clear.

Federal Guidelines for Design, Operation, and Maintenance of Wastewater Treatment Facilities (Federal Water Quality Administration 1970) require that:

> All water pollution control facilities should be planned and designed so as to provide for maximum reliability at all times. The facilities should be capable of operating satisfactorily during power failures, flooding, peak loads, equipment failure, and maintenance shutdowns.

The wastewater control systems design for the project area should consider the following types of factors to insure system reliability:

- Duplicate sources of electric power
- Standby power for essential plant elements
- Multiple units and equipment to provide maximum flexibility in operation
- Replacement parts readily available
- Holding tanks or basins to provide for emergency storage of overflow and adequate pump-back facilities
- Flexibility of piping and pumping facilities to permit rerouting of flows under emergency conditions
- Provision for emergency storage or disposal of sludge
- Dual chlorination units
- Automatic controls to regulate and record chlorine residuals
- Automatic alarm systems to warn of high water, power failures, or equipment malfunction
- No treatment plant bypasses
- Design of interceptor sewers to permit emergency storage without causing backups
- Enforcement of pretreatment regulations to avoid industrial waste-induced treatment upsets

- Floodproofing of treatment plant
- Plant Operations and Maintenance Manual to have a section on emergency operation procedures
- Use of qualified plant operators.

The wastewater treatment portion of the alternatives would be highly reliable if these measures were incorporated. The collection systems are less reliable because pump stations are required. If dual power lines from separate substations can be extended to every pump station or, if auxiliary power units are supplied for each station, a reasonable level of reliability can be attained. A failure of a pump station would likely result in raw sewage or septic tank effluent being discharged. When more than one pump station must operate in series, a failure of one downstream station would likely result in spillage.

Discharge of WWTP effluent to the bay or lake involves pumping and transmission mains, and would have reliability similar to collection systems.

Land application of WWTP effluent is still not very common in the United States (compared to the number of surface water discharges), but its use is growing steadily. Potential problems with land application include: mounding of groundwater under the site; elevated nitrate levels in the groundwater, surface water contamination; and difficulty in farming the site. These problems can be minimized with proper design of the facility.

Wetland discharge of WWTP effluent is less common than land application, but its use is also growing. In Wisconsin, WWTP effluent discharge to wetlands may be required to be treated to a higher level than secondary (effluent BOD_5 and suspended solids must both be 20 mg/l or less) which minimizes some potential impacts but adds an additional process (intermittent sand filtration). The major potential problem is possible alteration of the hydrologic system in the wetland which in turn can disturb the local vegetation. Other potential problems are heavy metal accumulation, increased solids in the spring and fall outwashes, and changes in species composition due to added levels of nutrients and pH changes. These prob-

lems can be minimized with proper preliminary site investigation and proper design of the facility.

In addition to these considerations, the wetland discharge site for Baileys Harbor in Sec. 8 that was proposed in the 1980 Facilities Plan and further evaluated in this Environmental Report is adjacent to the Ridges Sanctuary and the Mud Lake Natural Area. Both areas are designated National Natural Landmarks and Wisconsin Scientific Areas. Because of the high quality of the entire wetland complex, as evidenced by its species diversity and uniqueness, and because of the protected status of the areas adjacent to the proposed discharge site, the use of the proposed site in Sec. 8 would be subject to critical review and would require coordination and/or approval from the US Fish and Wildlife Service, US National Park Service, and WDNR.

The alternative wetland discharge site (Sec. 7) for Baileys Harbor that was evaluated in this Environmental Report is approximately two miles west of the Mud Lake Natural Area. However, because the wetland discharge site is within the overall wetland complex that includes the Mud Lake Natural Area and the Ridges Sanctuary, and there is a hydrologic connection between the proposed discharge site and the two natural areas, the use of this site for effluent disposal also would be subject to critical review. A finding of no impact by the US National Park Service and WDNR would be required before either of the wetland discharge sites that were investigated for Baileys Harbor could be considered as viable components of a wastewater treatment alternative.

The onsite systems are generally a reliable means of treating and disposing of wastewater. Except with certain systems, they operate with no power inputs and little attention. When failures do occur, the impact on the environment is small and diffuse. Total failures rarely occur in which no treatment at all takes place.

Septic tanks provide reliable treatment when they are properly designed and maintained. The principal maintenance requirement is periodic pumping of the tank, usually every three to five years. The treatment

process can be harmed if large quantities of strong chemicals are flushed into the tank.

Soil absorption systems generally provide excellent treatment if the design and installation are accomplished properly and the soil conditions are suitable. Other key factors in the successful operation of soil absorption systems are proper functioning of the septic tank or other treatment unit and observance of reasonable water conservation practices consistent with the design flows. Soil absorption systems can malfunction when extended wet weather results in saturation of the soil, when solids carryover plugs the seepage bed, and when compaction of the soil surface results in restricted permeability. Mound soil absorption systems are more reliable than seepage bed systems where water tables are high because the potential groundwater problems are minimized. They do require an effluent pump, though, and rely on a dependable power supply. The septic tank and pump chamber generally can hold about 1.5 days of storage, which is probably longer than the average power outage. A malfunctioning pump can be replaced readily if the units are standardized. The cost of a mound system is about two times that of a seepage bed system; thus, it would be utilized only where a seepage bed system has failed or has little chance of operating properly. The average design life of soil absorption systems is greater than 20 years; although some could be expected to fail earlier. Some soil absorption systems could be expected to last indefinitely, as long as the system is not overloaded with water or solids.

Community or "cluster" systems serve a group of houses with components similar to a septic tank-soil absorption system or mound system. The individual septic tanks would operate at similar levels of reliability. The septic tank effluent sewers are exposed to hazards of breakage and to plugging due to cleanout failure similar to gravity sewers. Sewage solids accumulations in the sewers do not occur when the septic tanks are maintained properly. The pump station that doses the drain fields may not operate properly due to mechanical failure or power interruption. An effluent spill may occur at that time. A soil absorption system would be sited on permeable soils that have a water table that is always greater than six-feet deep. A cluster mound system would be sited on reasonably

permeable soils where a high groundwater table, high bedrock or other condition makes the site unsuitable for a soil absorption system. The operation of the drain field should be more reliable than an individual onsite soil absorption or mound systems because of pressure distribution by dosing and because of the optimum location.

2.5. Comparison of Alternatives and Selection of the Recommended Alternatives

The selection of the most cost-effective and environmentally acceptable alternatives that could be realistically implemented involved the consideration of technical feasibility, reliability, costs, environmental effects, and public desirability of each alternative, and compliance with the applicable design and effluent discharge standards for the State of Wisconsin. Selection of the most cost-effective alternative required identification of trade-offs between costs and other relevant criteria.

2.5.1. Comparison of Alternatives

2.5.1.1. Project Costs

Project costs were categorized into capital expenses, operating and maintenance (O&M) expenses, and salvage values for the equipment and structures for each alternative. The costs for the collection, treatment, and disposal for each alternative were estimated separately. A summary of the estimated costs of "build" alternatives are displayed in Table 2-16 for Egg Harbor, Table 2-17 for Fish Creek, Table 2-18 for Ephraim, and Table 2-19 for Baileys Harbor (Section 2.3.). Appendix E contains a description of the methodology and assumptions used in the analyses as well as the detailed costs for each alternative. The capital cost for the selected alternative could be shared by the State government through the Wisconsin Fund (60% of eligible costs) and the local community. Annual O&M costs would be financed entirely by the local users of the system.

The financial impact analysis (Section 4.1.3.) indicates that for many of the centralized collection and treatment alternatives, the capital costs

associated with the alternatives could cause the community's outstanding debt to full equalized valuation ratio to exceed 5%, particularly if Wisconsin Fund grants are unavailable. The State of Wisconsin limits municipal indebtedness, in the form of general obligation bonds, long-term notes, State trust fund loans, and installment contracts to 5% of the full equalized value of general property.

Egg Harbor

The system alternatives for Egg Harbor consisted of a combination of the following components: centralized collection for two alternative groups of subareas; aerated lagoon and RBC WWTPs with discharge to Green Bay or land application; cluster drainfield treatment and disposal, and onsite upgrading for subareas without collection; and a full onsite upgrade alternative. The No Action Alternative is estimated to have the lowest present worth cost, although the costs were not developed in detail. The estimated costs for the Egg Harbor "build" alternative are summarized in Table 2-16. Of the seven "build" alternatives considered, Alternative 7 - upgraded onsite systems for all subareas - had the lowest present worth cost and Alternative 5 - septic tank effluent gravity collection for the smaller group of subareas with cluster drainfield treatment and disposal, and onsite upgrades for the other subareas - was the next least costly.

The alternative similar to that recommended in the Facilities Plan (Alternative 2B - collection for the larger group of subareas with an RBC WWTP and outfall to Green Bay, and onsite upgrades for the other subareas) was the highest cost alternative. The total estimated present worth costs ranged from approximately $1.7 million for Alternative 7 to $2.6 million for Alternative 2B.

Fish Creek

The components combined to form the system alternatives for Fish Creek include the following: centralized collection for two groups of subareas; aerated lagoon WWTP with discharge to Green Bay or land application; cluster drainfield and cluster mound treatment and disposal, and onsite up-

grades for subareas without collection; and a full onsite upgrade alternative. A total of 6 "build" alternatives were considered for Fish Creek. Table 2-17 summarizes the estimated costs for the alternatives. The "build" alternative with the lowest total present worth cost is Alternative 4 - centralized collection for some subareas with treatment and disposal at a cluster mound, and onsite upgrades for the other subareas. The next least cost alternative is Alternative 5 - centralized collection for some subareas with treatment and disposal at a cluster drainfield, and onsite upgrades for other subareas. The alternative similar to the Facilities Plan Addendum recommendation (Foth and Van Dyke and Associates, Inc. 1982), Alternative 2 - centralized collection for some subareas with aerated lagoon WWTP and bay discharge, and onsite treatment in the other subareas - ranked fourth. The estimated total present worth cost of the alternatives ranged from $2.6 million for Alternative 4 to $3.3 million for Alternative 7 - upgraded onsite systems for all subareas.

Ephraim

Five "build" alternatives were considered for Ephraim. They consisted of combinations of the following components: centralized collection for two alternative groups of subareas; aerated lagoon WWTP with discharge to Green Bay or wetland discharge; cluster drainfield treatment and disposal; onsite system upgrades for areas without collection; and a full onsite upgrade alternative. The estimated total present worth costs are presented in Table 2-18 for the Ephraim "build" alternatives. Although the costs were not estimated in detail, the No Action Alternative would likely have the lowest total present worth cost. Alternative 6 - upgraded onsite systems for all subareas - was the least costly "build" alternative. The second least costly alternative was Alternative 5 - centralized collection for the smaller number of subareas with treatment and disposal in a cluster drainfield, and onsite upgrades for other subareas. Alternative 2 - centralized collection for the larger number of subareas with an aerated lagoon WWTP and outfall to Green Bay, and onsite upgrades for other subareas - was similar to the alternative recommended in the Facilities Plan and was the most costly alternative considered. The estimated present worth costs ranged from $2.9 million for Alternative 6 to $5.9 million for Alternative 2.

Cost estimates, and alternative rankings, are based on a WWTP location selected in the Facilities Plan. If a more northerly location is feasible, the total estimated present worth costs could be reduced for the alternatives with outfalls to Green Bay; a $0.57 million reduction for Alternative 2, and a $0.39 million reduction for Alternative 3. This would not change the ranking of Alternative 2, which would remain the highest cost of the "build" alternatives. However, Alternative 3 (now ranked fourth) would rank third, and Alternative 4 - centralized collection for the smaller number of subareas with an aerated lagoon WWTP and wetland discharge and onsite system upgrades for other subareas, - (now ranked 3) would rank fourth. Alternatives 6 and 5 would remain the least costly and the second least costly, respectively.

Baileys Harbor

The system alternatives considered for Baileys Harbor were a combination of the following components: centralized collection for two groups of subareas; aerated lagoon WWTP with discharge to Green Bay or two alternative wetland sites; onsite upgrades for subareas without collection; and a full onsite upgrade alternative. Table 2-19 summarizes the estimated total present worth costs for the seven "build" alternatives. Alternative 6 - upgraded onsite systems for all subareas - was the "build" alternative with the lowest estimated present worth cost. The No Action Alternative probably would have a lower total present worth cost than any of the "build" alternatives.

The alternative with the second lowest total present worth cost is Alternative 5 - centralized collection for one subarea, aerated lagoon WWTP with discharge to a wetland in Section 7, and upgraded onsite systems for subareas without collection. The alternative similar to the Facility Plan recommended alternative is Alternative 2B - centralized collection for two subareas, recirculating sand filter WWTP with wetland discharge in Section 8 (adjacent to protected natural area) and onsite upgrades for subareas without collection - which had the highest estimated total present worth cost of the six "build" alternatives considered. The estimated total present worth of the alternatives ranged from $3.6 million for Alternative 6 to $4.5 million for Alternative 2B.

2.5.1.2. Environmental Impacts

For each of the four communities, the No Action Alternative would entail almost no construction impacts. The environmental impacts of the "build" alternatives would primarily be short-term impacts on the local environment due to construction (Section 4.1.1.)

The implementation of the onsite systems component of each alternative, or the full onsite upgrade alternative, would have impacts on those lots where upgraded onsite systems are necessary. These impacts may be considerable on some lots but overall they would be of limited extent.

Cluster drainfield and cluster mounds would involve construction on the drainfield sites of a similar nature to that of the onsite upgrades.

The construction of centralized collection facilities would have considerable impacts on the right-of-way where the sewers are located. Construction would be difficult because the extensive shallow bedrock requires blasting and because many right-of-ways are narrow and tree lined. Dewatering for deep sewer excavations and pump stations could affect wells in the vicinity.

Construction of the aerated lagoon, rotating biological contractor, or recirculating sand filter WWTPs would have a significant effect on the particular site. Some of the proposed sites contain prime agricultural land that would be irretrievably converted to treatment plant use.

Construction of a lake or bay outfall would have similar construction impacts as collection systems, except that, additionally, the lake or bay environment would be temporarily disturbed resulting in an increase in turbidity, decreases in dissolved oxygen, and possibly some fish mortality.

The treatment facilities discharging to the lake or bay would be required to meet the effluent requirements established by WDNR. Water quality would be altered, but not seriously degraded. Spills of septic tank effluent or of raw sewage at pump stations could occur if a malfunc-

tion or power failure were to occur. The nutrient load from one spill could easily equal the average annual nutrient load from existing onsite systems. Proper maintenance of the pumps and backup power sources for all the pump stations would reduce the potential for such an impact.

Treatment plant effluent discharged to land application sites or wetlands would be required to meet the effluent requirements established by WDNR. Both should result in minimal operating impacts because the applied effluent should be of comparatively high quality. Possible operations impacts with land application are mounding of groundwater under the site and nitrate buildup in the groundwater. The possible operations impacts of concern with wetlands are disturbance of natural flora and fauna due to alteration of hydrologic parameters of the site, and flushing of solids into surface waters in the spring and fall.

The centralized collection, treatment and disposal facilities, and the onsite upgrading would have a positive effect on groundwater quality by eliminating existing failing onsite systems. Onsite upgrades and management of onsite systems would replace failing onsite systems with appropriate new systems or holding tanks.

The significant environmental impacts expected for each community are outlined in the following sections.

Egg Harbor

The environmental impacts from the construction of the collection systems would be significant in Egg Harbor because of the rock excavation required. Alternatives 2A, 2B, and 3 have less lineal feet of sewer (and rock removal) than Alternatives 4, 5, and 6, and would have less of an impact. Alternative 7 - upgraded onsite systems for all subareas - would have no impacts from sewer construction.

The discharges proposed to Green Bay for Alternatives 2A, 2B, and 4 would have a significant temporary impact due to construction as discussed above. A possible significant operating impact is nutrient buildup in the

harbor on a temporary basis, due to currents causing a current gyre and entraining the nutrients into the harbor. Alternative 7 is the most cost effective alternative for Egg Harbor.

Fish Creek

Construction impacts for sewer construction would be a significant impact in all the "build" alternatives except Alternative 7 - upgraded onsite systems for all subareas. Rock excavation would be significant in construction of sewers in Fish Creek.

Prime agricultural farmland would be converted to treatment facilities for Alternatives 2 (aerated lagoon), 3 (aerated lagoon), 5 (cluster drainfield), and 6 (land application).

The discharge to Green Bay in Alternatives 2 and 3 would have temporary construction impacts as discussed above. A possible operational impact from the outfall discharge is fish mortality in the immediate area of the outfall due to disturbance of spawning grounds. Alternative 4 is the most cost effective alternative for Fish Creek.

Ephraim

Construction impacts during sewer construction would be signficant in Ephraim because of the shallow bedrock. Alternative 2 would have considerably more lineal feet of sewer than Alternatives 3, 4, and 5 which serve fewer subareas. Alternative 6 - upgraded onsite systems for all subareas - includes no sewer construction.

The Green Bay discharge proposed in Alternatives 2 and 3 would have significant temporary construction impacts as discussed above. A possible significant operating impact is temporary nutrient buildup in Eagle Harbor due to low-energy current gyres entraining nutrients in the Harbor. Alternative 6 is the most cost effective alternative for Ephraim.

Baileys Harbor

Temporary construction impacts from sewer construction will be significant in Baileys Harbor because of the shallow bedrock and possible permanent impacts on plants on the Wisconsin threatened species list occuring along roadsides. Alternatives 2A, 2B, and 3 have more lineal feet of sewer than Alternatives 4 and 5 and would result in a proportionally greater impact. Alternative 6 - upgraded onsite systems for all subareas - has no sewer construction and would not involve any such impacts.

The discharge to Lake Michigan proposed in Alternative 4 would have significant permanent and temporary construction impacts as discussed above. Possible operating impacts could be temporary nutrient buildup in Moonlight Bay due to currents causing nutrients to be trapped in the Bay, and possible fish mortality in the immediate area of the outfall due to disturbance of spawning grounds. The potential operating impacts of a wetland discharge (as discussed above) would be greater for Alternatives 2A and 2B than for Alternatives 3 and 5 because of the proximity to protected natural areas. Alternative 6 is the most cost effective alternative for Baileys Harbor.

2.5.1.3. Implementability

The means by which the wastewater management plan is implemented for each community depends upon whether the selected alternative relies primarily upon centralized or decentralized components. Because most sanitary districts have in the past been organized around centralized collection and treatment of wastewater, there is a great deal of information about the implementation of such systems. Decentralized collection and treatment, including onsite systems and cluster systems with subsurface disposal, is relatively new and there is less management experience on which to draw.

In this section the term "management agency" refers to the authority responsibile for managing the systems. A management agency need not be an autonomous organization devoted solely to the management of these systems. It may in fact be charged with other duties, and may share systems management responsibility through agreements with other agencies.

The value of small waste flows systems as a long-term rather than short-term alternative to centralized collection and treatment began to be recognized in the 1970s. As a result, communities preparing facilities plans after 30 September 1978 were required to provide an analysis of the use of innovative and alternative wastewater processes and techniques that could solve a community's wastewater needs (PRM 78-9, USEPA 1978a). Included as alternative processes are individual and other onsite treatment systems with subsurface soil disposal systems.

Regardless of whether the selected alternative for a community is primarily centralized or decentralized, four aspects of the implementation program must be addressed:

- There must be legal authority for the managing agency to exist and financial authority for it to operate
- The agency must manage construction, ownership, and operation of the sanitary district
- A choice must be made between the several types of long-term financing that are generally required in paying for capital expenditures associated with the project
- A system of user charges to retire capital debts, to cover expenditures for operation and maintenance, and to provide a reserve for contingencies must be established.

The Villages of Egg Harbor and Ephraim have the institutional ability to implement and finance wastewater disposal facilities within their respective Village limits. They have the legal ability to apply for the Wisconsin Fund and other funding for design and construction; to finance the operating costs and local share of the construction costs; and to generate revenues through user charges. Management of wastewater disposal facilities outside the Village limits, as required for a small portion of the Ephraim service area, can be accomplished either by annexation to the Village or through contractual arrangements to provide service.

The communities of Baileys Harbor and Fish Creek are not incorporated. Wisconsin statutes provide that unincorporated communities can form sanitary districts to implement wastewater disposal systems. A sanitary district may be formed by petition from residents or by WDNR order. Commis-

sioners of the district are appointed by the Town Board or elected. They have the legal managerial power to issue bonds, borrow money, and plan and construct wastewater collection and treatment facilities. The sanitary district is responsible for levying user charges, operating and maintaining the system, and keeping records as required by WDNR.

The existing sanitary district serving Fish Creek would have to be expanded to include the full service area designated in this report. A sanitary district would have to be formed in Baileys Harbor to include the entire proposed service area.

The villages and sanitary districts would be the management agency for implementation of the selected alternative for each community.

The management agency would own, construct, maintain, and operate the collection, treatment, and disposal facilities in the centralized component of the alternative selected. Most of the proposed facilities are typical of centralized sewage facilities. If an alternative utilizing septic tank effluent pumps is considered, the following are several options appropriate to the management of the septic tank effluent pump stations located on individual lots:

- The station may be designed to agency specifications, with the responsibility for purchase, maintenance, and ownership residing with the homeowner
- The station may be specified and purchased by the agency, with the homeowner repurchasing and maintaining it
- The station may be specified and owned by the agency, but purchased by the homeowner
- The station may be specified, purchased, and owned by the agency.

The management agency would also be responsible for the decentralized or onsite component of the selected alternative. Management options range from private ownership of facilities, with a detailed permit process to complete agency ownership of all facilities. There are certain advantages with each type of management and ownership option. Complete control by the

agency comes closest to guaranteeing that the systems will be operating at optimal levels but represents the most costly approach. The least costly approach would be to keep the homeowner responsible for all maintenance activities and costs. The homeowner then would be more inclined to utilize water-saving measures and other methods to minimize maintenance costs. However, as is currently the case, environmental protection is more likely to suffer when the homeowner is responsible for maintenance.

Capital expenses associated with a project may be financed by several techniques. Both centralized and decentralized components are eligible for construction grants under the Wisconsin Fund administered under Chapter NR 128 of the Wisconsin Administrative Code. Centralized systems are funded under section NR 128.11. Only a certain portion of the total capital costs for centralized sytems are eligible for funding, and the grant is for 60% of the eligible costs.

Onsite systems can be funded under section NR 128.08, which requires that the individual systems be owned by the management agency, and by section NR 128.30 which funds private systems. In a manner similar to centralized systems, only a certain portion of the total capital costs are eligible for funding. The grants pay up to 60% of the eligible costs. Grants under section NR 128.30 have a limit of $3,000 per individual system.

It is anticipated that the onsite systems will be funded under section NR 128.08 and that the onsite systems will be owned, constructed, operated, and maintained by the management agency. The local costs for the construction and operation of the centralized and decentralized systems can be assessed to each user equally by a variety of means.

2.5.2. Conclusions

The least cost alternative for each community from both an economic and environmental impact perspective is as follows:

- Egg Harbor: Alternative 7 - Upgraded onsite systems for all subareas.

- Fish Creek: Alternative 4 - Septic tank effluent gravity collection for Subareas 2 and 3A, transmission to site in SWNE Sec. 32, and treatment and disposal in cluster mound; upgraded onsite systems for remainder of subareas.

- Ephraim: Alternative 6 - Upgraded onsite systems for all subareas.

- Baileys Harbor: Alternative 6 - Upgraded onsite systems for all subareas.

These alternatives are the least cost based on the population projections and available needs documentation. For Fish Creek, the year 2000 population projection used in this report is smaller than that used by the Facilities Planner (Foth and Van Dyke and Associates, Inc. 1982). The use of a larger year 2000 population projection could result in the least cost alternative becoming technically unfeasible. In that case, Alternative 5, STE gravity collection system with treatment and disposal in a cluster drainfield in Sec. 3, appears to be the least costly, technically feasible alternative.

The cost estimates for onsite system upgrading for Egg Harbor, Ephraim, and Baileys Harbor are highly sensitive to the number of holding tanks required. An increase in the number of holding tanks above that estimated would increase the cost of these alternatives. The need for a holding tank is based, in turn, on the soil condition of each individual property at the location of the soil absorption system. The soil condition of an area was based on several sources of information, particularly the SCS soil maps, soil borings, and soil investigations for adjacent onsite systems. When soil data becomes available for each lot, the number of holding tanks required may be greater than estimated here, and a collection and treatment alternative for Egg Harbor, Ephraim and Baileys Harbor could then be the least cost alternative. Should this be the case the alternatives that are the most likely to be the least costly are as follows:

- Egg Harbor: Alternative 5 - STE gravity collection system for Subareas 1AN, 1BS, and 2AS, transmission to site in Sec. 31 T30N R27E, and treatment and disposal in cluster soil absorption system; upgraded systems for the remainder of subareas.

- Ephraim: Alternative 5 - STE gravity collection system for Subareas 1A, 1B, and 2, transmission to site in Sec. 24, and treatment and disposal in cluster drainfield; upgraded onsite systems in remainder of subareas.

- Baileys Harbor: Alternative 5 - Conventional gravity collection system for Subarea 3, transmission to aerated lagoon WWTP and discharge to wetland in Sec. 7; upgraded onsite systems for remainder of subareas.

3.0. AFFECTED ENVIRONMENT

3.1. Natural Environment

3.1.1. Atmosphere

Elements of the atmospheric environment that are relevant to the consideration of the proposed wastewater treatment alternatives include temperature, precipitation, wind, and noise levels. Other than the consideration of potential odor generation by the treatment processes, air quality is not expected to be affected significantly and, therefore, is described briefly.

3.1.1.1. Climate

The Door Peninsula has a continental type of climate that is moderated by the surrounding waters of Green Bay and Lake Michigan. This modification is indicated by the narrow range of average daily temperatures and by the few days with extreme temperatures exceeding 32 degrees Centigrade (°C) (90 degrees Fahrenheit [°F]) or less than -18°C (0°F). The average annual temperature for Door County during the period of record, 1941 through 1970, was 6.5°C (43.7°F). The mean date for the last frost is 6 May, and the mean date of the first frost is 30 October. Door County has a growing season of approximately 161 days (By phone, Mr. Fred Doering, National Oceanic and Atmospheric Administration [NOAA], to WAPORA, Inc., 18 January 1979). Climatological data from Green Bay, the monitoring point nearest to the project area, are presented in Appendix F.

The average annual precipitation in Door County is 68.6 centimeters (27.01 inches), of which 53% occurs during the period from May to September. The average annual snowfall is 113.3 centimeters (44.6 inches). The winds are generally from the southwest at an average annual speed of 16.4 kilometers per hour (10.2 miles per hour).

Upper air data can be used to determine the occurrence and characteristics of elevated inversions. These inversions trap contaminants in

ground-based mixing layers and can result in air pollution episodes. The lower the inversion layer is, or the shallower the mixing layer is, the more concentrated the pollutants may be. The mean annual afternoon mixing height in the project area is approximately 1,190 meters (3,904 feet), ranging from 720 meters (2,362 feet) in winter to 1,580 meters (5,184 feet) in summer (Holzworth 1972). An atmospheric dispersion factor, indicative of the ability of the atmosphere to dilute pollutants, can be developed from mixing height and wind velocity data (Edwards and Wheat 1978). The annual average dispersion factor of 4,000 square meters for Door County indicates good dispersion conditions.

3.1.1.2. Air Quality

Door County is located in USEPA's Lake Michigan Air Quality Control Region (AQCR) and is subject to the National Ambient Air Quality Standards (NAAQS; Appendix G). The Wisconsin Ambient Air Quality Standards are identical. A new or modified wastewater treatment facility must comply with the NAAQS, as well as the New Source Performance Standards for sewage sludge incinerators, if such equipment is planned. The facility also would be subject to regulation by the Bureau of Air Management, Wisconsin Department of Natural Resources.

Ambient air quality data for Door County during the period from 1975 to 1977 were obtained from the WDNR air quality monitoring station at Fish Creek. The monitored levels of total suspended particulates (TSP), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2) are given in Appendix G. The levels of NO_2 and SO_2 never have exceeded the primary standards (health related) or the secondary standards (welfare related). TSP concentrations, however, have exceeded the 24-hour average primary standard. In one instance, concentrations of 325 micrograms per cubic meter were recorded at the Fish Creek monitoring station. Subsequent microscopic analysis of the filters revealed primarily (72%) soil particles. Dry soil conditions, high winds, and fall crop harvesting activity, rather than industrial sources or urban areas, were responsible for the high concentrations.

Although the hydrocarbon and the carbon monoxide levels were not monitored, the concentrations are assumed to be low. No major highway, petro-chemical facilities, or other significant sources are located in the project area.

3.1.1.3. Noise

There are no major noise sources in the project area other than intermittent quarry, highway, and recreational vehicle sources (snowmobiles and motorboats). The WDNR has not received complaints of excessive noise in the Door County area (By phone, Mr. Raj Raisoni, WDNR, to WAPORA, Inc., 18 January 1979).

3.1.1.4. Odor

The occasional failure of an on-site system may release some odors. Septage haulers using inadequate or improperly maintained equipment also may create odor nuisances. Ephemeral odor problems do occur in the project area. The WDNR Bureau of Solid Wastes has received complaints of odors in Door County from spreading of holding tank wastes and septage (By interview, Mr. Terry Hegeman, WDNR, to WAPORA, Inc., 21 April 1982).

3.1.2. Land

3.1.2.1. Geology

3.1.2.1.1. Physiography and Topography

The project area is characterized by an upland ridge of bedrock overlain by shallow drift. The edge of this ridge forms the Niagaran escarpment, extending the length of the Green Bay coastline. The Silurian dolomite bedrock slopes from the Niagaran escarpment to the Lake Michigan shore with outcrops at numerous locations. Successive glaciation has eroded the dolomite bedrock and deposited glacial till and moraines on this part of the Door Peninsula.

Sand dunes and beach ridges also are distinctive features of the project area. They were formed during periods of glaciation when the lake levels were altered. In the project area these inactive sand dunes and gravel ridges are located south of Kangaroo Lake and north of Baileys Harbor.

Few streams are located in the project area. The soils and bedrock are moderately permeable and most precipitation percolates to the groundwater. Groundwater seeps occur along the escarpment and at interior locations where local relief is considerable. These seeps contribute to the streams that drain the project area. Blockage of some of the drainage patterns by glacial deposits has resulted in the formation of the large inland and shoreline swamps near Ephraim and Baileys Harbor. Kangaroo Lake, at one time a bay on Lake Michigan, became an inland lake after the mouth was sealed by beach ridges.

3.1.2.1.2. Bedrock Geology

The project area bedrock formations consist of gently dipping Silurian sedimentary rocks that overlie the Ordovician and Cambrian age strata and the Precambrian basement. The strata generally dip to the southeast at approximately 9 meters per kilometer (45 feet per mile), deepening toward Lake Michigan.

The bedrock units underlying Door County and the project area are presented in Table 3-1. The upper levels of bedrock are particularly important because most of the wells in the project area draw from the surficial unconsolidated material, the Niagaran series, and the Alexandrian series. The Ordovician sandstone is utilized as a water source in the southern part of Door County and also could be used in the project area at some future date (Sherrill 1978).

With the exception of a margin of Alexandrian dolomite along the Green Bay coast, the bedrock surface in the project area is primarily Niagaran dolomite (Figure 3-1). The bedrock is a buff-gray, medium-to-coarse grained dolomite that ranges in thickness from thin to massive. Many natural

Table 3-1. Lithologic characteristics of rock units in Door County (Sherrill 1978).

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	--	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	Croundwater 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 ± 50	(?)	Lower sandstone aquifer	Not presently used as a source of water in Door County. A test well through these units near Jacksonport 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.

crevices and fissures occur in the Niagaran dolomite, and numerous vertical joints at the surface permit rapid water recharge of the lower, horizontal bedding plane joints. Quarries in the Niagaran formation provide crushed dolomite for highway construction and riprap for breakwater construction.

The bedrock topography is characterized by the escarpment along Green Bay and the gradual slope to the Lake Michigan shore. The project area land surface is basically a bedrock surface interrupted by several bedrock valleys. The most prominent valley is the low area between Ephraim and Baileys Harbor. Bedrock heights of more than 229 meters (750 feet) in elevation are located near the escarpment (Figure 3-1). Bedrock surface elevations of less than 168 meters (550 feet) occur at Ephraim, at Kangaroo Lake, and in the Baileys Harbor-North Bay area.

3.1.2.1.3. Surficial Geology

Unconsolidated deposits of Quaternary age overlie the project area where the bedrock is not exposed. These deposits are generally very shallow, although depths of 60 feet or more occur near Ephraim, Kangaroo Lake, and in the Baileys Harbor-Moonlight Bay area. Originally pre-glacial valleys, these low areas were filled with glacial materials. The valleys have a north-northwest to south-southeast orientation.

Sherrill (1978) categorized the surficial materials according to their method of deposition, or in the case of the residual soils by the depth to bedrock (Figure 3-2). The alluvium, marsh, and lake deposits consist of silt, clay, and organic matter. These fine grained, stratified materials occur mostly at the Lake Michigan level and in drainageways where the slope is minimal. The outwash, beach deposits, and sand dunes consist of well-sorted sand and gravel. These coarse grained, stratified deposits occur primarily along historic or present shorelines as beach sands and sand dunes, or along drainageways as alluvial material. The ground moraines, end moraines, and drumlins consist of till, intermixed clay, silt, sand, gravel, and boulders. These unsorted materials are located in the filled valleys and border the bedrock highlands. Surficial materials in areas of near-surface or exposed bedrock may be composed of dolomite fragments, silt, or clay, depending upon the origin of the material.

3.1.2.2. Soils

Sewage disposal in rural areas most often depends on soil-based systems. Whether they function properly or not depends on proper design and construction of the system and a careful selection of proper design criteria. One approach to selection of design criteria is to generalize soils into similar groupings (soil associations) based on pertinent physical characteristics.

A soil association is a distinctive pattern of soils in defined proportions (Soil Conservation Service [SCS] 1978). Each association contains one or more major soils and at least one minor soil. The name of an association is derived from the names of the major soils. The project area exhibits four of the six soil associations found in Door County (Figure 3-3). The four associations are:

- Summerville - Longrie - Omena association. The dominant association, these soils cover approximately 60% of the project area. The approximate percent composition of the association by soil is: Summerville, 24%; Longrie, 20%; Omena, 20%; and minor soils, 36%. This association typically is found on glacial till and upland plains and ridges. The major soils occur on nearly level to moderately steep slopes, are well-drained, and consist of loam or sandy loam. The Summerville and Longrie soils are underlain by dolomite bedrock at a depth of approximately 1 meter (3.5 feet). In most cases, the shallow depth of the soils render them unsuitable for soil absorption systems, although they generally are suitable for mound systems. Omena soils are underlain by sandy loam glacial till at a depth of approximately 0.5 meters (1.5 feet) and generally are suitable for on-site systems. The minor mapping units in this association include the Alpena, Bonduel shallow variant, Bonduel wet variant, Namur, and Solona soils.

- Deford - Yahara variant - Carbondale association. This association is found in a region extending east and north of Baileys Harbor beyond the northern tip of Mud Lake. Each of the major soils comprises approximately 14% of the association. The minor soils account for the remaining 58%. The soils in this association usually occur on nearly level, poorly drained sites, and are usually located in areas characterized by glacial lakes and outwash plains or broad depressions. Deford soils are characterized by a loamy surface layer underlain by fine sand at a depth of about 10 centimeters (4 inches). The Yahara variant surface layer and

subsoil consist of a fine loamy sand underlain by stratified silt, sand, and silty clay lake sediment. The Carbondale soils are deep mucks located where organic material from herbaceous plants has accumulated. Because of wetness problems, soil in this association generally are unsuitable for on-site systems. Markey, Rousseau, Deford, Wainola, and Yahara soils comprise the minor soils.

- Carbondale - Cathro association. This association is found in three relatively small pockets located at the north end of Kangaroo Lake, in Ephraim swamp, and at the northeast corner of the project area. The Carbondale mucks account for 49% of the association; Cathro muck, 23%; and the minor soils, 28%. Both of the soils occur on nearly level, poorly drained areas, and contain organic material derived from herbaceous plants. The Carbondale soils are deep mucks; Cathro soils are mucks underlain by loam and clay loam at a depth of about 0.75 meters (2.5 feet). The high organic content and typically saturated nature of these soils renders them unsuitable for on-site systems. The minor soils include the Allendale, Angelica, and Pinconning soils.

- Rousseau - Kiva - Markey association. This association occurs in a small section of the project area at the southern end of Kangaroo Lake. The soil composition of the association is: Rousseau, 28%; Kiva, 16%; Markey, 15%; and the minor soils, 41%. The association is found on outwash plains, stabilized dunes, beach ridges, and in depressions. Rousseau and Kiva soils occur on gently sloping to sloping areas and are moderately well to well drained. The Rousseau soils consist of fine sand at all levels. In general, the limited depth to the water table associated with Rousseau soils necessitates the use of a mound system. Kiva soils have a gravelly loam surface layer, a sandy loam subsoil, and a substratum of stratified outwash sand and gravel at a depth of approximately 0.5 meters (1.5 feet). On-site systems generally operate satisfactorily in Kiva soils. Markey soils are nearly level, poorly drained, and consist of muck underlain by outwash sand at about 0.70 meters (2.3 feet). Because of wetness problems, Markey soils usually are not suitable for on-site systems. The minor soils in the association include the Boyer, Duel, Sisson, and Wainola soils.

The individual soil series in Door County are mapped at a scale of 4 inches = 1 mile. The smallest area mapped is approximately 2.5 acres (1.1 hectares). This scale is useful for identifying the soil characteristics in a field-sized unit, but is of limited usefulness for individual resi-

dential lots. The detailed soil maps are not published in this report but are available for inspection in the SCS office in Sturgeon Bay.

Each series represents soils that have similar characteristics, but by no means are uniform. Thus, considerable variation may be present within one mapping unit on the detailed soil maps. For example, the depth to the water table may vary from zero to greater than 6 feet and slope may vary from zero to 18%. The characteristics of the major soil series that relate to soil-based sewage disposal are presented in Appendix H. The SCS has given many of the soils in the project area a severe rating for soil absorption systems. The primary limitations are near surface bedrock (Figure 3-4), high water tables (Figure 3-5), or steep slope (Figure 3-6). The different soils, though rated as severe based on these limitations, exhibit considerable variability in the performance of soil absorption systems. Unfortunately, whether the soil absorption system removes pollutants from the septic tank effluent cannot be readily assessed. Groundwater quality samples would have to be traced directly back to the soil absorption system to establish that it was failing to properly treat the septic tank effluent.

Soils in the predominant Summerville-Longrie-Omena association generally have a depth to bedrock of less than 1.5 meters (5 feet). Numerous pockets where the depth to bedrock is greater occur throughout the project area. Many of these pockets, however, have high water tables, a characteristic of the other soil associations found in the project area. Steep slopes are concentrated along Green Bay and cover a comparatively small amount of land.

3.1.2.3. Terrestrial Biota

3.1.2.3.1. Vegetation

The vegetation in Wisconsin is divided into northern and southern sections, based upon the climate and the geologic history. Door County is contained in the northern sector and was covered predominantly by a northern mesic forest before settlement. The most common species were sugar

maple, eastern hemlock, yellow birch, and American basswood. Other predominant plant communities included: pine forests, conifer swamps, pine barrens, and boreal forests. The woodlands were primarily maple-beech-birch and aspen-birch communities with scattered stands of white pine-red pine-jack pine, spruce-fir, oak-hickory, and elm-ash-cottonwood. The aspen-birch stands generally were the first tree-form vegetation to invade cleared land, usually maturing in 30-50 years. The shade tolerant species, such as sugar maple, balsam fir, and white spruce, have replaced many aspen-birch stands (Spencer and Thorne 1972).

A unique combination of historical, geological, and climatological factors have resulted in the development of unusually diverse plant communities with numerous rare plant species in Door County, specifically, in Middle Door County. The project area contains five Wisconsin Scientific Areas (Figure 3-7): Peninsula Park Beech Forest, Peninsula Park White Cedar Forest, The Ridges Sanctuary, Toft Point, and Mud Lake. These areas are described in Table 3-2. Six additional project area sites have been identified as unique and noteworthy, but do not meet all the criteria for placement on the official list. The six sites are: Button Marsh, the Logerquist Tract, the Manger Tract, Meridian County Park, Pickerel Pond, and Thorp Pond (By letter, Mr. William Tans, Wisconsin Scientific Areas Preservation Council, to WAPORA, Inc., 4 April 1979).

Three of the scientific areas, the Ridges Sanctuary, Toft Point, and Mud Lake also have been designated as National Natural Landmarks by the National Park Service (WDNR 1976b).

The plant communities in the project area were grouped into nine major vegetation and land-cover types for mapping purposes (Figure 3-8). The cover map was based on 1975 low altitude, black and white, aerial photographs (scale = 1:20,000), and on field observations (April 1979). Each cover type is discussed briefly below. (The scientific equivalents of the common names for the plant species cited in the text are listed in Appendix I.)

- Agricultural. This classification comprises areas that are cultivated for crops. In Door County, approximately 12,000

Table 3-2. Wisconsin Scientific Areas located in the project area (WDNR 1976b).

Scientific Area	Size (acres)	Features
Mud Lake	1,060	Spring-fed, estuarian lake surrounded by extensive shrub and timber swamp. Waterfowl and fish spawning use of the lake is extensive. Designated as a National Natural Landmark.
Peninsula Park Beech Forest	30	Undisturbed sugar maple, American beech and hemlock codominant mesic forest.
Peninsula Park White Cedar Forest	53	A diverse number of plant community types including: open marsh, calcareous meadow, white cedar-black and white spruce forest, and northern dry mesic woodland. Some rare plant species are present.
The Ridges Sanctuary	708	Parallel abandoned beach ridges and swales, both open and forested. Unusual flora including boreal forest and many local and rare plant species. Wisconsin's first National Natural Landmark.
Toft Point	340	Part of Lake Michigan Peninsula with northern mesic hardwood forest and old-growth hemlock and white pine. The area contains rocky lake frontage, conifer forest, and open bog and marsh. Designated as a National Natural Landmark.

acres are planted in row crops (predominantly corn), 35,000 acres are planted in broadcast crops (predominantly oats), and 13,000 acres are planted in special crops. An additional 41,000 acres are idle cropland. The principal crops include corn, oats, grass-legumes, hay, and Kentucky bluegrass (SCS 1978). This classification also included pastureland. Areas covered with grasses and legumes that are grazed by domestic animals were designated as pasture. The agricultural lands generally were located on the uplands; as a result they appear as wide diagonal bands across the center of the project area.

- Orchard. Cherry and apple orchards are scattered throughout the project area. The largest concentration of this vegetation type is located on the west side of the project area between Fish Creek and the Village of Egg Harbor.

- White Pine Plantation. Small plantations of white pine are located in the northern section of the project area, usually on deep loam to sandy loam soils.

- Oldfield. Vegetation that inhabits abandoned cropland or pastureland varies from herbaceous plants to mixtures of herbaceous plants and shrubs. The common herbaceous species include: fescue, bluegrass, love-grass, orchard grass, brome grass, switch grass, goldenrod, and beggar-ticks. The predominant shrub species include: sumac, red-ozier dogwood, dwarf juniper, and horizontal juniper.

- Deciduous Forest. Stands of deciduous forest are located throughout the project area, particularly along the upland coastal areas. The composition of the stands varies widely. The predominant species are sugar maple, American beech, yellow birch, trembling aspen, and white birch. Other common species include Eastern hophornbeam, American elm, northern red oak, red maple, green ash, and white ash.

- Mixed Forest. The mixed forests also are concentrated on the coastal uplands. The predominant species of trees include sugar maple, American beech, hemlock, and white cedar. The other tree species frequently occurring in these stands include northern red oak, eastern hophornbeam, basswood, trembling aspen, and white ash. Red-ozier dogwood, arrowwood, and beaked hazel are the predominant shrub species. Solomon's seal and twisted-stalk are among the most common species of herbs.

- Wetland Forest. Wetland forest is a significant cover type in the project area, with large concentrations located north of the community of Baileys Harbor and southeast of Ephraim and Fish Creek. White cedar, hemlock, balsam fir, paper birch, sugar maple, black ash, and green ash are the pre-

dominant species of trees. Large sections of these forests are composed exclusively of white cedar.

- Shrub Swamps. Shrub swamps often are located in wetland forests. Red-ozier dogwood, pussy willow, and alder are the predominant species of shrubs.

- Wetlands. Wetlands generally are located near the center of the project area where they occur intermittently around lakes and along the borders of wetland forests. The predominant species of plants include bluejoint, meadow fescue, cattail, and sedge.

The 1979 Federal Register's list of threatened and endangered species (50 CFR 17.11) does not include any plant species that have been recorded in the project area. Northern monkshood, the only listed species that occurs in Wisconsin, has not been identified in Door County. The WDNR, however, has designated 33 species of plants as endangered and 23 species of plants as threatened. Six of the endangered species and eight of the threatened species have been identified in Door County (Table 3-3). Prior to adoption of the official list, which became effective 1 October 1979, WDNR prepared a more extensive list of plant species that were believed to be threatened, endangered, or extirpated in Wisconsin. Although the list is unofficial, it includes numerous other species not identified on the official list. The plants on this list that occur in Door County are given in Appendix J.

3.1.2.3.2. Wildlife

Because of the lack of development and the diversity of vegetative cover, the project area provides an abundance of food and shelter for a wide variety of wildlife, particularly birds. Wildlife habitat ranges from rocky-barren cliffs to heavily-wooded lowlands and wetlands. Large sections of the project area have been designated as Class I wildlife habitat (Figure 3-9; Wisconsin Coastal Zone Management Program 1977).

Although a literature search has revealed that technical studies on wildlife in the project area have not been conducted, general information pertaining to wildlife on a regional and state basis is available. Local organizations and agencies also have documented the presence of certain species of amphibians, reptiles, birds, and mammals in the project area.

Table 3-3. Species of plants occurring in Door County that have been designated as threatened or endangered by the State of Wisconsin (Wisconsin Statutes, Section 29.415). E indicates endangered and T indicates threatened.

Scientific Name	Common Name	Status
Asplenium viride	Green spleenwort	E
Carex concinna	No common name	T
Carex lenticularis	Lenticular sedge	T
Cirsium pitcheri	Dune thistle	T
Cypripedium arietinum	Ram's head lady's slipper	T
Draba lanceolata	No common name	E
Festuca occidentalis	Western fescue	T
Geocaulon lividum	Northern comandia	E
Iris lacustris	Dwarf lake iris	T
Orchis rotundifolia	Small round-leaved orchis	T
Parnassia parviflora	Grass-of-parnassus	E
Pterospora andromedea	Pine-drops	E
Solidago spathulata var. *gillmani*	Dune goldenrod	T
Tanacetum huronense	Lake Huron tansy	E

- Amphibians and Reptiles. The amphibians known to inhabit Door County (primarily frogs, toads, and salamanders) normally occur in or around water or in forested or shaded areas where leaf litter and other detritus maintain a high degree of ground moisture. The reptiles in the project area (primarily snakes, lizards, and turtles) occur in most of the extant habitat types. The amphibians and the reptiles that possibly occur, or are known to occur in the project area, are listed in Appendix K. The status of each species is based on observations made at Newport State Park, which is located approximately 8 kilometers (5 miles) northeast of North Bay, and is probably indicative of their status in the project area.

- Birds. Over 130 species of birds have been sighted by members of local conservation organizations (WDNR 1974, 1975). All of the sightings were reported at Marshalls Point, Toft Point, or Peninsula State Park. The species of birds observed at these locations, as well as species that have a distributional range that extends to the project area, are listed in Appendix K. Birds can be expected to occur in most of the habitat types present in the project area.

- Mammals. Most of the habitat types in the project area support one or more species of mammals. The species that are known to occur, or believed to occur, in the project area are listed in Appendix K. Many of these mammals inhabit or visit Newport State Park, and their relative abundance in the park is probably indicative of their status in the project area. The black bear, gray fox, bobcat, eastern fox squirrel, southern bog lemming, and meadow jumping mouse have distributional ranges that include the project area (Burt and Grossenheider 1976); however, they presently are not known to occur in the project area.

The Federal Register's listing of threatened and endangered species (1979) includes two species with distributional ranges that encompass the project area (Table 3-4). The American peregrine falcon, an endangered species, and the bald eagle, a threatened species (in Wisconsin), have not been sighted in Door County during recent years.

In addition to the wildlife listed in the Federal Register, the State of Wisconsin also has identified species that have, or may have, difficulty maintaining population levels in Wisconsin. The species that have been listed by the State, and that may inhabit or visit the project area, also are given in Table 3-4.

3.1.3. Water

3.1.3.1. Surface Water

3.1.3.1.1. Setting and Flow

The Door County project area is bounded on the west by Green Bay and on the east by Lake Michigan. Kangaroo Lake, Mud Lake, and three smaller ponds are the principal inland bodies of water in the project area. Their

Table 3-4. Species of animals known to occur in Door County that have been designated as threatened or endangered by the federal government or the State of Wisconsin (Federal Register 1979 (50 CFR 17.11); Wisconsin Statutes, Section 29.415). E indicates endangered and T indicates threatened.

Class or Phylum	Scientific Name	Common Name	Status Federal[a]	Status State[b]
Fishes	*Coregonus alpenae*	Longjaw cisco	E	--
	Notropis crysocephalus	Striped shiner	--	E
Amphibians	*Ambystoma maculatum*	Spotted salamander	--	T
	Rana palustris	Pickerel frog	--	T
Reptiles	*Thamnophis sauritus*	Northern ribbon snake	--	E
Birds	*Accipiter cooperii*	Cooper's hawk	--	T
	Buteo lineatus	Red-shouldered hawk	--	T
	Casmerodius albus	Great egret	--	T
	Charadrius meloders	Piping plover	--	E
	Falco peregrinus	Peregrine falcon	E	E
	Haliaeetus leucocephalus	Bald eagle	T	E
	Lanius ludovicianus	Loggerhead shrike	--	T
	Phalacrocorax auritus	Double-crested cormorant	--	E
	Sterna forsteri	Forster's tern	--	E
	Sterna hirundo	Common tern	--	E

[a] As identified in the Federal Register, 17 January 1979, pp. 3637-3653.

[b] As identified by WDNR (Section 29.415 Wisconsin Statutes). Endangered species are "species or subspecies that are in trouble. Their continued existence as a part of the State's wild fauna is in jeopardy, and without help they may be extirpated." Threatened species are "species or subspecies which appear likely, within the forseeable future, to become endangered."

physical dimensions are given in Table 3-5. The project area is drained by six streams, and their physical dimensions are given in Table 3-6.

Kangaroo Lake is located approximately 1.6 kilometers (1 mile) southwest of the community of Baileys Harbor. Originally a bay of Lake Michigan, Kangaroo Lake was formed when sand dunes closed the mouth of the bay. A spring-fed stream at the north end of the lake is the principal water source. The lake is drained by a 0.9-meter (3-foot) high dam that discharges water into Heins Creek and, eventually, into Lake Michigan (Poff and Threinen 1965). Mud Lake is a shallow lake located in a large swamp between North Bay and Moonlight Bay. The main source of water is a spring-fed stream that enters from the north. The lake discharges to Moonlight Bay through Rieboldts Creek. The three smaller bodies of water (Pluff Pond, Thorp Pond, and Voeks "Marsh") are all relatively remote, and are part of extensive swamp and wetland complexes.

All of the project area streams originate in the project area and have small watersheds. The streams are less than 9 kilometers (5.5 miles) in length. Ephraim Creek is a low gradient stream that drains Ephraim Swamp and flows north to Eagle Harbor. Fish Creek is an intermittent stream with a moderate gradient. It is drains Button Marsh and flows north to Fish Creek Harbor. Heins Creek drains Kangaroo Lake and passes through an area of sand dunes before emptying into Lake Michigan. Hibbard Creek is a long, marsh bordered stream that flows out of Thorp Pond and into Lake Michigan near Jacksonport. Hidden Springs Creek is a small, spring-fed stream that flows parallel to Ephraim Creek into Eagle Harbor. Rieboldts Creek drains an extensive wetland forest and enters Mud Lake before emptying into Moonlight Bay.

Flow data for project area streams are limited to short-term, spot measurements. Both Ephraim Creek and Fish Creek have been observed with low or no flow following dry summers.

Due to the offshore pattern of currents around the Door Peninsula, all of the water entering Green Bay eventually returns to Lake Michigan north of the Door Peninsula. Generally, the water flows to the north along the

Green Bay coast of the project area and to the south along the Lake Michigan coast (Mortimer 1978). These major patterns are sometimes reversed by seasonal changes and/or prevailing winds. The major patterns also are affected by the coastal bays and harbors and by the presence of offshore islands (e.g., the Strawberry Channel).

The surface waters in the project area yield a variety of fish for recreational and commercial purposes. Excellent smallmouth bass fisheries are located on both sides of the Door Peninsula and along the shores of nearby islands. Deeper waters are a source of several species of trout and salmon. Although Lake Michigan seldom freezes, Green Bay waters provide carp, smelt, and other fish for ice fishermen. Inland lakes and streams also are popular fishing sites. The species populating these lakes and streams are given in Table 3-5 and 3-6. Commercial fishing occurs in the deeper offshore waters, outside the project area bays and harbors and beyond 0.4 kilometers (0.25 miles) of the shoreline.

Table 3-5. Characteristics of lakes in the project area (Poff and Threinen 1965, WDNR 1978a).

Lake	Surface Area (acres)	Shoreline (miles)	Maximum Depth (feet)	Public Access	Species of Fish Present
Kangaroo Lake	1,123.0	8.82	12.0	Boat ramp	Bluegill, bowfin, carp, common white sucker, largemouth bass, northern pike, rainbow trout, rock bass, smallmouth bass, walleye, yellow perch
Mud Lake	155.0	3.20	5.0	Trail	Smallmouth bass
Pluff Pond	0.5	0.14	5.0	None	None
Thorp Pond	6.4	0.40	2.5	None	None
Voeks "Marsh"	19.1	1.10	2.0	None	None

Table 3-6. Characteristics of streams in the project area (Kmiotek 1973, Poff and Threinen 1965).

Stream	Surface (acres)	Length (miles)	Gradient (feet/mile)	Watershed (square miles)	WDNR Stream Classification[a]	Trout Species	
						Brook	Rainbow
Ephraim Creek	1.6	1.5	2.0	3.0	II	o	o
Fish Creek	1.0	1.0	15.0	2.0	b		
Heins Creek	5.0	2.9	7.8	14.0	II	o	o
Hibbard Creek	9.8	5.4	7.6	17.0	II	o	o
Hidden Springs Creek	0.2	1.0	10.0	2.0	I	o	
Rieboldts Creek	1.9	1.0	5.0	12.0	b		o[c]

[a] Class I - high grade trout waters; little or no stocking of hatching fish.
Class II - some native trout; moderate to heavy stocking required.
Class III - marginal trout habitat; stocking required.

[b] Fish Creek and Rieboldts Creek are unclassified.

[c] Experimental stocking of rainbow trout.

Water-body contact recreation is popular in the summer with residents and seasonal visitors engaged in swimming, diving, sunbathing, and other beach activities. Green Bay beaches are located at Egg Harbor, Fish Creek, Nicolet Bay (Peninsula State Park), and Eagle Harbor. The only project area public beach on the Lake Michigan coast is at Baileys Harbor. Small craft boating and water skiing are limited primarily to Kangaroo Lake and to the bays, harbors, and shore areas on Green Bay. Larger seaworthy boats and pleasure craft are common on both coasts.

3.1.3.1.2. Surface Water Quality

Section 304 of the Federal Water Pollution Control Act (1972) authorizes the establishment of water quality standards and effluent limitations. State regulation and enforcement is authorized where standards of performance are at least as stringent as those established by the Federal government. The Wisconsin Department of Natural Resources is responsible for the quality of surface waters in Door County. Standards are based on use and currently are divided into three categories: general standards for fish and aquatic life, standards for recreational use, and standards for public water supply. These standards are summarized in Appendix L.

Door County is part of the Door River Basin. The Basin includes all or parts of eight coastal counties south and east of Green Bay. Surface waters in the Basin are classified as "effluent limited" because they are capable of meeting water quality standards with the application of basic treatment technology (WDNR 1975a). The Basin waters are described as medium hard to very hard, bicarbonate lake waters and streams.

Detailed water quality data are available for Kangaroo Lake, Mud Lake, Fish Creek, Heins Creek, and Rieboldts Creek. Ephraim Creek, Hibbard Creek, and Hidden Springs Creek have not been sampled, and water quality data for these streams are unavailable (By phone, Mr. Jerry McKersie, WDNR, to WAPORA, Inc., 15 February 1979). The following paragraphs summarize the available water quality data:

- Kangaroo Lake. Water quality data for Kangaroo Lake are presented in Appendix L. The lake was in compliance with

the Wisconsin water quality criteria. Dissolved oxygen (DO) concentrations were high, indicating that the lake is capable of supporting a wide variety of aquatic species. Kangaroo Lake had a Trophic Status Index (TSI) of 3 (WDNR 1975b). The TSI is a classification scheme that utilizes a variety of techniques to evaluate the trophic status of a body of water. The Kangaroo Lake TSI indicates the Lake was oligotrophic, or very low in plant materials. Winterkill, pollution, algae, macrophyte problems, or other signs, indicative of eutrophy, are absent

- Mud Lake. Only limited water quality data are available for Mud Lake. The Lake had a TSI value of 12 and is classified as mesotrophic due to a moderate amount of dissolved nutrients in the water (WDNR 1975b)

- Fish Creek. Limited water quality data for Fish Creek are presented in Appendix L. The lowest DO concentration measured was 7.6 milligrams per liter (mg/l). This level was above the minimum Wisconsin standard of 5 mg/l for warm water fisheries. Ammonia-N, a natural constituent of some groundwater, can be indicative of sewage or industrial contamination in surface waters when concentrations exceed 0.1 mg/l. Ammonia-N levels in Fish Creek were within this background range. The pH and fecal coliform values were also within the limits established in the Wisconsin standards

- Heins Creek. Available water quality data for Heins Creek are presented in Appendix L. Measured levels of parameters were within Wisconsin standards

- Rieboldts Creek. Available water quality data for Rieboldts Creek are presented in Appendix L. Mean values for DO, ammonia-N, and fecal coliform were within State standards.

Water quality data for the coastal bays and harbors in the project area are unavailable. General information indicates that Lake Michigan is slightly fertile and has a composition reflecting the carbonate source materials. Green Bay is more fertile and variable in alkalinity, pH, and ionic composition (Poff and Threinen 1965). Thermal and turbidity variations between Green Bay and Lake Michigan waters are evident from recent multispectral scanner imagery (USEPA 1979). The variations are attributable to inherent differences in the two water bodies and physiographic differences along the Door Peninsula coast. The Lake Michigan shoreline of the project area is characterized in many locations by a slight bottom gradient, rocky shoals and considerable bottom deposition. These features

result in numerous, nearly uniform, thermal and turbidity bands. Temperatures may vary up to 4°C within 2,000 meters (0.5 mile) of the shore. In contrast, the Green Bay coast has a sharp bottom gradient along the escarpment, and the shoreline exhibits relatively few bands of thermal or turbidity variation. Temperatures generally vary by only 1°C within 2,000 meters of the shore.

The only known point source discharging into surface waters in the project area is the Baileys Harbor Yacht Club. An average summer flow of 4,000 gallons per day is discharged into Baileys Harbor following secondary treatment. The Peninsula State Park sewage treatment plant, with average summer flows of 53,000 gallons per day, relies on lagoon seepage and evaporation rather than discharge to surface waters.

Non-point sources contribute pollutants to surface waters in a diffuse manner that precludes identification of specific sources. The pollutants generally are associated with intensive rainfall, snowmelt, or othe runoff events, and they include organic materials, fecal coliform, pesticides, phosphorus, and nitrogen. WDNR has developed control strategies for non-point sources as part of the Section 208 basin plan.

3.1.3.2. Groundwater

3.1.3.2.1. Setting and Flow

The groundwater in the project area is located in three aquifer systems: the Silurian dolomite system, the sandstone system, and the sand-and-gravel system. Most of the water for the area wells is obtained from the Silurian dolomite system. The St. Peter sandstone system, composed of Ordovician and Cambrian bedrock units, is not an important source of water, and the upper sandstone aquifer is usually tapped only where the dolomite system is absent or thin. The quantity of water available is directly related to the thickness of the system. The sand-and-gravel system is an insignificant source of groundwater due to the screening requirements that

inflate the costs of wells in glacial drift material. It is, however, an important source of recharge for the Silurian dolomite system.

The Silurian dolomite system contains the Niagaran and Alexandrian aquifers. The Niagaran aquifer is the most extensive aquifer and is found beneath approximately 98% of the project area. Eight water-bearing zones, separated by unproductive rocks, have been identified in the aquifers and in the underlying Maquoketa shale (Sherrill 1978).

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 25 liters per second (400 gallons per minute) are obtainable from the Silurian dolomite system (Sherrill 1978).

The Silurian dolomite system has a high contamination potential due to highly permeable soils, a lack of adequate soil cover over bedrock, and fractured bedrock in areas with high relief. The areas that have high contamination potential because of lack of adequate soil cover, the primary factor in contamination potential, are shown in Figure 3-4.

Transmissivity, the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient, varies in the project area. Representative transmissivity values in the dolomite system range from approximately 641 square meters (6,900 square feet) per day at Baileys Harbor to 1,208 square meters (13,000 square feet) per day at Fish Creek (Sherrill 1978).

The hydrologic atlas (Skinner and Borman 1973) indicates that depths to groundwater range from the ground surface to 42 meters (140 feet). The depths generally are greatest where ground elevations are the highest. The

water table contours for the Silurian dolomite in Door County are shown in Figure 3-10. The piezometric surface corresponds to the topography of the land. Water recharge occurs in the high areas and discharge occurs in the lowlands. The groundwater discharge is at right angles to the contour lines in Figure 3-10. The aquifer recharge is largest in early spring because of snowmelt and increased precipitation. Discharge, generally into Lake Michigan and Green Bay, is most evident by late summer or early fall.

3.1.3.2.2. Groundwater Quality

Groundwater quality data for selected wells in Door County are presented in Table 3-7. Most of the samples were obtained from the Silurian dolomite system and are representative of the well samples in the project area. The water is very hard (more than 180 mg/l of calcium carbonate) and requires softening for many uses. Water temperatures are generally cool, between 9.5° C (49° F) to 15° C (59° F), and the water has a slightly basic pH.

The groundwater in the project area can be classified as a calcium magnesium bicarbonate type. Calcium and magnesium account for more than 80% of the cations. Alkalinity in the pH range of the groundwater sampled is attributable to the bicarbonate ion. Bicarbonate concentrations range from 100 mg/l to 426 mg/l. The Silurian system is low in sulfates, although the underlying Maquoketa shale far exceeds the recommended health standard of 250 mg/l. The iron concentrations in the samples exceeded the recommended standard of 0.3 mg/l in nearly 25% of the wells. The chloride concentrations are generally low.

The principal groundwater quality problems in the project area are hardness, locally high iron concentrations, and contamination from surface sources. Hardness and high iron concentrations are primarily related to geochemical processes and can be ameliorated through softening and treatment to remove iron. Contamination, however, is a more serious groundwater problem. Several cases of dysentery and other more severe diseases related to water quality have been reported in the past (Becher-Hoppe Engineers, Inc. 1972). Gasoline, road salt, domestic and farm wastes, and septic tank

Table 3-7. Selected chemical analysis of groundwater from wells in the project area (Sherrill 1978).

Well No.	Date of Collection	Sample Source[a]	Chemical Constituents[b]								Solids	Hardness (as $CaCO_3$)	pH
			Fe	Ca	Mg	Na & K	HCO_3	SO_4	Cl	NO_3			
18	05/20/68	Om	0.40	286	83	11.0	268	776	14.0	0.3	1,430	1,060	7.4
18	07/07/70	Om	0.16	344	107	13.0	245	1,080	20.0	0.1	1,710	1,300	7.3
28	11/10/72	Sn	0.06	62	33	1.6	326	13	1.1	0.4	274	290	7.9
36	05/28/68	Sa	0.10	72	32	3.0	362	15	4.0	0.2	304	311	7.7
47	05/29/68	Sn,Sa	0.03	74	37	NA	372	25	3.0	0.5	322	353	7.5
58	10/12/71	Sn	0.08	62	29	1.5	302	24	4.0	7.8	275	270	7.4
144	10/13/71	Sa	0.05	70	30	2.0	294	28	4.0	9.0	298	300	8.4
151	09/08/72	Sn	0.04	60	30	8.7	300	16	16.0	4.1	273	280	7.4
255[c]	08/06/71	Sn	0.30	69	33	5.5	358	12	9.0	4.4	366	308	7.8
255[d]	08/11/71	Sn,Sa	0.03	54	31	1.0	312	6	3.0	0.4	250	264	7.7
255[e]	08/19/71	Sn,Sa,Om	0.40	42	42	1.0	310	23	2.0	0.4	350	278	8.6
268[f]	10/13/72	Sa	2.0	62	32	NA	266	30	3.0	0.5	324	288	NA
268[g]	08/22/73	Sa,Om	0.10	66	26	13.0	260	20	3.0	0.5	344	272	7.6

[a] Sample source: Sn = Niagaran aquifer; Sa = Alexandrian aquifer; Om = Maquoketa Shale.

[b] Fe-Iron, Ca-Calcium, Mg-Magnesium, Na-Sodium, K-Potassium, HCO_3-Bicarbonate, SO_4-Sulfate, Cl-Chloride, NO_3-Nitrate.

[c] Sample taken when well was 102 feet deep, with no casing. From water-bearing zone 1.

[d] Sample taken when well was 295 feet deep, with 100 feet of casing. From water-bearing zones 2, 3, and 4.

[e] Sample taken when well was completed to 519 feet, with 100 feet of casing. From water-bearing zones 2, 3, 4, 5, 6, 7, and

[f] Sample taken at start of aquifer test. Well was 102 feet, with no casing. From water-bearing zone 5.

[g] Sample taken when well was 329 feet feep, with 100 feet of casing. From water-bearing zones 6,7, and 8.

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 well casings.

High nitrate concentrations in the well water usually indicate groundwater contamination from surface sources (Hem 1959, Walton 1970). None of the nitrate levels exceed the USEPA water quality standard for drinking water of 10 mg/l of nitrogen or 45 mg/l of nitrate, although some samples were slightly elevated above background levels.

Bacterial contamination of wells has been a chronic problem in Door County (Wieniewski 1942, Sherrill 1978). When the bacteria reach the saturated zones in the bedrock, they are capable of traveling long distances underground with little attenuation. Total and fecal coliform bacteria were monitored from March 1972 through October 1973 at five wells and two springs in Door County. The results indicated that both total and fecal coliforms were generally low (less than 2 colonies per 100 milliliters), although total coliform ranged as high as 600 colonies per 100 milliliters and fecal coliform ranged as high as 18 colonies per 100 milliliters (Sherrill 1978).

Contamination is localized in zones of the dolomite system and affects only a small percentage of the total groundwater system. Precipitation in late summer and early fall also contributes to the higher contaminant levels. The rapid groundwater recharge in the area, however, enables a relatively fast flushing of the system after the contaminant sources are removed.

3.1.3.3. Aquatic Biota

3.1.3.3.1. Vegetation

The existing information on vascular aquatic plants indicates that, with the exception of bays and other sheltered areas, Lake Michigan waters are relatively barren. The bays and sheltered areas provide the necessary protection from heavy wave action and shifting substrates (Salamun and

Stearns 1978). The aquatic plants observed by Salamun and Stearns (1978) in three Lake Michigan bays adjacent to, or near, the project area are listed in Appendix M.

Although the existing literature does not discuss aquatic vegetation on the Green Bay coast of the Door Peninsula, the rocky shores and deeper waters of that coast would most likely support submerged species of vegetation. Information concerning aquatic plants in project area lakes and streams also is unavailable, although many of the species listed in Appendix M would be expected to occur in those waters.

3.1.3.3.2. Fishes

Fish are an important commercial and recreational resource in the Door Peninsula area. Green Bay and Lake Michigan fisheries bound the Middle Door County project area on the east and west. These fisheries are supplemented by the inland waters of the project area where public access to two lakes and six streams provides additional recreational opportunities. Species of fish with distributional ranges that include the project area waters are listed in Appendix N.

Bishop and others (1978) estimated the value of commercial catches of fish in Wisconsin waters to be $2.6 million in 1976 and $2.9 million in 1977. In both years, more than 95% of the harvest value was derived from whitefish, alewives, yellow perch, and chubs. Whitefish comprised approximately half of the total catch value, and over 87% of the total catch (by weight) were whitefish harvested from waters adjacent to Door County. Lake Michigan bays and waters adjoining the project area, particularly Moonlight Bay and North Bay, provide important spawning grounds for whitefish (Imhoff 1977, Gunderson 1978, and Humphreys 1978). Estimates of the Wisconsin whitefish stock originating from these spawning beds, some as high as 75% (Humphreys 1978), indicate their significance.

The recreational fisheries in the project area attract local residents, as well as tourists, and provide a significant source of income for many local businesses. This appears to be particularly significant since

the initiation of an intensive trout and salmon stocking program by WDNR in 1963 (Anonymous 1978). The rapid growth and good survival rates of the initial plantings have encouraged interest in Great Lakes sportfishing. Brown trout, rainbow trout, brook trout, lake trout, and chinook salmon continue to be planted in the Door County area (By phone, Mr. Lee Kernan, WDNR, to WAPORA, Inc., 26 April 1979).

Salmonids generally frequent inshore areas during the fall, winter, and spring, and move offshore during the warmer, summer months. Spawning normally occurs in the fall or spring, depending on the species, in rivers, streams, or inshore areas where the substrate consists of gravel or cobble. Spawning, however, has not been successful in project area waters (By phone, Mr. Lee Kernan, WDNR, to WAPORA, Inc., 2 April 1979). Major food sources include macroinvertebrates and small fish.

Smallmouth bass and yellow perch also provide excellent recreational fishing. These species were the mainstay of the recreational fishery for many years prior to the intensive salmonid stocking program. Current interest in the recreational fishery is probably divided equally among the salmonids, bass, and perch, with the salmonids attracting more fisherman in the fall, winter, and spring months and the bass and perch attracting more fisherman during the summer months. With the exception of Baileys Harbor, where the water is too cold, the bays of the project area are believed to be successful spawning grounds for bass and perch (By phone, Mr. Lee Kernan, WDNR to WAPORA, Inc., 26 April 1979).

There are five inland lakes within the project area boundaries. Only two of the five are capable of supporting sustained fisheries; the other three are too shallow and lack sufficient oxygen during the winter to support fish populations. Kangaroo Lake, the largest and deepest of the lakes, has a public boat launch area. Walleye and northern pike have been planted in the lake at various times since 1954 by WDNR. The lake area north of the causeway is a prime spawning area for the northern pike. In addition to walleye and pike, a WDNR fish survey conducted in 1973 recorded the presence of nine other species (Table 3-5). The survey revealed that no significant changes in the fish populations had occurred since the previous survey conducted in 1966 (WDNR intra-office memo 1978).

A species of fish that once was common in Lake Michigan is included in the Federal Register's list of threatened and endangered species (1979). Listed as endangered, the longjaw cisco is a deepwater fish and is not likely to frequent the shallow waters adjacent to the project area.

3.2. Manmade Environment

3.2.1. Land Use

3.2.1.1. Existing Land Use

Current land use within the 260-square kilometer (100-square mile) project area largely is dictated by the natural features of the Door Peninsula. The residential and commercial uses are concentrated near Green Bay and Lake Michigan harbors and bays. Most of the agricultural land is located in the interior of the project area. Natural areas are found throughout the project area and generally consist of steep, wooded slopes along Green Bay, interior wetlands, and the Lake Michigan shoreline.

Existing land use was segregated into nine classifications, based on a 1975 inventory compiled by the Bay Lake Regional Planning Commission. The acreage distribution is presented in Table 3-8. The nine classifications have been combined into the following six categories for mapping purposes (Figure 3-11):

- Natural Areas and Agriculture/Silviculture. This combined category represents the most extensive land uses in the project area. Together, they comprise 90.5% of the total area. Natural areas, including the Ridges Sanctuary, Mud Lake, and Peninsula State Park, cover 13,048 hectares (32,342 acres), 50.5% of the project area; agriculture/silviculture uses account for 10,380 hectares (26,648 acres), 40.0% of the project area.

- Residential. Residential uses are concentrated in the four project area communities and along the shoreline of Kangaroo Lake. The 967 hectares (2,389 acres) classified as residential comprise 3.7% of the project area.

- Transportation. The transportation classification includes all roadways and airports. Transportation uses account for 884 hectares (2,185 acres), 3.4% of the project area.

Table 3-8. Land use acreage in the project area in 1975 (Bay-Lake Regional Planning Commission 1975a).

Jurisdiction	Residential	Commercial	Industrial	Transportation	Communications/ Utilities	Institutional/ Government	Outdoor Recreation	Agriculture/ Silviculture	Natural Areas	Total Acreage
Baileys Harbor T.	657.59	34.69	138.67	536.57	0.59	8.79	311.28	6,198.94	12,120.29	20,007.41
Egg Harbor T.	319.57	1.45	7.79	295.38	40.09	2.35	27.25	6,347.78	2,286.38	9,328.04
Egg Harbor V.	355.90	26.92	--	101.69	--	6.61	93.18	58.35	364.49	1,007.14
Ephraim V.	266.35	52.89	--	153.83	--	3.09	70.84	735.18	1,173.38	2,455.56
Gibraltar T.	639.02	57.47	64.86	870.54	65.56	32.96	413.31	7,448.33	12,574.92	22,166.97
Jacksonport T.[a]	45.25	--	--	84.34	--	--	--	2,285.79	1,467.11	3,882.49
Liberty Grove T.[a]	105.06	11.18	27.82	142.16	36.19	4.41	3.82	2,573.21	2,355.45	5,259.30
Project area	2,388.74	184.60	239.14	2,184.51	142.43	58.21	919.68	25,647.58	32,342.02	64,106.91

[a] Includes only the acreage within the project area.

- Outdoor Recreation. There were 372 hectares (920 acres) assigned to this classification, 1.4% of the project area. The acreage includes golf courses, ski areas, and boating facilities.

- Industrial/Commercial. Industrial land use accounts for 97 hectares (239 acres), 0.4% of the project area. Gravel pits and limestone quarries are the predominant industrial land uses. Commercial areas are concentrated in the communities and consist of mixed residences, small shops, service stations, and resort motels and cottages. The 75 hectares (185 acres) classified as commercial constitute 0.3% of the project area.

- Other. Communication, utility, institutional, and governmental facilities comprise 27 hectares (66 acres), 0.4% of the project area. The principal uses include electrical substations, churches, schools, and town halls.

Significant changes in land use trends are not expected. New summer and vacation homes will increase the amount of land in residential use. Proposed residential construction plans indicate a greater mix of housing types, with fewer single family structures erected in linear concentrations along shorelines and more multi-family units (e.g., new or proposed condominium units) at Baileys Harbor, Egg Harbor, and Fish Creek. Commercial growth would accompany new residential development and most likely would cater to seasonal visitors. No expansion in industrial use is foreseen, particularly because of local housing costs and the lack of natural gas, sewer, and water facilities.

3.2.1.2. Development Controls

Zoning is the principal development control exercised in the project area. Zoning is intended to promote compatibility among land uses by regulating their location, size, and use. As a growth management tool, zoning also may be used to control density and direct development into environmentally compatible areas.

All four communities in the project area are zoned (Figure 3-12). Baileys Harbor (unincorporated) is "zoned" by the State by virtue of its shoreline location. In Wisconsin all unincorporated land within 1,000 feet

of the normal high water mark of navigable waters is zoned as a Shoreland Protection District (Wisconsin Statutes, Section 59.97(2)(a)). Responsibility for the establishment and administration of these zoning districts rests with the Door County Board. Similar shoreland zoning also is in effect for the immediate area surrounding Kangaroo Lake.

The unincorporated community of Fish Creek is zoned under the overall ordinance adopted by the County. Wisconsin statutes authorize enforcement of a county zoning ordinance in townships (e.g., Gibraltar Township) when the ordinance is ratified by the Town Board. Door County administers the county zoning ordinance in Gibraltar with the assistance of the Town Board, acting in an advisory capacity.

The Village of Ephraim adopted its zoning ordinance in 1965. The Village revised the ordinance in 1979 and added a subdivision code.

The Village of Egg Harbor adopted a zoning ordinance in 1979. The new ordinance replaced interim zoning and is designed to preserve the character of Egg Harbor and limit population density.

Because county zoning is extended only to those townships that have ratified the County zoning ordinance, the parts of Baileys Harbor Township and Egg Harbor Township that are located outside the Shoreland Protection Districts (land within 1,000 feet of the normal high water mark of navigable waters) currently are unzoned. Only Gibraltar Township and the part of Liberty Grove Township that is included in the project area currently are zoned under the County ordinance. In addition to the County zoning ordinance adopted in 1968, Door County adopted a subdivision code in 1970 that also is enforced in divisions in which the zoning ordinance has been ratified.

The County Comprehensive Plan, completed in 1964, was the basis for the initial planning and zoning efforts in the project area. Subsequent planning has focused on specific topics (e.g., Overall Economic Development Plan, Outdoor Recreation Plan, and Comprehensive Sewer and Water Plan). Door County also is participating in a State-sponsored farmland preserva-

tion program (Farmland Preservation Act of 1977) that may serve as the basis for a new comprehensive plan (By phone, Mr. Robert Florence, Door County Planning Office, to WAPORA, Inc., 19 March 1979).

The Village of Egg Harbor is the only project area community with a comprehensive plan. All of the communities in the project area, however, have developed individual wastewater treatment plans in the past.

3.2.1.3. Prime and Unique Farmlands

Prime farmland is cropland, pastureland, rangeland, forest land, or other land, neither urbanized nor wet, that has the best combination of physical and chemical characteristics for producing crops. The SCS generally has defined prime farmlands as lands having "an adequate and dependable moisture supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt or sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood or are protected from flooding" (SCS 1977).

Prime farmlands in the project area have been identified by specific soil units. The soil units classified as prime (By letter, Mr. A. J. Klingelhoets, SCS, to USEPA, 17 April 1978) are listed in Table 3-9 and mapped in Figure 3-13. Approximately 47% of Door County is classified as prime farmland. Prime farmland acreage for the project area is not available.

Unique farmlands are classified in a different manner and are not identifiable by specific soil units. These lands may have the following characteristics (SCS 1977):

- moisture supply adequate for specific or specialty crops
- growing season long enough, and temperatures warm enough, to produce specific or specialty crops

- a location with a unique combination of soil quality, temperature, humidity, air, drainage, elevation, or other conditions, such as nearness to market, that favor the growth or distribution of specific or specialty food or fiber crops.

The cherry and apple orchards in Door County are considered to be unique farmlands (By letter, Mr. A. J. Klingelhoets, SCS, to USEPA, 17 April 1978). Approximately 837 hectares (2,069 acres) of orchards are located in the project area; these orchards are classified as long-term specialty crops (Bay-Lake Regional Planning Commission 1975a). The orchards

Table 3-9. Prime farmlands in the project area.

Mapping Units
Angelica loam (when drained)
Bonduel loam
Bonduel wet variant loam (when drained)
Emmet sandy loam, 0 to 6 percent slopes
Kewaunee silt loam, 0 to 6 percent slopes
Kolberg silt loam, 0 to 6 percent slopes
Longrie loam, 0 to 6 percent slopes
Manawa silt loam, 0 to 3 percent slopes
Omena sandy loam, 2 to 6 percent slopes
Omena variant sandy loam, 2 to 6 percent slopes
Omro silt loam, 2 to 6 percent slopes
Poygan silty clay loam (when drained)
Sisson fine sandy loam, 0 to 8 percent slopes
Solona loam, 0 to 3 percent slopes
Yahara fine sandy loam, 0 to 3 percent slopes

are tabulated by project area jurisdiction in Table 3-10 and mapped in Figure 3-14.

Table 3-10. Orchard acreage in the project area in 1975 (Bay-Lake Regional Planning Commission 1975a).

Jurisdiction	Acres
Baileys Harbor Township	430.7
Egg Harbor Township	985.8
Egg Harbor Village	37.5
Ephraim Village	167.2
Gibraltar Township	305.4
Jacksonport Township[a]	87.2
Liberty Grove Township[a]	54.8
Project area	2,068.6

[a] Includes only the acreage within the project area.

The climatic conditions in Door County are especially favorable for cherry production (relatively steady day and night temperatures, and spring breezes that retard blossoming until after the danger of frost damage). The County has accounted for as much as 98% of the total cherry production in Wisconsin (Door County Board of Supervisors 1964). Long-term trends, however, indicate a decline in orchard acreage since the 1960 peak of 5,261 hectares (13,000 acres). This figure had dropped to 3,440 hectares (8,500 acres) by 1975, although the recent successful years for cherry production may have slowed the rate of decline.

3.2.2. Demographics

3.2.2.1. Population Distribution and Density

Historically, Door County population trends have exhibited considerable variance. The population gains and losses have reflected both national trends and local economic aberrations, particularly changes associated with the development of the natural resource base of the County. The Door Peninsula was opened for settlement at the end of the Black Hawk War in 1832. The County was created in 1851 and had a population of 2,948 at the time of the first census in 1860 (Table 3-11). Fishing attracted the first settlers and was the major industry until 1890. New residents were attracted by the development of the lumber and pulp industry in the 1850s. This economic expansion, coupled with increased accessibility, stimulated growth, and by 1880 Door County had a population of 11,645. The County continued to grow after 1880, but the eventual decline in the fishing and forestry industries reduced the rate of increase (Table 3-12).

The population reached 17,583 by 1900 when the focus of economic activity began to shift to shipbuilding, fruit growing and canning, and tourism. The first decline in County population occurred between 1920 and 1930 when the number of residents decreased by nearly 900 people. Growth resumed after 1930, and the County's population grew to 20,870 by 1950. Much of the recovery was due to the expansion of the Sturgeon Bay shipbuilding industry during World War II.

The second decline in County population occurred between 1950 and 1970 and was indicative of the national rural-to-urban migratory pattern. Population declined in communities in the project area, although many summer homes were built in the project area during this same period. Between 1950 and 1960, it is estimated that the number of seasonal homes built in Door County equalled the number built during all the previous years (Door County Board of Supervisors 1964).

A definite reversal of the 20-year trend of declining population occurred between 1970 and 1980 (Table 3-12). The population of Door County in 1980 was 25,029, an increase of 24.5% over the 1970 census population

Table 3-11. Historic population growth in the project area between 1860 and 1980 (Bay-Lake Regional Planning Commission 1975b; US Bureau of the Census 1981). Dashes indicate that no data were available.

Years	Baileys Harbor Township	Egg Harbor Township	Egg Harbor Village	Ephraim Village	Gibraltar Township	Project Area	Door County	Wisconsin
1860	--	--	--	--	439	439	2,948	775,881
1870	297	165	--	--	466	928	4,919	1,054,670
1880	549	730	--	--	832	2,111	11,645	1,315,497
1890	603	821	--	--	934	2,358	15,682	1,693,330
1900	645	882	--	--	1,185	2,712	17,583	2,069,042
1910	628	1,031	--	--	1,119	2,778	18,711	2,333,860
1920	679	1,011	--	--	1,011	2,701	19,073	2,632,067
1930	641	947	--	191	771	2,550	18,182	2,939,006
1940	677	926	--	254	880	2,737	19,095	3,137,587
1950	715	916	--	244	764	2,639	20,870	3,434,575
1960	654	852	--	221	606	2,333	20,685	3,951,777
1970	615	693	184	236	590	2,318	20,106	4,417,731
1980	799	825	238	319	742	2,923	25,029	4,705,335

Table 3-12. Percent change in the population of the project area from 1860 to 1980 (Bay-Lake Regional Planning Commission 1975b; US Bureau of the Census 1981). Dashes indicate that no data were available.

Years	Baileys Harbor Township	Egg Harbor Township	Egg Harbor Village	Ephraim Village	Gibraltar Township	Project Area	Door County	Wisconsin
1860-1870	--	--	--	--	6.2	111.4	66.8	--
1870-1880	84.8	342.4	--	--	78.5	127.5	136.7	24.7
1880-1890	9.8	12.5	--	--	12.3	11.7	34.7	28.7
1890-1900	7.0	7.4	--	--	26.9	15.0	12.1	22.2
1900-1910	-2.6	16.9	--	--	5.5	2.4	6.4	12.8
1910-1920	8.1	-1.9	--	--	-9.6	-2.8	1.9	12.8
1920-1930	-5.6	-6.3	--	--	-23.7	-5.6	-4.6	11.6
1930-1940	5.6	-2.2	--	33.0	14.1	7.3	5.0	6.7
1940-1950	5.6	-1.1	--	-3.9	-13.2	-3.6	9.3	9.5
1950-1960	-8.5	-7.0	--	-9.4	-20.7	-11.6	-0.8	14.4
1960-1970	-6.0	-18.7	--	11.8	-2.6	-0.6	-2.8	12.3
1970-1980	29.9	19.0	29.3	35.2	25.8	26.1	24.5	6.5

(US Bureau of the Census 1981). During the same period the project area population increased by 605 residents, or 26.1%. Baileys Harbor Township had a net increase of 184 residents, the largest in the project area. Ephraim Village, which grew by 35.2%, had the highest rate of increase. Egg Harbor Township's growth rate of 19.0% since 1970 was the lowest in the project area. Although this was less than Door County's 24.5% growth rate since 1970, it was considerably more than the State's 6.5% growth rate. These post-1970 population increases are consistent with State and national trends. Many urban-area populations have declined since 1970, whereas rural "amenity" areas, similar to Door County, have grown.

The entire population of the project area was classified as rural in the 1970 census. The census categorized 67.5% of the population as rural non-farm and 30.1% as rural farm. The only urban population in Door County is located at Sturgeon Bay. There were 27.4 persons per square mile in the project area in 1980. This was considerably less than densities for Door County (50.9) and for the State (86.1; Wisconsin Department of Administration 1978, US Bureau of the Census 1981).

3.2.2.2. Population Characteristics

3.2.2.2.1. Household Size

The average number of persons per household in the project area declined from 2.97 in 1970 to 2.59 in 1980 (Table 3-13). This decline is consistent with nationwide trends toward later marriages, smaller families and increased numbers of one- and two-person households. This trend also was apparent in Door County where the average household size declined from 3.08 to 2.72 between 1970 and 1980 and in the State where it declined from 3.32 to 2.85. The Town of Egg Harbor, however, had a greater number of persons per household, 3.02, than the project area, Door County or the State. The relatively high percentage of minors in Egg Harbor could be a result of the Town's proximity to Sturgeon Bay and its employment opportunities.

Table 3-13. Selected population characteristics in the project area in 1970 and 1980 (US Bureau of Census 1973, By telephone, Mr. Robert Naylor, Demographic Services Department, Wisconsin Bureau of Administration, to WAPORA, Inc., 27 May 1982). Dashes indicate that no data are available.

Jurisdiction	Population		Number of Households		Persons per Household		Median Age		Percent Under 18 Years		Percent 65 Years and Over	
	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980
Baileys Harbor Township	615	799	220	325	2.80	2.46	42.5	40.1	27.8	22.9	15.4	21.0
Egg Harbor Township	693	825	198	273	3.50	3.02	28.8	27.3	39.7	31.7	12.1	10.8
Egg Harbor Village	184	238	72	107	2.56	2.22	48.6	45.4	26.1	20.2	15.8	22.7
Ephraim Village	236	319	88	137	2.68	2.33	42.5	47.4	30.1	22.5	20.8	24.8
Gibraltar Township	590	742	200	285	2.95	2.60	38.6	35.8	30.3	24.4	19.8	20.1
Project area	2,318	2,923	778	1,127	2.97	2.59	40.2	39.5	30.9	24.4	16.1	19.9
Door County	20,106	25,029	6,526	9,207	3.08	2.72	33.8	31.7	34.1	--	14.8	--
Wisconsin	4,417,731	4,705,521	1,328,604	1,652,261	3.32	2.85	27.2	29.4	35.8	--	10.7	--

3.2.2.2.2. Median Age

Median age is an index of the overall age structure. The median age in the project area in 1980 (39.5) was significantly higher than the County or State median ages, but was less than the 1970 median age for the project area of 40.2 (Table 3-13). Between 1970 and 1980 the population of the US aged as a result of the declining fertility rates that have occurred since approximately 1965. The median age in the US in 1970 was 28.1 and in Wisconsin it was 27.2 (US Bureau of the Census 1973). According to the 1980 census, the median age in the US and in Wisconsin was 30.0 and 29.4, respectively (By telephone, Mr. Robert Naylor, Demographic Services Department, Wisconsin Department of Administration, to WAPORA, Inc., 27 May 1982). The median age in Door County, however, decreased from 33.8 in 1970 to 31.7 in 1980. Four of the five jurisdictions in the project area also recorded decreases in median age between 1970 and 1980. The one exception, Ephraim Village, recorded an increase in the median age between 1970 and 1980 from 42.5 to 47.4. Even though there is a general trend of declining median ages in the project area, the higher than average median ages, as compared to the County, the State and the US, can be attributed to the growing number of retired residents who are attracted by the recreational and scenic amenities of the project area.

3.2.2.2.3. Mobility

The mobility of the population can be determined by comparing a person's residence in 1965 and 1970. In 1970, 63.9% of the population reported that they resided in the same house as they did in 1965 (US Bureau of the Census 1973). An additional 19.1% reported that they resided in the same county in 1965, but in a different house. Another 9.4% either lived in a different county or state in 1965. All those residing in a different state in 1965 lived in the North Central region of the US. The large number of individuals residing in the same house in 1970 as in 1965 is related to the high median age in the project area; mobility tends to decrease with age. Similar data for the project area from the 1980 census are not yet available.

3.2.2.3. Housing Stock Characteristics

The housing stock in the project area comprises both year-round and seasonal dwellings. Year-round units account for 1,895 units, or 64.4% of the housing stock (Table 3-14). These year-round units include 1,127 occupied units and 768 vacant units. These vacant units comprise 663 held for occasional use; 30 for sale or rent; and 73 held for janitorial use, estate settlements, or other private reasons. Seasonal housing represents 1,048 units. The 1,711 housing units used for only part of the year (Table 3-14) is derived by adding the 663 occassionally-used, year-round units to the 1,048 seasonal units. The 1,711 seasonal units in the project area in 1970 constituted 58.1% of the total housing units. Among the project area communities, the Villages of Ephraim and Egg Harbor had the highest percentages of seasonal housing, 68% of the housing units in both communities are used on a seasonal basis. Because the townships include large rural areas that are distant from water-related amenities, their seasonal housing percentages were lower.

Comparisons between the project area, the County, and the State housing stock characteristics in 1970 reveal numerous differences (Table 3-15):

- The project area housing stock is more often owner occupied. The low percentage of renter-occupied units is typical of low-density rural areas. The owner-occupied homes had an average of 5.9 rooms per unit; rental properties averaged 5.3 rooms per unit

- The project area housing stock is newer. In 1970, 48.1% of the housing stock predated 1940 and 22.0% was built in 1960 or later. The vacant housing, primarily units reserved for occasional use, was newer than the year-round, occupied housing, indicating a higher recent construction rate for seasonal dwellings

- The project area housing stock more frequently lacks complete plumbing facilities (piped hot water, a flush toilet, and a bathtub or shower). There were 175 occupied and vacant units that lacked some or all plumbing facilities. Of the 133 units lacking flush toilets, 73 were occupied.

Table 3-14. Project area housing summary for 1980 (Wisconsin Department of Administration, n.d.)

Jurisdiction	Year-round Vacant Units	+	Year-round Occupied Units	=	Total Year-round Units	+	Seasonal Units	=	Total Units	Seasonal Units + 86% of Year-round Vacant Units
Baileys Harbor Township	201		325		526		331		857	513
Egg Harbor Township	27		273		300		198		498	202
Egg Harbor Village	169		107		276		85		361	246
Ephraim Village	235		137		372		134		506	343
Gibraltar Township	136		285		421		300		721	407
Project area	768	+	1,127	=	1,895	+	1,048	=	2,943	1,711

Table 3-15. Selected housing stock characteristics for the project area in 1970 (US Bureau of the Census n.d.a, n.d.b).

Jurisdiction	Occupied Units		% Units by Year Structure Built				Units Lacking Some or All Plumbing Facilities	
	% Owner	% Renter	1960 - March 1970	1950-1959	1940-1949	1939 or Earlier	Number	Percent
Baileys Harbor Township	85.9	14.1	21.0	17.3	4.7	57.0	28	11.1
Egg Harbor Township	86.4	13.6	25.3	27.3	5.2	42.3	80	24.1
Egg Harbor Village	87.5	12.5	8.5	20.2	22.3	48.9	8	8.9
Ephraim Village	87.5	12.5	17.3	17.3	28.6	36.7	6	6.4
Gibraltar Township	86.5	13.5	24.7	10.8	13.6	50.8	53	15.2
Project area	86.5	13.5	22.0	18.3	11.5	48.1	175	15.7
Door County	81.5	18.5	18.6	12.6	12.3	56.4	748	9.2
Wisconsin	62.9	37.1	20.2	17.4	9.7	52.7	101,372	7.2

3.2.2.4. Population Projections

Accuracy in the development of population projections is highly dependent on two factors: the size of the base population and the period of time for which the projections are made. The estimation of population generally is less accurate for small populations than for larger populations over long periods of time. This is because attitudinal or technological changes can significantly affect small communities, whereas larger communities can better absorb such changes.

The effect of these limitations can be minimized if population projections are based on observations derived from a thorough analysis of historical trends and future expectations. Four observations regarding population trends in Door County and the project area must be considered in forecasting future population levels:

- Until recently, the population of Door County had been slowly declining. The previous peak population level was reached in 1950 when Door County had 20,870 residents. The population of the project area, however, peaked in 1940 at a level of 2,737 people. The decline that followed paralleled the national trend of rural to urban migration during the 1950's and 1960's. The younger sectors of the rural population usually were attracted to the urban areas by employment and educational opportunities. This downward trend of population growth, however, was reversed after 1970. Between 1970 and 1980, Door County's population increased by 24.5% from 20,106 to 25,029. Population growth in the project area occurred at a similar rate during this same period, increasing 26% from 2,318 to 2,923 (US Bureau of the Census 1973, 1981).

  The reversal of population trends in Door County is consistent with recent national trends of net migration from urban to rural areas. Rural areas are attractive for a variety of reasons, including lower land values, the amenities of "country life," and an absence of urban problems. The current trend of population increase is expected to continue in Door County, because of its varied scenic attractions and popularity as a retirement area.

- Although the County and the project-area populations will continue to grow, the growth will occur at a decreasing rate. The fertility rate (the number of births per female in the 20- to 34-year age group) between 1970 and 1975 was more than the replacement level in Door County. The fertility

rate, however, is expected to decline over a 30-year period. Population projections developed by the Wisconsin Department of Administration indicate that the growth rate for Door County will gradually decrease as it approaches the replacement level.

- The relationship between population change in the County and population change in the project area has been very stable over the period from 1950 to 1980 (Table 3-16). The proportion of the Door County population attributable to each minor civil division did not vary by more than 0.73% during any of the ten-year periods from 1950 to 1980. This suggests a relatively strong correlation between County and project area trends.

- The demand for housing utilized for seasonal or occasional use is high. Information from the 1980 census indicates that there has been a substantial increase since 1970 in the number of housing units used on a seasonal or occasional basis. Between 1970 and 1980, the number of occupied year-round housing units in the project area increased by 45% (Wisconsin Department of Administration, n.d.). Housing units used on a seasonal or occasional basis increased by 72%, from 994 to 1,711, during the same period. Whereas the ratio of seasonal to occupied year-round dwellings was 1.28 in 1970, the high demand for seasonal dwellings resulted in an increase in the ratio to 1.52 in 1980 (i.e., there were 1.52 seasonal housing units for every occupied year-round housing unit).

Table 3-16. Percentages of Door County population residing in the project area minor civil divisions in 1950, 1960, and 1970. (US Bureau of the Census 1952, 1963, 1973, 1981).

Jurisdiction	Percent of Total County Population 1950	1960	1970	1980
Baileys Harbor Township	3.43	3.16	3.06	3.19
Egg Harbor Township	4.39	4.12	3.45	3.30
Egg Harbor Village[a]	--	--	0.92	0.95
Ephraim Village	1.17	1.07	1.17	1.27
Gibraltar Township	3.66	2.93	2.93	2.96

[a]The Village of Egg Harbor was not enumerated as a minor civil division until 1970. Prior to 1970, the population for the Village of Egg Harbor was included in the population for Egg Harbor Township. For purposes of comparison with the 1950 and 1960 Egg Harbor Township percentages, the 1970 and 1980 combined Village and Township percentages were 4.37% and 4.25%, respectively.

Other factors also will have some impact on future population growth. Higher fuel cost and/or restrictions on fuel availability might reduce tourism and indirectly affect population growth. The growth attitudes of existing residents, local governments, and commercial interests also could affect future population levels.

3.2.2.4.1. Permanent Population Projections

Permanent population forecasts for the project area are based on projections prepared for Door County by the Wisconsin Department of Administration (1975). These State projections are the most recent and comprehensive figures available. They were generated using a cohort-component model that adjusts the base population as a result of changes in fertility, mortality, and net migration over 5-year increments. In accordance with State recommendations, the "toward replacement fertility level" projections, characterized by a declining growth rate, were employed in forecasting future local population. These projections for the permanent population in Door County in 1985, 1990, and 2000 were allocated among the governmental jurisdictions. The percentages of the County population allocated to each community were derived from a "least squares" trend line calculated from known percentages from 1960 to 1980. Three unincorporated areas were not enumerated in the 1980 Census (the Baileys Harbor community, the Fish Creek community, and the Kangaroo Lake area). The current population for these areas was estimated from 1979 housing counts conducted in the map areas previously delineated in the Door County, Wisconsin, Comprehensive Sewer and Water Plan (Becher-Hoppe Engineers, Inc. 1972). The number of houses indicated for each map area was multiplied by 2.63 people (the average of the 1970 occupancy rates for the Villages of Ephraim and Egg Harbor). The community share of the County population was based on the 1979 population. The permanent population projections are presented in Table 3-17.

3.2.2.4.2. Seasonal Population Projections

The seasonal peak population projections were calculated from 1980 census data. The number of seasonal housing units for each jurisdiction

Table 3-17. Permanent population projections for the project area in 1985, 1990, and 2000.

Jurisdiction	1980 Population	1979 Population[a]	Toward Replacement Fertility Level Projections[b] 1985	1990	2000
Baileys Harbor Township	799		893	978	1,111
Baileys Harbor community		313	(408)	(455)	(536)
Kangaroo Lake area		147	(191)	(213)	(253)
Egg Harbor Township	825		872	955	1,091
Egg Harbor Village	238		270	300	369
Ephraim Village	319		346	393	466
Gibraltar Township	742		805	878	1,009
Fish Creek community		224	(236)	(252)	(278)
Project area[c]	2,923		3,186	3,503	4,046

[a] The three areas with figures in this column are unincorporated and are not enumerated by the US Bureau of Census. These figures were calculated from 1979 housing counts because census data were not available. Projections for these areas were calculated using the proportional share method.

[b] The permanent projections for the Townships and Villages (not in parentheses) were calculated using the least squares method, "averaging" each jurisdiction's historical percentage of the Door County population.

[c] The totals do not include figures in parentheses because they are already included in the figures for Baileys Harbor Township and Gibraltar Township.

was multiplied by a recommended occupancy rate of 3.0 (By telephone, Mr. Jack Grey, University of Wisconsin Recreation Resources Center, to WAPORA, Inc., 9 April 1979), and a ratio of seasonal to permanent population was calculated for 1980. The resultant ratio multiplier was applied to the projections of permanent population to yield the seasonal population projections that are presented in Table 3-18. Seasonal housing stock data (percentage of total housing units classified as seasonal) for the housing count areas were obtained from the wastewater treatment plans prepared in 1973 for the Townships of Baileys Harbor and Gibraltar. Projections for these areas were developed using the multipliers derived from the ratio of seasonal to permanent population in 1979. The combined permanent and seasonal peak populations are presented in Table 3-19.

Seasonally-transient visitors are an additional population component. The numbers of cottage, motel, and campsite units available in the project area were tabulated from directories provided by the Door County Chamber of Commerce (1982). Appropriate multipliers were utilized to determine the population accommodated by these facilities (Table 3-20). There are no known future plans for expansion of project area campgrounds, and the limited historical data on overnight lodging facilities in Door County preclude identification of a trend. Therefore, the 1982 population accommodated by these facilities was held constant for the purpose of projecting total peak population.

3.2.3. Economics

3.2.3.1. Local Economic Characteristics

3.2.3.1.1. Basic Sector

Agriculture, manufacturing, tourism, and mining comprise the basic, or "export" sector, of the local economy in Door County. The basic sector produces goods or services exported to other areas. The specific components of the basic sector may vary with locale, but usually include the industries listed above. Although tourism services are not exported, they are considered basic because local consumption is attributable to non-

Table 3-18. Seasonal population projections for the project area in 1985, 1990, and 2000.

Jurisdiction	1980 Population	1979 Population[a]	1985	1990	2000[b]
Baileys Harbor Township	1,539		1,723	1,889	2,144
Baileys Harbor community		78	(161)	(180)	(212)
Kangaroo Lake area		387	(440)	(482)	(547)
Egg Harbor Township	606		641	702	802
Egg Harbor Village	738		837	930	1,144
Ephraim Village	1,029		1,118	1,269	1,505
Gibraltar Township	1,221		1,328	1,449	1,665
Fish Creek community		375	(517)	(551)	(610)
Project area[c]	5,133		5,647	6,239	7,260

[a] The three areas with figures in this column are unincorporated and are not enumerated by the US Bureau of Census. These figures were calculated from 1979 housing counts because census data were not available. Projections for these areas were calculated using the proportional share method.

[b] The seasonal projections for the Townships and Villages (not in parentheses) assume that the 1980 ratio of seasonal to permanent population remains constant during the planning period.

[c] The totals do not include figures in parentheses because they are already included in the figures for Baileys Harbor Township and Gibraltar Township.

Table 3-19. Combined permanent and seasonal population projections for the project area in 1985, 1990, and 2000.

Jurisdiction	1980 Population	1979 Population[a]	Toward Replacement Fertility Level Projections[b] 1985	1990	2000
Baileys Harbor Township	2,338		2,616	2,867	3,255
Baileys Harbor community		391	(569)	(635)	(748)
Kangaroo Lake area		534	(631)	(695)	(800)
Egg Harbor Township	1,431		1,513	1,657	1,893
Egg Harbor Village	976		1,107	1,230	1,513
Ephraim Village	1,348		1,464	1,662	1,971
Gibraltar Township	1,963		2,133	2,327	2,674
Fish Creek community	———	599	(753)	(803)	(888)
Project area[c]	8,056		8,833	9,743	11,306

[a] The three areas with figures in this column are unincorporated and are not enumerated by the US Bureau of Census. These figures were calculated from 1979 housing counts because census data were not available. Projections for these areas were calculated using the proportional share method.

[b] The combined projections for the Townships and Villages (not in parentheses) were calculated by combining the permanent and seasonal population projections.

[c] The totals do not include figures in parentheses because they are already included in the figures for Baileys Harbor Township and Gibraltar Township.

Table 3-20. Seasonally transient population estimates for the project area in 1980.

Jurisdiction	Population Accommodated by Resort/ Motel Facilities[a]	Population Accommodated at Campsites[b]	Total
Baileys Harbor Township	753	456	1,209
Baileys Harbor community	(473)	--	(473)
Kangaroo Lake area	(101)	--	(101)
Egg Harbor Township	165	1,066	1,231
Egg Harbor Village	473	--	473
Ephraim Village	728	--	728
Gibraltar Township	540	2,184	2,724
Fish Creek community	(540)	--	(540)
Project area[c]	2,659	3,706	6,365

[a] Based on a rate of 2.8 persons per cottage or motel unit (By telephone, Mr. Jack Grey, University of Wisconsin Recreation Resources Center, to WAPORA, Inc., 9 April 1979).

[b] Based on a rate of 3.26 persons per campsite (By telephone, Mr. Jack Grey, University of Wisconsin Recreation Resources Center, to WAPORA, Inc., 9 April 1979).

[c] The vertical totals do not include figures in parentheses because they are already included in figures for Baileys Harbor Township and Gibraltar Township.

residents. The income generated by the basic sector circulates within the local economy and supports non-basic, or "service" sector industries, that provide goods and services for local consumption.

Because income and production data are usually difficult to obtain, employment figures routinely are used for small-area economic base analyses. The economic and population trends are directly related to employment opportunities in the basic sector. The ratio of total employment (basic and service sector employment) to basic employment quantitatively describes this relationship. Specifically, the ratio indicates the total number of jobs generated by each job in the basic sector. The relationship between basic and total employment underlies the historic population decline in Door County. As basic employment opportunities in agriculture and in the lumber and fishing industries decreased, the service employment and total population levels were affected.

Post-1970 employment trends in Door County indicate accelerated growth in the basic sector (Table 3-21). The growth rate of 71% was primarily attributable to a 168% increase in manufacturing and 53% increase in tourism. Manufacturing accounts for 38% of the year-round wage and salary jobs in the County, most of which are located in Sturgeon Bay. Manufacturing jobs are concentrated in the production of durable goods, where employment increased by 270% between 1971 and 1979 (1,013 employees to 3,750 employees). Jobs associated with the production of non-durable goods decreased by 33% (513 employees to 349 employees) during the same period. The primary reason for the increase in manufacturing employment is the expansion of the shipbuilding industry in Sturgeon Bay. Congress recently extended eligibility for construction rebates and mortgage guarantees to Great Lakes and inland vessel operators (Amendment to Title XI of the Merchant Marine Act of 1936). Continued growth in this industry is expected.

Tourism, a basic industry in Door County, is particularily important in the project area. In addition to the numerous restaurants and retail firms that are dependent on seasonal visitors, there are 2,086 tourist rental units and campsites in the project area (Door County Chamber of

Table 3-21. Door County employment trends, by sector, in 1971 and 1979 (BEA 1981).

Category	1971	1979	Percent Change 1971 - 1979
Total employment	8,792	13,510	54%
Farm proprietors	1,421	1,256	-12
Non-farm proprietors	1,050	1,448	38
Wage and salary	6,321	10,806	71
Basic	4,268	7,302	71
Agriculture[a]	1,821	1,824	0.2
Mining[b]	--	27	--
Manufacturing	1,526	4,095	168
Tourism[c]	886	1,356	53
Non-basic (service)	4,525	6,208	37
Basic: Service multiplier[d]	1.06	0.85	-20
Civilian Labor Force[e]	8,400	14,600	74
Employed	8,000	14,000	75
Unemployed	400	530	33
Unemployment rate	5.1%	3.6%	-29

[a] Includes farm proprietors, farm wage and salary employees, agricultural service, forestry, fisheries, and other.

[b] Mining not disclosed in 1971.

[c] Tourism = 50% of the retail trade employment + 9% of the FIRE, insurance, and real estate employment + 23% of the services employment (Strang 1970).

[d] The multiplier indicates the number of service jobs generated by 1 basic job.

[e] By phone, Mr. Russ Heilman, Wisconsin Bureau of Research and Statistics, to WAPORA, Inc., 18 June 1982.

Commerce 1982). Although tourism employment data for the project area are unavailable, growth most likely occurred at a rate equal to, or greater than, the County rate between 1971 and 1979 (Table 3-21), and continued expansion is forseen.

Employment in agriculture remained relatively stable between 1971 and 1979. Although farm wage and salary employment increased from 400 to 532 during that period, the number of farm proprietors decreased by 165. This trend is expected to persist as more attractive manufacturing and tourism employment opportunities develop and farm consolidation continues.

The mining industry in Door County is limited to sand, gravel, and stone extraction. In 1979 the industry employed 27 people.

3.2.3.1.2. Service Sector

Employment in the service sector in Door County increased by 37% between 1971 and 1979. A decline in transportation/public utilities was offset by growth in construction; wholesale trade; retail trade; finance, insurance, and real estate (FIRE); and government (Table 3-22). The increase in FIRE employment (53) was significant. Although relatively small in terms of actual jobs, finance activities are considered tertiary and require an increasingly sophisticated economic base to support them.

Government was the largest service sector employer in 1979, with 1,448 employees. Most of these employees are located in Sturgeon Bay, the County seat and largest municipality in Door County.

Service employment change between 1971 and 1979 ranged from an increase of 191% in wholesale trade to a decrease of 31% in transportation/public utilities. Specific reasons for these changes are not evident in the available literature.

The number of non-farm proprietors grew from 1,050 in 1971 to 1,448 in 1979. The types of proprietory operations are unknown, but most likely include art and craft shops, small grocery stores, and galleries. Although

Table 3-22. Door County employment trends, by service sector categories, in 1971 and 1979 (BEA 1981).

Category	1971	1979	Percentage Change 1971 - 1979
Non-farm proprietors	1,050	1,448	38%
Construction	362	460	27
Transportation/public utilities	267	183	-31
Wholesale trade	68	198	191
Retail trade[a]	654	939	44
FIRE[b]	136	208	53
Services[c]	728	1,324	82
Government	1,260	1,448	15
Total	4,525	6,208	37

[a] 50% of the retail trade employment. Remaining 50% allocated to the basic sector (tourism).

[b] 91% of the FIRE, insurance, and real estate employment. Remaining 9% allocated to basic sector (tourism).

[c] 77% of the service employment. Remaining 23% allocated to basic sector (tourism).

these proprietors are considered part of the service sector, they probably conduct most of their business during the summer tourist season.

3.2.3.1.3. Employment Multipliers

Employment trends in Door County do not parallel the State trends shown in Table 3-23. Basic and service sector employment grew at a faster rate in Door County, and the basic sector expanded more rapidly than the service sector. The Door County employment multiplier decreased slightly, with each basic sector job generating 1.06 service jobs in 1971 compared with 0.85 service jobs in 1979. Two factors may have contributed to the reduced multiplier. First, Door County is not a self-contained economic unit. Many retail goods, wholesale goods, and other services are available only outside the County, often in Green Bay. Therefore, service jobs

Table 3-23. Percent change in Door County and Wisconsin employment, by sector, 1971-1979 (BEA 1981).

Category	Door County Percent Change 1971 - 1979	Wisconsin Percent Change 1971 - 1979
Total employment	54%	23%
Farm proprietors	42	-9
Non-farm proprietors	38	23
Wage and salary	71	25
Basic	71	19
Agriculture[a]	0.2	9
Mining[b]	--	4
Manufacturing	168	23
Tourism	53	c
Non-basic (service)	37	25

[a] Includes farm proprietors, farm wage and salary employees, agricultural service, forestry, fisheries, and other.

[b] Door County mining data not disclosed.

[c] Not considered a basic industry at the State level.

generated by growth in the basic sector in Door County may develop elsewhere. Second, the service sector may be exhibiting a "lag time" in response to increase in basic sector employment.

3.2.3.1.4. *Labor Force*

Door County had a resident labor force (persons between ages 16 and 65) of 13,600 people in 1981, 54% of the total population. This was greater than the State proportion of 50%. The higher labor force participation rate in Door County is a change that has occurred in recent years. It reflects the rapid population growth that took place in Door County during the 1970's (Section 3.2.2.).

The unemployment rate for Door County generally has been higher than the rate for the State (Table 3-24). The past scarcity of jobs, particularly at Sturgeon Bay, and the seasonal character of the tourist industry, contributed to the higher unemployment rates. This trend has changed, however, as denoted by the lower County rate of 1979, 1980, and 1981. This change reflects the continued expansion of the ship building industry at Sturgeon Bay and the concentration of employment in the non-manufacturing industries which have been less severely affected by the current nation-wide recession.

Table 3-24. Unemployment rates (percent of total work force unemployed) in Door County and Wisconsin (By phone, Mr. Russ Heilman, Wisconsin Bureau of Research and Statistics, to WAPORA, Inc. 19 June 1982).

	Year					
	1950	1960	1970	1979	1980	1981
Door County	3.8	4.3	3.7	3.6	5.8	7.1
Wisconsin	2.9	3.3	4.0	4.5	7.1	7.8

3.2.3.2. Recreation and Tourism

3.2.3.2.1. Facilities

Door County hosts an estimated two million visitors each year (By phone, Mr. Tolin Hyland, Door County Chamber of Commerce, to WAPORA, Inc., 7 March 1979). Most are attracted by the white sand beaches, towering cliffs, rocky palisades, and overall natural beauty of the Door Peninsula. The scenic rural landscape, characterized by orchards, historic villages and farm buildings, and architecturally unique cottages and resorts, provides an atmosphere often compared to Cape Cod.

The project area includes many recreational features and some of the finest scenery on the Door Peninsula. Peninsula State Park, the third largest park in Wisconsin, has 465 campsites and facilities for golf, swimming, picnicking, and boating. The Ridges Sanctuary, near Baileys Harbor, is well known for its wildflowers, lighthouse, and unique landscape. The 45 miles of project-area shoreline are interrupted by numerous bays that provide excellent fishing, particularly for salmon and lake trout. The communities located on these bays usually have beaches, marina facilities, and picnic sites. The various recreational resources are listed and classified by location in Appendix O. Although most of the recreational opportunities are summer oriented, participation in winter activities is growing. Peninsula State Park now has 25 winter campsites and facilities for cross-country skiing, ice fishing, skating, and snowmobiling.

3.2.3.2.2. Hospitality-Recreation-Tourism Industry

Although no specific economic data are available for the project area, County figures indicate the importance of the hospitality-recreation-tourism (HRT) industry (Table 3-25). In 1977, the HRT industry in Door County generated $23,587,565 in gross sales (University of Wisconsin-Extension 1977), an increase of 12% over 1976 gross sales. With the subtraction of an annual inflation rate of 5.9%, real growth was actually 6.1%, slightly above the 5.7% real growth in State HRT gross sales. The HRT gross sales comprised 9.3% of the total County business sales. These figures reflect

Table 3-25. Hospitality-recreation-tourist industry gross sales in 1976 and 1977 (University of Wisconsin-Extension 1977)[a].

SIC Category	1976 Gross Sales	1976 Number Reporting	1977 Gross Sales	1977 Number Reporting	Percent Change 1976 - 1977	Real Growth 1976 - 1977
Restaurants	$ 6,483,550	86	$ 8,134,395	75	25.5	19.6
Hotel-motel-resorts	6,767,107	219	7,385,869	239	9.1	-0.4
Taverns	4,410,472	137	4,563,230	121	3.5	-2.4
Sporting goods	1,454,946	10	1,363,162	13	-6.3	-12.2
Amusement/recreation	1,441,235	19	1,554,109	20	7.8	1.9
Trailer parks/camping	297,636	11	353,459	9	18.7	12.8
Motion pictures	204,220	4	233,341	4	14.3	8.4
Subtotal	21,059,166	486	23,587,565	481	12.0	6.1
Recreation sensitive sales[b]	46,163,543	205	50,877,934	209	10.2	4.3
Total	67,222,709	691	74,465,499	690	10.7	4.8
Total County[c]	207,503,162	1,329	253,673,547	1,389	22.3	16.4

[a] Use of gross sales data has some shortcomings: establishments involved in a variety of businesses may distort number reporting, chain operations reporting from central offices show gross sales only for headquarters county, and gross sales for sales tax delinquents are not included.

[b] Department, food, drug, and liquor stores; vending machines; and automotive and gasoline dealers.

[c] All businesses subject to sales tax.

only HRT sales by restaurants, hotel-motel-resorts, taverns, sporting goods stores, amusement/recreation establishments, trailer parks, campgrounds, and movie theaters. When combined with the 1977 recreation sensitive sales of retail and service establishments (department, food, drug, and liquor stores; vending machines; and gasoline stations), gross sales total $74,465,499, approximately 29% of the total business sales in the County. Despite a decrease in the number of restaurants and trailer park/ camping establishments reporting, these two categories exhibited significant growth since 1976.

The importance of the HRT sales in Door County is apparent when compared with the other counties in Wisconsin. Although Door County ranked 28th of the 72 counties in the level of gross sales, it ranked 7th in the impact of HRT sales on local income. The County percent of statewide HRT gross sales (0.88%) was twice the percent the County contributed to statewide consumer spendable income (0.42%; individual income remaining after deduction of personal tax and non-tax payments to the Federal and State governments). The HRT sales are also significant in terms of their "multiplier effect" on other sectors of the Door County economy. Strang (1970) estimated that every dollar in tourist receipts generated an additional $2.17 in total County sales.

The HRT industry is expected to continue as the dominant economic force in Door County. The outlook for the project area is similar because development alternatives are severely limited and because many of the major recreation and tourist attractions are located there. The recent completion of Interstate 43 between Sheboygan and Green Bay has reduced travel time from the south and may result in more visits by tourists and seasonal residents. Although some reduction in HRT sales was anticipated following gasoline shortages during the spring of 1979, a survey of local proprietors indicated business sales were equal to, or only slightly less than, the previous year (Adams 1979).

3.2.3.3. Local Financial Status

3.2.3.3.1. Income Levels

The incomes of Door County laborers and proprietors consistently fall below the State and National average annual incomes (BEA 1981). The comparatively low annual incomes in Door County are directly related to the relatively large proportion of the labor force (26%) that is dependent on the seasonally oriented tourist and agriculture industries. The low incomes also are related directly to the large elderly population (Table 3-13). The fixed incomes of the elderly, generally derived from Social Security and pension benefits, dividends, and interest, are usually less than the income generated by wages, salaries, or self-employment (By phone, Mr. John Michalski, Door County Bureau of Social Services, to WAPORA, Inc., 17 April 1979).

Per capita income levels in the project area townships were lower than the levels recorded for Door County and the State, while the levels for the two villages were higher (Table 3-26). Per capita income levels in Door County historically have been lower than the State, and the per capita incomes in the three townships generally reflect these lower incomes. Since 1969, per capita income in the townships, Door County and the State have increased at approximately the same rate, with the exception of Egg Harbor Township. In 1969, Egg Harbor Township had a higher per capita income level than the other project area jurisdictions, Door County, and the State. By 1980, Egg Harbor Township had a lower per capita income level than any of the other jurisdictions. Per capita income increased in Egg Harbor Township by 73.2% from 1969 to 1980, compared with the 148.4% and 133.8% increases recorded in Door County and the State, respectively. In comparison, the Village of Ephraim had the lowest per capita income in 1969 and the highest in 1980. Per capita income in Ephraim increased by 317.2% between 1969 and 1980.

Supplemental income recipients comprise about 25% of the project area population. In December of 1977 there were 720 individuals with Social Security or supplemental security income in the project area (By phone, Mr.

Table 3-26. Per capita income[a] in the project area (US Bureau of the Census 1979; By telephone, Ms. Carol Doran, Wisconsin Department of Revenue, to WAPORA, Inc., 18 June 1982).

Jurisdiction	1969	1975	1980	Percent Change 1969-1980
Baileys Harbor Township	2,645	4,214	6,392	141.7
Egg Harbor Township	3,198	4,782	5,540	73.2
Egg Harbor Village	2,899	4,499	7,480	158.0
Ephraim Village	2,360	3,729	9,845	317.2
Gibraltar Township	2,456	3,719	6,155	150.6
Door County	2,637	4,210	6,550	148.4
Wisconsin	3,032	4,722	7,088	133.8

[a] Per capita income is the sum of wage and salary income; net non-farm self-employment income; net farm self-employment income; Social Security and railroad retirement income; public assistance income; and other income including interest, dividends, veterans payments, pensions, unemployment insurance, alimony, etc. The income is computed prior to deductions for personal income taxes, Social Security, bond purchases, union dues, Medicare, etc.

Erik Matson, Wisconsin Department of Social Security, to WAPORA, Inc., 16 April 1979). The Social Security payments were made to retired persons and the supplemental security payments were made to disabled persons.

The project area is characterized by a very small proverty-level population. In April of 1979, there were only seven cases of aid to families with dependent children (AFDC) and one case of general relief in the project area (By phone, Mr. John Michalski, Door County Bureau of Social Services, to WAPORA, Inc., 17 April 1979).

Although the population of northern Door County is increasing, the number of participants in the food stamp program and other public assistance efforts has declined. Among the reasons for this decline are the following: low income rental units were removed from the market after 1970 and were converted to seasonal or permanent housing; new housing construction has consisted of exclusively middle- and upper-income units; and very

few of the individuals that comprise the growing retirement population can qualify for public assistance because their income levels are considered adequate.

3.2.3.3.2. Local Government Finances

The 1980 property valuations, both assessed and fully equalized, for each governmental jurisdiction in the project area are presented in Table 3-27. The statutory debt limitations also are listed in Table 3-27. The State of Wisconsin limits municipal indebtedness, in the form of general obligation bonds, long-term notes, State trust fund loans, and installment

Table 3-27. Assessed valuations, full valuations, and statutory debt limitations for the project area municipalities and the Gibraltar and Sevastopol school districts during 1980 (By phone, Ms. Carol Doran, Wisconsin Department of Revenue, to WAPORA, Inc., 11 June 1982).

Jurisdiction	Assessed Valuation[a]	Full Equalized Valuation[b]	Statutory Debt Limitation
Baileys Harbor Township	$ 20,297,755	$ 56,877,580	$ 2,843,879
Egg Harbor Township	38,576,558	41,207,940	2,060,397
Egg Harbor Village	14,396,128	24,409,290	1,220,465
Ephraim Village	15,503,400	46,065,260	2,303,263
Gibraltar Township	62,143,770	51,139,990	2,557,000
Door County	571,053,957	968,287,820	48,414,391
Gibraltar School District[c]	e	336,361,787	16,818,089
Sevastopol School District[d]	e	160,944,271	8,047,214

[a]The value of all taxable general property as determined by the municipal assessor or the Wisconsin Department of Revenue.

[b]The value of all taxable general property as determined by the Wisconsin Department of Revenue. This value is determined independently of the assessed value and reflects actual market value.

[c]The Gibraltar School District includes all of the Towns of Baileys Harbor and Gibraltar and the Villages of Egg Harbor and Ephraim. Although the District also includes a small part of the Town of Egg Harbor, all of the Town of Egg Harbor was considered part of the Sevastopol School District for this analysis.

[d]The Sevastopol School District includes the Town of Egg Harbor.

[e]Not available.

contracts, to 5% of the full equalized value of general property. The Town of Baileys Harbor had the highest full equalized valuation, and the Village of Egg Harbor had the lowest valuation.

In 1980, municipal indebtedness (Table 3-28) was low. Gibraltar Township had the largest debt, although the amount was only 7.5% of the statutory limitation. Egg Harbor Village had the greatest relative debt, although the amount was only 10.2% of its statutory limitation. The largest debts were assumed by the two project area school districts. Again, the amounts were considerably less than the legal limits. The 1980 debt service costs, property taxes, municipal revenues, and adjusted gross incomes for the various jurisdictions are presented in Table 3-28.

Criteria for prudent fiscal management have been developed by several authors, and an adaption of these criteria is presented in Table 3-29. These recommended standards can be compared with relationships developed from the previously discussed municipal data (Table 3-30) to assess local financial conditions. With the exception of the Village of Egg Harbor, all of the jurisdictional values fall below the limits given in Table 3-29. Debt per capita for the Village of Egg Harbor surpassed the $500 upper limit by $147, and the debt to income percentage was greater than the national average.

3.2.4. Transportation

The economic welfare of the project area is dependent on the transportation facilities that provide accessibility to seasonal residents and tourists. Although various means of transportation are available to reach Door County, the principal project area transportation facilities are limited to the highway system and two small, community airports.

3.2.4.1. Highways

Door County has a simple well-developed highway system. The two major arterials, State Trunk Highways (STH) 42 and 57, are combined through the City of Sturgeon Bay, but split about nine miles south of the project area.

Table 3-28. Selected financial characteristics for the project area municipalities and school districts in 1980 (By phone, Ms. Carol Doran, Wisconsin Department of Revenue, to WAPORA, Inc., 10 June 1982).

	Debt[a]	Debt Service[b]	Property Taxes[c]	Local Purpose Revenue[d]	Adjusted Gross Income[e]
Baileys Harbor Township	$50,000	$12,900	$654,555	$131,153	$4,704,597
Egg Harbor Township	-0-	-0-	659,110	131,685	4,210,960
Egg Harbor Village	124,500	19,382	292,413	106,029	1,735,578
Ephraim Village	16,452	4,836	516,115	100,063	2,638,491
Gibraltar Township	190,475	30,381	616,965	240,395	4,370,699
Door County	3,050,000	-0-	3,450,866	7,586,137	158,618,235
Gibraltar School District	405,000	--	--	--	--
Sevastopol School District	341,000	--	--	--	--

[a] General obligation bonds, long-term notes, State trust fund notes, and installment contracts.

[b] Debt payment = principal + interest.

[c] State, County, local, and school property tax levies.

[d] Total revenues for general operations.

[e] Adjusted gross income is income reported on 1980 calendar year individual income tax returns.

Table 3-29. Criteria for local government full-faith and credit debt analysis (Adapted from Moak and Hillhouse 1975, and Aronson and Schwartz 1975).

Debt Ratio	Standard Upper Limit for Debt
Debt per Capita	
Low Income	$ 500
Middle Income	1,000
High Income	5,000
Debt to Market Value of Property	10% of current market value
Debt Service to Revenue (or Budget)	25% of the local government's total budget
Debt to Personal Income	7%[a]

[a] Not an upper limit, but the national average in 1970.

Table 3-30. Project area values for local government full-faith and credit debt analyses during 1980.

Jurisdiction	1980 Population	Debt Per Capita[a]	Debt to Full Value[a]	Debt Service to Revenue[b]	Debt to Income[a,c]	Tax Per Capita[d]
Baileys Harbor Township	799	$148	2.1%	9.8%	2.5%	$ 819
Egg Harbor Township	825	106	2.1	-0-	2.1	799
Egg Harbor Village	238	647	6.3	18.3	8.9	1,229
Ephraim Village	319	225	1.6	4.8	2.7	1,618
Gibraltar Township	742	340	4.9	12.6	5.8	831

[a] Debt includes school debt, apportioned on the basis of each jurisdiction's percentage of the full equalized value of the school district. The entire Town of Egg Harbor was considered part of the Sevastopol School District for the analysis.

[b] Debt includes only municipal debt.

[c] Adjusted gross income.

[d] Property tax.

STH 42 follows the Green Bay coast and serves the communities of Egg Harbor, Ephraim, and Fish Creek. STH 57 serves Baileys Harbor and the Lake Michigan side of the project area. A network of county highways and local roads connect with these major routes.

STH 42 and STH 57 were designed to carry an average of 5,000 to 6,000 cars daily. The estimated average daily traffic (ADT) in the project area on STH 42 is 3,000 vehicles. The estimated ADT on STH 57 is 2,000-2,500 vehicles (By phone, Mr. David Harp, Wisconsin Department of Transportation to WAPORA, Inc., 16 November 1978). Traffic count data for combined STH 42 and 57 are presented in Table 3-31. The last year which data are available from April through November is 1978 (Wisconsin Department of Transportation 1978). The seasonal increase in traffic is quite apparent, with the ADT approaching 10,000 on August weekends. Traffic counts for April and May of 1982 also are available and although the data are limited, increases of 7 to 23% have occurred since 1978 (By phone, Wisconsin Department of Transportation, to WAPORA, Inc., 23 June 1982). The peak traffic counts on the combined highway (over 9,500 per day on July and August weekends) would seem to exceed the design capacities. The Wisconsin Division of Highways, however, characterized it as "heavy traffic" that would not result in excessive congestion or traffic jams (By phone, Mr. David Harp, Wisconsin Division of Highways, to WAPORA, Inc., 16 November 1978).

3.2.4.2. Airport Facilities

The Ephraim/Fish Creek Airport, located approximately 1.6 kilometers (1 mile) southwest of Ephraim, is owned and operated by the Village of Ephraim and the Town of Gibraltar. Commercial service is not available and only light aircraft are allowed to use the facilities. Another small field is located immediately northwest of Baileys Harbor and also is limited to light aircraft. The only airport in Door County with regularly scheduled commercial flights is located approximately 24 kilometers (15 miles) southwest of the project area near Sturgeon Bay.

Table 3-31. Seasonal traffic count data for combined State Trunk Highways 42 and 57 (Wisconsin Department of Transportation 1978; By phone, Wisconsin Department of Transportation, to WAPORA, Inc., 23 June 1982). The automatic traffic recorder was located approximately 0.25 miles north of Sturgeon Bay (Station #6103).

Month	24-hour Average Weekday	(1982)	Saturday	(1982)	Sunday	(1982)
April	4,958	(5,302)	5,350	(6,070)	4,640	(5,200)
May	5,462	(6,222)	5,735	(6,130)	5,025	(6,190)
June	6,305		7,590		7,900	
July	8,080		9,640		9,530	
August	8,322		9,903		9,820	
September	5,587		6,600		6,850	
October	5,410		6,720		5,690	
November	3,866		4,030		3,120	

3.2.5. Energy Use

There are six fuel types generally available for residential, commercial, industrial, and agricultural use in the project area: electricity; bottled, tank, or liquified petroleum gas (LPG); fuel oil; coal or coke; wood; and gasoline. Natural gas is not available in the project area. Electricity is provided to Middle Door County by the Wisconsin Public Service Corporation. A 67,000 volt transmission line extends from Sturgeon Bay to substations that are located near the Villages of Egg Harbor and Sister Bay (By letter, Mr. Steven Neuenfeldt, Wisconsin Public Service Corporation, to WAPORA, Inc., 9 November 1978). The other fuels are transported by highway to the project area for local distribution. Most of the wholesale outlets are located at Sturgeon Bay.

3.2.6. Cultural Resources

3.2.6.1. Archaeological Sites

The Wisconsin Archaeological Codification Files, which are maintained by the Historic Preservation Division of the State Historical Society of Wisconsin, list nine known archaeological sites in the project area (Appendix P). The approximate locations are shown in Figure 3-15. (In accordance with standard archaeologic practices, only the generalized locations are disclosed to insure site integrity.) The nine identified sites were used for a variety of purposes ranging from a campground (DR 11) to a village (DR 73). One site (DR 2) is a multicomponent site (utilized for various purposes at intervals spanning a considerable period of time), and excavations have yielded valuable information on northern Wisconsin's prehistory (Mason 1966).

In addition to the documented sites, there is an absolute certainty that other undocumented sites are located in the project area (By phone, Mr. Ronald Mason, Department of Anthropology/Archaeology, Lawrence University, to WAPORA, Inc., 22 February 1979). These sites could be culturally important because of the likelihood that they are multi-component and would provide chronologic records of the prehistory of the Door Peninsula.

General historical literature pertaining to the project area indicates extensive use of the Door Peninsula, often as a battleground, by the Winnebago, Potawatomi, and Sacs Indian tribes. The Ottawa and Huron tribes established a fortified village, circa 1650, along Hibbards Creek near the south boundary of the project area (Holand 1917). Prehistoric cornfields associated with numerous village sites on the Door Peninsula are still visible. Fields of 40 acres or less, with mounds of earth 0.5 meters high (1.5 feet) and 1.0 meter (3 feet) apart, may exist in the project area. The dome-shaped mounds resulted from the continued heaping of soil, and are highly visible when depressions between the small mounds are covered by light snow (Stout 1911).

3.2.6.2. Historical and Architectural Sites

Because population growth and development pressures in Door County were hindered by the historic dependence on limited natural resources (lumber and fish), many vestiges of the cultural evolution of the project area remain. Some of the existing building types and styles date back to the original period of settlement and simple log houses and cribs, initial coastal settlements, and early tourist endeavors are still visible among the modern dairy barns, lakeshore homes, and tourist facilities.

A considerable number of historic log structures, particularly out-buildings, have been identified in the project area. Although housing types changed and log houses gradually were replaced, the log out-buildings often were retained as functional structures. Simple log barns, usually referred to as "cribs" because of their storage use and size, were easily transformed by frame additions and coverings and as a result often go unnoticed today.

Numerous examples of "stovewood" construction, a unique type of log building fabrication, are located in the project area. Resembling a pile of stacked firewood, a stovewood wall was composed of short lengths of wood, usually cedar, laid horizontally in mortar. This type of log construction generally was confined to Wisconsin, and Door County contains most of the remaining examples (Kahlert and Quinlan 1978). Perrin (1963) postulated that this building type originated in Germany. Most of the stovewood buildings in the project area are located between Ephraim and Baileys Harbor where the German immigrants from Pomerania and other eastern provinces established homesteads. An effort was initiated in 1977 to establish a rural stovewood historic district that included 19 structures (18 in the project area) in the vicinity of Baileys Harbor (Romano and others 1977). Because detailed site information is unavailable, the locations denoted by asterisks in Figure 3-15 are approximate.

Other examples of early settlement are lighthouses, churches, schools, and residences. Most of the sites are concentrated in the four project area communities.

A listing of documented sites, each identified as historically or architecturally significant, is presented in Appendix Q. Their locations are shown in Figure 3-15. Sites 1, 2, and 3 (the Cana Island Lighthouse, the Eagle Bluff Lighthouse, and the Cupola House) are listed in both the National Register of Historic Places and the Wisconsin Inventory of Historic Places. Sites 4 through 42 are listed in the Wisconsin Inventory of Historic Places. Sites 1, 2, 3, 5, 7, 9, 10, 15, 17, and 32 are described in detail in the publication "Early Door County Buildings" (Kahlert and Quinlan 1978).

In addition to the Toft House (Site 32), 11 buildings (Sites 43 through 53) have been listed on a National Register inventory nomination form. The 12 buildings would comprise a proposed historic district in Baileys Harbor.

The Village of Ephraim has retained some of the original buildings erected by Norwegian settlers during the 1850's. The 1973 "Plan for Ephraim" (Land Plans, Inc. 1973) identified 28 village sites that were architecturally or historically significant. Sites 54 through 74 include those Ephraim sites not listed previously. The Ephraim plan recommended the establishment of a historic district at the southeast corner of Eagle Harbor.

The remaining sites listed in Appendix Q were obtained from a variety of sources. Sites 75 and 76 were listed in the County file of the Historic Preservation Division of the State Historical Society of Wisconsin. Site 77 was described by Kahlert and Quinlan (1978). Four other sites (Sites 78 through 81) were identified by the Door County Historical Society (By interview, Mr. Orville Schopf, Door County Historical Society, to WAPORA, Inc., 6 March 1979). Mr. Schopf also indicated that a log house, reputedly built by Increase Claflen (the first white settler in Door County) north of Fish Creek, is presently stored in a barn at Site 33. The Society plans to restore the structure and relocate it at the Ridges Sanctuary.

The final four sites (Sites 82 through 85) were identified by WAPORA personnel during a brief windshield survey of the project area that was conducted on 5 and 6 March 1979. The purpose of the survey was to confirm the locations and status of all of the documented sites and also to identify additional sites.

4.0. ENVIRONMENTAL CONSEQUENCES

The potential environmental consequences of the system alternatives (Section 2.3.) are discussed in the following sections. The impacts resulting from the construction and operation of the alternatives for each of the four communities may be beneficial or adverse, and may vary in duration (either short-term or long-term) and significance. The significant impacts of the alternatives on the four communities are summarized by environmental component in Table 4-1.

Environmental effects are classified as either primary or secondary impacts. Primary impacts result directly from the construction and/or operation of the proposed project. Short-term primary impacts generally occur during construction. Long-term primary impacts occur throughout the life of the project and generally result from the operation of the proposed project.

Secondary impacts are the indirect effects of the project and occur because the project causes changes that in turn induce other actions or effects that would not have taken place in the absence of the project. Because the project creates change in the affected area, associated impacts can result. For example, improved and/or expanded wastewater treatment systems can open up land for urban development that otherwise would not have experienced such development because of the lack of this capability. This residential, commercial, and/or industrial development could, in turn, create an increased demand for other public facilities and services, increase development pressure on agricultural lands, woodlands, or other environmentally sensitive areas, increase ambient noise levels, lead to air and water pollution, increase property values, or displace low and moderate income families. Secondary impacts also may be either short-term or long-term. Short-term secondary impacts, for example, include the disruption of the environment that occurs during the construction of the development that is induced by the proposed project. An example of a long-term secondary impact would be the urban runoff that occurs indefinitely after the induced development of agricultural land or open space/undeveloped areas.

Table 4-1. Potential major primary and secondary impacts from the construction and operation of wastewater treatment facilities in the Middle Door County project area.

		Centralized Collection and Treatment Alternatives		
	OnSite System Alternatives	Surface Water Discharge	Wetland Discharge	Cluster Soil Absorption System
Atmosphere	Construction: No significant impacts are anticipated.	Construction: The construction of WWTPs and conveyance lines or cluster mound systems will temporarily adversely affect the atmosphere of the project area. Fugitive dust, odors, hydrocarbons, and noise from construction equipment and activities will create a nuisance for a short period of time.		
	Operation: Failing on-site systems will continue releasing odors. Truck traffic for holding tank wastes and septage hauling will continue to be noticeable, particularly during the summer.	Operation: WWTPs will release some low level odors, aerosols, and potentially hazardous gases. Odors at pump stations would be more problematic.		Operation: Occasional failures of cluster systems, septage hauling and pumping may create temporary malodorous conditions.
	Secondary: No significant impacts are anticipated.	Secondary: No significant impacts are anticipated.		

Table 4-1. Potential major primary and secondary impacts from the construction and operation of wastewater treatment facilities in the Middle Door County project area (continued).

		Centralized Collection and Treatment Alternatives		
	Onsite System Alternatives	Surface Water Discharge	Wetland Discharge	Cluster Soil Absorption System
Soils	Construction: Onsite system upgrading would expose small areas to erosion and sedimentation.	Construction: The placement of conveyance lines and construction of WWTPs would result in considerable disturbance and potential for erosion and sedimentation.		Construction: Limited area sewering and cluster sites would expose soil to erosion and sedimentation. Onsite system upgrading would expose small areas to erosion and sedimentation.
	Operation: The capability of the soils to accept effluent and attenuate nutrients and pathogens would continue to be exceeded around some soil absorption systems necessitating the installation of holding tanks.	Operation: No significant impacts are anticipated.	Operation: The wastewater effluent would create saturated soil conditions in the immediate discharge area changing the chemical composition including pH. The capacity of the soils to filter nutrients is not expected to be exceeded.	Operation: The capacity of the soils to sorb phosphorus and to attenuate nitrogen may be exceeded at the soil absorption system site.
	Secondary: No significant impacts are anticipated.	Secondary: Additional development within the proposed sewer service areas may result in increased soil erosion and sedimentation and in additional nonpoint source nutrients to Green Bay and/or Lake Michigan.		Secondary: No significant impacts are anticipated.

Table 4-1. Potential major primary and secondary impacts from the construction and operation of wastewater treatment facilities in the Middle Door County project area (continued).

	Onsite System Alternatives	Centralized Collection and Treatment Alternatives		
		Surface Water Discharge	Wetland Discharge	Cluster Soil Absorption System
Vegetation	Construction: No significant impacts are anticipated.	Construction: Conveyance line routes would result in removal of some natural vegetation. Treatment plant sites would replace existing vegetation, possibly including agricultural crops or orchards. Possible impact on Wisconsin threatened species in Baileys Harbor.		
	Operation: No significant impacts are anticipated.	Operation: No significant impacts are anticipated.	Operation: Probable change in vegetative regime in immediate discharge area with decreasing impact away from discharge points.	Operation: No significant impacts are anticipated.
	Secondary: No significant impacts are anticipated.	Secondary: No significant impacts are anticipated.		

Table 4-1. Potential major primary and secondary impacts from the construction and operation of wastewater treatment facilities in the Middle Door County project area (continued).

		Centralized Collection and Treatment Alternatives		
	Onsite System Alternatives	Surface Water Discharge	Wetland Discharge	Cluster Soil Absorption System
Surface Water	Construction: No significant impacts are anticipated.	Construction: Placement of discharge lines would temporarily increase turbidity and decrease DO levels, displace local fish populations and increase mortality of fish fry.	Construction: Increased sedimentation resulting from construction activity could result in water quality degradation and potentially adverse conditions for aquatic biota.	
	Operation: No significant impacts are anticipated.	Operation: Increased nutrient levels in project area bays could result in water quality degradation and potentially adverse conditions for aquatic biota if adequate dispersion of effluent does not occur. There would be some benefits from removal of discharge from faulty onsite systems into bays and harbors.	Operation: Changes in the wetland hydraulic regime could cause localized changes in the vegetative regime and related fauna regime.	Operation: No significant impacts are anticipated.
	Secondary: No significant impacts are anticipated.	Secondary: No significant impacts are anticipated.		

Table 4-1. Potential major primary and secondary impacts for the construction and operation of wastewater treatment facilities in the Middle Door County project area (continued).

		Centralized Collection and Treatment Alternatives		
	Onsite System Alternatives	Surface Water Discharge	Wetland Discharge	Cluster Soil Absorption System
Groundwater	Construction: No significant impacts are anticipated.	Construction: The placement of sewer and conveyance lines could expose vertical joints and permit the direct inflow of surface runoff into the groundwater.		
	Operation: A program for upgrading onsite systems diminish the potential for contamination of groundwater by pathogenic organisms. Septage and holding tank wastes may occasionally contribute elevated nitrates to groundwater.	Operation: Exfiltration from sewage conveyance and treatment facilities may cause localized groundwater contamination by pathogenic organisms and nitrates. The surface water discharge would have no effect on groundwater.	Operation: Exfiltration from sewage conveyance and treatment facilities may cause localized groundwater contamination by pathogenic organisms. The wetlands discharge may result in elevated nitrate levels in groundwater from the effluent and from decomposition of organics within the wetland. Elevated nitrate levels are only a concern if public water supplies are obtained from the groundwater.	Operation: Exfiltration from sewage conveyance and treatment facilities may cause localized groundwater contamination by pathogenic organisms. Groundwater below a cluster soil absorption system would contain elevated levels of nitrates and other soluble nutrients, but water quality criteria would not be exceeded unless a failure occurs.
	Secondary: No significant impacts are anticipated.	Secondary: Sewer systems would allow construction in thin soil and high groundwater areas, which could contribute to contamination of groundwater.		

Table 4-1. Potential major primary and secondary impacts from the construction and operation of wastewater treatment facilities in the Middle Door County project area (continued).

		Centralized Collection and Treatment Alternatives		
	Onsite System Alternatives	Surface Water Discharge	Wetland Discharge	Cluster Soil Absorption System
Wildlife	Construction: No significant impacts are anticipated.	Construction: Permanent displacement of wildlife from primarily agricultural lands would occur from construction of new WWTPs. Temporary disturbance of wildlife along rights of way from construction of conveyance lines and mortality to some small mammals and reptiles from all construction activities would occur.	Construction: Same as surface water discharge with additional impacts to solitude-dependent species possibly permanently displaced by construction activities.	Construction: Same as surface water discharge alternative.
	Operation: No significant impacts are anticipated.	Operation: No significant impacts are anticipated.	Operation: Changes in hydraulic and vegetative regime could displace some wildlife populations and attract others that are favored by such ecosystem changes.	Operation: No significant impacts are anticipated.
	Secondary: No significant impacts are anticipated.	Secondary: No significant impacts are anticipated.		

Table 4-1. Potential major primary and secondary impacts from the construction and operation of wastewater treatment facilities in the Middle Door County project area (continued).

	Onsite System Alternatives	Centralized Collection and Treatment Alternatives: Surface Water Discharge	Wetland Discharge	Cluster Soil Absorption System
Demography	Construction: No significant impacts are anticipated.	Construction: Temporary jobs created by construction of WWTPs and sewer systems would not attract new residents to the project area.		
	Operation: No significant impacts are anticipated.	Operation: Permanent jobs created by the operation of WWTPs and Sanitary Districts would not attract new residents to the project area. Positions likely would be filled by persons from the project area or other parts of Door County.		
	Secondary: No significant impacts are anticipated.	Secondary: Induced growth could occur as a result of an improvement in wastewater collection and treatment capability although other factors (land availability, cost, site amenities, etc.) probably will have a greater effect on overall project area growth rates. The amount and nature of the induced growth that might take place probably would vary between the four communities depending on the alternative selected, the size of the service area, the amount of vacant buildable land within the service area, and the general perception of the particular community as compared to other locations on the Door Peninsula.		

Table 4-1. Potential major primary and secondary impacts from the construction and operation of wastewater treatment facilities in the Middle Door County project area (continued).

		Centralized Collection and Treatment Alternatives		
	Onsite System Alternatives	Surface Water Discharge	Wetland Discharge	Cluster Soil Absorption System
Land Use	Construction: No significant impacts are anticipated.	Construction: Existing land uses at the sites of the WWTPs would be displaced. Construction of sewer systems may temporarily disrupt land uses along right of ways.		
	Operation: Land area needed for drainfields and seepage beds may influence the intensity of future development.	Operation: The release of low level odors and aerosals from WWTPs and the knowledge that hazardous gases could be released may affect land use adjacent to the WWTPs.		Operation: Improper maintenance of cluster systems could create malodorous conditions which may adversely affect adjacent land uses.
	Secondary: No significant impacts are anticipated.	Secondary: Availability of centralized wastewater collection and treatment systems could result in additional infill development within the proposed service areas. Increased development adjacent to sewer service areas could result in demands for extension of the system. Increases in the sewer service areas could stimulate development with attendent impacts on land use, sensitive environmental areas, prime and unique farmland, etc.		

Table 4-1. Potential major primary and secondary impacts for the construction and operation of wastewater treatment facilities in the Middle Door County project area (continued).

		Centralized Collection and Treatment Alternatives		
	Onsite System Alternatives	Surface Water Discharge	Wetland Discharge	Cluster Soil Absorption System
Prime and Unique Farmlands	Construction: No significant impacts are anticipated.	Construction: Fish Creek: The WWTP proposed in Section 33 would require 5 acres, not all of which is prime farmland. Ephraim: The WWTP proposed in Section 24 would require 5 acres of prime farmland. Baileys Harbor: The WWTPs proposed in Section 7 or 17 would require 5 acres of prime farmland. The conversion of prime farmland to nonfarm use must be compared to the benefits associated with an improvement in wastewater collection and treatment (e.g., lower potential for groundwater contamination).		Construction: Egg Harbor: The cluster drainfield proposed in Section 31 could require up to 10 acres of prime farmland. Fish Creek: The cluster drainfield proposed in Section 3 could require up to 10 acres of prime farmland. The mound system proposed in Section 32 would require 5 acres of prime farmland. Ephraim: The cluster drainfield proposed in Section 24 could require up to 10 acres of prime farmland.
	Operation: No significant impacts are anticipated.	Operation: No significant impacts are anticipated.		
	Secondary: No significant impacts are anticipated.	Secondary: The conversion of prime farmland to developed land uses will continue as population growth and development occurs. However, improvements in wastewater collection and treatment are not expected to enhance the rate at which population growth and development occurs. The conversion of prime farmland to developed land uses could be lessened if a greater proportion of the projected growth takes place within the sewer service areas or if projected growth occurs at increased densities.		

Table 4-1. Potential major primary and secondary impacts from the construction and operation of wastewater treatment facilities in the Middle Door County project area (continued).

	Onsite System Alternatives	Centralized Collection and Treatment Alternatives		
		Surface Water Discharge	Wetland Discharge	Cluster Soil Absorption System
Economics	Construction: No significant impacts are anticipated.	Construction: Construction of conveyance lines could disrupt local businesses. A limited number of short-term construction jobs would be created. Purchases of goods and services necessary for construction activities would benefit local communities. The capital costs of many of the alternatives would cause the communities outstanding debt to exceed 5% of full equalized value (Wisconsin statutory debt limit), particularly if a Wisconsin Fund grant were unavailable.		
	Operation: No significant impacts are anticipated.	Operation: A few long-term jobs would be created. Business volumes for on-site system installers and septage haulers would decline. The user costs for most of the alternatives would exceed the standard which USEPA uses to characterize projects as expensive.		
	Secondary: No significant impacts are anticipated.	Secondary: Improvements in wastewater treatment capability are not likely to induce additional economic growth within the project area.		

Table 4-1. Potential major primary and secondary impacts from the construction and operation of wastewater treatment facilities in the Middle Door County project area (continued).

	Onsite System Alternatives	Centralized Collection and Treatment Alternatives		
		Surface Water Discharge	Wetland Discharge	Cluster Soil Absorption System
Transportation	Construction: No significant impacts are anticipated.	Construction: Construction of the sewer systems would disrupt traffic flows, particularly in the downtown areas of the communities. Some roads would be temporarily closed causing inconvenience and increased traffic congestion.		
	Operation: Holding tank waste haulers would expand operations to service the increased holding tanks.	Operation: No significant impacts are anticipated.		
	Secondary: No significant impacts are anticpated.	Secondary: No significant impacts are anticipated.		

Table 4-1. Potential major primary and secondary impacts from the construction and operation of wastewater treatment facilities in the Middle Door County project area (continued).

		Centralized Collection and Treatment Alternatives		
	Onsite System Alternatives	Surface Water Discharge	Wetland Discharge	Cluster Soil Absorption System
Energy	Construction: No significant impacts are anticipated.	Construction: Trucks and construction equipment would temporarily increase demand for local supplies of fossil fuel.		
	Operation: No significant impacts are anticipated.	Operation: Requires more electricity but less fossil fuel than cluster system alternatives.		Operation: Requires less electricity but more fossil fuel than the other centralized collection and treatment alternatives.
	Secondary: No significant impacts are anticipated.	Secondary: No significant impacts are anticipated.		

Table 4-1. Potential major primary and secondary impacts from the construction and operation of wastewater treatment facilities in the Middle Door County project area (concluded).

		Centralized Collection and Treatment Alternatives		
	Onsite System Alternatives	Surface Water Discharge	Wetland Discharge	Cluster Soil Absorption System
Cultural Resources	Construction: No significant impacts are anticipated.	Construction: Construction activities should not adversely affect historic sites or structures. Detailed site investigations of the conveyance line routes and proposed WWTP sites will be needed to determine if archaeological sites are present. Known archaeological sites should be avoided.		
	Operation: No significant impacts are anticipated.	Operation: No significant impacts are anticipated.		
	Secondary: No significant impacts are anticipated.	Secondary: No significant impacts are anticipated.		

Most adverse impacts can be controlled, and many should be of short duration. The possible mitigative measures outlined in the following sections include planning activities and the utilization of construction techniques that reduce the severity of both primary and secondary adverse impacts. Construction plans and specifications, developed by facilities planners for the communities and reviewed by the WDNR, must include these mitigative measures if state or Federal monies are used to assist in the financing of the proposed project.

4.1. Primary Impacts

4.1.1. Construction Impacts

Each of the alternatives, excluding the onsite system alternatives, requires some construction. The onsite system alternatives include the construction of some new systems and the upgrading of some existing systems throughout the life of the project; therefore, impacts associated with these alternatives are discussed in the section on operation impacts (Section 4.1.2.). The construction impacts associated with the centralized collection and treatment, or "build", alternatives are addressed in the following subsections for each of the major categories of the natural and man-made environment.

4.1.1.1. Atmosphere

The construction activities associated with the build alternatives, including placement of conveyance lines and land clearing for WWTPs, will produce short-term adverse impacts to local air quality. Clearing, grading, excavating, backfilling, and related construction activities will generate fugitive dust, noise, and odors. Emission of fumes and noise from construction equipment will be a temporary nuisance to residents living near the construction sites.

4.1.1.2. Soil Erosion and Sedimentation

Soils exposed during construction activity will be subjected to accelerated erosion until the soil surface is protected by revegetation or other means. Conveyance lines typically are laid within road right-of-ways, if possible, and runoff from construction activities tend to concentrate in roadside drainageways. The alternatives that involve considerable lengths of sewers and force mains can be expected to result in the greatest erosion and subsequent sedimentation. The adverse impacts resulting from construction related erosion and sedimentation include elevated phosphorus imputs to Green Bay and Lake Michigan, possible siltation of whitefish spawning areas in Baileys Harbor, clogging of road culverts, and localized flooding where drainageways are filled with sediment.

4.1.1.3. Surface Water

Increased sedimentation resulting from the construction of collection sewers could result in surface water quality degradation as noted above. The impacts associated with the constructon of sewer lines - increased phosphorus inputs, increased turbidity, possible siltation of fish spawning areas - would occur under all of the centralized collection and treatment alternatives. The construction impacts would vary in intensity and duration depending on the length of the sewer lines and their placement in relation to drainageways. Both factors will influence the amount of sediment that reaches the bays (i.e., Baileys Harbor, Eagle Harbor, Egg Harbor, the Fish Creek bay), and ultimately the severity of the construction impacts.

The centralized collection and treatment alternatives that include effluent discharges to surface waters would have additional impacts associated with the construction of the effluent outfall. The construction activities would temporarily increase turbidity levels, increase nutrient concentrations, possibly affect temperature and dissolved oxygen (DO) concentrations, and disrupt the aquatic community. The adaptability of the near-shore fishery and other biota to habitat disturbance will be a primary factor in the severity of the impacts.

Depending on the length of the effluent outfall and the characteristics of the bottom, the impacts of the construction on surface water quality could be significant. Although the composition of the bottom materials in the vicinity of each of the possible discharge lines is not known, WDNR divers recently conducted an investigation of the bottom along the route of the proposed discharge line serving Fish Creek (By telephone, Mr. Tim Raceman, WDNR, to WAPORA, Inc., 7 July 1982). This investigation found that gravel and cobble dominate the substrate out to 520 ft from shore. At 600 ft offshore, the substrate is primarily sand with some cobble and is covered with a thin layer of silt (approximately 1/8 inch). Construction of an outfall in the gravel and cobble would probably disturb fish spawning sites, and would certainly disturb, at least temporarily, fish feeding and schooling habits in the immediate area. Other impacts that could occur from the construction of effluent discharge lines along the bottom of Green Bay or Lake Michigan include:

- Disruption of the benthic community could affect the aquatic food web in the area.

- Increased nutrient levels
  Mixing of sediment pore waters (the water present in the interstitial spaces of the sediment) with overlying waters could contribute additional nutrients to the water column.

- Oxygen depletion
  Resuspended fine organics rapidly become bacteria coated. Rapid decomposition may deplete dissolved oxygen concentrations within these turbid areas. The effects should be local and temporary but will affect less mobile organisms. Rapid oxygen depletion could also lower the pH if the waters are not adequately buffered (Peterson 1979).

- Reduced primary production
  Decreased light penetration due to turbidity may result in lower rates of primary production.

- Temperature alteration
  Suspended sediments may absorb radiation and transform it into heat. If intense enough, this might produce minithermal stratification, preventing mixing and distribution of oxygen (Parker and others 1975 as cited in Peterson 1979). Oxygen-holding capacity of the water also would be reduced.

4.1.1.4. Groundwater

The Niagaran dolomite that forms the bedrock surface in the project area contains numerous vertical joints at the surface that permit rapid water recharge of the lower, horizontal bedding plane joints (Section 3.1.2.1.2.). The blasting required for the installation of sewer and conveyance lines could expose vertical joints, or create new fractures, which could permit the direct inflow of surface runoff into the groundwater. The exposure of vertical joints would reduce the filtering of surface runoff by the overlying soils prior to recharge. Because the surface runoff would contain relatively high concentrations of sediments as a result of construction activities, water drawn from wells near the construction zone could contain high sediment concentrations while vertical joints are directly exposed to surface runoff. In addition, the dewatering required for sewer construction could cause a temporary lowering of the water table near the sewer line right of way. Shallow wells within this affected zone could experience a temporary loss of pressure while construction is taking place.

4.1.1.5. Terrestrial Biota

Construction activities associated with various components of the alternatives would result in impacts to wildlife and vegetation in various degrees. The presence of construction equipment and attendent noise along the routes of the collection sewers and at the sites of the WWTPs would cause the temporary displacement of most vertebrate species and the mortality of a few (probably small mammal) species. The replacement of vegetation and the cessation of construction activities would allow the reestablishment of displaced species. The removal of locally rare species could preclude their replacement, though. The construction of new WWTPs would, however, permanently displace wildlife species that reside on or adjacent to the primarily agricultural or open space land.

Construction impacts to wildlife would be more acute under the wetland discharge alternatives. The removal of vegetation along the outfall right-of-way would displace, possibly permanently, resident wildlife species. In

addition, construction activities and noise could displace solitude dependent species whose ranges include the outfall area.

Because detailed plant or animal inventories have not been conducted along the outfall routes, and because the overall wetland complex contains rare or threatened plant species, disturbances along the outfall corridors could result in significant impacts. During the detailed design of outfalls to any wetland areas, indepth biological surveys of proposed/ alternative placements should be made to determine the least sensitive routes.

4.1.1.6. Wetlands

Environmental impacts associated with the construction of a wastewater outfall to a wetland (evaluated as alternatives for Baileys Harbor and for Ephraim) include the removal of vegetation along the outfall right-of-way with attendant loss of wildlife habitat and possibly rare or threatened plant species, and erosion and possible sedimentation of the wetland. The rate and direction of groundwater flow in the wetland also may be disrupted and permanently altered unless care is taken in the construction process to backfill with materials that have the same approximate permeability of those removed. Adverse impacts could be minimized if the corridor for the outfall paralleled existing highway rights of way and former logging roads to the extent possible. Construction activity during spring and early summer should be avoided to reduce disruption of wildlife reproductive cycles.

4.1.1.7. Demography

Temporary jobs created by the construction of wastewater collection and treatment facilities are not likely to attract any new permanent residents to the project area. These positions probably would be filled by workers from the middle Door County project area or from adjacent Door County communities (e.g., Sturgeon Bay). Some seasonal residents could reduce their use of seasonal dwellings while construction activities are taking place on or adjacent to their property. No significant demographic impacts are anticipated during the construction of wastewater facilities.

4.1.1.8. Land Use

The construction of WWTPs associated with the centralized collection and treatment alternatives would require the conversion of existing open space and agricultural land uses to developed land uses. The aerated lagoons that are proposed as treatment alternatives for each of the communities would require a land area of approximately 5 acres. However, a larger land area might be purchased to buffer the operation from adjacent areas and to allow for expansion of the plant at a later date.

In general, the only land uses that are compatible wih WWTPs include agricultural, small wood lot, open space, or similar land uses. Developed land uses, i.e., residential, commercial or institutional land uses, typically are imcompatible with WWTPs. In addition, the construction of sewer systems could temporarily disrupt land uses along the right-of-ways. The magnitude of these impacts is not anticipated to be significant, though, because most of the sewer systems would follow existing rights-of-way, such as those along roadways.

4.1.1.9. Prime and Unique Farmlands

The construction of WWTPs and/or cluster soil absorption systems would irreversibly convert prime farmland to developed land use. All of the WWTPs proposed for the project area would require approximately 5 acres. Because few land uses are compatible with the WWTPs, though, a larger land area might be purchased as a condition of the land sale. Agricultural and forest uses generally are compatible with the operation of WWTPs, however, and the construction of a WWTP on a 20 acre parcel, for example, would not preclude the use of the remaining 15 acres for agricultural or small woodlot uses.

The alternatives for Fish Creek include an aerated lagoon system in Section 33 and a mound system in Section 32. Both systems would require approximately 5 acres. Not all of the general area under consideration in Section 33 is prime farmland, however, (i.e., classified in soil capability classes I or II by the SCS). Thus, the actual prime farmland impacts

associated with the use of the site in Section 33 would depend on the portion of the site that is used.

A WWTP is proposed for Ephraim in Section 24. This site contains soils that are classified as prime farmland, but the site is not currently being cultivated. The construction of a WWTP at this site would convert approximately 5 acres of forest land to developed land use.

The alternatives for Baileys Harbor include a WWTP in either Section 7 or Section 17. Both sites are classified as prime farmland and the construction of a WWTP at either site would consume approximately 5 acres of prime farmland.

In addition, cluster drainfields are proposed for Egg Harbor, Fish Creek, and Ephraim. To accommodate the projected flows generated from the communities, a maximum of 10 acres would be required for each of the cluster drainfields. The proposed cluster drainfield for Egg Harbor is located in Section 31 and the site is classified as prime farmland. For Fish Creek and Ephraim, the proposed sites are located in Sections 3 and 24, respectively. Each of these sites also is classified as prime farmland.

Wisconsin statutes (Section 32.035) require the preparation of an agricultural impact statement (AIS) if a proposed project involves the actual or potential exercise of the powers of eminent domain in the acquisition of an interest in more than 5 acres of land from any one farm operation. The AIS is prepared by the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) and describes and analyzes the potential effects of the project on farm operations and agricultural resource. If a proposed project involves 5 acres or less from any one farm operation, an AIS may be prepared at the discretion of the DATCP. The AIS is intended to reflect the general objectives and policy concerns of the DATCP of conserving important agricultural resources and maintaining a healthy rural economy. The DATCP recognizes, however, that final project decisions must consider a number of factors including, but not limited to, potential agricultural impacts. In the case of the proposed WWTPs, the AIS would have to consider the increased costs associated with alternative plant sites as

well as the trade-offs between removing prime farmland from the agricultural land base versus improving surface water quality and/or lessening the potential for groundwater contamination from onsite systems.

4.1.1.10. Economics

The construction activities associated with the centralized collection and treatment alternatives would create a limited number of short-term construction jobs. Most jobs would be filled by persons living within the project area or within a reasonable commuting distance of the project area.

The purchase of construction materials from merchants within the project area would benefit the local economy. However, few firms offering the necessary building materials are present within the project area. Most construction materials would be imported from outside the project area probably either from Sturgeon Bay or Green Bay. Purchases made by construction workers within the project area also would benefit the local economy. These benefits would be offset, though, by the reduced patronage that businesses along the sewer lines would experience as a result of road closings and the disruptions caused by construction activities.

4.1.1.11. Recreation and Tourism

Any increase or decrease of tourism and the use of recreational facilities within the project area attributable to the construction of wastewater collection and treatment facilities is dependent upon construction activities which detract from the recreational amenities of the project area. Most recreational activities within the project area are water related and take place on or along the perimeter of Green Bay or Lake Michigan. No major air, water, noise, or traffic impacts are expected to occur near Green Bay or Lake Michigan which would significantly disrupt tourism and recreation activities. The disruption of traffic flows in the downtown areas of the project area communities could cause a temporary displacement of tourists, particularly if construction took place in these areas during the summer. Access to some recreational facilities, particularly those along the bays, interrupted by construction activities may curtail temporarily some recreation and tourist activities.

4.1.1.12. Transportation

Increased truck traffic during the construction of centralized wastewater collection and treatment systems would increase traffic congestion and disrupt traffic flows, particularly in the downtown areas of the project area communities. Vehicular traffic also would be inconvenienced by excavating, grading, backfilling, and temporary road closures during the construction of conveyance lines along roadways. The temporary closure of some roads would inconvenience permanent residents and tourists and result in increased traffic congestion on adjacent roadways.

4.1.1.13. Energy Resources

Residential, commercial, and industrial energy requirements are not likely to be affected during the construction of wastewater collection and treatment facilities. Trucks and construction equipment used for the construction of wastewater treatment facilities would increase demand for local supplies of gasoline and diesel fuel. The increased demands resulting from construction activities are not anticipated to have a significant impact on the availability of fossil fuels in the project area.

4.1.1.14. Cultural Resources

Construction activities should not adversely affect historic sites or structures within the project area. A cursory archaeological survey was made of the project area by WAPORA, Inc. in October 1982 (Appendix P). The survey evaluated the environmental and cultural background of the area to determine the potential for significant archaeological sites. A field investigation was made at nine alternative WWTP sites (3 in Egg Harbor, 3 in Fish Creek, 1 in Ephraim, and 2 in Baileys Harbor).

The evaluation of the environmental and cultural background of the upper Door Peninsula and the analysis of the nine known archaeological sites in the area (Section 3.2.6.1.) indicates that present or past coastal areas (sand ridges and fossil beachs) seem to be the preferred habitation sites of long term, but intermittent, occupation. Significant archaeolo-

gical finds are likely in these areas. Upland areas were not preferred for habitation and archaeological evidence found in these areas would be small, isolated finds of cultural material.

None of the nine known archaeological sites would be affected by construction under any alternative.

The field inspection conducted during the survey found cultural materials on the WWTP site for Baileys Harbor Alternative 4 (Appendix P). If construction is proposed for this location, further examination would be necessary to assess the archaeological significance of the site and to determine if it is eligible for listing on the National Register of Historic Places.

Two other alternative WWTP sites were found to be archaeologically sensitive areas (Appendix P): The WWTP site for Egg Harbor Alternatives 2A, 2B, and 4; and the WWTP site for Baileys Harbor Alternatives 2A and 2B. If WWTP facilities are proposed at these locations, a reconnaissance survey should be undertaken to locate and identify cultural resources that might be affected by construction activitiy. If archaeological materials are discovered, further coordination would be necessary to mitigate any adverse impacts on the sites.

Based on the cursory archaeological survey, with the exception of these three sites, none of the other WWTP sites for the other project alternatives (for any of the four communities) would have archaeological sites that would be adversely affected by construction. The WWTP site for Baileys Harbor Alternatives 3 and 5, was not examined in the survey. This site should be inspected if either of these alternatives is selected. The final routing of sewer and conveyance lines and the location of WWTP sites should be presented to the SHPO for assessment before construction activities begin. Construction excavations could uncover significant cultural resources which otherwise might not be discovered. To provide adequate consideration of impacts affecting these resources, an archaeological survey of specific sites should be conducted following the selection of an alternative.

4.1.2. Operation Impacts

Each of the alternatives, including the No Action Alternatives, include operations that will continue through the 20-year project period. Included in the definition of operations are constructing new septic tank systems for new structures, upgrading failing onsite systems, and constructing centralized wastewater collection and treatment systems. Operation impacts associated with the different alternatives for the four project area communities (Egg Harbor, Fish Creek, Ephraim, Baileys Harbor) are addressed for each of the major categories of the natural and man-made environments.

4.1.2.1. Atmosphere

The potential emissions from the operation of the wastewater management alternatives include aerosols, hazardous gases, and odors. The emissions could pose a public health risk or be a nuisance.

Aerosols are defined as solid or liquid particles, ranging in size from 0.01 to 50 micrometers that are suspended in the air. These particles are produced at wastewater treatment facilities during various treatment processes. Some of the constituents of aerosols could be pathogenic and could cause respiratory and gastrointestinal infections. Concentrations of bacteria or viruses in aerosols, however, are generally insignificant (Hickey and Reist 1975). The vast majority of the microorganisms in aerosols are destroyed by solar radiation, desiccation (drying out), and other environmental phenomena. There are no records of disease outbreaks resulting from pathogens present in aerosols. Therefore, no adverse impacts are expected from aerosol emissions for any of the alternatives.

Discharges of hazardous gases could have adverse affects on public health and the environment. Explosive, toxic, noxious, lachrymose (causing tears), and asphyxiating gases can be produced at wastewater treatment facilities. These gases include chlorine, methane, ammonia, hydrogen sulfide, carbon monoxide, nitrogen oxides, sulfur, and phosphorus. The knowledge of the possibility that such gases can escape from the facilities or

into work areas in dangerous or nuisance concentrations might affect the operation of the facilities and the adjacent land uses. Gaseous emissions, however, can be controlled by proper design, operation, and maintenance procedures.

Odor is a property of a substance that affects the sense of smell. Organic material that contains sulfur or nitrogen may be partially oxidized anaerobically and result in the emission of byproducts that may be malodorous. Common emissions, such as hydrogen sulfide and ammonia, are often referred to as sewer gases and have odors of rotten eggs and concentrated urine, respectively. Some organic acids, aldehydes, mercaptans, skatoles, indoles, and amines also may be odorous, either individually or in combination with other compounds. Sources of wastewater related odors include:

- Fresh, septic, or incompletely treated wastewater
- Screenings, grit, and skimmings containing septic or putrescible matter
- Oil, grease, fats, and soaps from food handing enterprises, home, and surface runoff
- Gaseous emissions from treatment processes, manholes, wet wells, pumping stations, leaking containers, turbulent flow areas, and outfall areas
- Raw or incompletely stabilized sludge or septage.

Wastewater stabilization lagoons typically emit considerable odors when the ice cover goes out in the spring. These odors are likely to be noticeable for at least one-half mile in the wind direction. Odors from septic tank effluent sewers may escape from lift stations where turbulent flow occurs unless proper design steps are taken to minimize odors.

The occasional failure of an onsite system may release some odors. Septage haulers using inadequate or improperly maintained equipment may create odor nuisances.

4.1.2.2. Soils

The operation of the land application sites and cluster soil absorption system sites for wastewater treatment would alter the soils of these sites over the life of the project. The potential changes depend on the existing soil chemical and hydraulic properties and on the chemical characteristics and application rates of the effluent. The cropping and tillage practices on the land application sites will, to some extent, affect what changes occur in the soil. The pH, cation exchange capacity, and phosphorus retention capacity should be adequate to ensure that most constituents in the effluent will be removed effectively at the proposed irrigation rates. Organics constituents in the applied water would be oxidized by natural biological processes within the top few inches of soil (USEPA 1981b). At Muskegon, Michigan, the BOD of renovated water from the underdrainage system ranged from 1.2 mg/l to 2.2 mg/l (Demirjian 1975). Suspended solids in the applied water also are removed by the soil through filtration. The volatile solids are biologically oxidized and inorganic solids become part of the soil matrix (USEPA 1981b).

Phosphorus would be present in the storage pond or septic tank effluent in an inorganic form as orthophosphate (primarily HPO_4^{-2}), as polyphosphates (or condensed phosphates), and as organic phosphate compounds. Because the pH of wastewater is alkaline, the predominant form usually is orthophosphate (USEPA 1976). Polyphosphate is converted quickly to orthophosphate in conventional wastewater treatment, in soil, or in water. Dissolved organic phosphorus is converted more slowly (day to weeks) to orthophosphate.

When effluent is applied to soils, dissolved inorganic phosphorus (orthophosphate) may be adsorbed by the iron, aluminum, and/or calcium compounds, or may be precipitated through reactions with soluble iron, aluminum, and calcium. Because it is difficult to distinguish between adsorption and precipitation reactions, the term "sorption" is utilized to refer to the removal of phosphorus by both processes (USEPA 1981b). The degree to which wastewater phosphorus is sorbed in soil depends on its concentration, soil pH, temperature, time, total loading, and the concentration of other wastewater constituents that directly react with phosphorus, or that affect soil pH and oxidation-reduction reactions (USEPA 1981b).

The phosphorus in the adsorbed phase in soil exists in equilibrium with the concentration of dissolved soil phosphorus (USEPA 1981b). As an increasing amount of existing adsorptive capacity is used, such as when wastewater enriched with phosphorus is applied, the dissolved phosphorus concentration similarly will be increased. This may result in an increased concentration of phosphorus in the percolate, and thus in the groundwater or in the recovered underdrainage water.

Eventually, adsorbed phosphorus is transformed into a crystalline-mineral state, re-establishing the adsorptive capacity of the soil. This transformation occurs slowly, requiring from months to years. Work by various researchers indicates that as much as 100% of the original adsorptive capacity may be recovered in as little as three months. However, in some instances it may take years for the adsorptive capacity to fully recover because the active cations may become increasingly bound in the crystalline form.

Dissolved organic phosphorus in applied effluent can move quickly through the soil and enter the groundwater. Adequate retention of the effluent in the unsaturated soil zone is necessary to allow enough time for the organic phosphorus to be hydrolized by microorganisms to the orthophosphate form. In the orthophosphate form, it then can be adsorbed.

The project area soils should have adequate sorption capacity for phosphorus where seepage beds of current design are constructed, based on similar analyses elsewhere (Ellis and Erickson 1969). The water quality sampling results appear to verify this conclusion.

The alternative that incorporates land application of lagoon effluent for treatment would result in increased levels of phosphorus in the soils. Irrigation onto the soil surface utilizes the surface soil for sorption of phosphorus. These surface soils typically have considerably greater sorption capabilities than the underlying soil (USEPA 1981b).

Nitrogen loadings in the wastewater are of greatest concern. Nitrogen would be present in applied wastewater principally in the form of ammonium

(NH_4), nitrates (NO_3), and organic nitrogen. When wastewater is applied to soils, the natural supply of soil nitrogen is increased. As in the natural processes, most added organic nitrogen slowly is converted to ionized ammonia by microbial action in the soil. This form of nitrogen, and any ionized ammonia in the effluent, is adsorbed by soil particles.

Plants and soil microbes both utilize ammonium directly. Microbes oxidize ammonium to nitrite (NO_2) that is quickly converted to the nitrate (NO_3) form through nitrification. Nitrate is highly soluble and is utilized by plants, or leached from the soil into the groundwater. Under anaerobic conditions (in the absence of oxygen), soil nitrate can be reduced by soil microbes to gaseous nitrogen forms (dentrification). These gaseous forms move upward through the soil atmosphere and are dissipated into the air. Denitrification depends on organic carbon for an energy source; thus, the interface between natural soil and the gravel fill in a seepage bed or mound has both requisite characteristics for denitrification.

Unlike phosphorus, nitrogen is not stored in soils except in organic matter. Increases in organic matter within the soils would result from increased microbial action and from decreased oxidation. The increased organic matter improves the soil tilth (workability), water holding capacity, and capability of retaining plant nutrients.

4.1.2.3. Surface Water

The attraction of the middle Door County project area as a recreation and retirement area is directly related to the high-quality water-related amenities of the Door peninsula. Degradation of Green Bay or Lake Michigan water quality, particularly in the bay-side communities of the project area, could lessen the attractiveness of the area. Effluent discharges from WWTPs to Green Bay, or in the case of Baileys Harbor, to Lake Michigan, are a component of two of the alternatives for each of the west side communities and one of the alternatives for Baileys Harbor.

The water quality impacts of the sewage treatment outfalls would be most pronounced in the immediate discharge area, but wastewater constituents also would be transmitted to Green Bay and Lake Michigan as well. Because of the higher population in the summer, higher wastewater discharge rates will occur in the summer than in the winter. Thus, a higher proportion of wastewater constituents will be introduced in the summer months than winter months. In addition, because of minimal sludge accumulation in the aerated lagoons, it is assumed that there will be relatively low removal efficiences of nitrogen and phosphorus. Projected yearly loads of wastewater constituents for the alternatives with sewer outfalls are shown in Table 4-2.

The transport, dispersion and ultimate impact of the wastewater constituents discharged into Green Bay would be difficult to predict. It is assumed that a sewage outfall placed from 200 to 650 feet offshore will discharge into a completely mixed water column. Limnological sampling conducted during the summer in the vicinity of the proposed Fish Creek effluent outfall indicates that the water column is well mixed to approximately 60 feet (By telephone, Dr. James Wiersma, University of Wisconsin, to WAPORA, Inc., 7 July 1982). The introduction of additional nutrients, BOD, suspended solids, and residual chlorine associated with the sewage outfall could create impacts in the immediate area of the outfall if rapid mixing with the Bay or Lake Michigan does not occur. Entrainment of unmixed effluent into small harbor or embayments would create the greatest potential for adverse impacts.

Although information on typical nutrient, BOD, and suspended solids concentrations in the project area harbors is not available, it is suspected that raw sewage from boats on moorings, in conjunction with nonpoint runoff from the communities, currently causes some water quality degradation, particularly during the summer. Thus, entrained unmixed effluent that enters the harbors could result in a cumulative increase in nutrients, BOD, and suspended solids.

The effluent outfalls discharging to Green Bay in the Fish Creek and Egg Harbor alternatives would be located offshore from the mouths of the respective bays. Depending on subsurface currents, the wastewater consti-

Table 4-2. Projected effluent loads to offshore harbor areas on an average annual basis.

Proposed Effluent Outfall Location	Proposed Means of Treatment (Alternative #)	Projected Wastewater Effluent Loads[a] Larger Service Area (kg per year)				Projected Wastewater Effluent Loads[a] Smaller Service Area (kg per year)			
		BOD_5	SS	P	N	BOD_5	SS	P	N
Offshore from Egg Harbor	aerated lagoon (2/4)	1023	1023	170-273	170-341	420	420	70-112	70-114
Offshore from Egg Harbor	rotating biological contactor (2B)	1023	1023	136-205	682	-	-	-	-
Offshore from Fish Creek	aerated lagoon (2/3)	1635	1635	273-545	273-545	1566	1566	261-418	261-522
Offshore from Eagle Harbor	aerated lagoon (2/3)	3126	3126	520-832	520-1040	1947	1947	325-519	325-649
Offshore from Baileys Harbor	aerated lagoon (4)	-	-	-	-	1239	1239	207-330	207-413

[a] Based on flow estimates derived from assumed seasonal usage of 125 days-per-year and on full time usage of permanent residences. Expected effluent quality is 30 mg/l BOD and 30 mg/l SS for both treatment methods; 5-8 mg/l P and 5-10 mg/l N for the aerated lagoon; and 4-6 mg/l P and 20 mg/l N for the RBC.

tuents from these discharges could be transported to the Strawberry Islands, or could be swept back and entrained in the harbor areas. Because of the proposed location of the Ephraim WWTP and the proximity of Peninsula State Park, feasible routes for the effluent outfall are through the central section of Eagle Harbor or along the northeast shore of the Harbor with discharge made offshore of the northern point of the Harbor shore. The locations of the three harbor areas which may potentially be affected by the proposed effluent discharges are presented in Figures 2-18, 2-21, 2-24, and 2-27. Of the three, Eagle Harbor, near Ephraim, appears to be the most confined and isolated from Green Bay. Entrainment of effluent into local harbor currents could have a significant impact in any of the three harbors but, because of the relative shallowness of Eagle Harbor, it was examined further as a case study of the "worst case" situation for potentially adverse water quality impacts. This study of potential adverse impacts is purely hypothetical because little is actually known about interactions between water in small harbor areas with Green Bay or Lake Michigan waters. However, the framework of the evaluation of Eagle Harbor discharge impacts, as presented in the following paragraphs, also is applicable to Egg Harbor, Fish Creek Bay, and Moonlight Bay (Figure 4-1).

Eagle Harbor is approximately 800 acres in size inside a line drawn from outlying point-to-point (just offshore from the 30 foot depth contour). Average depth inside that area is approximately 15 feet. The Harbor is sheltered from prevailing northerly longshore currents by the Strawberry Islands, by the point of Eagle Bluff, and by Horseshoe Island - all to the southwest. Additionally, the Harbor's shape and orientation tends to restrict interaction with Green Bay through the action of west to east wind driven surface layer currents; its axis is not perpendicular to the Green Bay axis.

The hydrodynamics of Green Bay are complex and do not result in uniform surface or subsurface currents (Mortimer 1978). The most typical current pattern in Green Bay appears to be a counter-clockwise flow that produces northward, longshore currents along the Door Peninsula. It is likely that under these conditions these longshore currents would create clockwise current eddies (gyres) of lower velocity in the embayments and

[1]Calculations of slope based on equation: $0=QC_o - QC - VkC$; treating the harbor as a steady state batch reactor of 80 acres size and with an average depth of 15 feet. Constants in the equation are:

$Q = 6.5 \times 10^7$ liters/year (flow or discharge from the WWTP)

C_o= concentration of phosphorus in the waste discharged to the harbor

C = the phosphorus concentration that results from sustained discharge to the harbor (ranging from 0.005mg. P/l. to 0.12mg. P/l.)

$k = 1/T_{years}$ (a first order reaction rate)

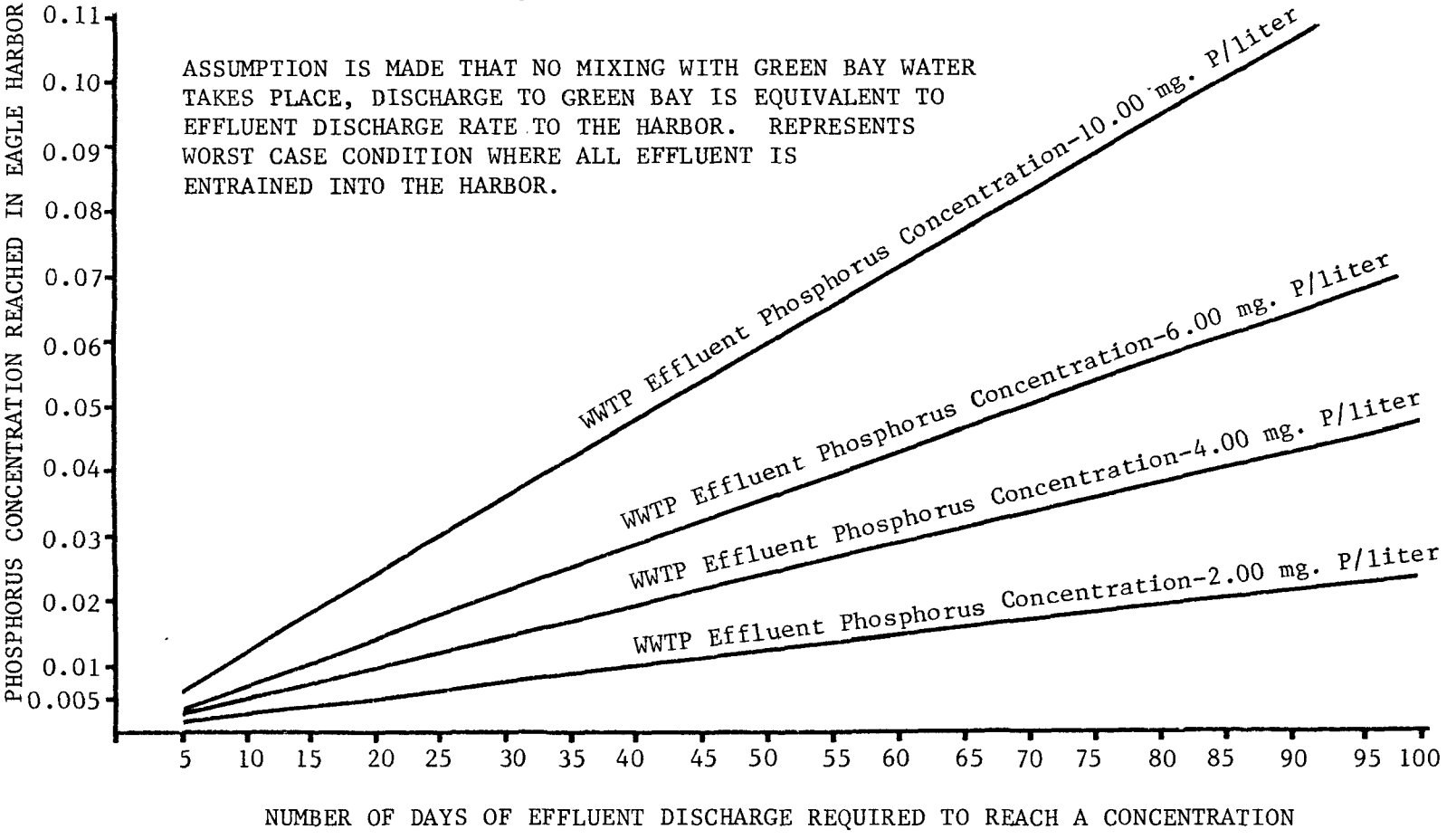


Figure 4-1. Theoretical phosphorus buildup relationships[1] for Eagle Harbor under various WWTP effluent loading regimes.

harbors located along the west side of the Door Peninsula. However, the water movement in Green Bay, when driven by strong local storms, may reach velocities of approximately three times the average. In addition, longshore surface current directions could reverse temporarily under storm conditions. Subsurface, long-wave, water movement phenomenon related to Lake Michigan and Green Bay seiches (see Glossary) also impact the storm driven longshore currents (Mortimer 1978). The result expected from such storm driven events would be a degree of Green Bay and Eagle Harbor water interchange causing complete, sudden replacement of the Harbor water.

Calculations of the theoretical rates of phosphorus "build-up" in Eagle Harbor were made for four phosphorus concentration levels representing a range that could be discharged from the Ephraim treatment lagoons. The calculations assume that no mixing of Harbor water with Green Bay water takes place. The results are presented in Figure 4-1 and represents a "worst-case" evaluation of the phosphorus accumulation due to effluent discharges. A steady condition is assumed where the effluent is completely mixed in the Harbor and water leaves at the same rate that effluent enters. In fact, periods of near total calm resulting in low interchange of Green Bay and Eagle Harbor water seldom exist for more than three or four days; therefore, the "worst-case" assessment (Figure 4-1) most closely approximates a very short time frame, e.g., less than 5 days.

There is no single, most appropriate solution to the equation used for the derivation of Figure 4-1. However, the figure does illustrate the relationship of effluent "P" concentrations to the rates of accumulation (theoretical) in Eagle Harbor, assuming no Bay/Harbor water interchange. If the water quality of Eagle Harbor is such that phosphorus concentrations presently are less than 0.01 mg/liter in the water column, that concentration could be exceeded in 8 days if effluent discharges at the 10 mg/liter concentration were detained in the Harbor for that period of time. This concentration could be sufficient to induce algal blooms in Eagle Harbor. In fact, phosphorus losses from the Harbor would be taking place due to settling and due to Bay/Harbor water interchanges. If, for example, the water interchange resulted in half of all the Harbor water being replaced in 8 days, the resultant Harbor "P" concentration that would result

from the 10 mg P/liter effluent concentration would be approximately one-half of the 0.1 mg/l value (or 0.05 mg P/liter).

In conclusion, effluent phosphorus could have a significant impact on Eagle Harbor water quality. The combination of north flowing surface currents along the Door Peninsula with a low energy gyre in the Harbor entraining the effluent plume could, in several days, elevate phosphorus concentrations in the Harbor to undesirable levels (greater than 0.01 mg/l). A potential exists for similar increases in phosphorus concentrations in the other embayments near proposed surface water discharge areas (i.e., Egg Harbor, Fish Creek Bay, Moonlight Bay). The potential is probably less than for Eagle Harbor, though, because the other embayments are not as confined or isolated, and dispersion by longshore currents probably would prevent nutrient accumulation.

4.1.2.4. Groundwater

Long-term impacts on groundwater that could be encountered in the operational phase of any of the alternatives concern the following three types of pollutants: bacteria and viruses, organics and suspended solids; phosphorus; and nitrate-nitrogen. Movement to groundwater of other wastewater constituents or of soil chemicals would occur, but are not expected to significantly affect any of the uses of the groundwater.

Bacteria, viruses, and suspended organics are readily removed by filtration and adsorption onto soil particles. Two feet of soil material is generally adequate for bacterial removal, except in very coarse-grained, highly permeable soil material. Contamination of drinking water wells or surface water with bacteria and suspended organics in the project area may occur under any of the alternatives.

The data on movement of bacteria, viruses, and other pathogens within soil and their rate of die-off are inconclusive (USEPA and others 1977c, USEPA 1978b, 1981b). The expected hazard to groundwater wells near application sites for WWTP effluent or holding tank wastes, or near soil absorption systems, cannot be assessed satisfactorily. Preliminary indi-

cations are that hydraulically overloaded systems, either from excessive effluent or holding tank wastes application or heavy rainfall, would cause breakthrough of pathogens to the groundwater. Most pathogenic organisms experience relatively rapid die-off when exposed on the soil surface or where the concentration of predator microorganisms is high. This latter situation occurs where the concentration of prey is typically high, such as the soil surrounding an absorption system.

The primary concern with pathogenic organisms in groundwater is in situations where the thickness of soils over bedrock or the water table is inadequate to effect immobilization of the organisms. This can occur within the sewer trenches if exfiltration were to occur, at the sewage treatment plants, under the soil absorption systems, or at the land application sites. Sufficient evidence exists to conclude that unprotected wells (those not constructed to Wisconsin code) have unsafe indicator bacteria concentrations for short intervals. Soil absorption systems have been suspected as the source, although in the interior of the peninsula, manure is suspected as the primary source.

Upgrading onsite systems should result in a reasonable level of protection of groundwater from contamination of pathogenic organisms. On-lot inspection of each soil absorption system with respect to type and thickness of soil below the absorption system would ensure that minimal concentrations of pathogenic organisms would migrate to the groundwater. Other sources, though, may continue to contribute indicator organisms to the groundwater and be found in wells.

Phosphorus is significant in groundwater because it can contribute to the excessive eutrophication of surface waters. Section 4.1.2.2. contains a discussion of phosphorus sorption in soils and supports the conclusion that, except for dry well soil absorption systems, phosphorus contributions to the groundwater from any of the alternatives would be minimal.

The ability to predict phosphorus concentrations in percolate waters from soil treatment systems has not yet been demonstrated (Enfield 1978). Models that have been developed for this purpose have not yet been evalu-

ated under field conditions. Field studies have shown that most soils, even medium sands, typically remove in excess of 95% of the phosphates in relatively short distances from effluent sources (Jones and Lee 1977).

One potential source of phosphorus inputs to groundwater are the soil absorptions systems included in all of the alternatives. The groundwater quality analyses performed in conjunction with the "Septic Snooper" survey (Appendix B) confirm that some phosphorus is reaching surface waters by way of the groundwater. The majority of groundwater samples, though, had phosphorus concentrations less than 0.05 mg/l (23 out of 31). The contribution of phosphorus to the lakes from onsite systems has not been quantified from the sampling data, but from theoretical data. Thus, onsite systems are likely stimulating algal growth in localized areas where effluent plumes emerge, but their contribution to eutrophication is not quantifiable. The greatest quantity of phosphorus would be contributed to groundwater under the No Action Alternative. A slight amount of phosphorus would be contributed to the groundwater under the alternatives that rely on onsite systems.

The alternatives that incorporate land application of lagoon effluent are not expected to significantly increase the phosphorus concentration in the groundwater. Irrigation onto the soil surface results in utilization of the complete soil profile for sorption in contrast to onsite systems that utilize only the subsoil. Phosphorus in groundwater under a land application site is of concern only when surface waters are affected. Groundwaters from the sites would likely flow primarily to the west toward Green Bay.

The aerated lagoons which are components of the centralized alternatives for each community may contribute phosphorus to the groundwater if seepage from the lagoons is considerable. A study of Minnesota wastewater stabilization lagoons (E.A. Hickok and Associates 1978) concluded that none of the ponds (all had natural soil liners) were capable of meeting the designed and specified seepage rates. Most of the ponds studied removed phosphorus effectively, although some had seepage rates considerably higher than the allowable maximum. The aerated lagoons in Door County would

probably require synthetic liners because suitable natural soil material is generally unavailable.

Nitrates in groundwater are of concern at concentrations greater than 10 mg/l as nitrogen because they cause methemoglobinemia in infants who ingest liquids prepared with such waters. The limit was set in the National Interim Primary Drinking Water Regulations (40 CFR 141) of the Safe Drinking Water Act (PL 93-523). A general discussion of nitrogen in soils is presented in Section 4.1.2.2.

The density of soil absorption systems is considered to be the most important parameter influencing pollution levels of nitrates in groundwater (Scalf and Dunlop 1977). That source also notes, however, that currently available "information has not been sufficiently definitive nor quantitative to provide a basis for density criteria." The potential for high nitrate concentrations in groundwaters is greater in areas of multi-tier or grid types of residential developments than in single tier developments. Depending on the groundwater flow direction and pumping rates of wells, nitrate contributions from soil absorption systems may become cumulative in multi-tier developments. Thus, separation distances are critical for new construction and maximum density codes are crucial for new subdivisions.

The results from the groundwater sampling (Section 3.1.3.2.2.) from wells indicate that elevated nitrates (greater than 2 mg/l as nitrogen) did not occur in any of the 33 wells that were sampled. Some of these wells appeared to have sources of nitrates other than soil absorption systems because chlorides or conductivity were not significantly elevated.

Some elevated levels of nitrate may occur under the No Action Alternatives and occasional violations of the drinking water quality standard may occur. The alternatives that include continued use of onsite systems and cluster systems may not necessarily result in declines in concentrations of nitrates in the groundwater. Wells that have high nitrate concentrations may need to be deepened so that the contaminated groundwater is bypassed.

Cluster drainfields and mounds are designed similarly to individual drainfields and mounds to ensure an adequate aeral distribution of the effluent for satisfactory removal of phosphorus. Nitrate concentrations within the groundwater below a cluster drainfield or mound are anticipated to be equivalent to those below an individual soil absorption system. Insufficient experimentation has been conducted to enable designing for nitrogen removal from septic tank effluent. One precaution would be to locate the soil absorption systems as far from wells as feasible. Once nitrates enter the groundwater, dilution is the only practical means of reducing the concentration.

Aerated lagoon effluent typically contains nitrogen levels of approximately 18 mg/l (USEPA 1978c). Nitrates in the groundwater below the land application sites probably would average considerably less than 10 mg/l, the drinking water quality standard. Volatilization, crop uptake and removal, soil storage, and denitrification would account for removal of nitrogen from the applied effluent. Some increase in nitrate concentration above background levels is anticipated, but no significant adverse impacts on the environment or proposed use is anticipated.

Seepage from the aerated and storage lagoons could result in elevated nitrate levels in the groundwater below the lagoons. Clay liners are not impermeable and plastic liners can be punctured or experience deterioration. Field studies (E.A. Hickok and Associates 1978) have shown that a seepage rate of 500 gallons-per-acre-per-day is very difficult to achieve even on in-place, fine-textured soils. On medium- to coarse-textured soils, the quality of the liner is of utmost concern for protection of groundwater quality. Monitoring wells would be installed and sampled on a regular basis. The sampling program would identify problems before neighboring residents are affected.

Nitrate movement below the disposal areas for holding tank wastes and septage is of concern. The safe loading rate could easily be exceeded if several truckloads were emptied in one place, such as may happen when access to field sites is limited. Also, continual applications at the maximum allowable application rate in the code would overload the capa-

bility of the soils to assimilate the nitrogen. A properly managed and operated disposal operation, particularly if the site were cropped, would contribute nitrates to groundwater only slightly above background concentrations.

Changes in groundwater levels would occur with the centralized alternatives. The greatest change in groundwater levels would occur in the vicinity of the land application site. Inadequate data have been assembled to accurately predict the water table rise. The water table rise would affect not only the land application site, but also the surrounding area and the normal outflow areas. Either draintile or recovery wells on the land application area would prevent the water table from rising to the surface, if it is shown to be necessary through further studies.

4.1.2.5. Terrestrial Biota

The land disposal sites proposed in Section 31 for Egg Harbor Alternative 6 and Section 3 for Fish Creek Alternative 6 would affect the terrestrial biota during plant operation, however, no significant adverse long-term effects would be expected during normal plant operating conditions. Wildlife may avoid the area during waste application. Periodic monitoring should be performed if this alternative is used to detect the presence of potentially harmful concentrations of heavy metals, other toxic substances, or micronutrients in the soil, crops, or other vegetation.

4.1.2.6. Wetlands

The discharge of wastewater effluent to adjacent wetland areas was evaluated as a project alternative for Ephraim and for two Baileys Harbor sites. The first wetland discharge alternative for Baileys Harbor was proposed in the Middle Door County Facilities Plan (Becher-Hoppe Engineers, Inc. 1980) and the Ephraim wetland discharge and second Baileys Harbor discharge alternatives were developed for this Environmental Report. In order to evaluate the potential impacts on the Baileys Harbor wetland from the proposed effluent discharge, an assessment was made of the existing characteristics of the wetland area (including a one-day field investiga-

tion by WAPORA, Inc. personnel) and a literature review was conducted as to the type of impacts that could result from the introduction of wastewater effluent into the wetland. Athough a similar investigation was not conducted for the "Ephraim Swamp" or for the second Baileys Harbor site, the Wisconsin Wetlands Inventory (WDNR 1978c) indicates that these wetlands have soils, hydrologic, and vegetative characteristics that are similar to the Baileys Harbor wetland.

The concept of employing natural wetland ecosystems as a component in the treatment of wastewater has come to receive considerable attention in recent years. The ability of wetlands to enhance water quality has led to much research pointing to the capability of wetlands to assimilate and treat municipal wastewater to a high degree. However, application of wastewater to wetlands would not occur without some adverse impacts. This dicussion presents factors to be taken into account to screen the potential for the wetlands to accommodate and treat municipal wastewater with minimal impact.

The Baileys Harbor wetland is located north of the community of Baileys Harbor and is part of a large wetlands complex that extends from Baileys Harbor on the south to north of North Bay along the Lake Michigan side of the Door County peninsula. According to the Middle Door County Facilities Plan, (Becher-Hoppe Engineers, Inc. 1980) the proposed discharge area is in the vicinity of the north-south section line approximately one-third of a mile north of Highway Q (Figure 4-2). The wetlands investigation was limited to the area bounded by the 600 ft contour on the west and north, Mud Lake on the east, and Highway Q on the south. This area encompasses approximately 3,000 acres or 4.7 square miles.

Two additional wetland discharge sites are evaluated as alternatives in this Environmental Report. An alternative Baileys Harbor treatment plant and discharge location about 1.5 miles northwest of the community in a wetland of about 900 acres was evaluated (Figure 4-2). An alternative Ephraim discharge was considered approximately 1 mile southeast of the Village in a wetland of approximately 1,000 acres (Figure 4-3).

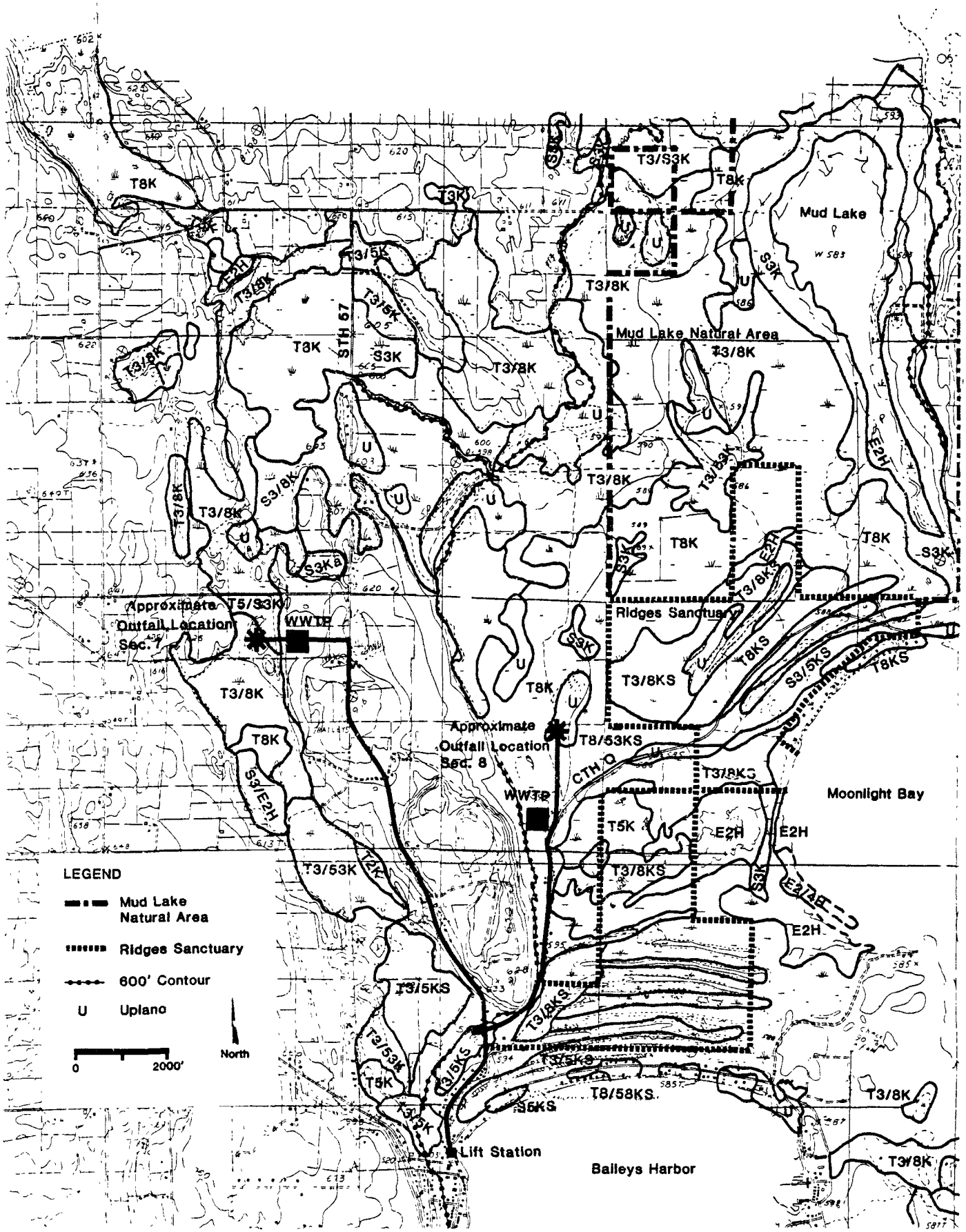


Figure 4-2. Baileys Harbor wetland associations, approximate outfall locations, and natural area boundaries.

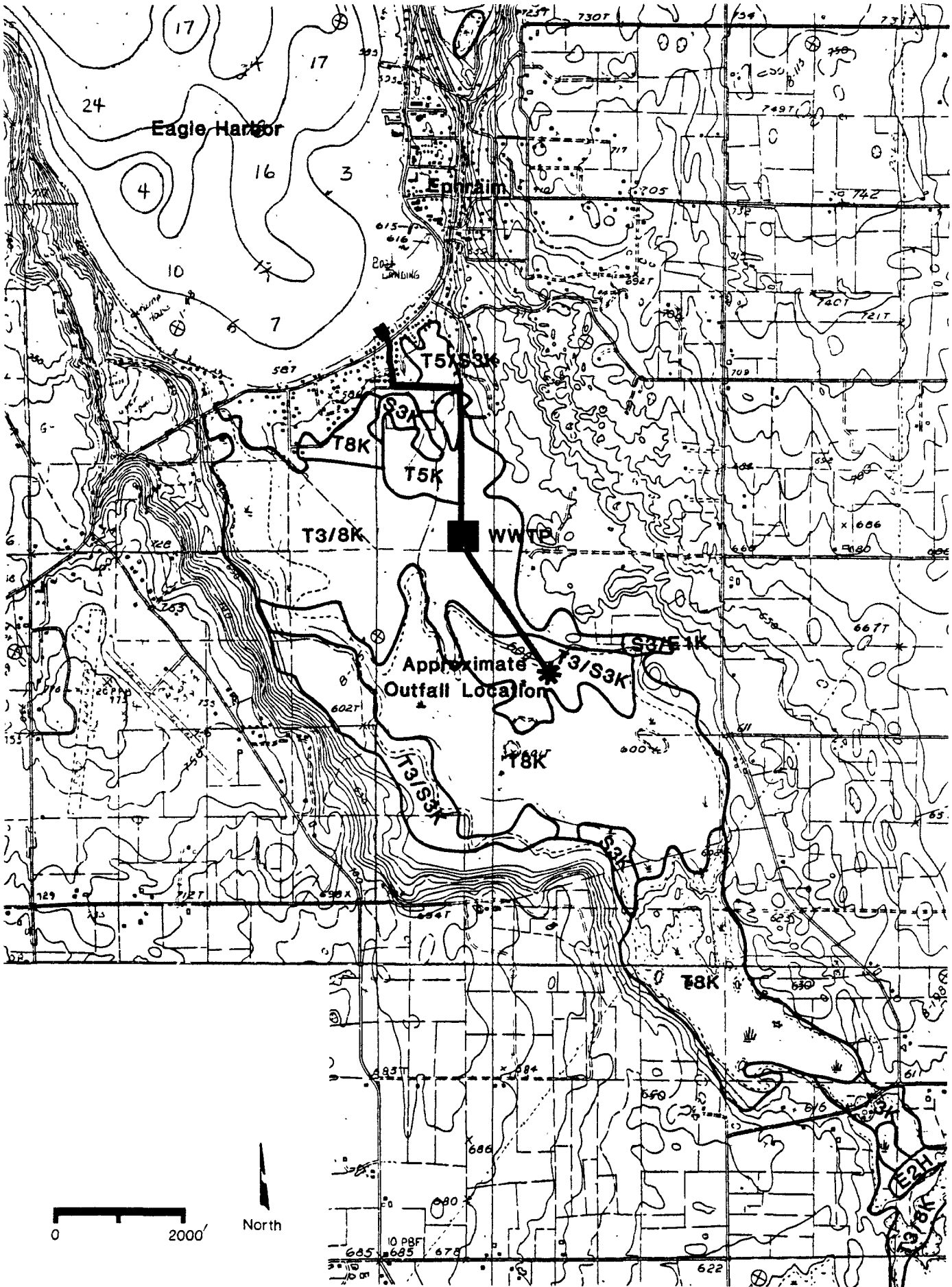


Figure 4-3. Ephraim wetland associations and approximate outfall locations.

The morphology of these wetlands indicate that following the retreat of the Wisconsin glacier approximately 10,000 years ago, the lowland area north of Baileys Harbor was inundated by Lake Chicago which occupied the present Lake Michigan Basin and had a lake level of about 600 ft (Bertrand et al. 1976). According to Sherrill (1978), the surficial materials present in the wetland are of Pleistocene age and consist of either alluvium, marsh, and lake deposits or coarser grained stratified material consisting of outwash, beach deposits, and sand dunes. As Lake Chicago retreated and Lake Michigan assumed its present configuration and water level, deposition in the previously inundated areas increased the thickness of the unconsolidated deposits that overlie the consolidated rock unit.

There are four major bedrock valleys that traverse the County from northwest to southeast, which probably were cut by preglacial streams that flowed toward Lake Michigan (Martin 1939 as cited in Sherrill 1978). One of these bedrock valleys is located between Ephraim and Baileys Harbor and the presence of a wetland ecosystem within this valley indicates that groundwater from adjacent uplands flows into the wetland complex north of Baileys Harbor. In addition to these groundwater flows, the depth of the outwash and lake deposits limit relief and also appear to be a primary contributing influence to the presence of saturated soils and, in some areas, standing water throughout the year. Additional hydrogeologic investigations are necessary, though, to describe in more detail the morphology, formation, and hydrogeology of the wetlands.

The topography within the marsh consists of a series of ridges and swales which differ in elevation by less than four feet. Surface drainage in the area north of Highway Q generally is toward the northeast into Mud Lake. Defined drainageways are present on the northwestern and northern margins of the wetland, but runoff diffuses throughout the wetland as the drainageways become increasingly diffuse due to the lack of relief.

The WDNR has mapped and classified wetlands in Wisconsin according to vegetation, cover-type, hydrology, human influence factors, and special wetland characteristics (WDNR 1978c). The classification system used by the Wisconsin Wetlands Inventory is based on the US Fish and Wildlife

Service (USFWS) classification system that is described in "Classification of Wetlands and Deepwater Habitats of the United States" (Cowardin et al. 1979). The wetland types that are present in the Baileys Harbor and Ephraim wetlands are depicted in Figures 4-2 and 4-3 and described below:

Classification	Class	Subclass	Hydrologic Modifier	Special Modifier
T8K	Forested	Needle-leaved	Wet soil, Palustrine	
S3K	Scrub/Shrub	Broad-leaved deciduous	Wet soil, Palustrine	
T8/S3Ks	Forested/ Scrub/Shrub	Needle-leaved/ Broad-leaved deciduous	Wet soil, Palustrine	Ridge and swale complex
E2H	Emergent/wet meadow	Narrow-leaved persistent	Standing water, Palustrine	
T3/8K	Forested	Broad-leaved deciduous/ Needle-leaved	Wet soil, Palustrine	
T5K	Forested	Needle-leaved evergreen	Wet soil, Palustrine	

Two National Natural Landmarks are located adjacent to the proposed area of application for the original Baileys Harbor wetland discharge alternative (Figure 4-2). The Ridges Sanctuary encompasses 708 acres on both sides of Highway Q north of Baileys Harbor. According to the Wisconsin Scientific Areas Preservation Council (WDNR 1977b):

> The Ridges Sanctuary consists of parallel, abandoned beach ridges and swales of former Lake Michigan levels, deposited over dolomitic bedrock. Some swales are wet and open, while others are forested with swamp conifers. Boreal forest occurs on some of the ridges, far disjunct from the Lake Superior region. A unique rich flora of many local, rare, and endangered plants make the tract world famous; Wisconsin's first National Natural Landmark.

In 1974, 960 acres surrounding Mud Lake also were established as a National Natural Landmark by the National Park Service. Mud Lake is an estuarine lake that flows into Moonlight Bay. Groundwater flows in the adjacent wetland areas probably are toward Mud Lake. According to the

Scientific Areas Preservation Council (WDNR 1977b): "Waterfowl and fish spawning use of the lake and wetlands is heavy. Periodic, natural fluctuation of Lake Michigan changes the vegetative composition of the wetland."

The management of state scientific areas, including the Ridges Sanctuary and Mud Lake, is based on specific plans that are recommended by the Scientific Areas Preservation Council and agreed to by the land managing agency. For the Ridges Sanctuary, land management is provided by the non-profit Ridges Sanctuary, Inc. Mud Lake is owned by the State of Wisconcin and managed by the WDNR.

The general objective of scientific areas managment is "to preserve the scientific area in a natural condition with the least possible man-induced disturbance" (WDNR 1977b). In particular, the usual conservation practices that are applied in many public forests or wildlife areas, such as timber harvesting, water level manipulation, herbicide or insecticide application, and introduction of plants or animals, are not considered to be compatible with the objectives of Wisconsin's Scientific Areas Program.

SITE SURVEY

A walk-through survey of the wetland area between STH 57 and Mud Lake, north of CTH Q, was conducted on 30 June 1982 by WAPORA, Inc. personnel. Soil cores were taken at several locations. Cores taken on ridges generally had the following characteristics:

- decomposing organic matter was confined to the upper 7 to 11 inches
- loam or sand/gravel underlie the organically enriched surface layer
- soils taken from ridges were moist, but were not saturated
- the upper soil horizons were aerobic.

Soil cores taken in the swales indicated Markey muck soils. The Door County Soil Survey (SCS 1978) describes this soil as a very poorly drained,

nearly level, organic soil that is formed in old glacial lake basins and in depressions of floodplains. The soils cores generally indicated that:

- decomposing plant materials were found to depths greater than 2.5 feet (the length of the soil corer)
- gravel and sand were present at a depth of approximately one foot in those areas where decomposing vegetation was less than 2.5 feet
- the soils were moist to saturated and in certain areas diffuse flow and/or standing water was observed
- the soils generally were anaerobic below eight inches.

The vegetation on the ridges was dominated by mature cedar interspersed with poplar, birch, balsam, black spruce, and tamarack. Occasional hemlock and pine also were present. The canopy ranged from broken to complete; where the canopy was complete, the understory vegetation was sparse. In areas were the canopy was less dense, annuals, perennials, and ferns provided ground cover. In the swales, scrub/shrub vegetation or cedars dominated. The understory contained grasses, sedges, annuals, perennials or mosses, and liverworts. In the northwest corner of the wetland, a cattail, sedge, and grass wet meadow is present. This association is maintained, in part, by the presence of a beaver dam (indicated by the S3/E2H classification; Figure 4-2).

Because of its areal extent, cover, and the availability of food, the wetland is an important wildlife habitat. The guidebook to the Ridges Sanctuary (Ridges Sanctuary, Inc. 1977) list 7 species of reptiles, 8 species of amphibians, 15 species of mammals, and 56 species of birds that utilize the Sanctuary for habitat. Species present in the wetland include white-tailed deer, red fox, snowshow hare, green heron, ruffed grouse, and american bittern.

Forested wetlands such as are found in this area are less well understood as wetland treatment systems than other wetland types. Because the climatic, hydrologic, geologic, and biologic characteristics of wetlands are so varied, the particular physical, chemical, and biological transformations occuring in a particular wetland results in reports of a range of removal efficiencies.

The principal mechanisms for the removal of contaminants in wastewater are:

- physical sedimentation of suspended solids
- chemical precipitation and adsorption of phosphorus
- microbial metabolization of BOD_5 and nitrogen
- natural die off, predation, and decomposition of pathogens.

The removal mechanisms are operative in the water column, in the soil column beneath the wetland, and at the interface between the water and soil column. Most of the biological transformations that occur in wetlands take place in the presence of emergent vegetation and high organic content soils, such as the Markey muck soils present in the proposed area of application.

The removal efficiencies reported in the literature of natural wetlands have varied widely. Removal efficiencies have been reported to range between 60 and 90 percent for suspended solids, between 70 and 96 percent for BOD_5, between 40 and 90 percent for nitrogen as total N, and between 10 and 50 percent for phosphorus as total P. For forested wetlands, the literature is not extensive but removal efficiencies of 62 to 91 percent of total phosphorus and 75 to 80 percent of total nitrogen have been reported (Kadlec 1979, 1982).

Removal efficiencies also will vary depending on the area of application. Although physical, chemical, and biological features will determine the field requirements for application of secondary effluent, the literature indicates that an area of 30 to 60 acres is needed per one million gallons per day (Reed 1980). However, because of the variations in wetlands, as noted above, "even with these quantities of land, removal of nitrogen and phosphores (sic) are uncertain and may require an even larger area for significant removal" (Reed 1980). Based on this standard, the field area required for application of effluent for Baileys Harbor under Alternative 3 (62,000 gpd average daily design flow) would be 1.9 to 3.7 acres, and under Alternative 5 (46,000 gpd) the field area requirement would be 1.4 to 2.8 acres. For Ephraim under Alternative 4 (118,000 gpd),

the field area requirement would be 3.5 to 7.1 acres. To achieve these application areas, the effluent should be applied via an open top gutter type pipe or piping with spaced holes.

The hydrology of the area is important to the consideration of this site for wetland treatment for two reasons; the residence time of wastewater in the wetland influences the degree of waste treatment, and the change in the hydrologic regime may alter the wetland habitat and thus result in a change in species composition. For a wetland to be effective in nutrient assimilation, wastewater must remain in contact with the soil/plant matrix long enough to allow removal by microbial transformation, adsorption by surfaces, uptake by plants, or deposition of particulate matter. Given the low relief, lack of defined drainage, and large size of this wetland area, residence time should be lengthy and thus permit these processes to take place.

The discharge of wastewater into a wetland may alter the habitat characteristics of existing species. Kadlec (1982) reports that two regimes will exist in a wastewater wetland system; a saturated region in the vicinity of the wastewater discharge and a zone of rapid constituent removal just outside of the saturated zone. If prolonged periods of standing water were to occur within the immediate saturated region, the change in hydrologic regime may result in the elimination of grasses, annuals, perennials, mosses, and liverworts. These conditions could impede seed germination for tree species in the overstory and could contribute to wind-throw because of shallow rooting (uprooting of mature trees during storms). This may result in vegetational succession by species more tolerant of standing water such as cattails (Typha spp.). In order to fully understand these processes, a detailed hydrogeologic analysis would be necessary.

The addition of nutrients could result in changes in biomass, growth, and production of selected wetland species. The result could be long term changes in species composition, and alterations in the areal distribution of component species. Certain vegetative species could be favored by elevated nutrient levels and standing water which would lead to increased growth and a competitive advantage of one over another species, thus im-

pacting species diversity. The exact transformations that would occur are not predictable at this time.

Secondary sewage effluent from small municipal sources typically is characterized by low levels of heavy metals. However, residual chlorine has been demonstrated to result in phytotoxicity on wetland vegetation species. Dechlorination or extended residence time in a storage lagoon would help mitigate this impact.

The addition of wastewater to wetlands could alter the structure and function of resident insect populations. These alterations include possible increases in insects, such as mosquitos, that carry diseases transmittable to man or wildlife, and increases in aquatic insects that indicate a loss of water quality, such as chironomids. However, very little is actually known about insect populations in wetlands and less on those receiving wastewater.

The effects of wetland treatment on associated wildlife communities is dependent on the ability of the wetland to provide necessary food, shelter, and breeding sites for particular species. The changes in water levels associated with the introduction of wastewater could result in shifts of the location of wildlife breeding and activity sites within the wetland. Changes also could take place in:

- habitat structure and components
- species richness and diversity
- presence and abundance of indicator species
- incidence of disease, wildlife condition, and potential for wildlife to act as vectors for human disease
- presence and abundance of endangered, threatened, and rare species.

Thus, the application of wastewater effluent to the Baileys Harbor or Ephraim wetlands has the potential to change the hydrologic regime of the application site and contiguous area and could lead to an alteration in the vegetative species composition. In particular, species that are more

tolerant of hydric conditions would succeed those that are less tolerant. Increased nutrient loads also would permit species capable of metabolizing nutrients to grow more vigorously and out-compete species that are not capable of metabolizing nutrients. Thus, the structure and function of the wetlands could change over time.

It is not possible to specifically determine the impacts that will occur in terms of the area affected, the biotic changes that will take place, or the significance of the changes to the overall wetland communities until a site specific ecological and engineering evaluation of the application sites is conducted. This evaluation would require detailed information on:

- the configuration and placement of the outfall line
- the hydrogeologic characteristics of the application site and contiguous wetland area
- the vegetative association of the application site and adjacent areas.

Given the size of the wetlands and the relatively small discharges that are proposed, nutrient absorption should be adequate to obviate any water quality impacts to Moonlight Bay, Baileys Harbor, or Lake Michigan, or in the case of Ephraim, to Green Bay.

The primary concern associated with an effluent discharge from the Baileys Harbor WWTP is the ability of the wetland to assimilate the wastewater without adversely affecting the contiguous Mud Lake and Ridges Sanctuary Scientific Areas. The Scientific Areas are managed so that the natural processes taking place are not disrupted by man-induced activities. The findings of this analysis indicate that it is highly probable that a change in habitat characteristics would occur in the Baileys Harbor wetland due to wastewater application. If a non-degradation policy is to be respected in this area, wastewater application to the wetland must be viewed as an incompatible use.

In evaluating and screening the use of a particular wetland for effluent discharge, factors other than the size and assimilative capacity of

the wetland also must be considered. Although a wetland may be able to assimilate the increased flows and nutrients, changes in the structure and function of the wetland, in terms of the hydrologic and biotic regimes, can occur. The factors that must be considered to determine whether such changes are acceptable or not include the uniqueness of the wetland, the richness and diversity of fauna and flora, its importance as a wildlife area, and/or its protection or designation on a federal, state, or local level.

As discussed previously, the proposed wetland discharge site in Sec. 8 for Baileys Harbor is adjacent to two National Natural Landmarks. The primary purpose of the National Natural Landmark (NNL) program is to identify and protect the best remaining example of a specific eco-type. The Ridges Sanctuary/Toft Point/Mud Lake area is described in the NNL listing in the Federal Register as "...a series of sand ridges and swales with associated boreal forest and bog vegetation and unusually high species diversity, as well as the best mixed stand of large red and white pine, hemlock, and northern hardwoods on the western shore of Lake Michigan." Thus, the proposed wetland discharge site can be characterized as locally and regionally unique, diverse, and important as wildlife habitat. The creation of a more monotypic ecosystem as a result of a wetland discharge could be considered a significant impact, regardless of whether or not the discharge affects the adjacent Natural Areas. Because of the high quality of the wetland, a high level screening test and critical review are necessary before the use of the proposed discharge site can be considered as a viable component of a treatment alternative. Although a field investigation was not conducted for the alternative Baileys Harbor wetland discharge site in Sec. 7 or the Ephraim wetland discharge site, the Wisconsin Wetlands Inventory indicates that they are similar, in terms of the classifications that are present, to the wetland complex north of Baileys Harbor. Thus, the use of either of these sites for effluent discharge also will require a high level screening test prior to their inclusion as viable options in a treatment alternative.

4.1.2.7. Land Use

Land use under the easement of sewage conveyance lines would be intermittently affected when maintenance or repairs were performed on sections of the lines. Periodic excavating and filling would disturb vegetation and soil along conveyance lines. The release of low level odors and aerosols from WWTPs and the knowledge that hazardous gases could potentially be released from those plants may affect land use adjacent to the plants. Improper maintenance of cluster and onsite systems may create malodorous conditions which would adversely affect adjacent land uses.

4.1.2.8. Demographics

The operation and maintenance of wastewater facilities proposed under the "build" alternatives will not have a significant impact on the demography of the study area. A limited number of long-term jobs created by the operation and maintenance of these facilities likely will be filled by persons living within the study area or within commuting distance. No new residents are expected to be attracted to the study area to fill these positions.

4.1.2.9. Economics

The operation of wastewater facilities under the centralized collection and treatment component of the proposed alternatives would create a few long-term jobs. These jobs could be filled by persons residing in the project area.

No new jobs are anticipated to be created under the upgrading of existing onsite systems component of the proposed alternatives. Existing contractors are expected to satisfy local demand for construction and maintenance services of onsite systems. Contractors and tradesmen involved in the construction and maintenance of onsite systems will suffer a loss of work opportunities within the project area under the centralized collection and treatment alternatives. No significant economic impacts are expected to occur during the operation of wastewater treatment facilities under any of the alternatives.

4.1.2.10. Recreation and Tourism

The operation of wastewater facilities under any of the "build" alternatives could affect tourist and recreational activities in the project area if a malfunction of those facilities occurred. A failure in the system components of the WWTPs with outfall discharge could cause untreated or partially treated waste to be discharged into Green Bay or Lake Michigan. This phenomenon would result in short-term water quality degradation and a reduction in the recreational use of that body of water. Odors emanating from malfunctioning onsite systems may curtail outdoor recreational activities in the near vicinity.

4.1.2.11. Transportation

Impacts arising during the construction of conveyance lines (Section 4.1.1.) would reoccur when maintenance or repairs are made on those lines. Occasionally some roads may be closed temporarily. Truck traffic to and from the proposed treatment facilities under the centralized collection and treatment components will be associated with supply deliveries. The sewering of residential and commercial properties currently on holding tanks would lead to a decline in truck traffic associated with waste hauling.

4.1.2.12. Energy

The operation of wastewater treatment facilities and pump stations under the "build" alternatives require the use of electricity and fossil fuels. Each of the wastewater treatment methods that were evaluated have relatively similar energy requirements. No significant demands would be placed on local energy supplies under any of the alternatives.

4.1.3. Public Finance

The costs of implementing a project in one of the project area communities could be apportioned between the State of Wisconsin and local residents. Grants of up to 60 percent of the eligible costs of implementing a wastewater improvement action could be available from the Wisconsin Fund.

In the case of a centralized collection and treatment system, the municipality or sewer district would apply to the Wisconsin Fund on behalf of the residents within the proposed service area. The Wisconsin Fund also is authorized to assist in funding onsite system upgrades. For onsite upgrades funded under NR 128.30 the individual property owner must apply for the grant. However, for onsite upgrades funded under NR 128.08 the municipality or sanitary district applies for the grant. Because of their position on the State priority list, it is unlikely that the communities in the project area will be eligible for any Federal funding under Section 201 of the FWPCA for construction of wastewater treatment facilities. The local construction costs and the entire costs of the system operation and maintenance would be borne entirely by the system users. The costs for each of the alternatives for the project area communities are presented in Appendix E.

Because of the mixture of seasonal and permanent residences and commercial and institutional uses within the proposed service area, the annual user costs for the different alternatives were computed based on population equivalents. The population equivalents provide an indication of the number of people within a particular area based on the number of permanent residences, seasonal residences, hotel and motel units, and campgrounds. Different population equivalents are assigned to each of the uses to reflect the differences between, for example, the number of people that typically reside in a permanent dwelling and the average number of people in a hotel or motel unit. The actual allocation of user charges between different types of uses (i.e., residential, commercial, institutional, year-round, seasonal) would be determined by the implementing authority prior to construction. The 1980 population equivalents used to compute the user costs associated with the project alternatives are presented in Table 4-3. The user costs by alternative for each community are summarized in Table 4-4.

Wastewater treatment facilities can create significant financial impacts for communities and users who will pay the capital, operation, maintenance, and debt costs associated with sewage treatment facilities.

Table 4-3. 1980 Population Equivalents (PE) for Egg Harbor, Fish Creek, Ephraim and Baileys Harbor service areas.

	Permanent[a]	Seasonal[b]	Seasonal Transient[c]	Total
Egg Harbor				
1980 dwelling units[d]	108	200	161	469
Population-per-unit[e]	2.07	3.0	2.8	-
1980 Population Equivalents (PE)	224	600	451	1275
Fish Creek				
1980 dwelling units[d]	79	123	216	418
Population-per-unit[e]	2.34	3.0	2.8	-
1980 PE	185	369	605	1159
Ephraim				
1980 dwelling units[d]	141	291	265	697
Population-per-unit[e]	1.96	3.0	2.8	-
1980 PE	276	773	742	1791
Baileys Harbor				
1980 dwelling units[d]	149	169	135[c]/20[f]	463
Population-per-unit[e]	2.32	3.0	2.8/3.26	-
1980 PE	347	507	378/65	1297

[a] Permanent (principal) residences (single family dwellings).

[b] Seasonal single family dwellings, condominiums, and apartments.

[c] Hotel and motel units.

[d] Dwelling units within onsite and off-site component service area based on house count.

[e] Population-per-unit from 1980 Census data.

[f] Campground spaces.

Table 4-4. Annual user costs for alternatives.

Alternative	Annual Cost per Population Equivalent[1] With State Grant	Without State Grant
Egg Harbor		
2A	$106.12	$157.73
2B	133.33	192.63
3	94.20	145.25
4	85.65	126.12
5	93.57	129.10
6	130.12	175.45
7	71.92	93.65
Fish Creek		
2	$177.95	$263.24
3	169.11	255.13
4	140.12	230.72
5	149.53	245.55
6	175.84	263.76
7	239.26	263.50
Ephraim		
2	$191.74	$303.69
3	140.76	210.16
4	138.36	190.69
5	99.55	154.10
6	97.15	114.52
Baileys Harbor		
2A	$214.57	$306.78
2B	232.15	331.61
3	219.89	316.42
4	208.71	311.87
5	206.71	292.21
6	185.81	229.22

[1] 1980 population equivalents for each community based on permanent, seasonal and transient population (Table 4-3).

Two guidelines for determining the magnitude of these impacts are the State of Wisconsin limitation on municipal indebtedness to 5% of the full equalized value of general property and the USEPA average annual user charge to median household income ratio (USEPA 1981c). The individual communities would assume the local share of additional debt under any of the "build" alternatives. In the case of the two unincorporated communities, Fish Creek and Baileys Harbor, sewer districts formed to implement a wastewater collection and treatment project would be responsible for the local share of additional debt. The total debt to full equalized value ratios associated with the project alternatives, with and without State grants, are presented in Table 4-5 through 4-8.

Table 4-5 indicates that for Egg Harbor, the implementation of Alternative 2A, 2B, 3, 4, and 6 would result in the 5% debt limit being exceeded if a State grant were unavailable. None of the Egg Harbor Alternatives would cause the debt limit to be exceeded, though, if a State grant was used.

In order to determine the debt to full equalized value ratios resulting from the Fish Creek Alternatives, an assumption must be made about the full equalized value within the proposed service area. Because Fish Creek is unincorporated, information on full equalized value only is available at the Township level. To compute the ratios, it was assumed that the proposed Fish Creek service area represents 50% of the full equalized value of Gibraltar Township. On this basis, all of the proposed Alternatives would result in the 5% debt limit being exceeded, with the exception of Alternative 7, upgraded onsite systems for all subareas (Table 4-6). Alternative 7, with or without a State grant, would not cause the debt limit to be exceeded.

In Ephraim, Alternative 2 would exceed the debt limit, regardless of whether a State grant was available or not. In addition, the implementation of Alternatives 3 and 4 without a State grant would cause the debt limit to be exceeded (Table 4-7).

Table 4-5. Egg Harbor debt as a percentage of full equalized value, by alternative, with and without State grant.

Alternative	Existing Debt 1980	Local Capital Share		Total Debt	Full Equalized Value	Debt-to-Value (%)
		With State Grant	Without State Grant			
2A	124,500 +	954,600 =		1,079,100 -	24,409,290 =	4.4
			1,618,900 =	1,743,400 -		7.1
2B	124,500 +	1,073,600 =		1,198,100 -	24,409,290 =	4.9
			1,836,800 =	1,961,300 -		8.1
3	124,500 +	933,300 =		1,057,800 -	24,409,200 =	4.3
			1,600,500 =	1,725,000 -		7.1
4	124,500 +	724,300 =		848,800 -	24,409,290 =	3.5
			1,244,900 =	1,369,400 -		5.6
5	124,500 +	636,900 =		761,400 -	24,409,290	3.1
			1,094,700 =	1,219,200 -		5.0
6	124,500 +	800,200 =		924,700 -	24,409,290 =	3.8
			1,383,000 =	1,507,500 -		6.2
7	124,500 +	380,900 =		505,400 -	24,409,290 =	2.1
			659,900 =	784,400 -		3.2

Table 4-6. Fish Creek debt as a percentage of full equalized value, by alternative, with and without State grant.

Alternative	Existing Debt 1980	Local Capital Share With State Grant	Local Capital Share Without State Grant	Total Debt	Full Equalized Value	Debt-to-Value (%)
2	95,238 +	1,426,200 =		1,521,438 -	25,569,995 =	6.0
			2,446,000 =	2,541,238 -		9.9
3	95,238 +	1,392,200 =		1,487,438 -	25,569,995 =	5.8
			2,399,200 =	2,494,438 -		9.8
4	95,238 +	1,327,400 =		1,422,638 -	25,569,995 =	5.6
			2,361,400 =	2,456,638 -		9.6
5	95,238 +	1,437,900 =		1,533,138 -	25,569,995 =	6.0
			2,562,300 =	2,657,538 -		10.5
6	95,238 +	1,421,400 =		1,516,638 -	25,569,995 =	5.9
			2,450,500 =	2,545,738 -		10.0
7	95,238 +	437,300 =		532,538 -	25,569,995 =	2.1
			721,000 =	816,238 -		3.2

Table 4-7. Ephraim debt as a percentage of full equalized value, by alternative, with and without State grant.

Alternative	Existing Debt 1980	Local Capital Share		Total Debt	Full Equalized Value	Debt-to-Value (%)
		With State Grant	Without State Grant			
2	16,452 +	2,910,900 =		2,927,352 -	46,065,260 =	6.4
			4,935,500 =	4,951,952 -		10.8
3	16,452 +	1,832,200 =		1,848,652 -	46,065,260 =	4.0
			3,086,800 =	3,103,252 -		6.7
4	16,452 +	1,454,400 =		1,470,852 -	46,065,260 =	3.2
			2,399,900 =	2,416,352 -		5.3
5	16,452 +	1,296,100 =		1,312,552 -	46,065,260 =	2.9
			2,283,200 =	2,299,652 -		5.0
6	16,452 +	499,200 =		515,652 -	46,065,260 =	1.1
			813,200 =	829,652 -		1.8

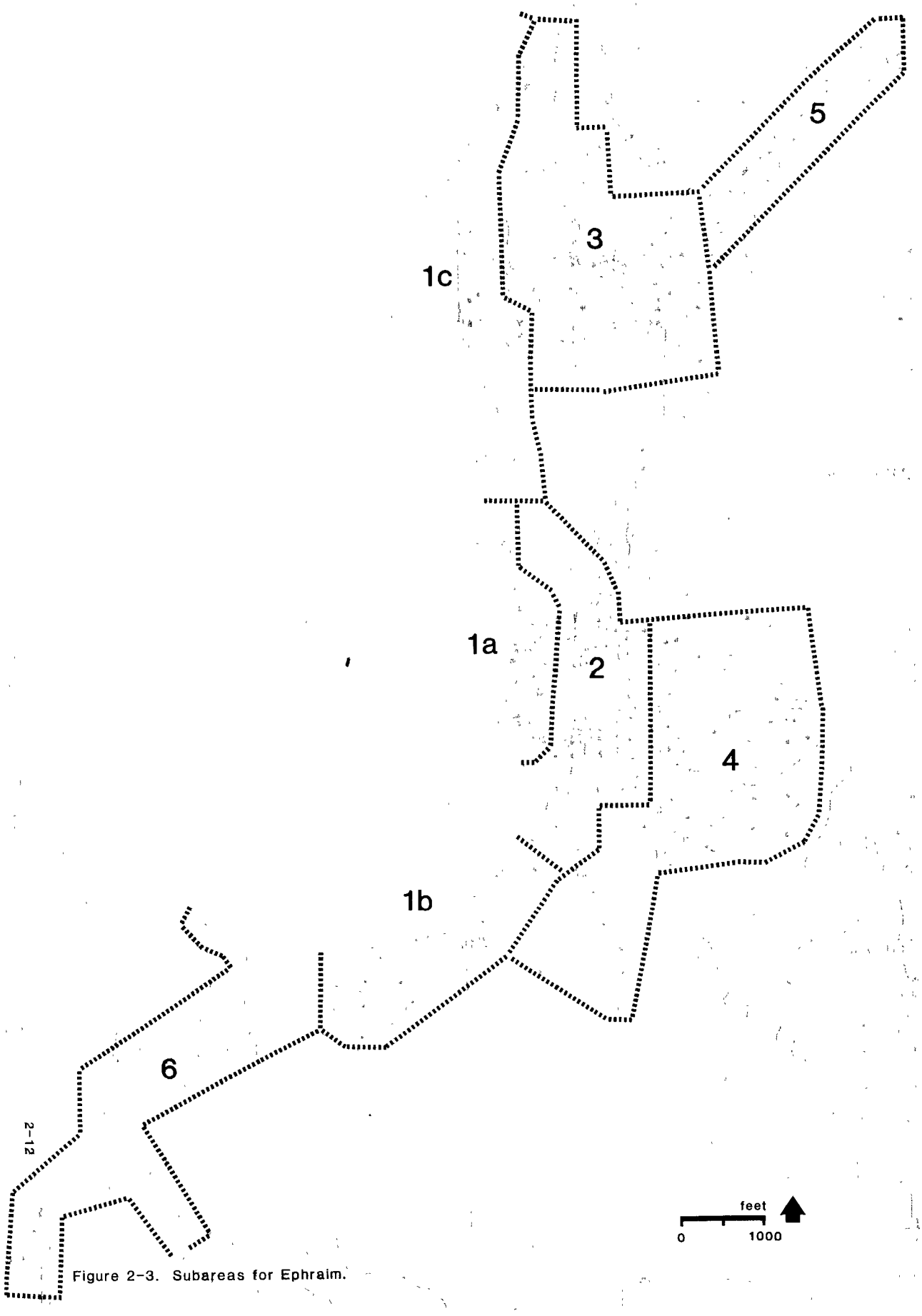


Figure 2-3. Subareas for Ephraim.

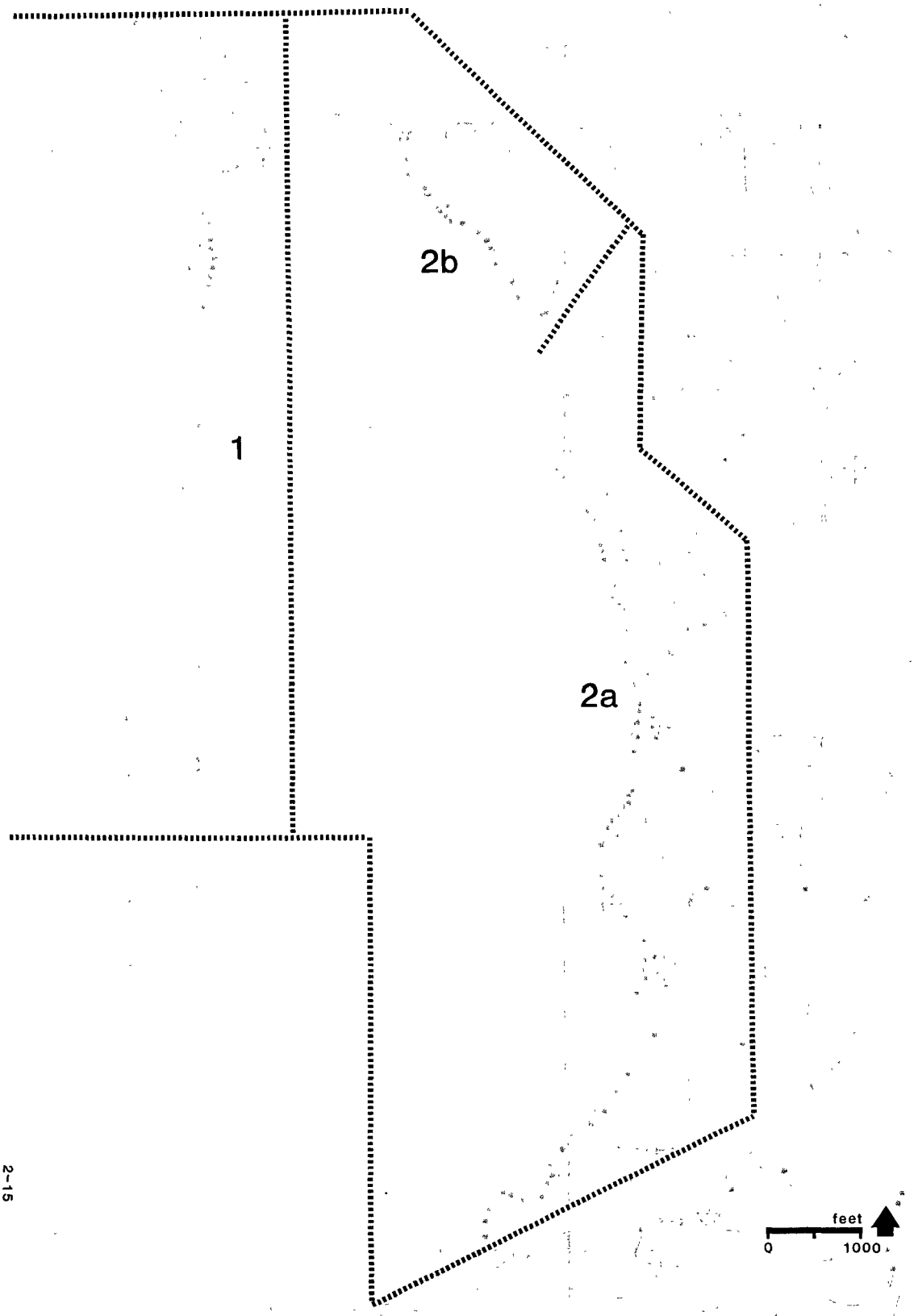


Figure 2-4. Subareas for Kangaroo Lake.

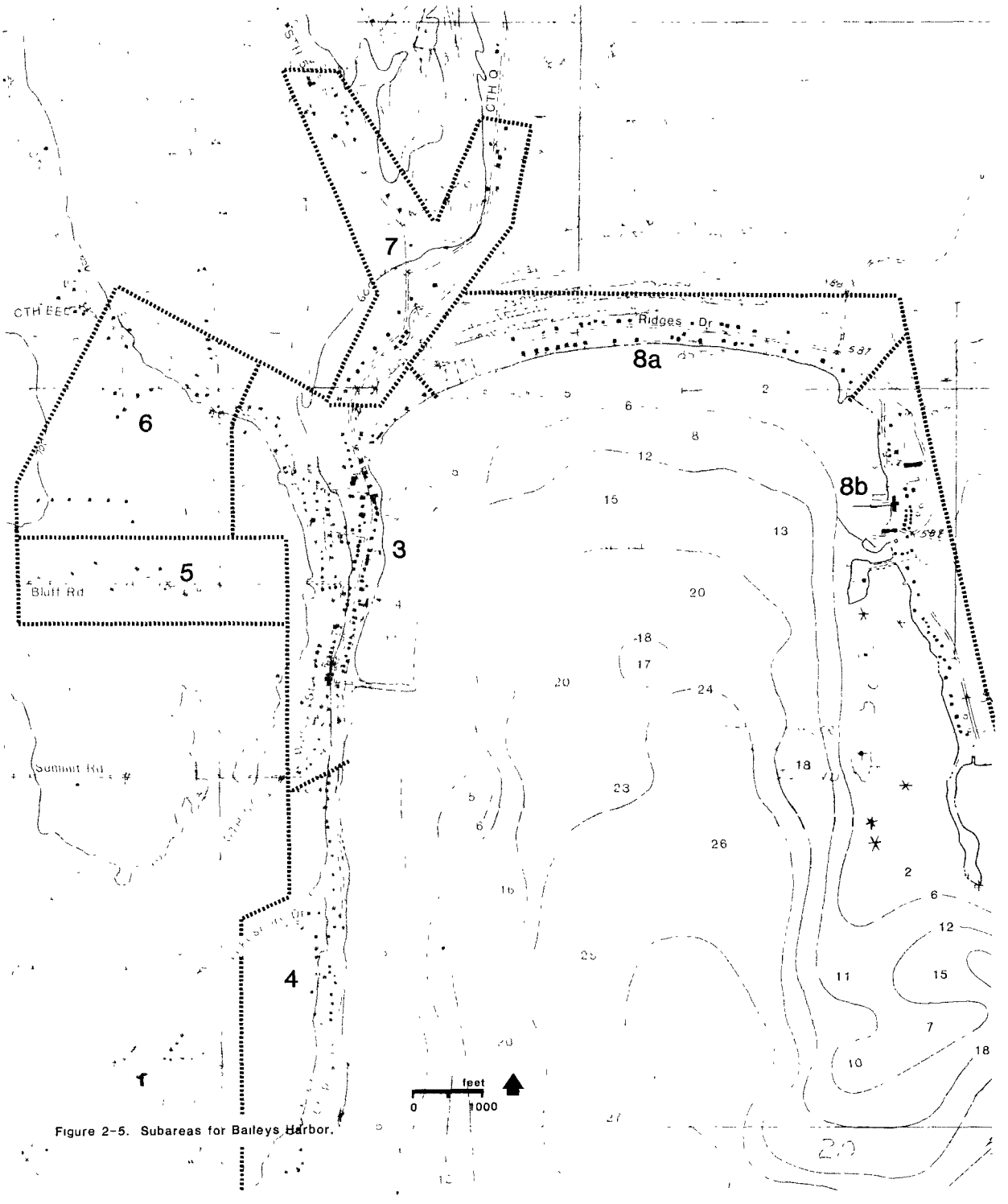


Figure 2-5. Subareas for Baileys Harbor.

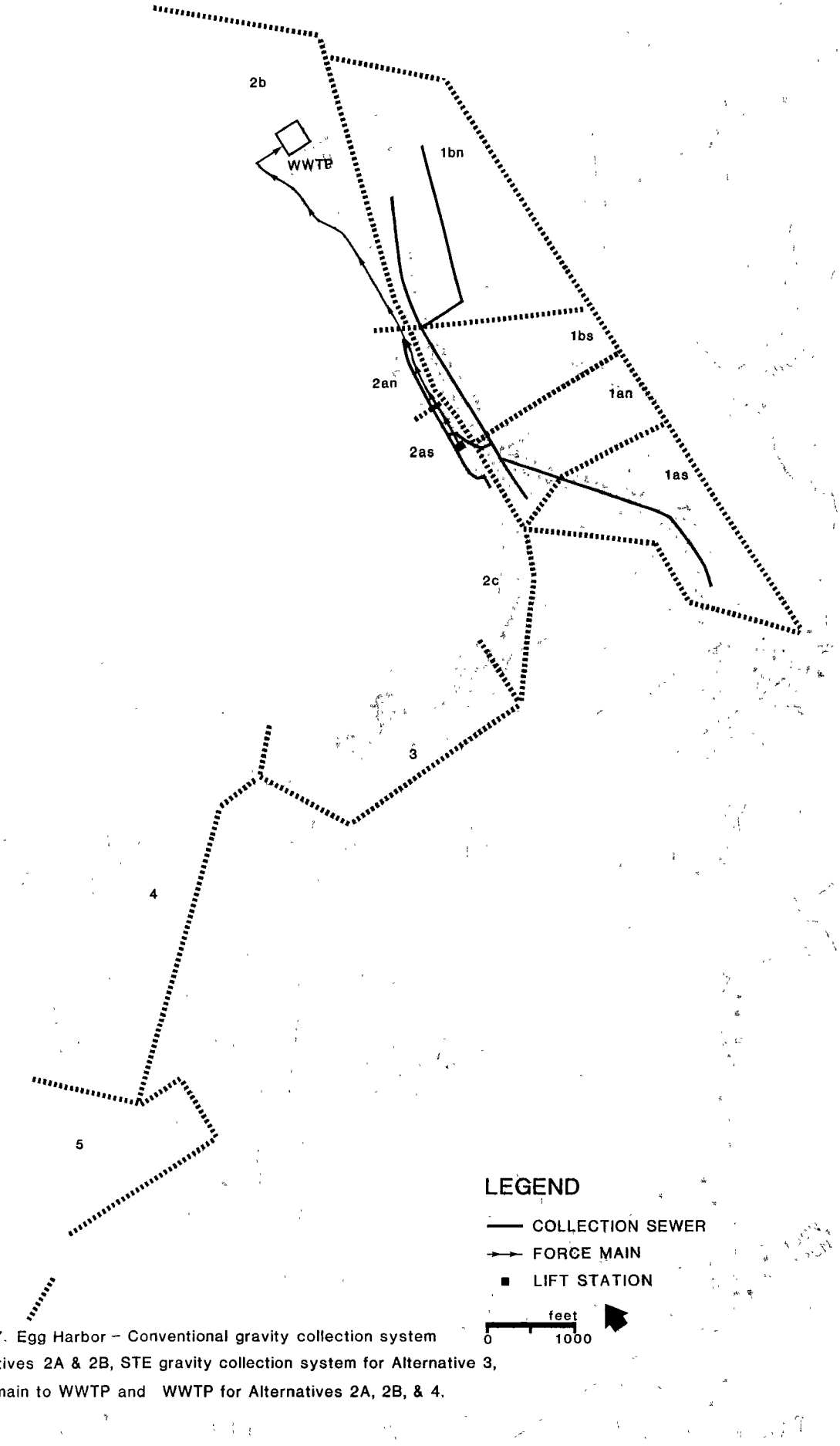


Figure 2-17. Egg Harbor – Conventional gravity collection system for Alternatives 2A & 2B, STE gravity collection system for Alternative 3, and force main to WWTP and WWTP for Alternatives 2A, 2B, & 4.

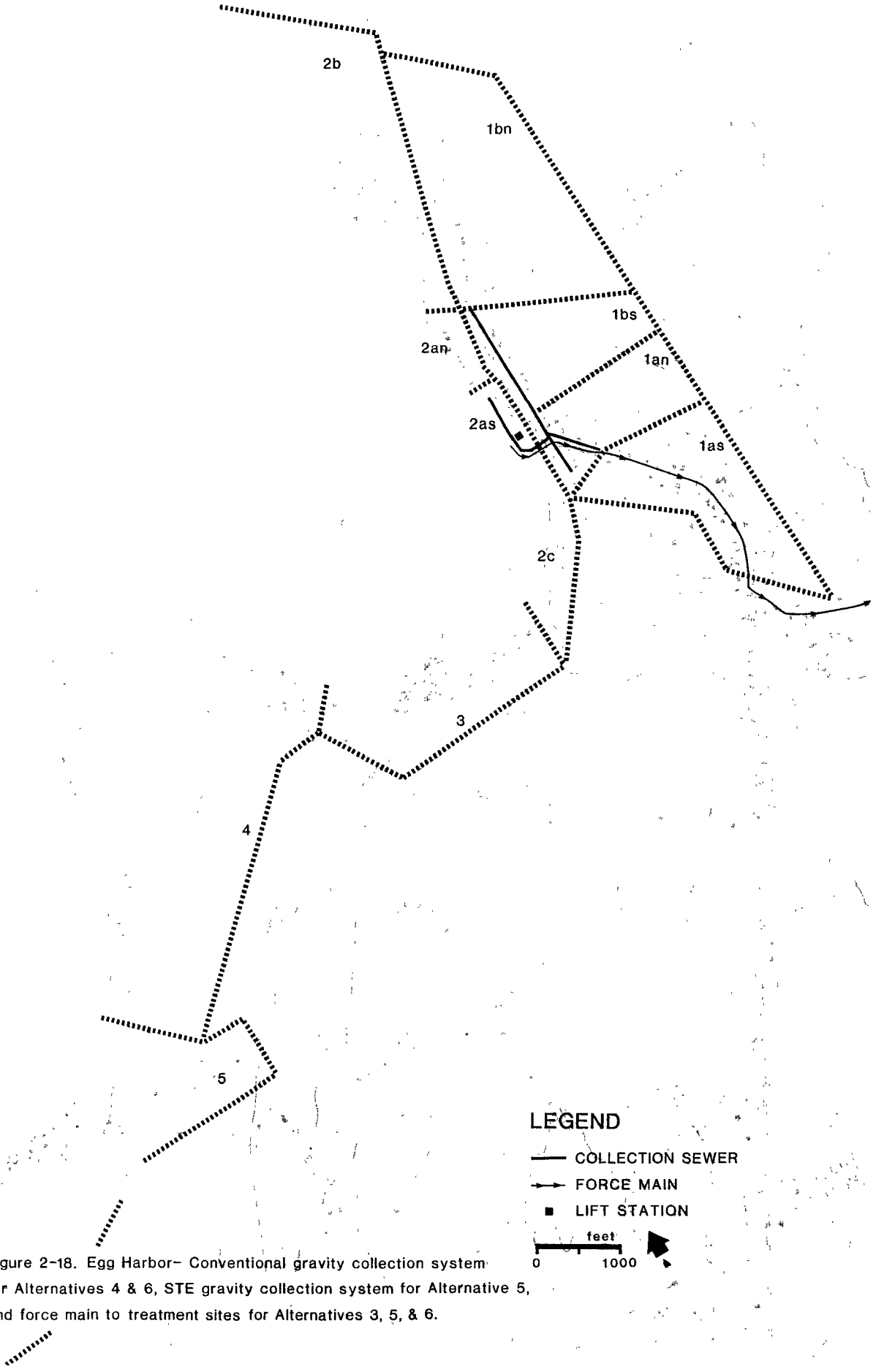
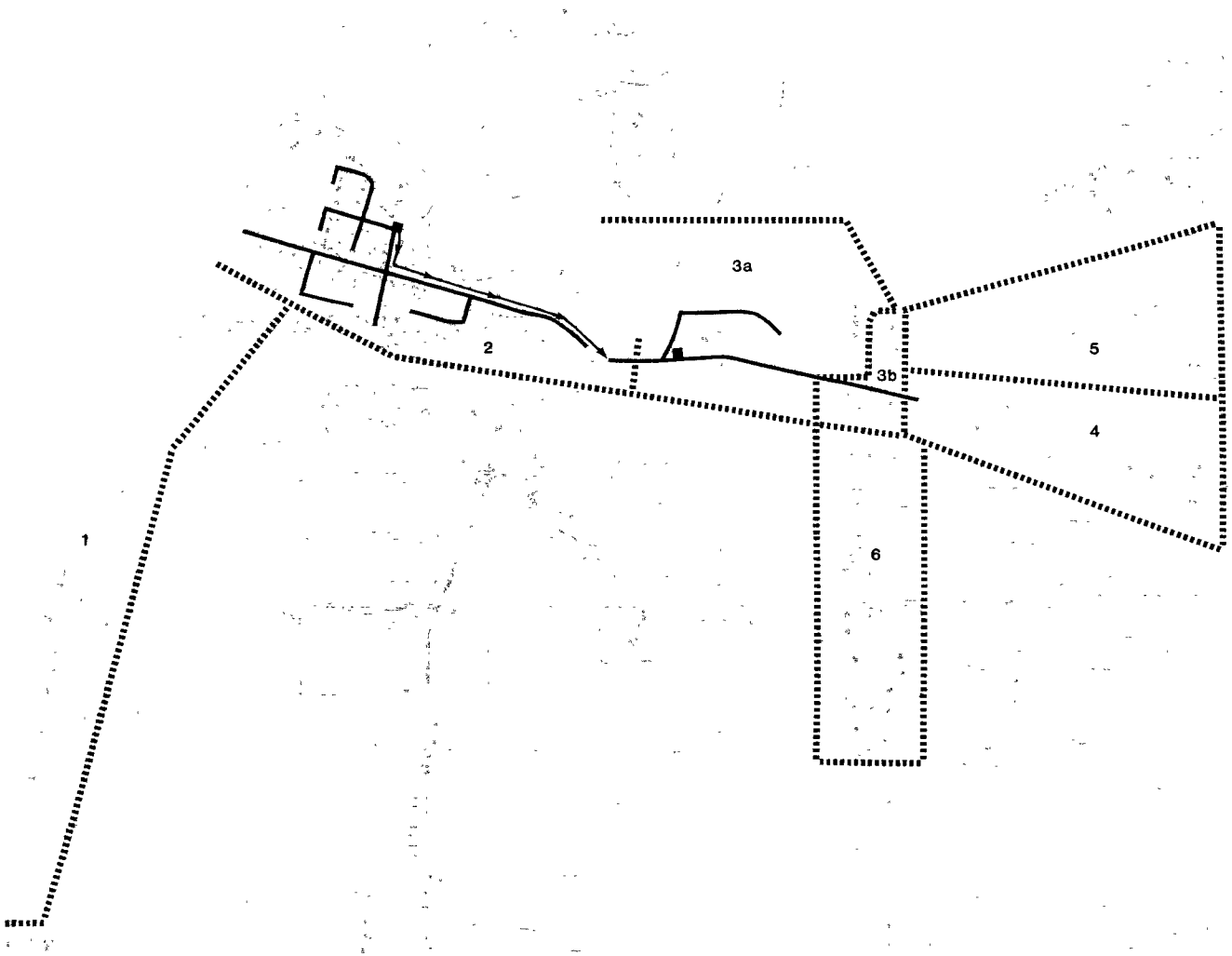


Figure 2-18. Egg Harbor- Conventional gravity collection system for Alternatives 4 & 6, STE gravity collection system for Alternative 5, and force main to treatment sites for Alternatives 3, 5, & 6.



NOTES – 1. Alternatives 3, 4, & 6 do not have the gravity collection sewer extending through Subarea 3b along CTH F.

2. STE pressure collection system is similar with elimination of lift stations.

LEGEND

COLLECTION SEWER

FORCE MAIN

LIFT STATION

feet

0 1000

igure 2-20. Fish Creek - Conventional gravity collection systems for Alternatives 2, 3, & 6, and TE gravity collection system for Alternatives 4 & 5.

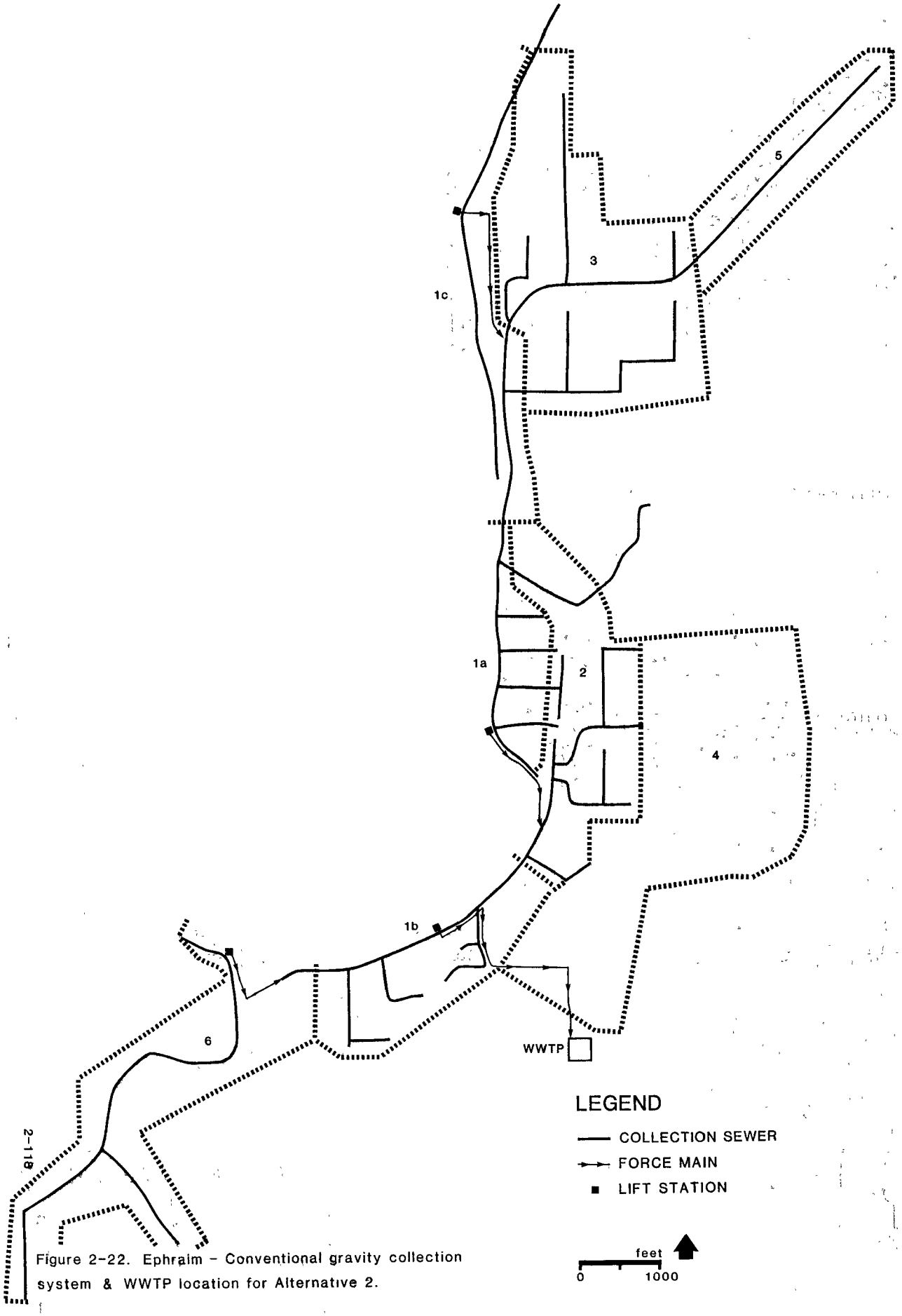
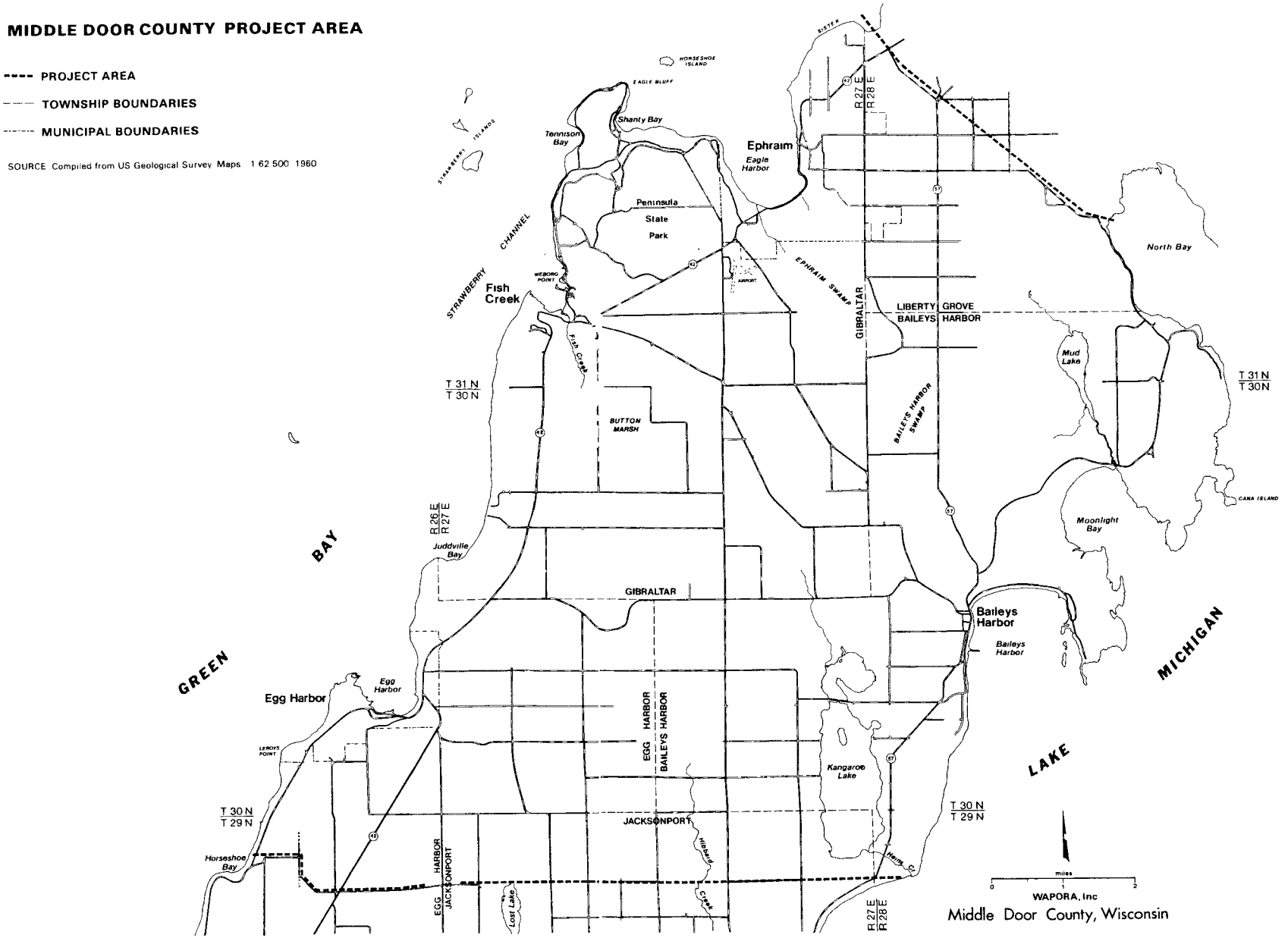


Figure 2-22. Ephraim - Conventional gravity collection system & WWTP location for Alternative 2.



S-2

Figure 1. Middle Door County project area.

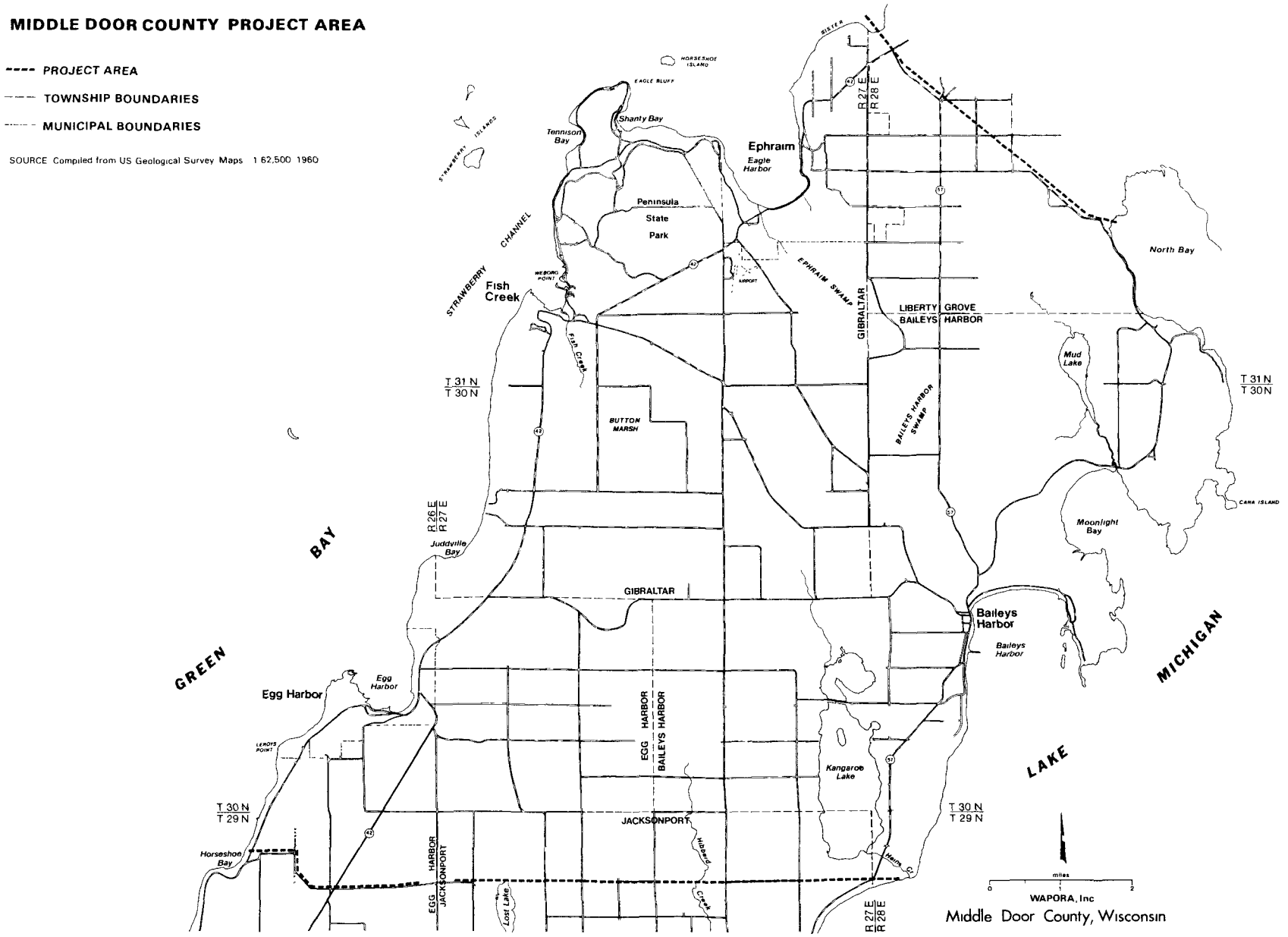


Figure 1-1. Middle Door County project area.

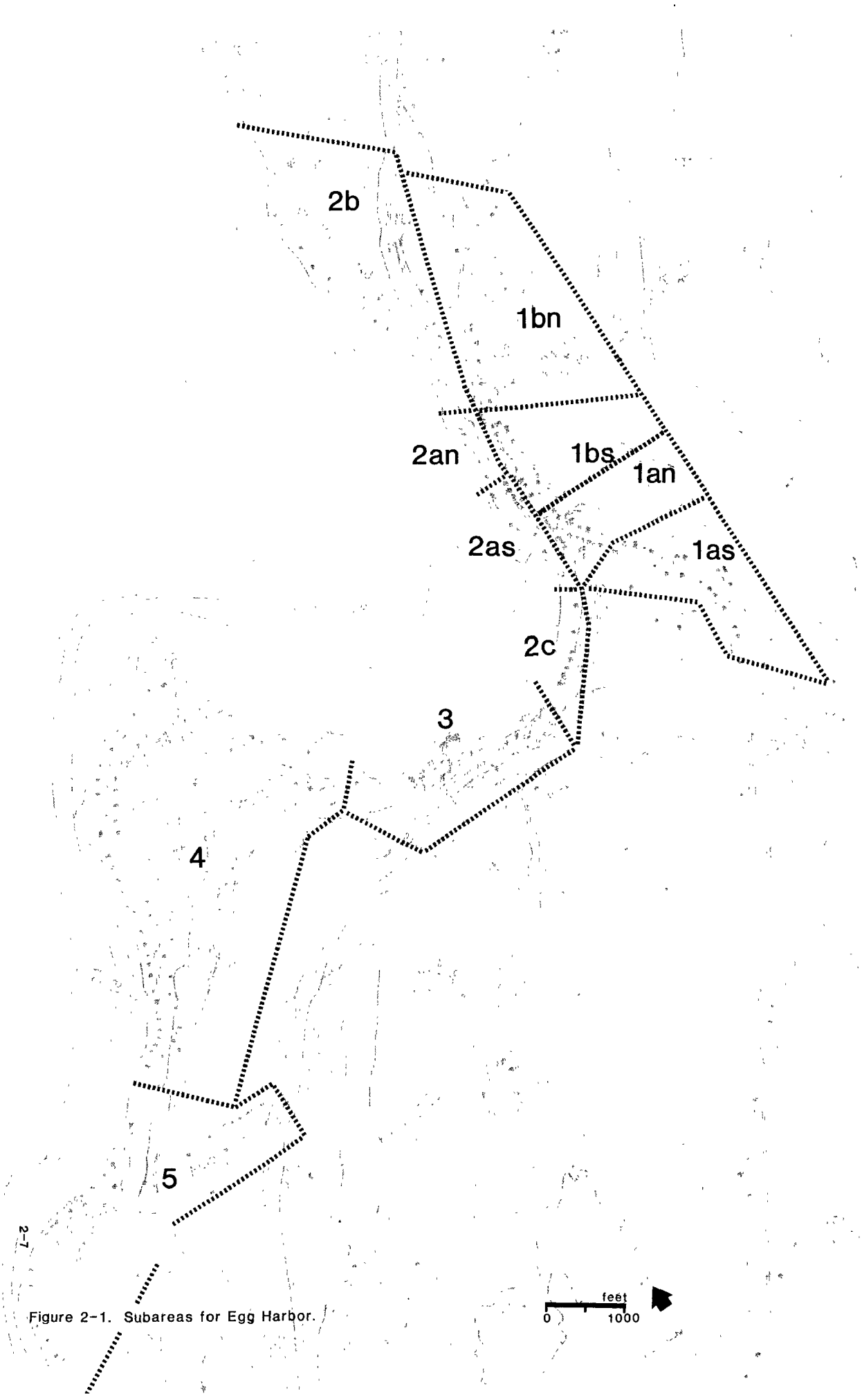


Figure 2-1. Subareas for Egg Harbor.

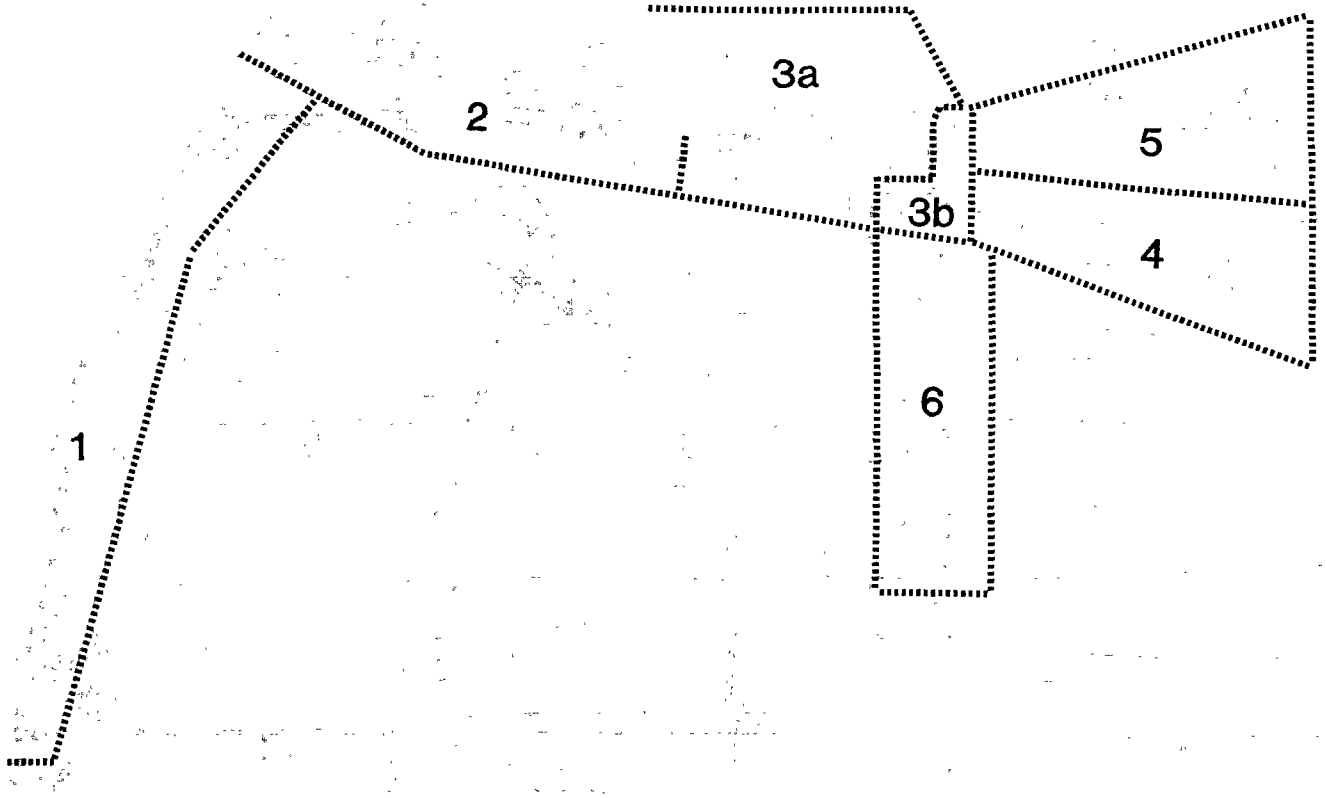


Figure 2-2. Subareas for Fish Creek.

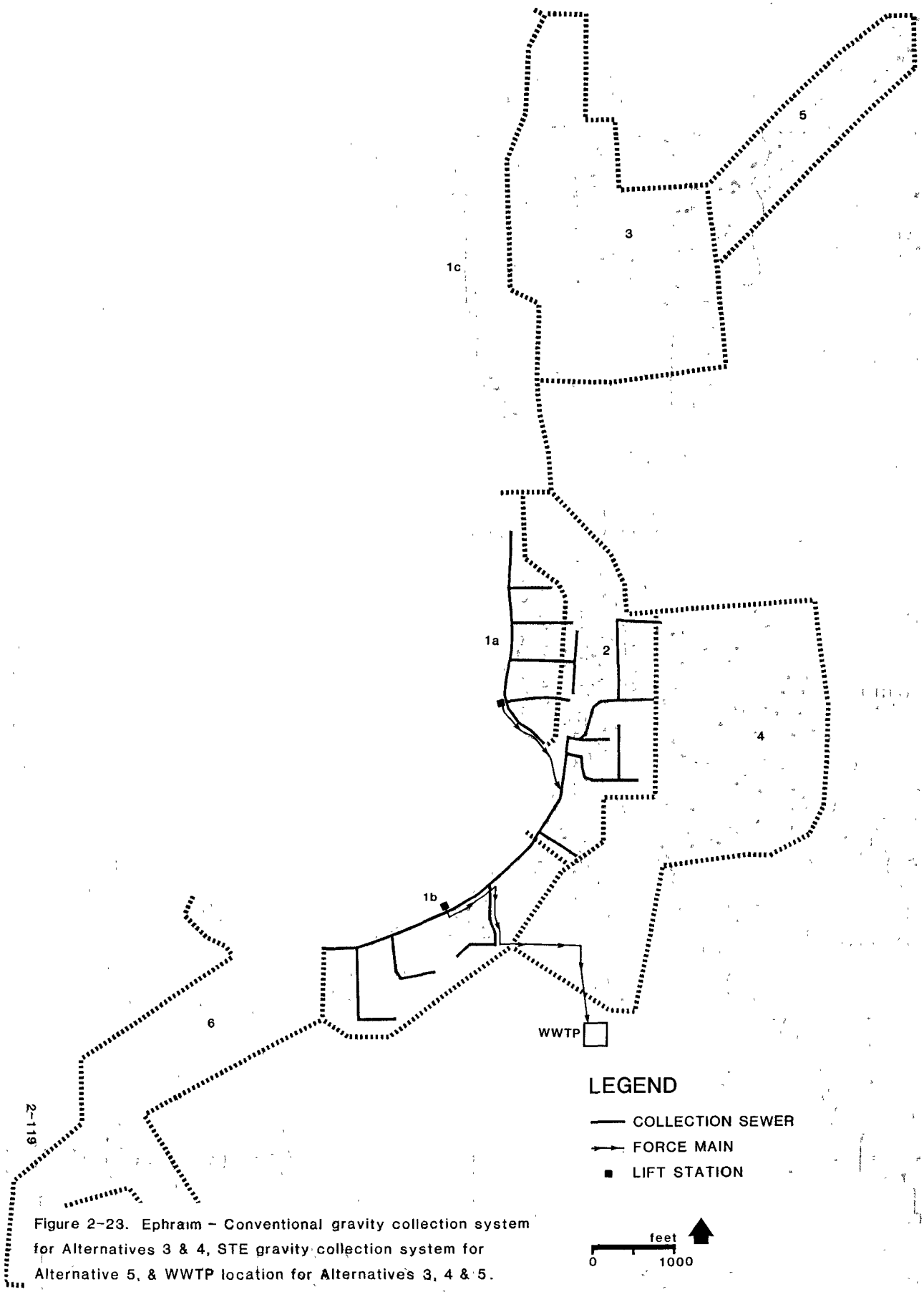


Figure 2-23. Ephraim - Conventional gravity collection system for Alternatives 3 & 4, STE gravity collection system for Alternative 5, & WWTP location for Alternatives 3, 4 & 5.

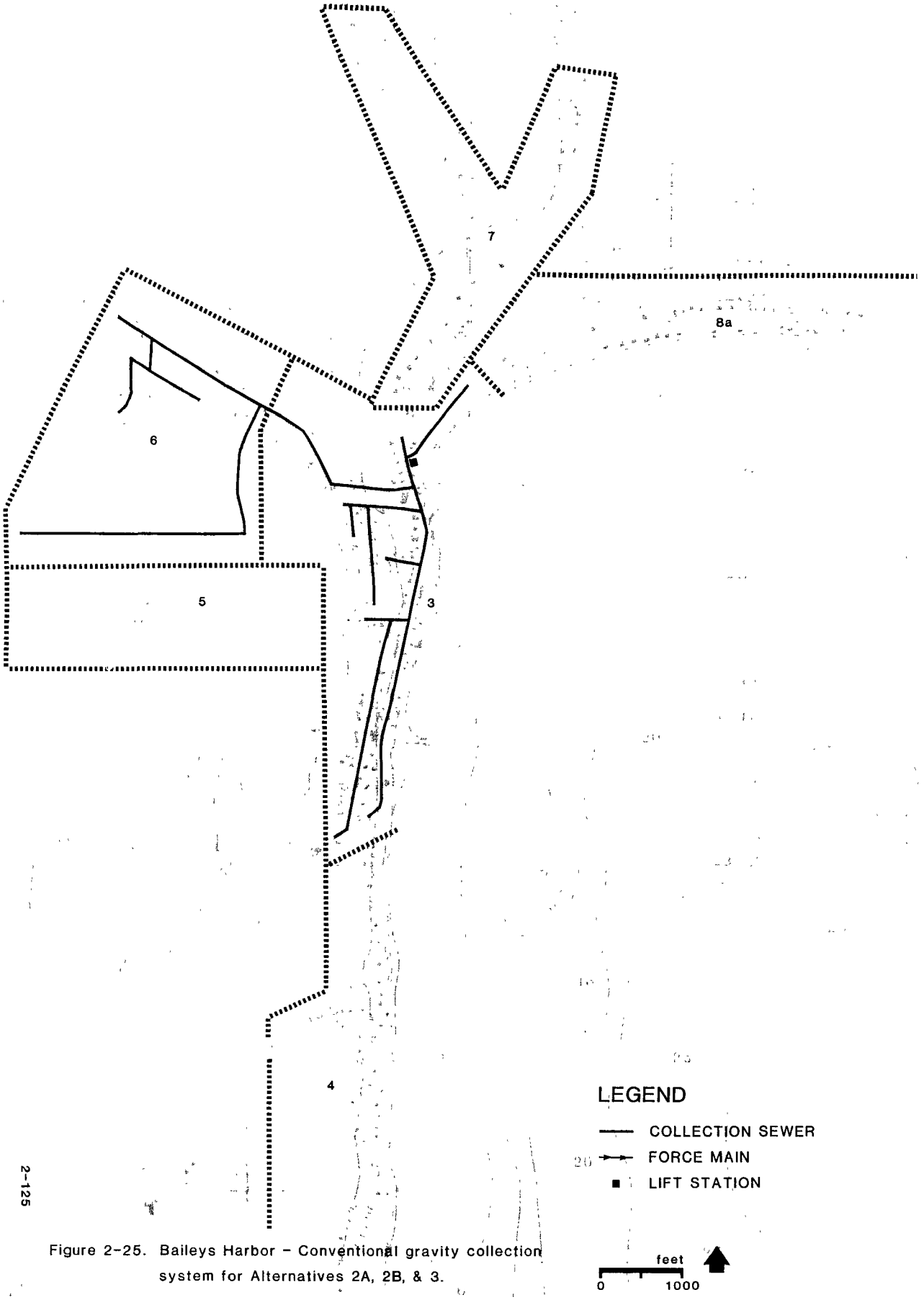


Figure 2-25. Baileys Harbor - Conventional gravity collection system for Alternatives 2A, 2B, & 3.

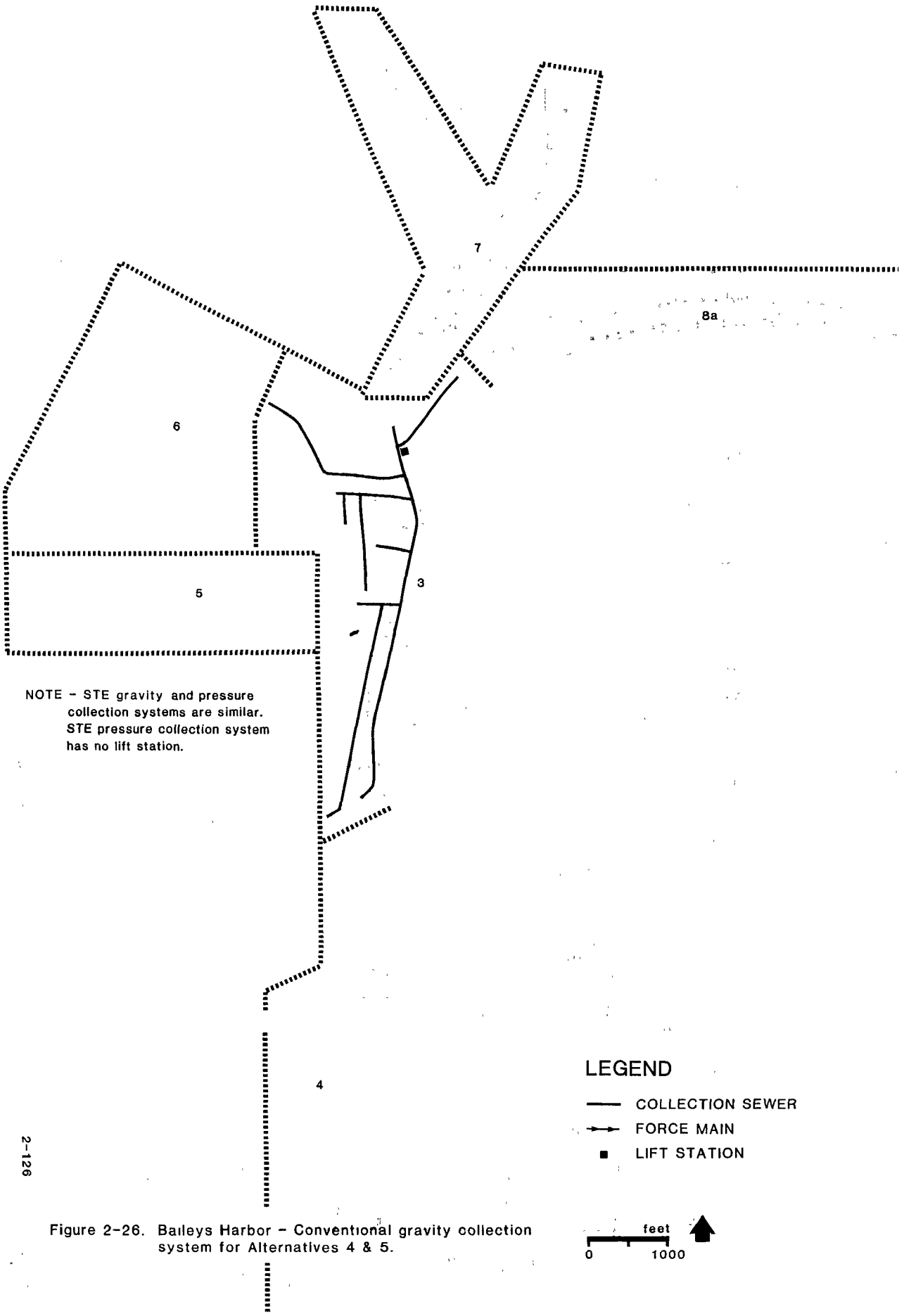


Figure 2-26. Baileys Harbor - Conventional gravity collection system for Alternatives 4 & 5.

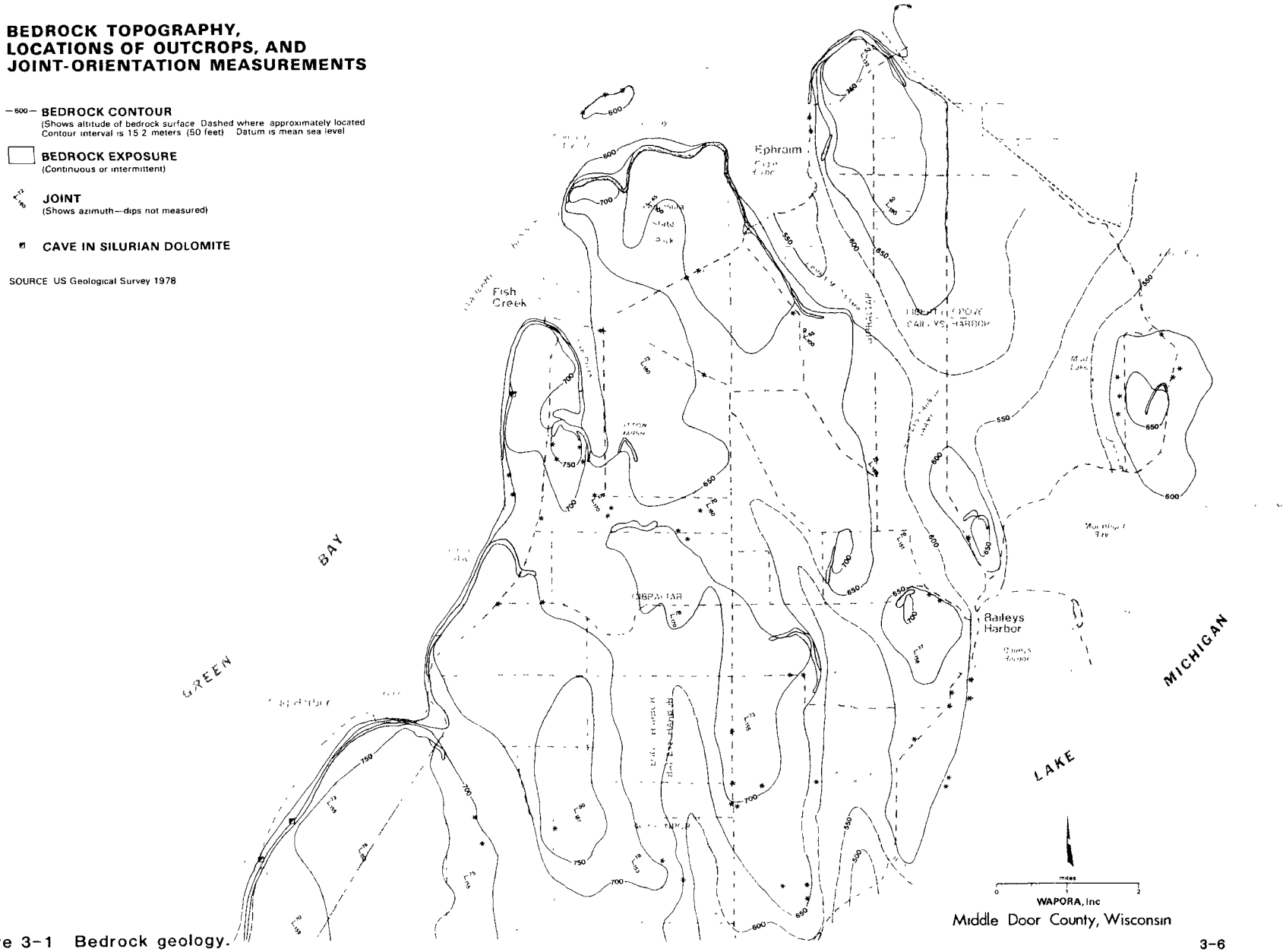


Figure 3-1 Bedrock geology.

SURFICIAL GEOLOGY, INFILTRATION AND RUNOFF POTENTIAL, AND THICKNESS OF UNCONSOLIDATED DEPOSITS

ALLUVIUM, MARSH, AND LAKE DEPOSITS
(Silt clay, and organic material with some sand Infiltration may be rapid or extremely slow depending on surface material)

OUTWASH, BEACH DEPOSITS, AND SAND DUNES
(Sand and gravel, well-sorted, may be locally covered by alluvium
Allows rapid infiltration and slight surface runoff well drained
Allows rapid recharge to the dolomite)

GROUND MORAINE, END MORAINE, AND DRUMLINS
(Till, intermixed clay, silt sand, gravel, and boulders, unsorted
Slow infiltration and rapid runoff Allows slow recharge to the dolomite)

NEAR SURFACE BEDROCK
(Silurian dolomite or Maquoketa shale within 1 2 meters (4 feet) of the surface
Overlying material is thin or residual clay and silt Moderate to rapid infiltration and recharge to the aquifer depending on type and thickness of overlying material)

—8— **LINE OF EQUAL THICKNESS OF UNCONSOLIDATED DEPOSITS**
(Dashed where approximately located Intervals in feet)

SOURCE US Geological Survey 1978

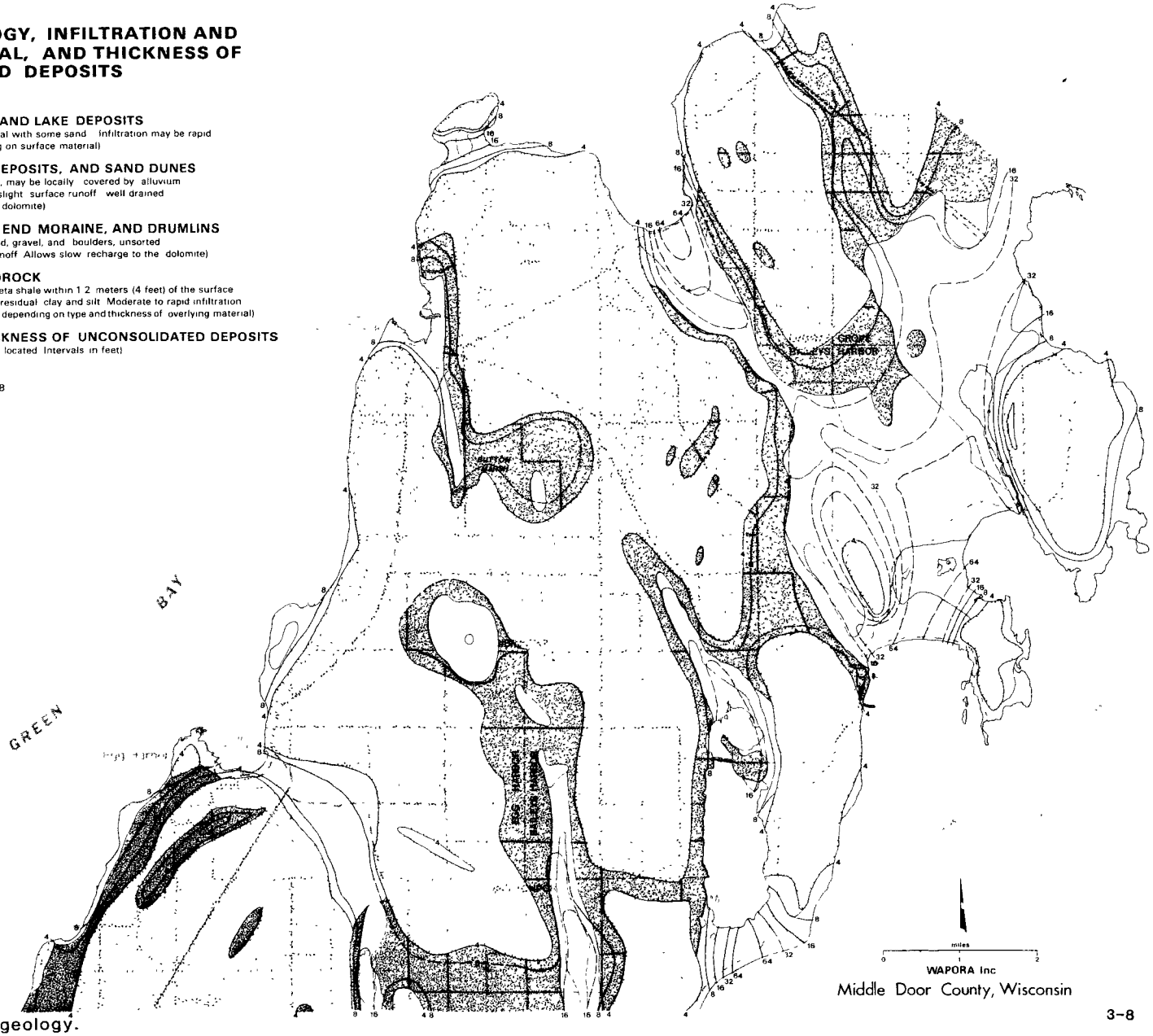


Figure 3-2. Surficial geology.

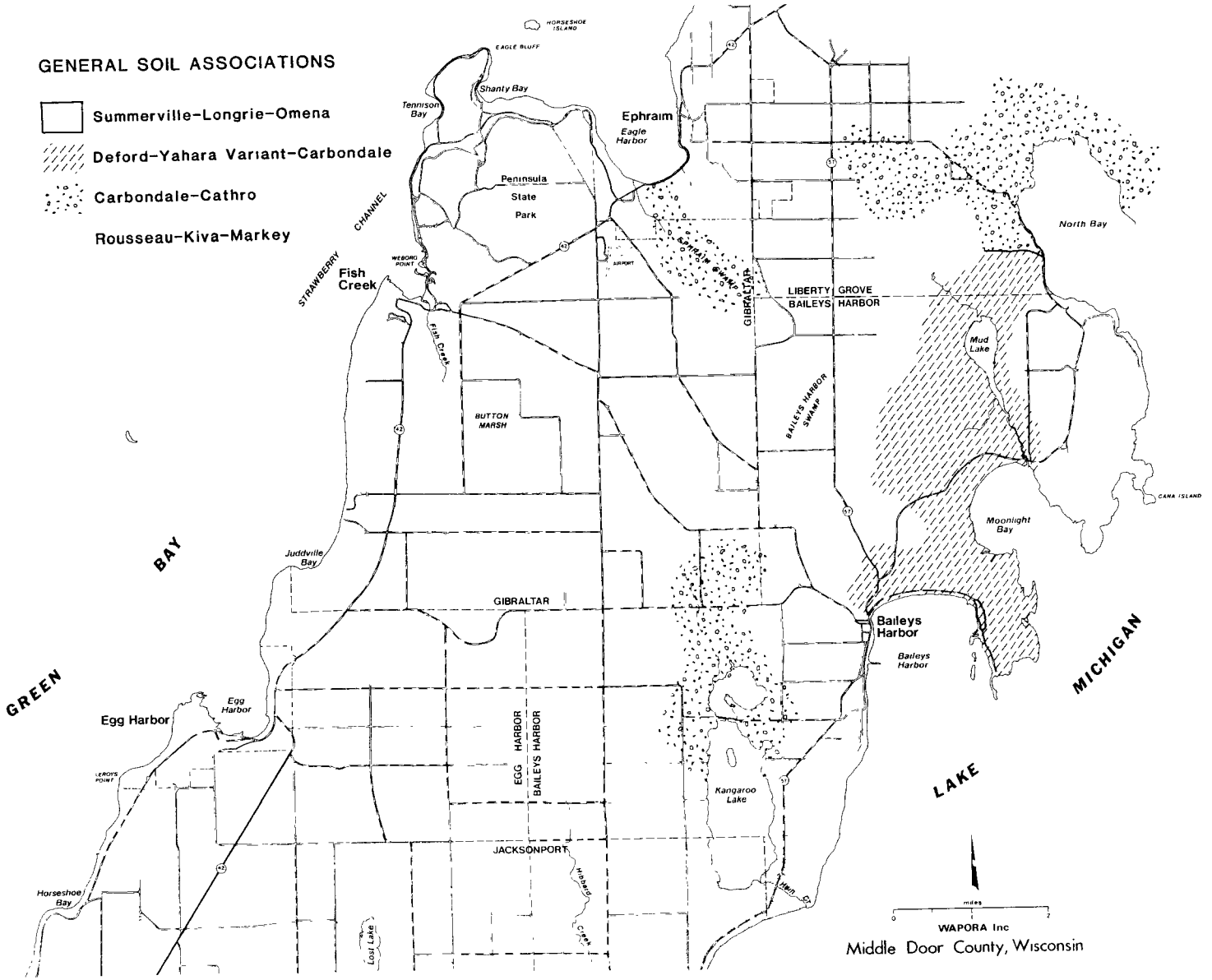


Figure 3-3. General Soil Associations

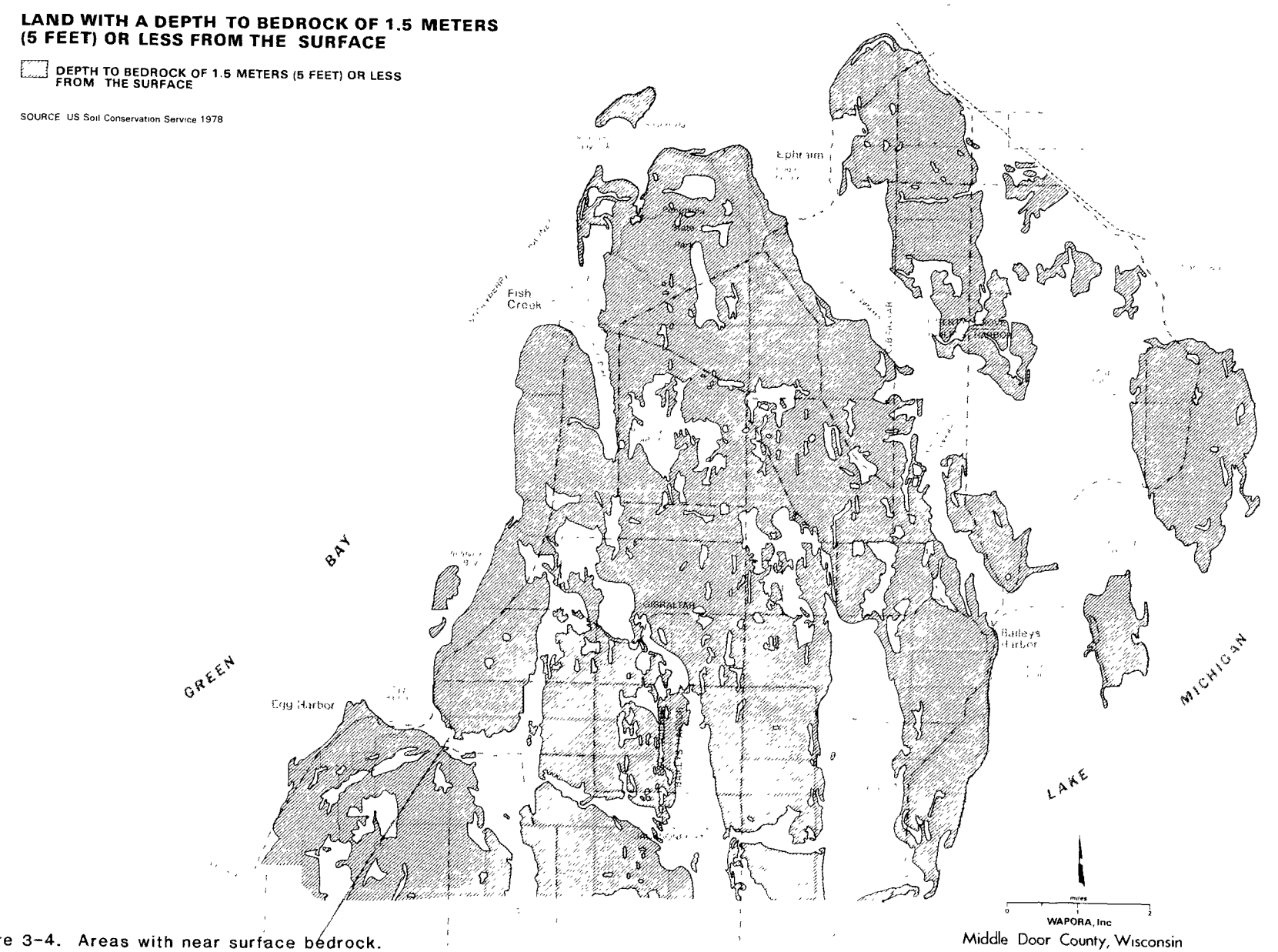


Figure 3-4. Areas with near surface bedrock.

LAND WITH A DEPTH TO THE HIGH WATER TABLE OF 1.8 METERS (6 FEET) OR LESS FROM THE SURFACE

DEPTH TO THE HIGH WATER TABLE OF LESS THAN 0.8 METERS (2.5 FEET) FROM THE SURFACE

DEPTH TO THE HIGH WATER TABLE OF GREATER THAN 0 8 METERS (2.5 FEET) *BUT LESS THAN 1 8 METERS (6 FEET) FROM THE SURFACE*
(May be suitable for mound systems)

SOURCE US Soil Conservation Service 1978

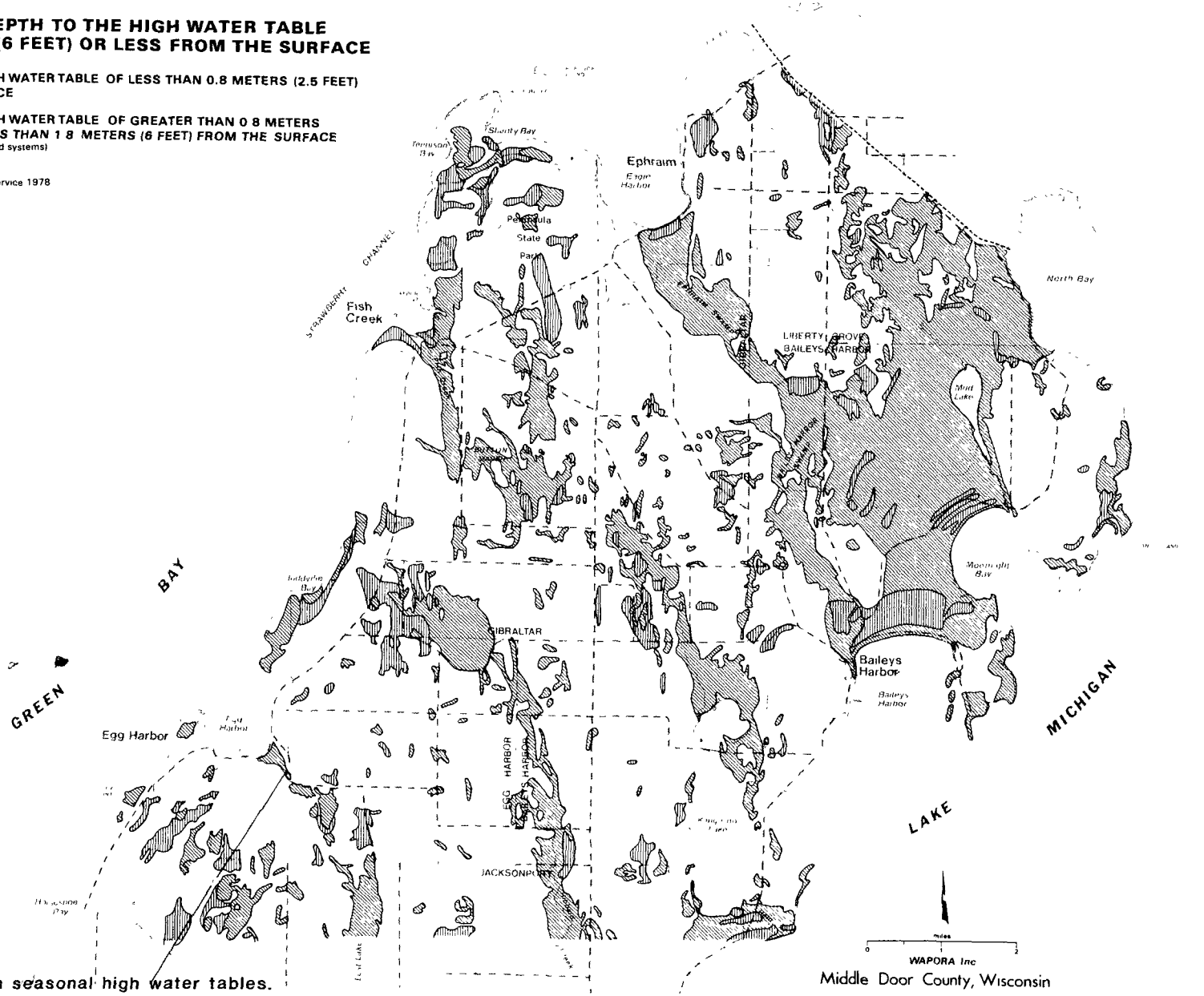


Figure 3-5. Areas with seasonal high water tables.

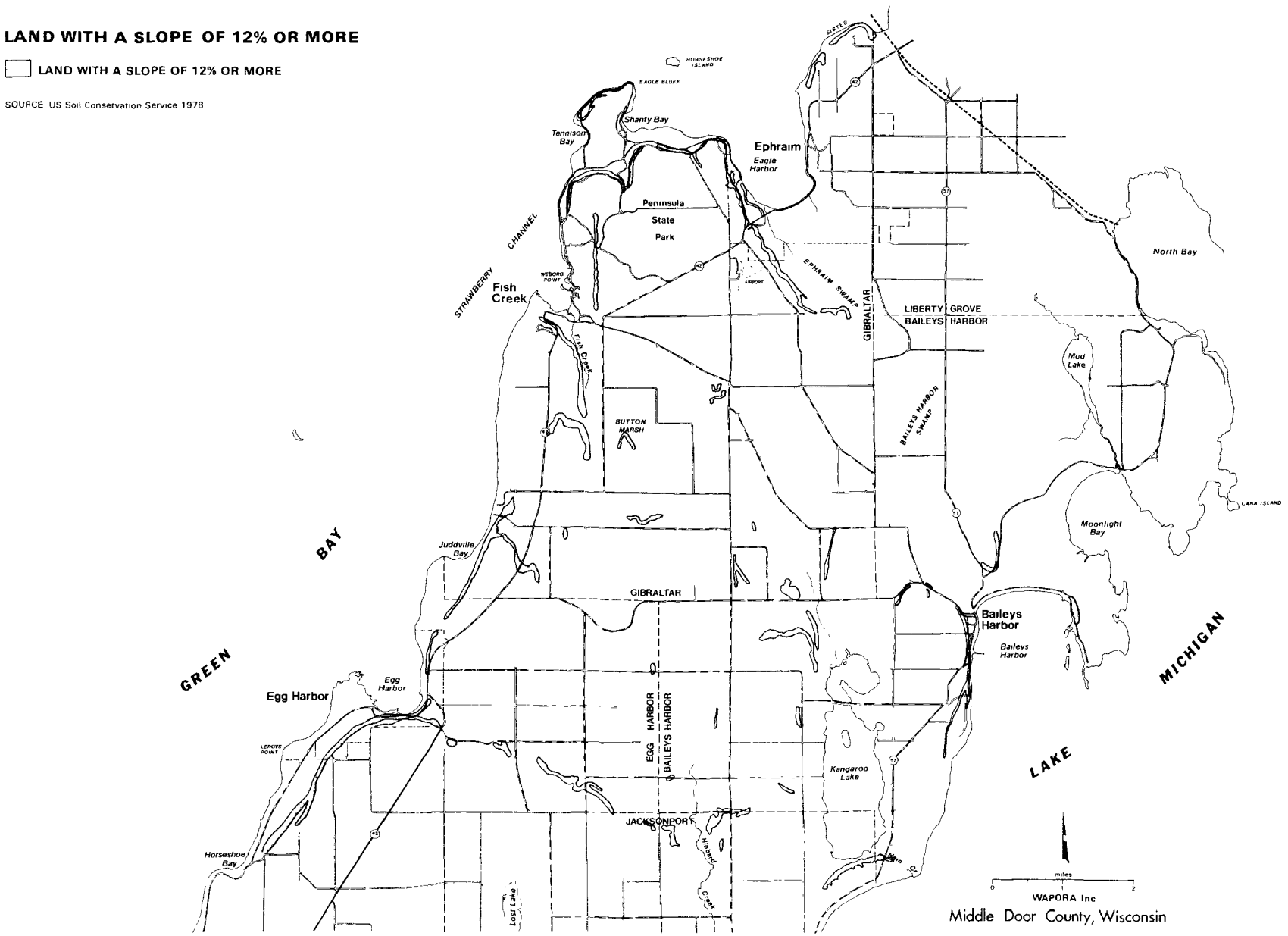


Figure 3-6. Areas with steep slopes.

SCIENTIFIC AND NATURAL AREAS

* WISCONSIN SCIENTIFIC AREAS
● UNIQUE NATURAL AREAS

1 Peninsula Park Beech Forest
2 Peninsula Park Cedar Spruce Swamp
3 Button Marsh
4 Thorp Pond
5 Mud Lake
6 Pickerel Pond
7 Manger Tract
8 The Ridges Sanctuary
9 Toft Point
10 Meridian County Park
11 Logerquist Tract

Source: Wisconsin Scientific Areas Council, 1979

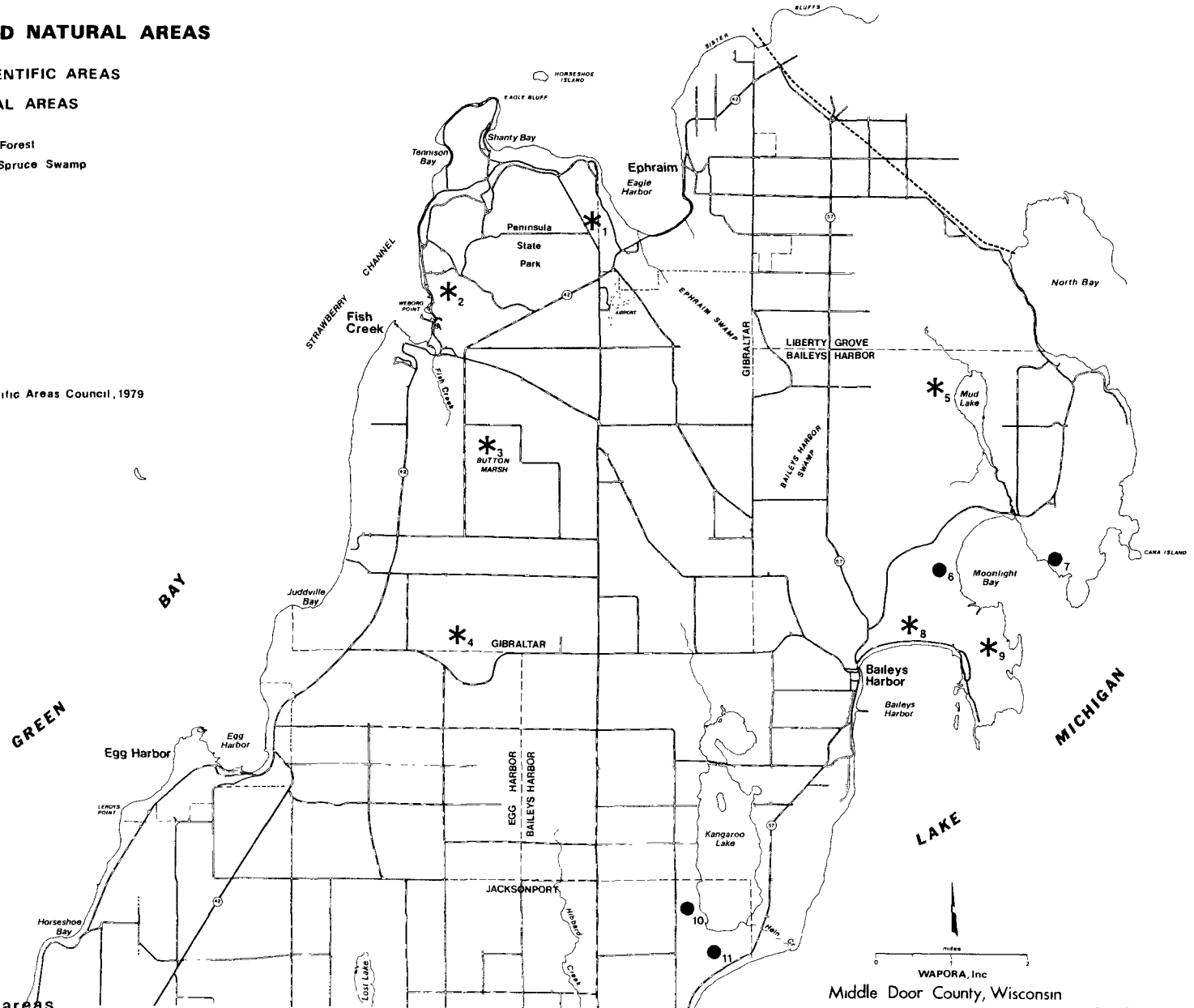


Figure 3-7. Scientific areas.

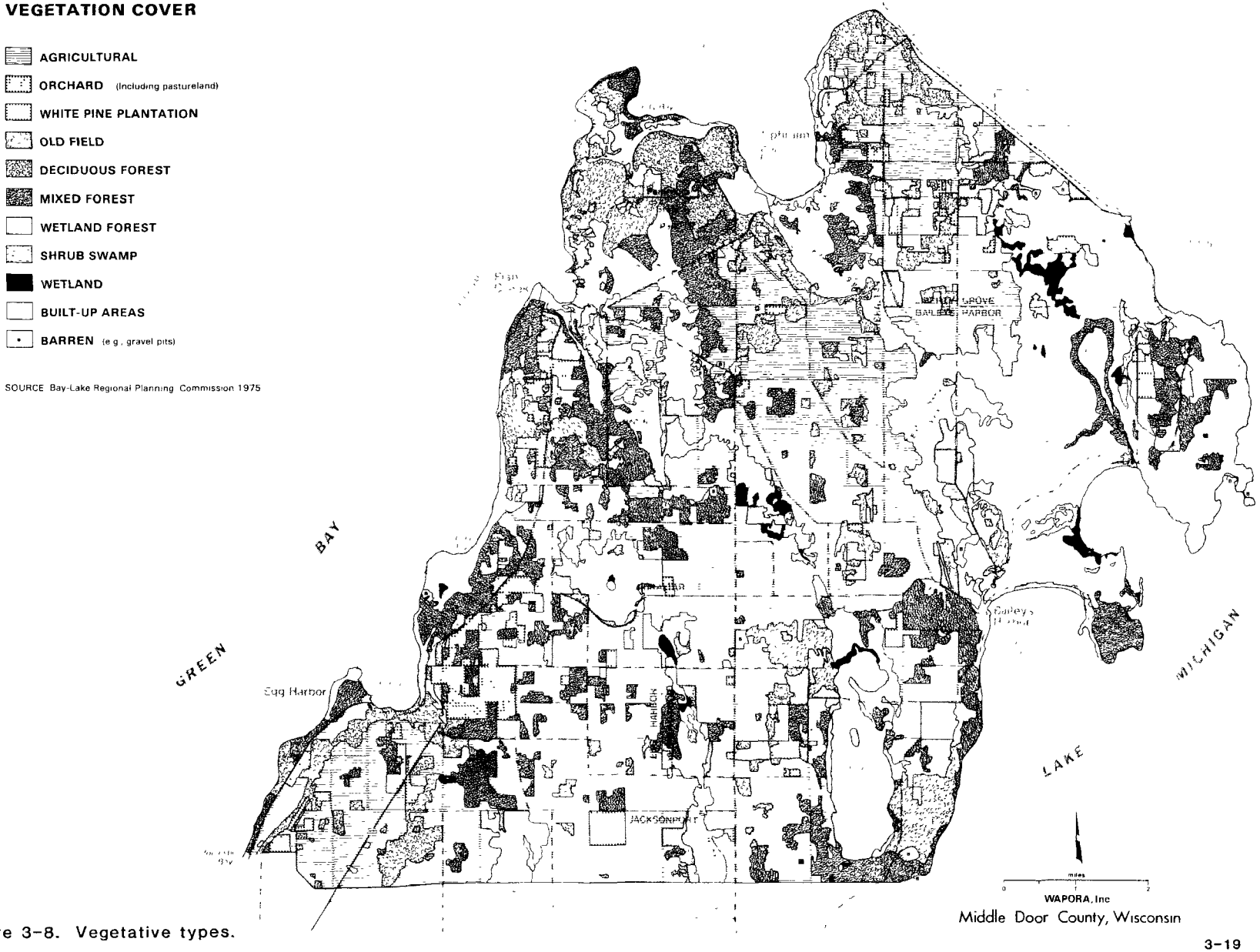


Figure 3-8. Vegetative types.

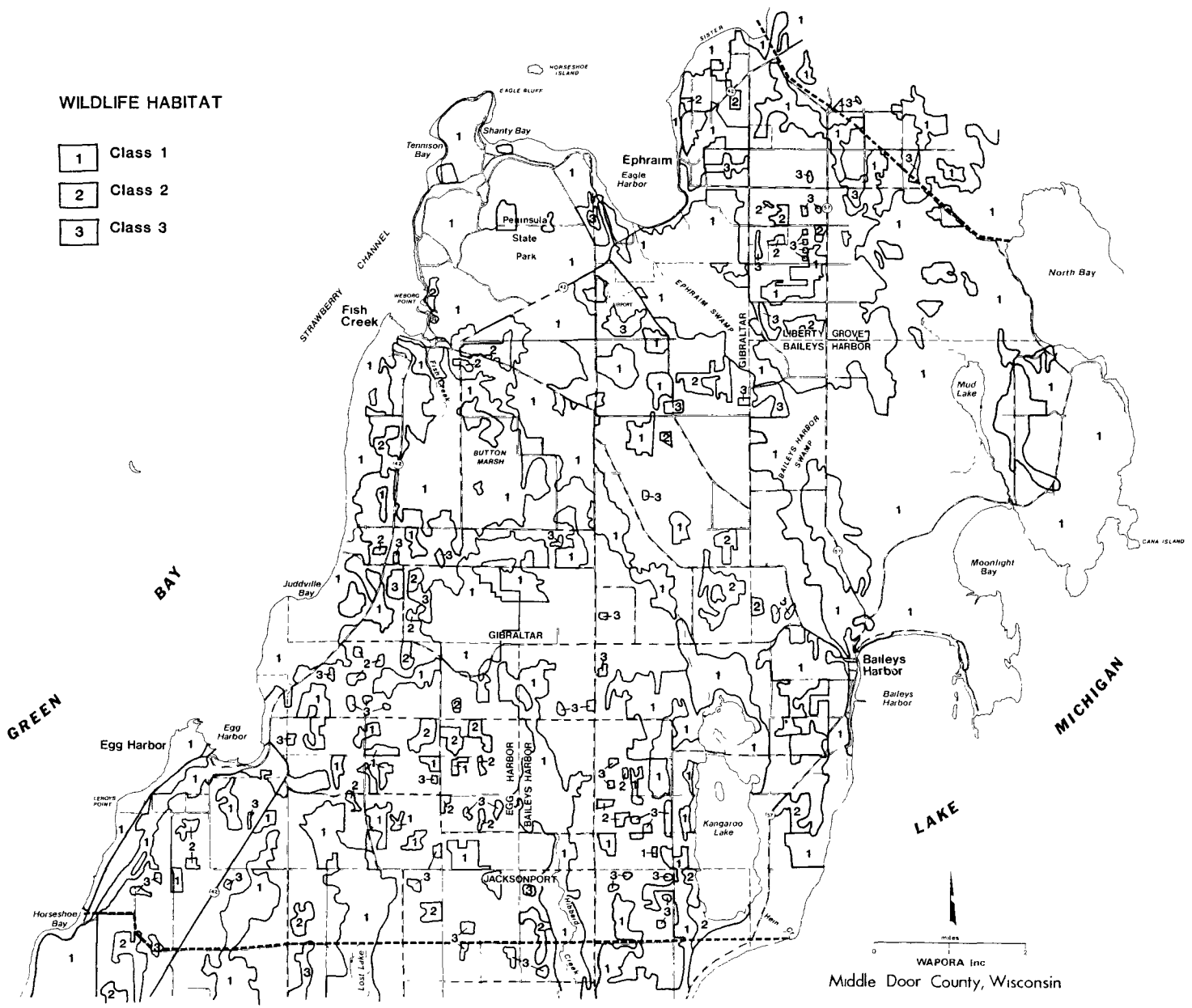


Figure 3-9. Class 1 wildlife habitats.

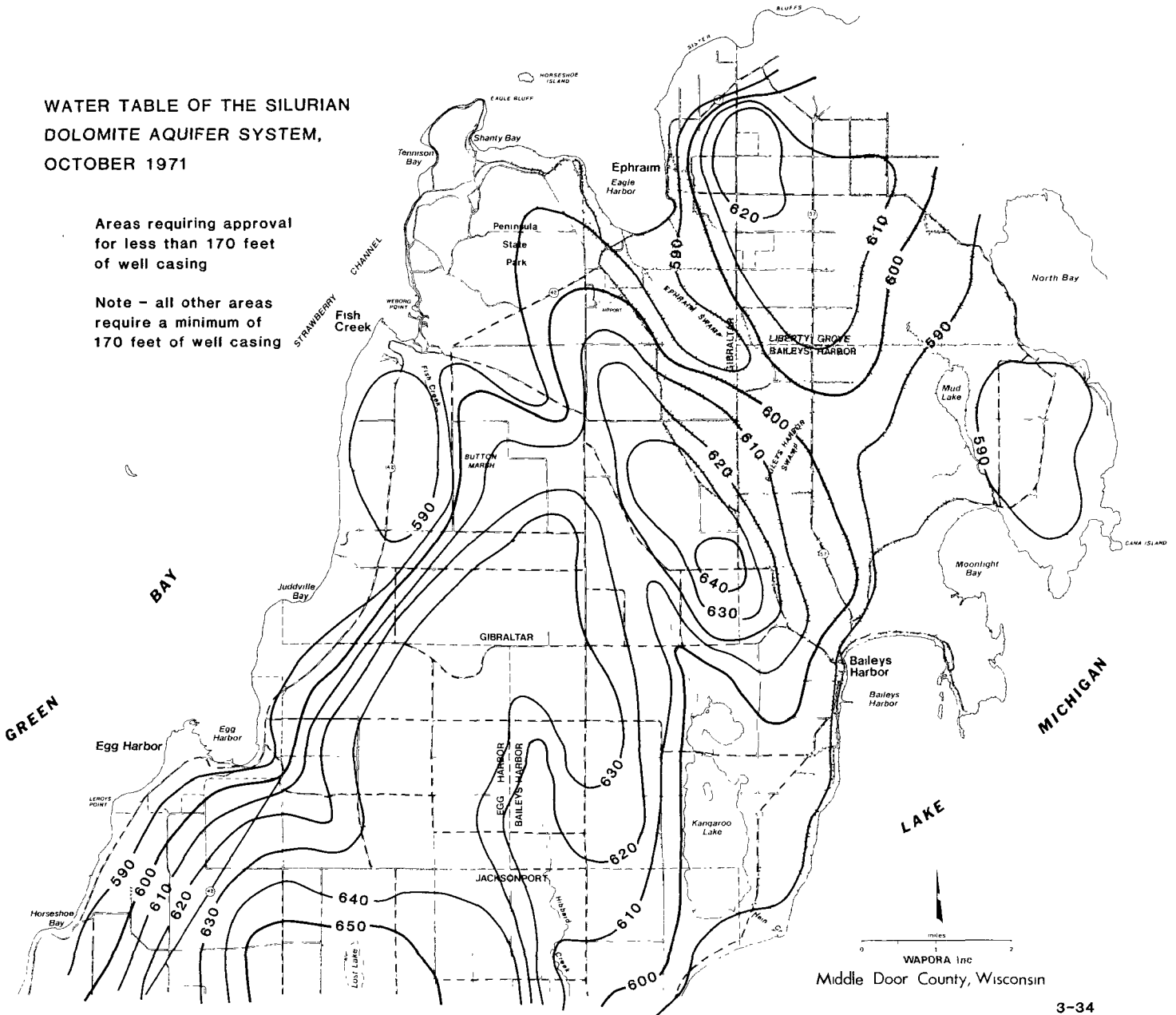


Figure 3-10. Water table of the Silurian Dolomite aquifer system.

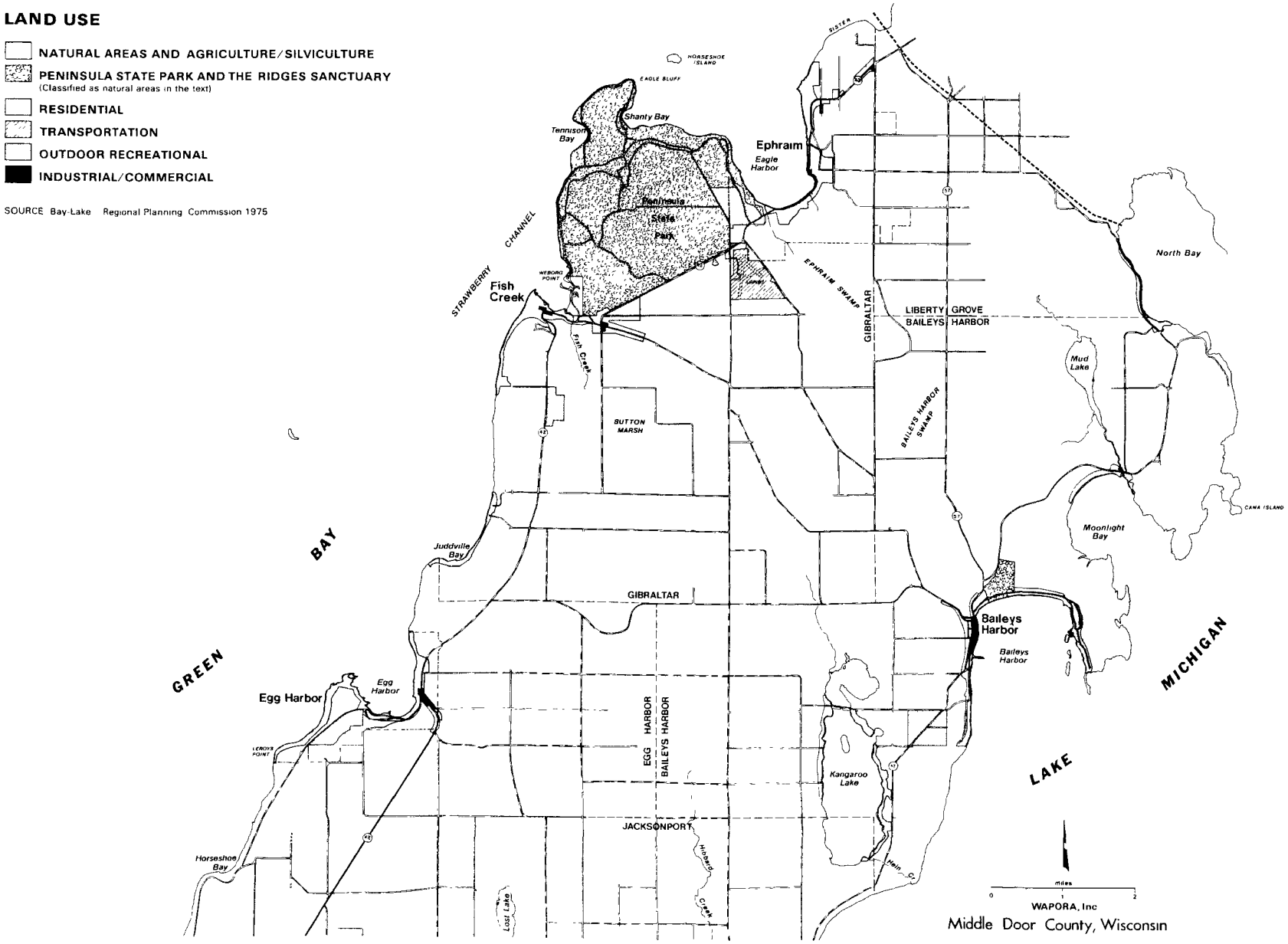


Figure 3-11. Land use.

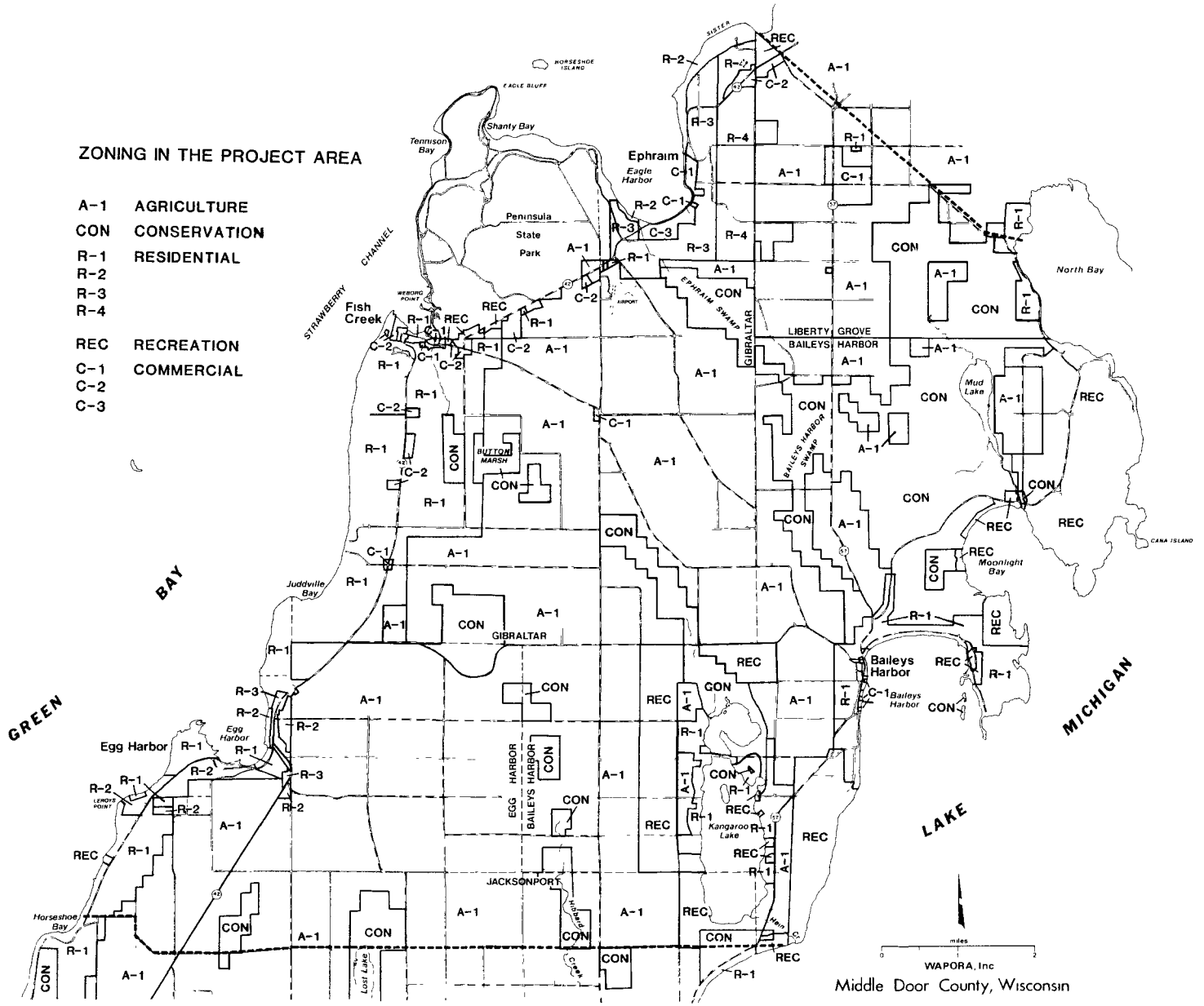


Figure 3-12. Zoning.

UNIQUE FARMLAND

UNIQUE FARMLANDS
(Primarily apple and cherry orchards)

SOURCE Bay-Lake Regional Planning Commission 1975,
US Soil Conservation Service 1978

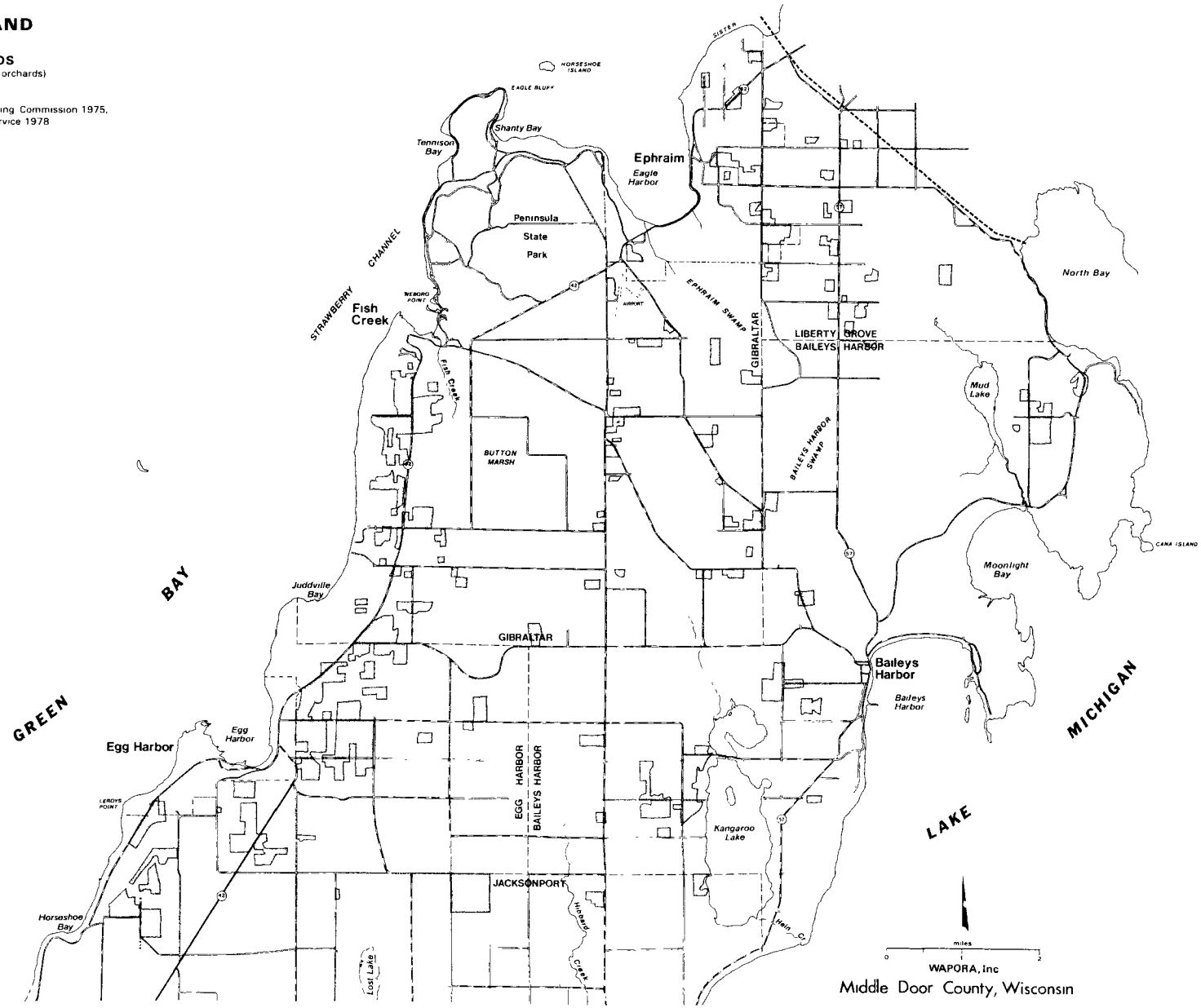


Figure 3-14. Unique farmland.

PRIME FARMLAND SOILS

PRIME FARMLAND SOILS
(As identified by the US Soil Conservation Service)

SOURCE US Soil Conservation Service 1978

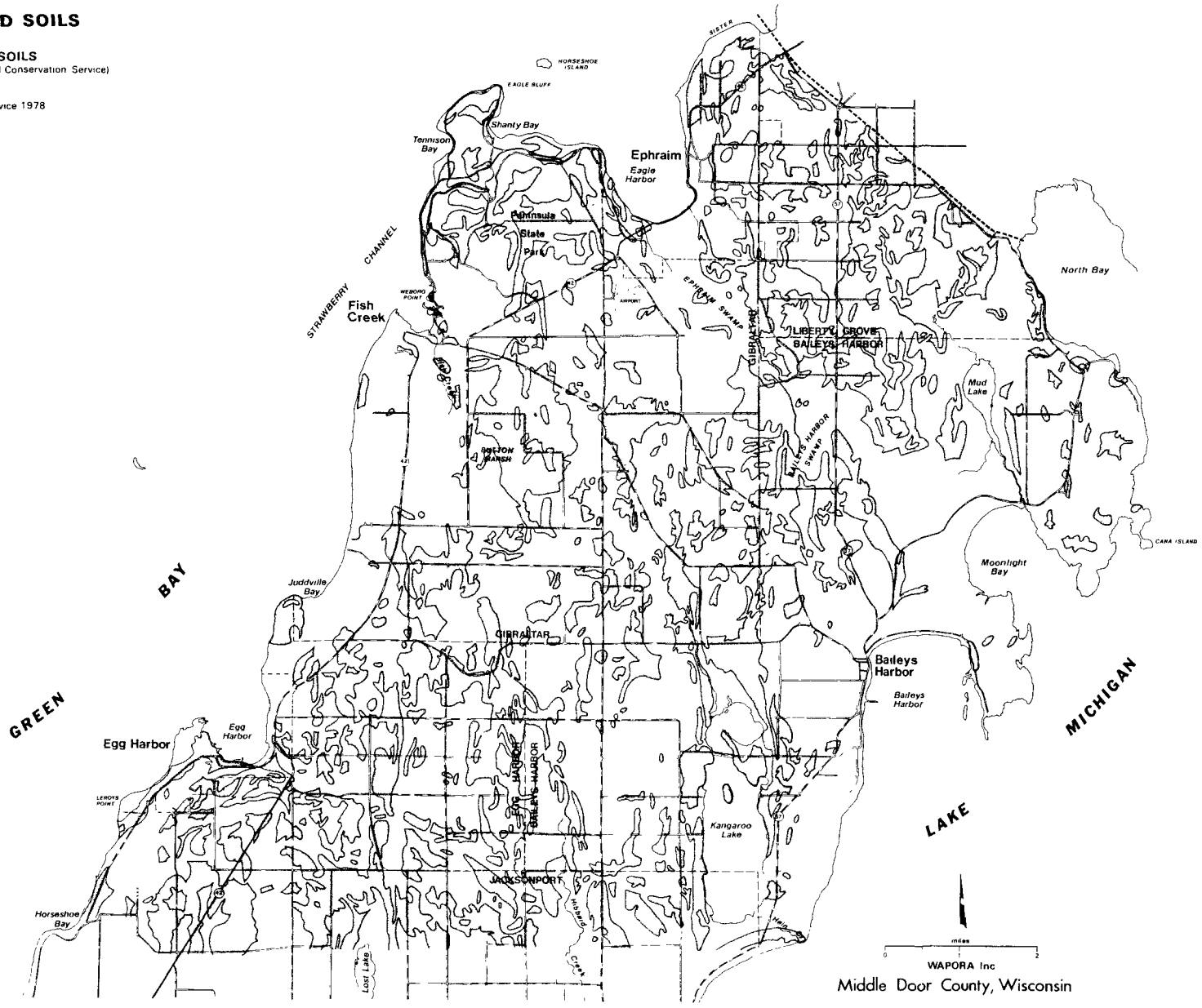


Figure 3-13. Prime farmland.

CULTURAL FEATURES

▲ **ARCHAEOLOGICAL SITES**
(Symbol denotes land survey section not specific site location
See text for numerical identification)

● **HISTORICAL OR ARCHITECTURAL SITES**
(Large circles at Ephraim and Baileys Harbor indicate site concentrations
See text for numerical identification)

* **STOVEWOOD STRUCTURES**
(As identified for proposed rural stovewood historic district)

SOURCE US Department of Interior 1979 State Historical Society of Wisconsin 1979, Land Plans Inc , 1973 Door County Historical Society 1979, Ramano and others 1977

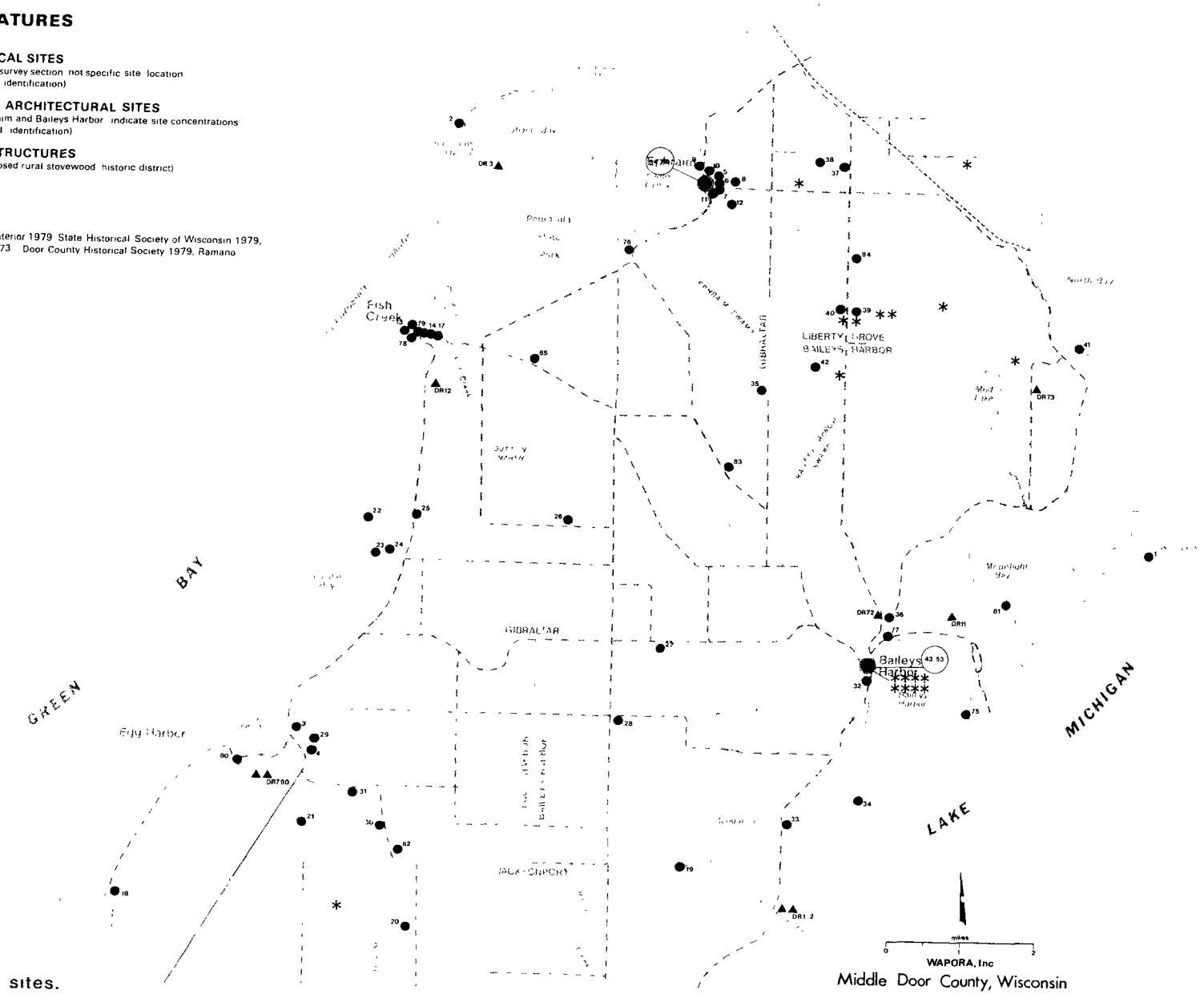


Figure 3-15. Cultural sites.

Table 4-8. Baileys Harbor debt as a percentage of full equalized value, by alternative, with and without State grant.

Alternative	Existing Debt 1980	Local Capital Share With State Grant	Local Capital Share Without State Grant	Total Debt	Full Equalized Value	Debt-to-Value (%)
2A	20,000 +	1,811,800 =		1,831,800 -	22,751,032 =	8.1
			3,018,900 =	3,038,900 -		13.4
2B	20,000 +	1,929,500 =		1,949,500 -	22,751,032 =	8.6
			3,232,900 =	3,252,900 -		14.3
3	20,000 +	1,881,500 =		1,901,500 -	22,751,032 =	8.4
			3,145,600 =	3,165,600 -		13.9
4	16,500 +	1,964,200 =		1,980,800 -	18,769,601 =	10.6
			3,301,600 =	3,318,100 -		17.7
5	16,500 +	1,698,600 =		1,715,100 -	18,769,601 =	9.1
			2,818,600 =	2,835,100 -		15.1
6	16,500 +	923,600 =		940,100 -	18,769,601 =	5.0
			1,495,700 =	1,512,200 -		8.1

The determination of the debt to full equalized value ratio in Baileys Harbor also requires the use of assumptions as to the proportion of the full equalized value within the proposed service area as compared to the overall Township. For Alternatives 2A, 2B, and 3, which encompass Subareas 3 and 6, it was assumed that the service area represents 40% of the Baileys Harbor Township full equalized value. For Alternatives 4, 5, and 6, which encompass Subarea 3, it was assumed that the service area represents 33% of the Township's equalized value. Based on these assumptions, the only alternative that would not cause the 5% debt limit to be exceeded is Alternative 6 with a State grant (Table 4-8).

The USEPA considers projects to be expensive and as having an adverse impact on the finances of the users when average annual user charges are:

- 1.0% of median household incomes less than $10,000
- 1.5% of median household incomes between $10,000 and $17,000
- 1.75% of median household incomes greater than $17,000.

Information on median household incomes for the project area communities currently is not available. However, according to 1980 census data that are available, the 1980 median household income in Door County was $15,810 (By telephone, Mr. Roger Nacker, Wisconsin Department of Development, to WAPORA, Inc., 29 October 1982). It is possible to estimate the median household incomes for the project area communities by comparing the 1980 per capita incomes for the communities with the 1980 per capita income for Door County (Table 3-26). Assuming that the ratios between the per capita incomes for each community and the Door County per capita income are the same for median household incomes, the estimated 1980 median household incomes for the four communities are:

Egg Harbor - $18,055	Fish Creek - $14,861
Ephraim - $23,715	Baileys Harbor - $15,431

Average annual user costs expressed as a percentage of median household income are presented in Table 4-9. The analysis only is applicable to permanent residents, however. Because of the mixture of permanent and seasonal residential and commercial uses, and their differing contributions

to the projected wastewater flows, the average annual user costs were calculated on a population equivalent (PE) basis. In order to compare the user costs with the median household incomes, the PE based user costs for each alternative were multiplied by the household size factors for the particular community (US Bureau of the Census 1981, Table 3-13) to determine the total annual user costs for permanent residential households. These total user costs then were divided by the median household income for the community. These estimated user costs for permanent households could vary, though, depending on the way in which the project costs are allocated between residential and commercial uses and seasonal and permanent uses. Although a specific methodology is not available for evaluating the financial impact of the alternatives on seasonal and commercial uses, it is likely that the financial impacts will be similar to those for permanent residents.

The analysis indicates that none of the Egg Harbor alternatives would exceed the 1.75% USEPA guideline, if a State grant was available. If a State grant was not available, Alternatives 2A, 2B, 3, and 5 would result in average annual user costs to permanent residences that exceed the 1.75% guideline.

For both Baileys Harbor and Fish Creek, the estimated user costs would represent a significant financial burden, regardless of whether a State grant was used or not. In Fish Creek, the user cost to median household income ratios range from 2.5% for Alternative 4 (with State grant) to 4.6% for Alternatives 2, 6, and 7 (without State grant). Because median household incomes in Fish Creek are less than $17,000, a project with a user cost ratio greater than 1.5% would be considered expensive by USEPA. In Baileys Harbor, the ratios range from 3.0% for Alternative 6 (with State grant) to 4.1% for Alternative 2B (without State grant). Median household incomes in Baileys Harbor also are less than $17,000 and thus subject to the 1.5% guideline.

Ephraim has the highest median household income of the four communities and consequently the estimated user costs have a less significant impact. If a State grant was available, only Alternative 2 would cause the

Table 4-9. Average annual user costs by alternative for permanent residences as a percentage of median household income[1].

Alternative	User Cost/Median Household Income Ratio With State Grant	Without State Grant
Egg Harbor		
2A	1.3%	1.9%
2B	1.6	2.4
3	1.2	1.8
4	1.1	1.6
5	1.2	1.6
6	1.6	2.2
7	0.9	1.2
Fish Creek		
2	3.1%	4.6%
3	3.0	4.5
4	2.5	4.0
5	2.6	4.3
6	3.1	4.6
7	4.2	4.6
Ephraim		
2	1.9%	3.0%
3	1.4	2.1
4	1.4	1.9
5	1.0	1.5
6	1.0	1.1
Baileys Harbor		
2A	3.4%	4.9%
2B	3.7	5.1
3	3.5	5.0
4	3.3	5.0
5	3.3	4.7
6	3.0	3.7

[1] The USEPA considers a project expensive when average annual user costs are 1.5% of median household income between $10,000 and $15,000 (Fish Creek and Baileys Harbor) and 1.75% of median household income greater than $17,000 (Ephraim and Egg Harbor). User costs for permanent residences were calculated by multiplying the population equivalent user costs by the 1980 average household size (person-per-unit) factors for each community.

1.75% guideline to be exceeded. If a State grant was not available, Alternatives 5 and 6 could still be implemented without significant financial impacts.

Based on these analyses, it appears that many of the project alternatives would have an adverse financial impact on community residents, as measured by their capability to afford the estimated average annual user costs. The capital costs of some of the alternatives also could have a significant negative impact on the financial condition of the individual communities. The financial burden imposed by the additional debt that is incurred could limit the ability of each community to engage in other capital improvement projects and potentially could impact their ability to provide other public services (e.g., police and fire protection) at a level consistent with that which is currently being provided.

4.2. Secondary Impacts

Each of the alternatives, including the No Action Alternative, will have effects that extend beyond primary or indirect impacts. These secondary impacts could occur because improvements in wastewater treatment can lead to changes in the project area that in turn induce or stimulate other actions that would not have taken place in the absence of a project. The categories that may experience signficant secondary impacts are described in the following sections.

4.2.1. Demographics

The availability and capacity of wastewater treatment systems historically has been a major factor in determining the ability of an area to support population growth and development. Onsite wastewater treatment facilities, although generally available to any potential user, limit development to areas with suitable soil and site characteristics. Sewer systems, while not always available at a specific location or with adequate capacity, allow development to be more site independent because soil, slope, and drainage become less constraining design parameters. Consequently, the construction of sewers in an unsewered area usually increases

the inventory of buildable land and provides for development at greater densities, both of which can enhance population growth.

The construction of wastewater collection and treatment facilities in the project area communities could lead to additional growth in excess of that which is all ready projected. However, the primary impetus for facilities planning in the project area has been a concern about the potential for groundwater contamination as a result of inadequate onsite systems. Facilities planning has been proceeding on the basis that there may be a need to correct an existing problem. Facilities planning has not had, however, the underlying assumption that sewers may be needed to accommodate projected growth. The proposed service areas in each of the communities essentially are "built-out". Some additional infill development could take place, but it cannot be concluded that the absence of sewer systems is inhibiting growth from taking place. High growth rates were experienced in each of the communities between 1972 and 1980 in spite of the lack of centralized wastewater collection and treatment facilities. Residential development has taken place throughout the project area and although waterfront areas appear to be preferred, development does not seem to be concentrating in any particular locations.

If sewers are constructed in a community, it is possible that the sewered area might "capture" some of the projected growth at the expense of other, unsewered areas. However, it also is possible that because of the density of existing development within the proposed service areas, the limited amount of buildable land within the service areas, and the fundamental attraction of the area as a recreational and retirement area, the sewered areas might not offer any particular competitive advantage over unsewered areas.

As discussed in Section 3.2.2., high population growth rates are projected for the area in the next twenty years. Other factors, though, probably will have a greater effect on population growth. These include land costs, site and locational amenities, and variations in demand between permanent and seasonal dwellings. It is possible that sewering an area would unleash some unrealized demand for permanent residences. Because of

the relatively high cost associated with year round reliance on a holding tank, a majority of the permanent population growth currently could be attracted to Sister Bay or Sturgeon Bay (which have centralized collection and treatment systems) or to outlying areas that are suitable for septic tank - soil absorption systems. The availability of sewer systems could increase the attraction of the project area communities for year round residences. It also is possible that induced growth could be an important factor in one community, for a variety of reasons, and of little consequence in another community.

4.2.2. Land Use

Economic and other considerations (Section 3.2.3.) probably will be a greater factor influencing changes in land use in the project area during the planning period than the provision of wastewater facilities. The availability of wastewater collection and treatment facilities within the proposed service area could result in additional infill development, either residential or commercial. Development also could take place at higher densities than would occur if onsite systems were used. As discussed in the previous section, it is possible that a greater proportion of the projected growth could take place within the sewered areas. It also is possible, though, that other factors such as site amenities, costs, location, and access will be more important considerations than the availability of sewer service to builders of new property. If this is the case, then growth within the sewer service area should not be more intense than growth outside the sewer service areas.

Prime Agricultural Land

Little prime agricultural farmland is likely to be taken out of production to accommodate wastewater treatment facilities. This will result in a minimal net loss of food and fibre which was previously produced or could have been produced on this land. Because induced growth is not anticipated from the implementation of the alternatives, the threat to prime agricultural farmland usually associated with the construction of wastewater facilities is reduced. However, as additional land is developed

to accommodate projected growth, the supply of prime farmland could diminish.

The amount of prime farmland that is converted to other land uses will depend to a great extent on the growth management policies of the Villages, Townships, and/or Door County. A large proportion of the project area is zoned either A-1, Agricultural or CON, Conservation (Figure 3-12). The maintenance of these zoning classifications will lessen the conversion of prime farmland to non-farm use. There appears to be enough vacant buildable land within the four communities in residential or commercial zoning to accommodate the projected growth. Thus, regardless of whether centralized collection and treatment systems are or are not constructed, the application of appropriate zoning designations and other growth management techniques can be used to maintain existing agricultural operations.

4.2.3. Surface Water

Increased housing development along lake shores may increase nutrient and sediment loads into Green Bay or Lake Michigan as a result of the following:

- increased runoff from construction of impervious surfaces such as rooftops, parking areas, and paved roads
- increased housing density normally accelerates storm water runoff thereby increasing not only the amount of runoff, but also its ability to erode soil and to transport contaminants
- lawn and garden fertilization may create unnaturally high nutrient levels in runoff.

4.2.4. Recreation and Tourism

Any increase or decrease of tourism and recreational activities within the project area attributable to the operation of wastewater facilities under the "build" alternatives would occur when a quantum change in water quality occurs. A significant decline in water quality would cause fewer tourists to visit the project area. Permanent and seasonal residents of the project area would likely decrease some of their recreational activities under these conditions.

A significant increase in water quality may contribute to an increase of recreational activities among local residents and tourists within the project area. Too great an increase in development and tourism, however, could have a negative impact on the area if the physical and cultural amenities of the area were diminished. A concern over the potential for well contamination as a result of failing onsite systems under the No Action Alternative would detract from the reputation of the area as a desirable recreational area. Recreation and tourist activities would likely decline. A management program for identifying and upgrading failing onsite systems would obviate this potential.

4.2.5. Economics

Economic growth should continue in conjunction with projected population growth and development. The availability of centralized collection and treatment systems within the service areas could result in additional commercial development such as hotels, motels, and restaurants. This additional development would depend, though, as much on ancillary economic factors such as costs, the tourist potential of the area, the limits of market saturation, etc., as on the availability of sewer service. Most large commercial uses in the service areas currently use holding tanks and the absence of sewers probably does not represent a constraint to expansion. If additional commercial development did occur as a result of the construction of sewers and WWTPs, the local economy would benefit from the increased tax revenues and employment opportunities. These potential benefits are not quantifiable, however.

As discussed in Section 3.2.3.3.1. Income Levels, the project area is characterized by a small poverty level population. Although the population of northern Door County is increasing, the number of participants in the food stamp program and other public assistance efforts has declined. Thus, it would be expected that few residents with low incomes or fixed incomes would be displaced as a result of the user charges and special assessments associated with the project alternatives.

4.3. Mitigation of Adverse Impacts

As previously discussed, various adverse impacts would be associated with the proposed alternatives. Many of these adverse impacts could be reduced significantly by the application of mitigative measures. These mitigative measures consist of a variety of legal requirements, planning measures, and design practices. The extent to which these measures are applied will determine the ultimate impact of the particular action. Potential measures for alleviating construction, operation, and secondary effects presented in Sections 4.1 and 4.2 are discussed in the following sections.

4.3.1. Mitigation of Construction Impacts

The construction oriented impacts presented in Section 4.1. primarily are short-term effects resulting from construction activities at WWTP sites or along the route of proposed sewer systems. Proper design should minimize the potential impacts and the plans and specifications should incorporate mitigative measures consistent with the following discussion.

The impact of noise from blasting for rock removal could be minimized by scheduling and public notification of the time, location, and extent of the work.

Fugitive dust from the excavation and backfilling operations for the sewers, force mains, and treatment plants could be minimized by various techniques. Frequent street sweeping of dirt from construction activites would reduce the major source of dust. Prompt repaving of roads disturbed by construction also could reduce dust effectively. Construction site, spoil piles, and unpaved access roads should be wetted periodically to minimize dust. Soil stockpiles and backfilled trenches should be seeded with a temporary or permanent seeding or covered with mulch to reduce susceptibility to wind erosion.

Street cleaning at sites where trucks and equipment gain access to construction sites and of roads along which a sewer or force main would be

constructed would reduce loose dirt that otherwise would generate dust, create unsafe driving conditions, or be washed into roadside ditches or storm drains.

Exhaust emission and noise from construction equipment could be minimized by proper equipment maintenance. The resident engineer should have and should exercise the authority to ban from the site all poorly maintained equipment. Soil borings along the proposed force main rights-of-way conducted during system design, would identify organic soils that have the potential to release odors when excavated. These areas could be bypassed by rerouting the force main if, depending on the location, a significant impact might be expected.

Spoil disposal sites should be identified during the project design stage to ensure that adequate sites are available and that disposal site impacts are minimized. Landscaping and restoration of vegetation should be conducted immediately after disposal is completed to prevent impacts from dust generation and unsightly conditions.

Lands disturbed by trenching for force main construction should be regraded and compacted as necessary to prevent future subsidence. However, too much compaction will result in conditions unsuitable for vegetation.

Areas disturbed by trenching and grading at the plant site should be revegetated as soon as possible to prevent erosion and dust generation. Native plants and grasses should be used. This also will facilitate the re-establishment of wildlife habitat.

Construction-related disruption in the community can be minimized through considerate contractor scheduling and appropriate public announcements. The State and County highway departments have regulations concerning roadway disruptions, which should be rigorously applied. Special care should be taken to minimize disruption of access to frequently visited establishments. Announcements should be published in local newspapers and broadcast from local radio stations to alert drivers of temporary traffic disruption on primary routes. Street closing and blasting schedules should

be announced by fliers delivered to each affected household.

Planning of routes for heavy construction equipment and materials should ensure that surface load restrictions are considered. In this way, damage to streets and roadways would be avoided. Trucks hauling excavation spoil to disposal sites or fill material to the WWTP sites should be routed along primary arterials to minimize the threat to public safety and to reduce disturbance along residential streets.

Erosion and sedimentation must be minimized at all construction sites. USEPA Program Requirements Memorandum 78-1 establishes requirements for control of erosion and runoff from construction activites. Adherence to these requirements would serve to mitigate potential problems:

- Construction site selection should consider potential occurrence of erosion and sediment losses
- The project plan and layout should be designed to fit the local topography and soil conditions
- When appropriate, land grading and excavating should be kept at a minimum to reduce the possibility of creating runoff and erosion problems which require extensive control measures
- Whenever possible, topsoil should be removed and stockpiled before grading begins
- Land exposure should be minimized in terms of area and time
- Exposed areas subject to erosion should be covered as quickly as possible by mean of mulching or vegetation
- Natural vegetation should be retained whenever feasible
- Appropriate structural or agronomic practices to control runoff and sedimentation should be provided during and after construction
- Early completion of stabilized drainage systems (temporary and permanent systems) will substantially reduce erosion potential
- Access roadways should be paved or otherwise stabilized as soon as feasible

- Clearing and grading should not be started until a firm construction schedule is known and can be effectively coordinated with the grading and clearing activities.

The Natural Historic Preservation Act of 1966, Executive Order 11593 (1971), the Archaeological and Historic Preservation Act of 1974, and the 1973 Procedures of the Advisory Council on Historic Preservation requires that care must be taken early in the planning process to identify cultural resources and minimize adverse effects on them. The State Historic Preservation Officer must have an opportunity to determine that the requirements have been satisfied.

Known archaeological sites should be avoided. After an alternative is selected and design work begins, a thorough pedestrian archaeological survey may be required for those areas affected by the proposed facility. In addition to the information already collected and consultation with the State Historic Preservation Officer and other knowledgeable informants, a controlled surface collection of discovered sites and minor subsurface testing should be conducted. A similar survey would be required of historic structures, sites, properties, and objects in and adjacent to the construction areas, if they might be affected by the construction or operation of the project.

In consultation with the State Historic Preservation Officer, it would be determined if any of the resources identified by the surveys appears to be eligible for the National Register of Historic Places. Subsequently, an evaluation would be made of the probable effects of the project on these resources and the mitigation procedures that are necessary.

4.3.2. Mitigation of Operation Impacts

The majority of potentially adverse operational impacts of the WWTP alternatives are related to the discharge of effluent to surface waters. For the land treatment alternative, the most significant potential adverse effects are impacts on groundwater and possible health risks. For the wetland discharge alternative, the most significant potential adverse

impact is on the ecology of the entire vegetative community, i.e., the community as a whole as well as individual species. Adverse impacts associated with the operation of cluster and onsite systems are primarily related to malodorous conditions which may affect outdoor recreational activities. Measures to minimize these and other operation phase impacts from all the alternatives are discussed below.

Adverse impacts related to the operation of the proposed sewer systems and treatment facilities would be minimal if the facilities are designed, operated, and maintained properly. Aerosols, gaseous emissions, and odors from the various treatment processes could be controlled to a large extent. Above-ground pumps would be enclosed and installed to minimize sound impacts. Concentrations of the effluent constituents discharged from the WWTPs would be regulated by the conditions of the NPDES permits. The effluent quality is specified by the WDNR and must be monitored. Proper and regular maintenance of cluster and onsite systems also would maximize the efficiency of these systems and minimize odors released from malfunctioning systems.

Special care to control chlorination and effluent concentrations of chlorine residuals should be taken to minimize adverse impacts to the aquatic biota of study area surface waters. Tsai (1973) documented that depressed numbers of fish and macroinvertebrates were found downstream from outfalls discharging chlorinated effluent. No fish were found in water with chlorine residuals greater than 0.37 mg/l, and the species diversity index reached zero at 0.25 mg/l. Arthur and others (1975) reported that concentrations of chlorine residuals lethal to various species of warm water fish ranged from 0.09 to 0.30 mg/l. Furthermore, chlorination of wastewater can result in the formation of halogenated organic compounds that are potentially carcinogenic (USEPA 1976). Rapid mixing of chlorine and design of contact chambers to provide long contact times, however, can achieve the desired disinfection and the minimum chlorine residual discharge (USEPA and others 1977c). Chlorination will require especially careful application and routine monitoring to insure that chlorine residual concentrations are kept to a minimum. The maximum chlorine residual allowed by WDNR is 0.5 mg/l (Section 2.2.1.2.). Therefore, the impact of chlorine should be minimal.

To avoid adverse impacts on fish spawning areas, a proposed outfall should be located beyond the cobble strata in the sands and silts. The outfall structure should be provided with diffusers to disperse the flow.

An investigation of the hydrologic and biologic conditions of a proposed wetland discharge site should be made prior to design to assure that the additional water added to the site will not disturb the existing vegetation and fauna. The application system should be designed to disperse the flow over a reasonable area.

In the document Federal Guidelines for Design, Operation, and Maintenance of Wastewater Treatment Facilities (Federal Water Quality Administration 1970), it is required that:

> All water pollution control facilities should be planned and designed so as to provide for maximum reliability at all times. The facilities should be capable of operating satisfactorily during power failures, flooding, peak loads, equipment failure, and maintenance shutdowns.

4.3.3. Mitigation of Secondary Impacts

As discussed in Section 4.2., few secondary impacts are expected to occur during the operation of any of the "build" alternatives. Adequate zoning, health, and water quality regulation and enforcement would minimize these impacts. Local growth management planning would assist in regulating the general location, density, and type of growth that might occur.

4.4. Unavoidable Adverse Impacts

Some impacts associated with the implementation of any of the "build" alternatives cannot be avoided. The centralized collection and treatment alternatives would have the following adverse impacts:

- Considerable short-term construction dust, noise, and traffic nuisance
- Alteration of vegetation and wildlife habitat along the sewer and force main corridors and at the WWTP sites

- Considerable erosion and siltation during construction
- Discharge of BOD, SS and phosphorus at greater than ambient levels to Green Bay or Lake Michigan with the WWTP and outfall alternatives
- Alteration and destruction of wildlife habitat at the cluster drainfield and mound sites
- Conversion of prime farmland to WWTP sites for some alternatives.

The decentralized alternatives that include primarily continued use of existing and upgraded onsite systems and holding tanks for critical areas would have the following adverse impacts:

- Some short-term construction dust, noise, and traffic nuisance
- Some erosion and siltation during construction
- Discharge of percolate with elevated levels of nitrates and chlorides from soil absorption systems to the groundwater
- Occasional ephemeral odors associated with pumping septic tanks and holding tanks and trucking it to disposal sites
- User fees for management and operation of wastewater treatment services for the residents within the proposed service areas.

4.5. Irretrievable and Irreversible Resource Commitments

The major type and amounts of resources that would be committed through the implementation of any of the "build" alternatives are presented in Sections 4.1. and 4.2. Each of the alternatives would include some or all of the following resource commitments:

- Fossil fuel, electrical energy, and human labor for facilities construction and operation
- Chemicals, especially chlorine, for WWTP operation
- Tax dollars for construction and operation
- Some unsalvageable construction materials.

For each alternative involving a WWTP, there is a significant consumption of these resources with no feasible means of recovery. Thus, non-recoverable resources would be foregone for the provision of the proposed wastewater control system.

Accidents which could occur from system construction and operation could cause irreversible bodily damage or death, and damage or destroy equipment and other resources.

Unmitigated WWTP failure potentially could kill aquatic life in the immediate mixing zone.

The potential accidental destruction of undiscovered archaeological sites through excavation activities is not reversible. This would represent permanent loss of the site.

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6.0. GLOSSARY OF TECHNICAL TERMS

Activated sludge process. A method of secondary wastewater treatment in which a suspended microbiological culture is maintained inside an aerated treatment basin. The microbial organisms oxidize the complex organic matter in the wastewater to carbon dioxide, water, and energy.

Advanced secondary treatment. Wastewater treatment more stringent than secondary treatment but not to advanced waste treatment levels.

Advanced waste treatment. Wastewater treatment to treatment levels that provide for maximum monthly average BOD_5 and SS concentrations less than 10 mg/l and/or total nitrogen removal of greater than 50% (total nitrogen removal = TKN + nitrite and nitrate).

Aerated lagoon. In wastewater treatment, a pond, usually man-made, to which oxygen is added mechanically for the purpose of decomposing organic wastes to elemental forms.

Aeration. To circulate oxygen through a substance, as in wastewater treatment, where it aids in purification.

Aerobic. Refers to life or processes that occur only in the presence of oxygen.

Aerosol. A suspension of liquid or solid particles in a gas.

Algae. Simple rootless plants that grow in bodies of water in relative proportion to the amounts of nutrients available. Algal blooms, or sudden growth spurts, can affect water quality adversely.

Algal bloom. A proliferation of algae on the surface of lakes, streams or ponds. Algal blooms are stimulated by phosphate enrichment.

Alluvial. Pertaining to material that has been carried by a stream.

Ambient air. Any unconfined portion of the atmosphere: open air.

Ammonia-nitrogen. Nitrogen in the form of ammonia (NH_3) that is produced in nature when nitrogen-containing organic material is biologically decomposed.

Anaerobic. Refers to life or processes that occur in the absence of elemental or free oxygen.

Aquifer. A geologic stratum or unit that contains water and will allow it to pass through. The water is stored in and travels through spaces between rock grains in a sand or gravel aquifer, small or cavernous openings formed by solution in a limestone aquifer, or fissures, cracks, and rubble in harder rocks such as shale.

Artesian (adj.). Refers to groundwater in a confined aquifer that is under sufficient pressure to have a piezometric level above the elevation of the aquifer.

Artesian well. A well that has a static water level higher than the water table or free water surface. A well in which the static water level is higher than the land surface is called a flowing artesian well.

Assessed valuation. The value of all taxable general property as determined by the municipal assessor of the Wisconsin Department of Revenue.

Bar screen. In wastewater treatment, a screen that removes large floating and suspended solids.

Base flow. The water in a stream channel that occurs typically during rainless periods, when stream flow is maintained largely or entirely by discharges of groundwater.

Bedrock. The solid rock beneath the soil.

Biochemical oxygen demand (BOD). A bioassay-type procedure in which the weight of oxygen utilized by microorganisms to oxidize and assimilate the organic matter present per liter of water is determined. It is common to note the number of days during which a test was conducted as a subscript to the abbreviated name. For example, BOD_5 indicates that the results are based on a five-day long (120-hour) test. The BOD value is a relative measure of the amount (load) of living and dead oxidizable organic matter in water. A high demand may deplete the supply of oxygen in the water, temporarily or for a prolonged time, to the degree that many or all kinds of aquatic organisms are killed. Determinations of BOD are useful in the evaluation of the impact of wastewater on receiving waters.

Biota. The plants and animals of an area.

Chlorination. The application of chlorine to drinking water, sewage or industrial waste for disinfection or oxidation of undesirable compounds.

Clarifier. A settling tank where solids are mechanically removed from waste water.

Coliform bacteria. Members of a large group of bacteria that flourish in the feces and/or intestines of warm-blooded animals, including man. Fecal coliform bacteria, particularly Escherichia coli (E. coli), enter water mostly in fecal matter, such as sewage or feedlot runoff. Coliforms apparently do not cause serious human diseases, but these organisms are abundant in polluted waters and they are fairly easy to detect. The abundance of coliforms in water, therefore, is used as an index to the probability of the occurrence of such disease-producing organisms (pathogens) as Salmonella, Shigella, and enteric viruses. These pathogens are relatively difficult to detect.

Collector sewer. A sewer designed and installed to collect sewage from a limited number of individual properties and conduct it to a trunk sewer.

Community. The plants and animals in a particular area that are closely related through food chains and other interactions.

Cultural resources. Fragile and nonrenewable sites, districts, buildings, structures, or objects representative of our heritage. Cultural resources are divided into three categories: historical, architectural, or archaeological. Cultural resources of special significance may be eligible for listing on the National Register of Historic Places.

Detention time. The average time required for a volume of water to flow through a basin.

Digestion. In wastewater treatment a closed tank, sometimes heated to 95°F where sludge is subjected to intensified bacterial action.

Disinfection. Effective killing by chemical or physical processes of all organisms capable of causing infectious disease. Chlorination is the disinfection method commonly employed in sewage treatment processes.

Dissolved oxygen (DO). Oxygen gas (O_2) in water. It is utilized in respiration by fish and other aquatic organisms, and those organisms may be injured or killed when the concentration is low. Because much oxygen diffuses into water from the air, the concentration of DO is greater, other conditions being equal, at sea level than at high elevations, during periods of high atmospheric pressure than during periods of low pressure, and when the water is turbulent (during rainfall, in rapids, and waterfalls) rather than when it is placid. Because cool water can absorb more oxygen than warm water, the concentration tends to be greater at low temperatures than at high temperatures. Dissolved oxygen is depleted by the oxidation of organic matter and of various inorganic chemicals. Should depletion be extreme, the water may become anaerobic.

Effluent. Wastewater or other liquid, partially or completely treated, or in its natural state, flowing out of a reservoir, basin, treatment plant, or industrial treatment plant, or part thereof.

Endangered species. Any species of animal or plant that is in known danger of extinction throughout all or a significant part of its range.

Epilimnion. Surface waters of a lake usually separated from the bottom layers by oxygen levels or temperature stratification.

Eutrophic. Waters with an abundant supply of nutrients and hence a prolific production of organic matter.

Eutrophication. The process of enrichment of a water body with nutrients.

Eutrophic Lakes. Lakes that contain an abundant supply of nutrients and plant life typically of nuisance levels.

Fauna. The total animal life of a particular geographic area or habitat.

Fecal coliform bacteria. See coliform bacteria.

Flora. The total plant life of a particular geographic area or habitat.

Flowmeter. A guage that indicates the quantity of water moving through a conveyance conduit.

Force main. A pipe designed to carry wastewater under pressure from a lift station.

Full equalized value. The value of all taxable general property as determined by the Wisconsin Department of Revenue. This value is determined independently of the assessed value and reflects actual market value.

Glacial drift. Rock and soil material picked up and transported by a glacier and deposited elsewhere.

Gravity sewer. A sewer in which wastewater flows naturally down-gradient by gravity.

Gravity sewer system. A layout of below grade pipes in which the liquid flows by gravity to collection point(s) within the system.

Groundwater. All interstitial water within soils and bedrock, especially that part in the zone of saturation.

Groundwater runoff. Groundwater that is discharged into a stream channel as spring or seepage water.

Gyre. A partially open circular system, but larger than a whirlpool or eddy. Gyres in Green Bay harbors or embayments typically are clockwise currents originating from counter-clockwise longshore current patterns.

Holding tank. Enclosed tank, usually constructed of fiberglass, steel or concrete, for the storage of wastewater prior to removal or disposal at another location.

Hypolimnion. Relatively undisturbed waters of a lake bottom separated from the surface layer by oxygen levels or temperature stratification.

Infiltration. The water entering a sewer system and service connections from the ground through such means as, but not limited to, defective pipes, pipe joints, improper connections, or manhole walls. Infiltration does not include, and is distinguished from, inflow.

Inflow. The water discharged into a wastewater collection system and service connections from such sources as, but not limited to, roof drains, cellars, yard and area drains, foundation drains, cooling water discharges, drains from springs and swampy areas, manhole covers, cross-connections from storm sewers and combined sewers, catch

basins, surface runoff, street wash waters or drainage. Inflow does not include, and is distinguished from, infiltration.

Influent. Water, wastewater, or other liquid flowing into a reservoir, basin, or treatment facility, or any unit thereof.

Interceptor sewer. A sewer designed and installed to collect sewage from a series of collection sewers and to convey it to a sewage treatment plant.

Innovative technology. A technology whose use has not been widely tested by experience and is not a variant of conventional biological or physical/chemical treatment.

Land treatment. A method of treatment in which the soil, air, vegetation, bacteria, and fungi are employed to remove pollutants from wastewater. In its most simple form, the method includes three steps: (1) pretreatment to screen out large solids; (2) secondary treatment; (3) application to cropland, pasture, or natural vegetation to allow plants and soil microorganisms to remove additional pollutants. Little of the applied water evaporates, and the remainder either percolates to the water table, or runs off and is collected. The water table may be artificially lowered by drain tiles or recovery wells.

Leachate. Solution formed when water percolates through solid wastes, soil or other materials and extracts soluble or suspendable substances from the material.

Lift station. A facility in a collector sewer system, consisting of a receiving chamber, pumping equipment, and associated drive and control devices, that collects wastewater from a low-lying district at some convenient point, from which it is lifted to another portion of the collector system or to an interceptor sewer.

Limiting factor. A factor whose absence, or excessive concentration, exerts some restraining influence upon a population.

Loam. The textural class name for soil having a moderate amount of sand, silt, and clay. Loam soils contain 7 to 27% of clay, 28 to 50% of silt, and less than 52% of sand.

Loess. Soil of wind-blown origin, predominantly silt and fine sand.

Macroinvertebrates. Invertebrates that are visible to the unaided eye (those retained by a standard No. 30 sieve, which has 28 meshes per inch or 0.595 mm openings); generally connotes bottom-dwelling aquatic animals (benthos).

Macrophyte. A large (not microscopic) plant, usually in an aquatic habitat. They can be rooted, floating, or submerged plants.

Melt water. Water that originates from the melting of snow or ice, usually in association with prehistoric glaciation.

Mesotrophic. Waters with a moderate supply of nutrients and no significant production of organic matter.

Mesotrophic lake. Lakes of intermediate characteristics between oligotrophic and eutrophic. They contain a moderate supply of nutrients and plant life.

Methemoglobinemia. The presence of oxidized hemoglobin in the blood after poisoning by chlorates, nitrates, ferricyanides, or various other substances.

Milligram per liter (mg/l). A concentration of 1/1000 gram of a substance in 1 liter of water. Because 1 liter of pure water weighs 1,000 grams, the concentration also can be stated as 1 ppm (part per million, by weight). Used to measure and report the concentrations of most substances that commonly occur in natural and polluted waters.

Moraine. A mound, ridge, or other distinctive accumulation of sediment deposited by a glacier.

National Register of Historic Places. Official listing of the cultural resources of the Nation that are worthy of preservation. Listing on the National Register makes property owners eligible to be considered for Federal grants-in-aid for historic preservation through state programs. Listing also provides protection through comment by the Advisory Council on Historic Preservation on the effect of Federally financed, assisted, or licensed undertakings on historic properties.

Nitrate-nitrogen. Nitrogen in the form of nitrate (NO_3). It is the most oxidized phase in the nitrogen cycle in nature and occurs in high concentrations in the final stages of biological oxidation. It can serve as a nutrient for the growth of algae and other aquatic plants.

Nitrite-nitrogen. Nitrogen in the form of nitrite (NO_2). It is an intermediate stage in the nitrogen cycle in nature. Nitrite normally is found in low concentrations and represents a transient stage in the biological oxidation of organic materials.

Nonpoint source. Any area, in contrast to a pipe or other structure, from which pollutants flow into a body of water. Common pollutants from nonpoint sources are sediments from construction sites and fertilizers and sediments from agricultural soils.

Nutrients. Elements or compounds essential as raw materials for the growth and development of an organism; e.g., carbon, oxygen, nitrogen, and phosphorus.

Oligotrophic. Waters with a small supply of nutrients and hence an insignificant production of organic matter.

Oligotrophic lakes. Lakes that have a low supply of nutrients and contain little organic matter. Such lakes are characterized by high water transparency and high dissolved oxygen.

Ordinance. A municipal or county regulation.

Outwash. Soil material carried by melt water from a glacier and deposited beyond the marginal moraine.

Outwash plain. A plain formed by material deposited by melt water from a glacier flowing over a more or less flat surface of large area. Deposits of this origin are usually distinguishable from ordinary river deposits by the fact that they often grade into moraines and their constituents bear evidence of glacial origin. Also called frontal apron.

Percolation. The downward movement of water through pore spaces or larger voids in soil or rock to the water table.

pH. A measure of the acidity or alkalinity of a material, liquid or solid. pH is represented on a scale of 0 to 14 with 7 being a neutral state; 0, most acid; and 14, most alkaline.

Phosphorus. An essential food element that can contribute to the eutrophication of water bodies.

Photochemical oxidants. Secondary pollutants formed by the action of sunlight on nitric oxides and hydrocarbons in the air; they are the primary components of photochemical smog.

Piezometric level. An imaginary point that represents the static head of groundwater and is defined by the level to which water will rise.

Plankton. Minute plants (phytoplankton) and animals (zooplankton) that float or swim weakly in rivers, ponds, lakes, estuaries, or seas.

Point source. In regard to water, any pipe, ditch, channel, conduit, tunnel, well, discrete operation, vessel or other floating craft, or other confined and discrete conveyance from which a substance considered to be a pollutant is, or may be, discharged into a body of water.

Pressure sewer system. A wastewater collection system in which household wastes are collected in the building drain and conveyed therein to the pretreatment and/or pressurization facility. The system consists of two major elements, the on-site or pressurization facility, and the pressurized sewer main.

Primary treatment. The first stage in wastewater treatment, in which substantially all floating or settleable solids are mechanically removed by screening and sedimentation.

Prime farmland. Agricultural lands, designated Class I or II (occasionally some Class III), having little or no limitations to profitable crop production.

Pumping station. A facility within a sewer system that pumps sewage or effluent against the force of gravity through an enclosed conduit.

Runoff. Water from rain, snow melt, or irrigation that flows over the ground surface and returns to streams. It can collect pollutants from air or land and carry them to the receiving waters.

Sanitary sewer. Buried pipelines that carry only domestic or commercial wastewater, not stormwater.

Screening. Use of screens to remove coarse floating and suspended solids from sewage.

Secondary treatment. The second stage in the treatment of wastewater in which bacteria are utilized to decompose the organic matter in sewage. Effective secondary treatment processes remove virtually all floating solids and settleable solids, as well as 90% of the BOD and suspended solids. USEPA regulations define secondary treatment as 30 mg/l BOD, 30 mg/l SS, or 85% removal of these substances.

Seepage cells. Unlined wastewater lagoons designed so that all or part of wastewater percolates into the underlying soil.

Seiches. Long-wave, free oscillations of water set up initially by a disturbance such as the wind piling up water against the lakeshore. Seiche waves are periodic, returning periodically until frictional forces dissipate their energy. The period for Lake Michigan seiches may vary from 2.5 to 9 hours. In the first half of each seiche period the water near the shoreline rises from several inches to several feet. Over the last half of the seiche period the water falls below the average level to a similar or greater distance. Generally, it takes an east/west wind of at least 20 mph to bring about a sizeable seiche in the vicinity of Green Bay. For one or several days following this wind, the water near the shore will rise and fall with continually diminishing energy. When coupled with longshore, littoral currents, seiche-generated currents within harbors and embayments provide a flushing action within Great Lakes harbors. During each seiche cycle, the Harbor or slip water is partially removed and replaced with fresh Lake Michigan water. Some harbors produce standing waves as a result of internal resonant seiche wave oscillations. These standing waves amplify the water level fluctuations inside harbors.

Septic Snooper. Trademark for the ENDECO (Environmental Devices Corporation) Type 2100 Septic Leachate Detector. This instrument consists of an underwater probe, a water intake system, an analyzer control unit and a graphic recorder. Water drawn through the instrument is continuously analyzed for specific fluorescence and conductivity. When calibrated against typical effluents, the instrument can detect and profile effluent-like substances and thereby locate septic tank leachate or other sources of organic decomposition products entering lakes and streams.

Septic tank. A buried tank used for the collection of domestic wastes. Bacteria in the wastes decompose the organic matter, and the sludge settles to the bottom. The effluent flows out to another treatment and disposal facility. Sludge is pumped out at regular intervals.

Septic tank effluent pump (STEP). Pump designed to transfer settled effluent from a septic tank to a higher elevation through a pressure pipe.

Septic tank-soil absorption system. A system of wastewater disposal in which large solids are retained in a tank; fine solids and liquids are dispersed into the surrounding soil by a system of pipes.

Settling tank. A holding area for wastewater, where heavier particles sink to the bottom and the liquid decanted.

Shoaling. The bottom effect that influences the height of waves moving from deep to shallow water.

Slope. The incline of the surface of the land. It is usually expressed as a percent (%) of slope that is the elevation difference per 100 feet of horizontal distance.

Sludge. The accumulated solids that have been separated from liquids such as wastewater.

Soil association. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single mapping unit.

Soil textural class. The classification of soil material according to the proportions of sand, silt, and clay. The principal textural classes in soil, in increasing order of the amount of silt and clay, are as follows: sand, loamy sand, sandy loam, loam, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. These class names are modified to indicate the size of the sand fraction or the presence of gravel, sandy loam, gravelly loam, stony clay, and cobbly loam, and are used on detailed soil maps. These terms apply only to individual soil horizons or to the surface layer of a soil type.

Storm sewer. A conduit that collects and transports storm water runoff. In many sewerage systems, storm sewers are separate from those carrying sanitary or industrial wastewater.

Stratification. The condition of a lake, ocean, or other body of water when the water column is divided into a relatively cold bottom layer and a relatively warm surface layer, with a thin boundary layer (thermocline) between them. Stratification generally occurs during the summer and during periods of ice cover in the winter. Overturns, or periods of mixing, occur in the spring and autumn. This condition is most common in middle latitudes and is related to weather conditions, basin morphology, and altitude.

Supernatant. The liquid that remains on the surface after the solids have settled out in a wastewater treatment process.

Surface water. All waters on the earth's surface such as streams, lakes, and oceans.

Suspended solids (SS). Small solid particles that contribute to turbidity. The examination of suspended solids and the BOD test constitute the two main determinations for water quality that are performed at wastewater treatment facilities.

Threatened species. Any species of animal or plant that is likely to become endangered within the foreseeable future throughout all or a significant part of its range.

Till. Unsorted and unstratified drift, consisting of a heterogeneous mixture of clay, sand, gravel, and boulders, that is deposited by and underneath a glacier.

Trickling filter process. A method of secondary wastewater treatment in which the biological growth is attached to a fixed medium, over which wastewater is sprayed. The filter organisms biochemically oxidize the complex organic matter in the wastewater to carbon dioxide, water, and energy.

Topography. The configuration of a surface area including its relief, or relative elevations, and the position of its natural and manmade features.

Trophic status. A measure of the productivity of a body of water typically expressed as oligotrophic (least), mesotrophic, and eutrophic (greatest).

Trunk sewer. A sewer designed and installed to collect sewage from a number of collector sewers and conduct it to an interceptor sewer or, in some cases, to a sewage treatment plant.

Unique farmland. Land, other than prime farmland, that is used for the production of specific high value food and fiber crops and that has the special combination of soil quality, location, growing seasons, and moisture supply needed to economically produce sustained high quality and/or high yields of a specific crop under modern management.

Wastewater. Water carrying dissolved or suspended solids from homes, farms, businesses, and industries.

Wastewater stabilization lagoon. In wastewater treatment, a shallow pond, usually man-made, in which sunlight, algal and bacterial action and oxygen interact to decompose the organics. Oxygen is added to the water by natural air to water interchange.

Water quality. The relative condition of a body of water, as judged by a comparison between contemporary values and certain more or less objective standard values for biological, chemical, and/or physical parameters. The standard values usually are based on a specific series of intended uses, and may vary as the intended uses vary.

Water table. The upper level of groundwater that is not confined by an upper impermeable layer and is under atmospheric pressure. The upper surface of the substrate that is wholly saturated with groundwater.

Wetlands. Those areas that are inundated by surface or ground water with a frequency sufficient to support and under normal circumstances does or would support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction.

APPENDIX A

Wastewater Disposal Questionnaire and Responses
to Questions 5 and 15

Wastewater Disposal Questionnaire

The communities of Bailey's Harbor, Egg Harbor, Ephraim and Fish Creek are currently participating in a study sponsored in part by the Environmental Protection Agency to solve the sewage disposal problems facing these communities. This information is being requested to obtain information on the current sewerage systems operating in the area, and to determine what type of waste disposal system is best suited for each community.

Please take a few minutes to complete this questionnaire and return it along with your tax payment. If you have any questions, please contact your Town or Village Clerk. Your cooperation is appreciated.

---

1. What type of residence do you live in? Year constructed_____

   Single Residence_____ Duplex_____ Other_____

2. Lot size - Width_____ Length_____

3. What kind of wastewater disposal system does your house use?

   A_____ Septic Tank

   B_____ Privy

   C_____ Cesspool*

   D_____ Holding Tank

   E_____ Discharge directly to ditch

   F_____ Discharge directly to sewer or tile line

   G_____ Do not know

4. If you have checked A, B or C above, where does it discharge?

   _____ Seepage field

   _____ Sewer or tile line

   _____ Ditch

   _____ Immediately percolates into the ground

   _____ Other (Explain _____)

   _____ Do not know

* A cesspool is the use of a dry well without a septic tank.

5. Does your disposal system satisfactorily serve your residence?

_____ Yes _____ No

If no, check the problem and seasons most frequent.

	Spring	Summer	Fall	Winter
_____ Overloaded	_____	_____	_____	_____
_____ Wet ground over seepage field	_____	_____	_____	_____
_____ Odor	_____	_____	_____	_____
_____ Other (Explain: _____ _____)	_____	_____	_____	_____

6. If your disposal system discharges to a sewer or tile line, where does that line eventually discharge?

Describe location in a few words _____

_____

_____ Do not know

7. If your disposal system discharges directly to the surface of the ground describe in a few words the nature and location of the discharge point (example: roadside ditch in front of house): (back of house)

_____

_____

8. If you checked #3, A, B, C or D above, what is the approximate age?

_____ years Installed prior to occupancy which has been _____ years.

9. If your system includes a holding tank

A. What is the size of your holding tank? _____

B. Approximately how often do you have your holding tank pumped out?

_____

10. Who pumps your disposal system?_____

Where is this hauler located?_____

11. If you have a septic tank, approximately how many times has it been cleaned in the last five years?_____ times _____ Do not know

12. What water sources, other than toilets, wash basins, showers and sinks are connected to your disposal system?

Laundry drains	_____ Yes	_____ No	_____ Do not know
Garbage grinder	_____ Yes	_____ No	_____ Do not know
Roof drain	_____ Yes	_____ No	_____ Do not know
Footing drain	_____ Yes	_____ No	_____ Do not know

Other (Explain:_____)

13. In the general area of your residence, what is the depth of soil to bedrock?_____ to groundwater?_____

14. Are there any liquid wastes, other than human wastes, such as laundry wash water, which discharge to other than your primary disposal system?

_____ Yes _____ No

If yes, which wastes? Where do they go?

_____

15. Are there any other wastewater problems in your community you think need correction? _____ Yes _____ No

If yes, briefly describe the problem and approximate location. Use additional pages, if necessary.

_____

_____

16. What is the source of your drinking water supply?

_____ Public watermains

_____ Private well

_____ Other (Explain:_____)

16. cont.

If private well -

1. Type of well (i. e. drilled, dug, driven)_____
2. Depth_____
3. Date well constructed_____
4. Distance from nearest septic system_____
5. Date of last bacteriological analysis_____ _____
   Results_____
6. Cased? _____ Yes _____ No If yes, to what approximate depth _____

17. What is the duration of your residency in this area (check one)?

_____ Year round

_____ Seasonal, from_____ (month) to_____ (month)

_____ Weekends, approximately _____ per year.

_____

Name (please print)

_____

Address

Response to Question #15

Egg Harbor

I would like to see a complete Village sewer disposal system installed.

Wastewater drains into ditch on East side of White Cliff Road in back of our cottage.

Gibraltar

Bayside Tavern - needs pumping twice/week.

Fish Creek downtown and school waste seeping into Bay.

Omnibus Ski ridge overflowed all summer.

Park Gate Laundromat causes soap bubbles in Fish Creek.

On an adjacent piece of property a local plumber dumps fresh effluent from holding tanks. This is a problem particularly in the summer on windy days and hot humid days. A better method of disposing this effluent should be considered.

Holding and septic tank disposal on open fields.

Water at Fish Creek Beach is noticeably polluted.

Needs municipal sewerage treatment.

Downtown Fish Creek cottages, apartments and businesses are not able to handle sewage in summer.

Problems in the water front area.

Mound septic tank systems built or near bedrock on top of cliff, overlooking Juddville Bay, on southwest corner of the Town of Gibraltar should be checked for proper functioning.

High water over level of drain fields along beach front speed ~~eutrofication~~ eutrophication of harbor and Green Bay.

Septic tanks discharging to the ground. These are located throughout the community. Some very old places on cottage row have cess pools and little or no drainage fields.

Holding tanks should be sealed only to be opened by licensed pumpers..

The whole area should be put on a sewerage system.

Village of Fish Creek in July and August. Dock and beach area visible debris, sewage at times Kangaroo Lake - West side - seepage from field which receives hauled sewage.

During holiday weekends the odors coming from the Tavern and C. C. Club indicate insufficient waste system for the peak crowds.

Polluted conditions in Village of Fish Creek. Direct discharges to Green Bay and Lake Michigan.

Need extreme caution to avoid overloading what the land can handle, especially in development areas.

Very concerned about the entire pollution problem in Green Bay. It seems to be getting worse rather than better.

A number of old inadequate septic systems on nearby properties.

In Door County land disposal of human raw sewage is a threat to human health.

All holding tank sewage should be treated by conventional method in light of potential Public Health Risk involved.

Seepage is occurring frequently along with overflowing from adjoining properties. Must be corrected soon.

Ephraim

Absolutely! Wastewater disposal is at a crisis level in the Ephraim area, unsafe. In 1977 there was a hepatitus case in our home and right now my son is in Childrens Memorial Hospital with an intestinal problem that is being checked. Why hasn't sewer gone in along time ago? I fear the deposit pouring in the bay where our children swim. Someone ought to take well and beach water samples in August.

Areas along shoreline.

General inspection of existing septic facilities. Supervision of holding tank effluent disposal.

The whole water front.

The whole village needs sewer and water.

I feel all towns in Door County need a sewer system.

Septic systems at water level are increasingly troublesome as more buildings (and more holding tanks) are located along the shoreline.

Inadequate supervision of disposal of holding tank effluent. Use of secondary treatment systems such as Sister Bay to justify promiscuous building of condominiums which contribute heavily to dumping inadequately treated sewage into Green Bay.

Lack of satisfactory depths of proper soil for installation of septic system makes it worthwhile trying to install sewer lines.

Bedrock, very high water table, creviced bedrock on bluff east of Village and entire length of Highway 42, the business district.

Lower Village along lakeshore is reported to have problems.

Shore cottage with inadequate septic systems.

High groundwater levels, particularly low shoreline areas.

Ephraim needs additional public toilets for the tourist season at public beach, Firehouse Dock, Anderson Dock.

We need a Village system.

Overloaded and/or inadequate septic field, inadequate public rest-room facilities contributing to overloading of septic systems at business locations. Definitely would prefer sewer system.

(Suspect two neighboring cottages have failing systems)

Am sure the long range answer is a sewage treatment system for the area.

Ephraim is noted for this problem.

Old defective septic systems.

I am concerned over the pumping of raw sewage in downtown Ephraim. The odor is in the Village and to dump this sewage on open farm fields and orchards is dangerous. I also heard that some is dumped over cliff sides. There must be some other way.

Center Village has questionable soil for septic systems.

Stagnant ditch along Larson place.

Wastewater along shore in the North part of Town.

Ephraim needs additional public toilet facilities for the tourist season, located at public beach, Firehouse Dock and Anderson Dock.

I am sure these are due to occasional odors detected throughout the community. Mostly noticed in times of heavy tourist influx.

Drainage pipe from area south of Highway 42 empties into Bay at our property line.

Need for sewage collection/treatment system, and safe water supply.

In my opinion, the Peninsula Park golf course is a major pollution source to Eagle Harbor from septic system, and fertilizer draining from the course to the harbor.

Drinking water on shore in Ephraim is questionable.

Boats at Anderson Dock.

I think the hotels and motels and Condos that have high population density should not expect one house on 3+ acres to help pay for their problems solution via taxes! ~~On~~ or an assessment on a front foot basis.

Community need group sanitary sewer ~~or~~ or holding tanks.

Large metal drain pipe draining swamp in Ephraim which discharges directly onto our beach.

Boats polluting Bay, human faces floating in the public beach area, for example.

Direct drainage into lake.

There should be a central sewerage and water treatment facility.

Baileys Harbor

There is no planning for the future need of the community or expansion and development of dwelling will create serious disposal problems in next 15-20 years.

Entire Main Street.

One of the major concerns is the surface disposal of holding tank material throughout the County.

In North Bay close to the lake. Should septic tanks be allowed? I often wonder if they are OK or if it leaches anything out into the water.

The misuse of holding tanks, outdated septic systems, the dumping of Baileys Harbor laundry and other holding tanks in the area low ~~lands~~ lands.

Downtown Main Street.

Holding tank pumpings discharged on shallow soils.

Continuous pump-outs of small holding tanks are a nuisance - also the dumping areas are unsatisfactory.

Florian II, Blue Ox, Baileys Harbor Laundry, Frontier Bar.

Downtown Baileys Harbor has old septic tanks that overflow onto street ~~where~~ when it rains.

We could use a good primary disposal system especially if we should live there year round, and need laundry and shower drainage.

The whole town needs water/sewer.

Bad odors (on the) three Main Streets of Baileys Harbor on occasion.

Many cottages on Kangaroo Lake have outdoor privy's - definitely not systems required by todays legal standards.

There has been some question of disposal of contents of holding tanks. It should be taken to disposal system rather than dumped on fields.

(Neighbors let water run onto adjacent properties, most of the year)

I suggest that all septic systems surrounding Kangaroo Lake should be tested for discharge into the lake.

Wet ground over seepage fields after heavy rains in the summer.

Response to Question #5

Gibraltar

Sometimes overloaded - seasonal user.

Overloaded in summer - seasonal user

Prohibits use of washer, showers, etc. - weekender

Ephraim

Overloaded, wet ground, and odor in Fall.

Ocasional wet ground over field in the summer.

Overloaded, wet ground over field and odors in the summer.

Overloaded in the summer.

Water level over septic tank in Spring.

Baileys Harbor

Inconvenient (Privy)

Overloaded in Summer.

Overloaded in Summer.

Saturated ground over septic field.

Overloaded in Spring.

APPENDIX B

Septic Leachate Survey
Door County, Wisconsin

#667

MEMORANDUM

To: Ms. Bobbie Lively
USEPA Project Officer

Date: 26 February 1980

From: Warren J. Buchanan, Jr. wjb
WAPORA Project Manager

Ref: Mr. Chuck Burney

Cc: Dr. William Kerfoot
Mr. Steve Jankowski
Mr. Phil Stecker
Mr. Phil Woerfel
Mr. Len Montie
Mr. Bill Barry

Subject: WAPORA comments to be appended to the final report prepared by K-V Associates on the septic leachate survey, Middle Door County, Wisconsin

1) The statements throughout the report that infer effluent-related bacterial contamination of drinking water wells are based largely on the USGS publication on Door County water supplies by Sherrill (1978). There is general agreement among state and local officials that conclusive evidence is lacking to substantiate such inferences. Therefore, such statements concerning the correlation of failing on-site treatment systems and wellwater contamination should not be taken for granted.

2) The introduction of the report describes typical septic leachate plumes (page 2). It should be noted that throughout much of the study area, the fissured dolomite substrate causes an atypical transport, dilution, and attenuation of septic leachate and an atypical manifestation of plumes, as described on page 11.

3) The description of traditional causes of septic system failures (page 4) is not completely relevant to the situation in the study area. A major cause of septic system failure in the study area is the too-rapid drainage of the septic fields into the fissured bedrock.

4) The description of wellwater sampling (page 10) states that the samples were taken from cottages "representative of the communities survey(ed)." Most well samples, however, were taken from motels; from deep, cased wells; and from shoreline areas. The wellwater survey, therefore, should not be construed as a statistically representative and complete survey. Because no effluent-related contamination was identified, the absence of septic contamination of wellwater may seem to be indicated. This is contrary to statements made elsewhere in the report. It must be emphasized that the survey methods were not adequate to develop any definitive conclusions.

It is noteworthy that Dr. Kerfoot made a qualitative judgement that some organic contaminant other than domestic wastewater was present in some wellwater, based on its odor. He verbally recommended a thorough chemical analysis.

5) The discussion on the percentage breakthrough of leachate plumes (pages 36-38) has limited value because the effects of the fissured dolomite on the septic leachate breakthrough largely are unknown. There is no way to attribute

the breakthrough points detected along the shoreline to a single source or to many sources inland. It was acknowledged that the groundwater flows that transport the leachate were impossible to measure in many instances because of the rocky substrate. Therefore, the rate of pollutants leaching to the surface waters cannot be determined. The conclusions that can be drawn are that:

- septic leachate plumes were present, signifying some amount of effluent-related groundwater and surface-water pollution;
- high bacterial populations were associated with a few of these plumes;
- significant organic contamination was found to be associated with wetland discharges elsewhere in the study area.

6) Conclusion 2 (page 45), which correlates background conductivity in Baileys Harbor-Eagle Harbor and Egg Harbor-Tennison Bay to the frequency of wastewater plumes is inadequately supported by the data. Only two background samples were recorded for Egg Harbor and none were recorded for Tennison Bay (Table 1). Dr. Kerfoot, however, advised WAPORA that such relationships between background conductivity and frequency of plumes is common.

7) The timing of the survey in October, after the tourist season, may be subject to question. Dr. Kerfoot, however, was confident that the lag between the time that septic leachate indicators entered the groundwater system and the time they were discharged along the shoreline was sufficient to permit detection of the contamination from the seasonal peak. Furthermore, discharge points that were no longer active were accounted for because inactive discharges also were detected readily as dormant plumes.

SEPTIC LEACHATE SURVEY

DOOR COUNTY, WISCONSIN

October 1979

Prepared for

WAPORA, Inc.
Chicago, Illinois

Prepared by

K-V Associates, Inc.
281 Main Street
Falmouth, Massachusetts 02540

January 1980

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1.0 INTRODUCTION

Door County is located along the western shores of Lake Michigan and is the principal eastern shoreline of Green Bay. The county has a permanent population of about 20,000 while another estimated 50,000 visit the peninsula resort areas as summer residents or tourists. The high bedrock of Silurian dolomite limestone and thin topsoils are not well-suited to wastewater disposal through septic tank absorption systems which service most residences in the area. Chemical and indicator coliform bacteria content of groundwater recharge are public concerns that threaten private water supplies. In support of the Environmental Impact Statement concerning sewering needs evaluation, this report presents the results of a comprehensive septic leachate survey performed during October, 1979. The study covered populated shoreline areas in Egg Harbor, Fish Creek, Eagle Harbor, Sister Bay, North and Moonlight Bays, Baileys Harbor, and inland Kangaroo Lake.

1.1 Effluent Plume Theory

In porous soils, groundwater inflows frequently convey wastewaters from nearshore septic units through bottom sediments and into lake waters, causing attached algae growth and algal blooms. The lake shoreline is a particularly sensitive area since: 1) the groundwater depth is shallow, encouraging soil water saturation and anaerobic conditions; 2) septic units and leaching fields are frequently located close to the water's edge, allowing only a short distance for bacterial degradation and soil adsorption of potential contaminants; and 3) the

recreational attractiveness of the lakeshore often induces temporary overcrowding of homes leading to hydraulically overloaded septic units. Rather than a passive release from lakeshore bottoms, groundwater plumes from nearby on-site treatment units may actively emerge along shorelines, raising sediment nutrient levels and creating local elevated concentrations of nutrients. The contribution of nutrients from subsurface discharges of shoreline septic units has been estimated at 30 to 60 percent of the total nutrient load in certain New Hampshire lakes, (LRPC, 1977).

The capillary-like structure of sandy, porous soils and horizontal groundwater movement induces a fairly narrow plume from malfunctioning septic units. The point of discharge along the shoreline is often through a small area of lake bottom, commonly forming an oval-shaped area several meters wide when the septic unit is close to the shoreline. In denser subdivisions containing several overloaded units, the discharges may overlap forming a broader increase. (See Figure 1)

1.1.1. Groundwater Plumes

Three different types of groundwater-related wastewater plumes are commonly encountered during a septic leachate survey: 1) erupting plumes, 2) passive plumes, and 3) stream source plumes. As the soil becomes saturated with dissolved solids and organics during the aging process of a leaching on-lot septic system, a breakthrough of organics occurs first, followed by inorganic penetration (principally chlorides, sodium, and other salts). The active emerging of the combined organic and inorganic residues into the shoreline lake water describes an

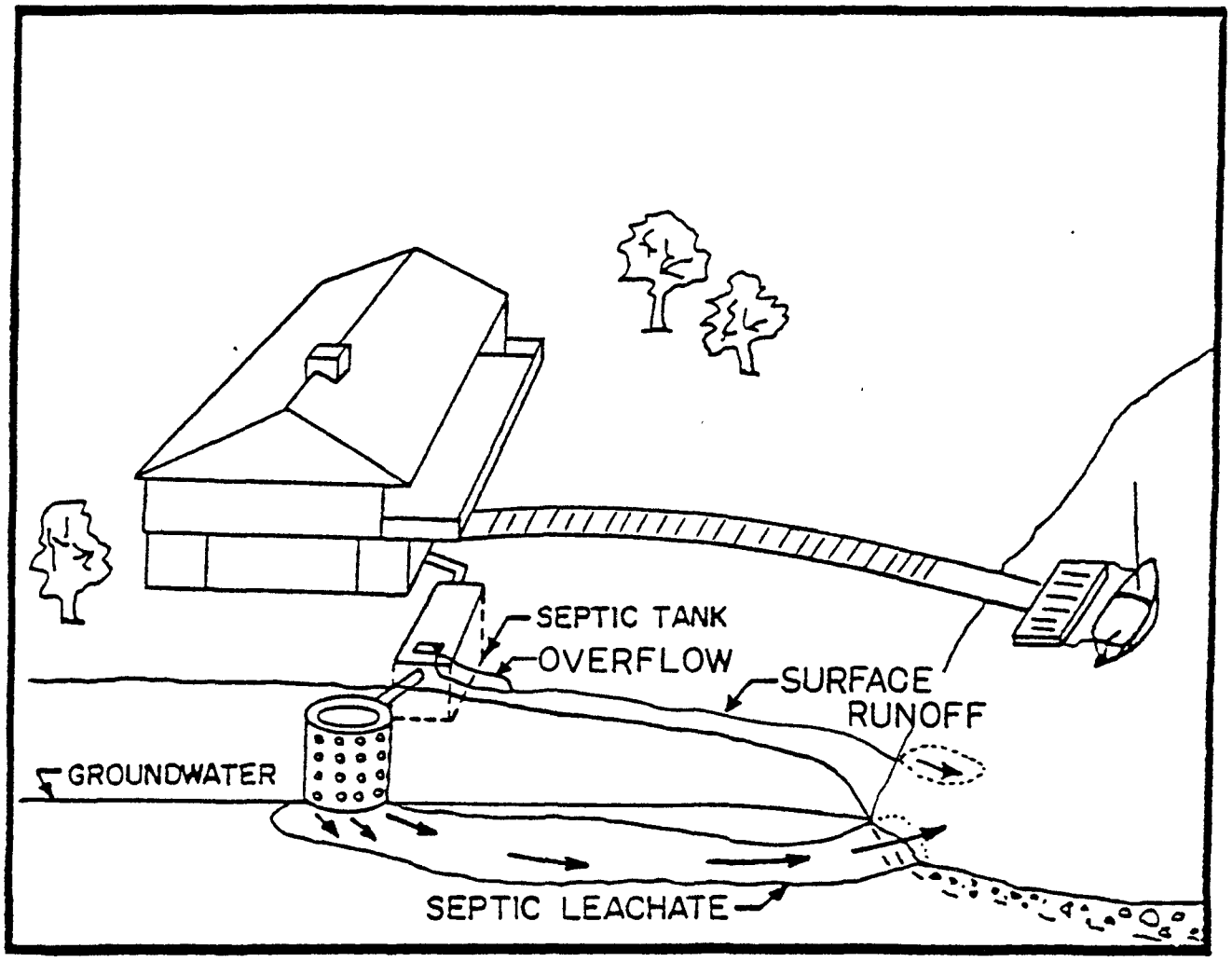


Figure 1. Excessive loading of septic systems causes the development of plumes of poorly-treated effluent which may 1) enter nearby waterways through surface runoff or which may 2) move laterally with groundwater flow and discharge near the shoreline of nearby lakes.

erupting plume. In seasonal dwellings where wastewater loads vary in time, a plume may be apparent during late summer when shoreline cottages sustain heavy use, but retreat during winter during low flow conditions. Residual organics from the wastewater often still remain attached to soil particles in the vicinity of the previous erupting plume, slowly releasing into the shoreline waters. This dormant plume indicates a previous breakthrough, but sufficient treatment of the plume exists under current conditions so that no inorganic discharge is apparent. Stream source plumes refer to either groundwater leachings or near-stream septic leaching fields which enter into streams which then empty into the lake.

1.1.2 Runoff Plumes

Traditional failures of septic systems occur in tight soil conditions when the rate of inflow into the unit is greater than the soil percolation can accomodate. Often leakage occurs around the septic tank or leaching unit covers, creating standing pools of poorly-treated effluent. If sufficient drainage is present, the effluent may flow laterally across the surface into nearby waterways. In addition, rainfall or snow melt may also create an excess of surface water which can wash the standing effluent into water courses. In either case, the poorly-treated effluent frequently contains elevated fecal coliform bacteria, indicative of the presence of pathogenic bacteria and, if sufficiently high, must be considered a threat to public health.

1.2 Special Survey Technique and Equipment

Wastewater effluent contains a mixture of near-UV fluorescent organics derived from whiteners, surfactants and natural degradation products which are persistent under the combined conditions of low oxygen and limited microbial activity. Figure 2 shows two samples of sand-filtered effluent from the Otis Air Force Base, Massachusetts, sewage treatment plant. One was analyzed immediately and the other after having been held in a darkened bottle for six months at 20°C. Note that little change in fluorescence was apparent, although during the aging process some narrowing of the fluorescent region did occur. The aged effluent percolating through sandy loam soil under anaerobic conditions reaches a stable ratio between the organic content and chlorides which are highly mobile anions. It is this stable ratio (conjoint signal) between fluorescence and conductivity that allows ready detection of leachate plumes by their conservative tracers. Such identified plumes are an early warning of potential nutrient breakthrough or public health problems. The septic leachate detector instrument utilizes this principal.

Septic surveys for shoreline wastewater discharges are conducted with a septic leachate detector, ENDECO^{R} Type 2100 "Septic Snooper"^{TM}, and the K-V Associates, Inc. "Dowser"^{TM} Groundwater Flow Meter. The leachate detector unit can be operated out of any small rowboat. It consists of the subsurface probe (water intake system), the analyzer control unit, and an analog stripchart recorder. Initially the unit is calibrated against incremental additions of wastewater effluent of

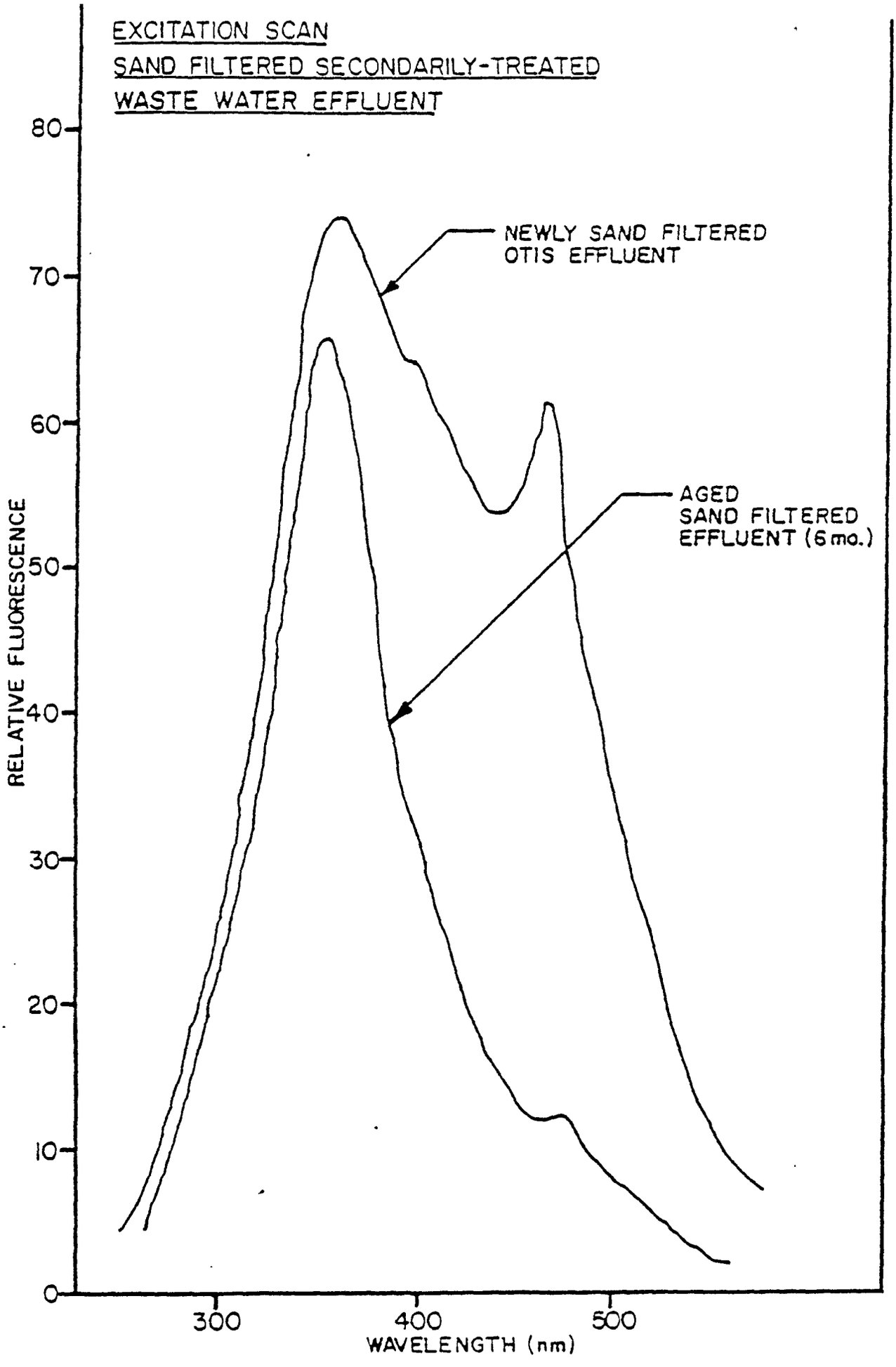


Figure 2. Sand-filtered effluent produces a stable fluorescent signature, here shown before and after aging.

the type to be detected to the background lake water. The pump end of the probe unit is then submerged in the lake water along the near shoreline. Groundwater seeping through the shoreline bottom is drawn into the screened intake of the probe and travels upwards to the analyzer unit. As it passes through the analyzer, separate conductivity and fluorescence signals are generated. The responses are sent to the signal processor which registers the separate signals on a strip chart recorder as the boat moves forward. The analyzed water is continuously discharged from the unit back into the receiving water. The battery-powered unit used for field studies can record individual fluorescence and conductivity or a combination signal. It has also been modified to operate under the conductivity conditions encountered in the field.

Well-point sampling of groundwater and bacterial sampling of surface run-off complement the leachate detector scan, surface water sampling and groundwater flow vector measurements for the complete survey.

2.0 METHODOLOGY - SAMPLING AND ANALYSIS

The septic leachate survey covered the unsewered populated shorelines of Egg Harbor, Eagle Harbor, Baileys Harbor, Fish Creek, North Bay, and Kangaroo Lake. Sewered and unsewered sections of Sister Bay shoreline were also investigated. Separated dwellings dot the more exposed rocky coastlines, while crowded cottages and business establishments mark the sandy inner shores of the harbor areas.

The objectives of this survey were:

1) To perform a shoreline scan of selected populated sections of several coastal communities for evidence of septic leachate (nutrient) intrusion from on-lot septic systems.

2) To take discrete water samples for subsequent nutrient analysis only at those locations of alleged effluent plumes revealed by the leachate detector instrument.

3) To take bacteria samples for fecal coliform analysis from all moving surface tributaries or exceptionally high shoreline effluent plumes.

4) To make groundwater flow measurements in the shallow holes in the loose sand shoreline of the study areas.

5) To make visual observations relevant to sources of lake water degradation.

This survey was executed during the period of October-November 1979. Daytime temperatures ranged, from 10° to 20°C with winds from 0-25 knots.

2.1 Procedure

Each harbor area was shoreline-scanned in a continuous counter-clockwise direction. The entire shoreline of Door County was not surveyed; rather, those specific sections around principal northern communities where density of settlement would likely give rise to significant pollution problems. The survey team consisted of two technicians and light-weight mobile survey gear. The basic equipment platform was a 14-foot aluminum boat with small outboard. The septic leachate detector instrument was securely lashed to a boat seat with shock cords and the water intake and exhaust tubes were extended over the starboard gunnel. A 12 vdc gel-cell battery provided electrical power to the instrument and submersible pump. The centrifugal water pump at the end of the 5-foot long metal tube intake wand drew near-bottom water through the instrument detector chamber and out a flexible plastic discharge tube from which retained samples could be taken.

A large ice chest held chilled water samples as well as supplies and maintenance gear. Groundwater specimens were drawn through a rugged stainless steel well-point sampler developed by K-V Associates, Inc. This 3/8 inch bore tube had 2½ foot threaded segments to accomodate different water and ground penetration depths. It was fitted with a slotted and pointed tip section. A 10-pound tubular steel hammer was used to drive the point into the sandy bottom at depths of up to 2 feet. Water flowed easily at this depth, but was impeded somewhat below this depth by finer, less permeable sand. Groundwater samples were drawn from bottom sediments of those locations displaying a high relative fluorescence signal. Interstitial water was extracted via

simple hand vacuum pump and large plastic receiving chamber. The captured groundwater could then be readily decanted apart from entrained sand and bottled for later analysis.

In summary the two-man team walked or motored the boat around the lake within 15 feet of shore in shallow water. Background or plume samples were taken as required. Specific conductance of each sample was measured as the water was prefiltered and bottled. Relative fluorescence and conductivity were continuously plotted on separate strip recorders with positional cross references to the sewer planning map of the lake. (See Figure 3a through k for sampling locations.)

2.2 Sample Handling

Both ground and surface water samples for nutrient analysis were retained in 250 ml clean plastic bottles. Each sample was prefiltered with .45 µm filters on the boat and acidified with sulfuric acid for preservation at the end of the sampling day following the procedures outlined by EPA Standard Methods.

Bacteria samples were captured in similar sterilized 250 ml plastic bottles and shipped to Badger Laboratories & Engineering Co., Inc. (Appleton, Wisconsin) for fecal coliform analysis.

2.3 Calibration

The shoreline scanning work day began with a calibration of the septic leachate instrument. Two solutions were required: the first, a background sample drawn from an assumed unpolluted central portion of the harbor area (here, water from offshore of Fish Creek served

for all calibrations in other areas); the second, a sample of local municipally treated effluent (Sister Bay Lagoon). The instrument was zero stabilized on background water and a response slope was established equal to a change of 50% of full scale for organics and 24% of scale for inorganics with 2% addition of local effluent in background water. This spiked solution was injected by syringe into the instrument detection chamber. Inorganics (conductivity) sensitivity was at a maximum level and could not be increased further to exact parity with the more responsive fluoresence.

2.4 Well Water Sampling and Groundwater Flow Measurement

Several well water samples were taken from cottages representative of the communities survey. These drinking water specimens were analyzed for signs of nutrient contamination from pollutant infiltrated groundwaters. Groundwater transport vectors were studied with the K-V Associates, Inc. Dowser instrument. Shallow bedrock and pebbly soils were limitations in obtaining this data on shallow soil flow. See section 7.0 for discussion of groundwater flow findings.

2.5 Water Analysis

All water samples were analyzed by EPA Standard Methods for the following chemical constituents:

Nitrate nitrogen (as combined NO_3-NO_2-N)

Ammonia nitrogen (NH_4-N)

Total phosphorous (TP)

Conductivity (μmhos/cm)

3.0 PLUME LOCATIONS

The Door County study area encompassed the populated shorelines of four coastal communities on the Green Bay exposure (Egg Harbor, Fish Creek, Eagle Harbor and Sister Bay), and three bay communities on the Lake Michigan exposure (Baileys Harbor, Moonlight Bay and North Bay), as well as an interior water body, Kangaroo Lake. The dominant geology is dolomite bedrock with bare outcropping along the outer shore and shallow silt or sand cover in more confined harbor areas which often abut low wetlands. The fractured substrate induces a fragmentation of plumes rather than encouraging discrete subsurface discharges characteristic of unconsolidated soils. For purposes of evaluation and consistent with our historical practice, a plume was judged to be a leachate detector signal excursion of at least 1% effluent equivalent of fluorescence and ½% of conductivity.

Egg Harbor

The Egg Harbor shoreline is primarily stone and bedrock with a shallow covering of silt soils. Two small plumes (26 and 27) were detected at opposite ends of the Alpine Resort in Egg Harbor. Groundwater samples were not available at several of these sites because of the underlying bedrock condition. The total phosphorus levels (.050 ppm) of 27 and 28 (near condominiums) are capable of sustaining algae growth which was already apparent on the rocks, even at location 26, though surrounding stones were free of vegetation.

Fish Creek

The resort village of Fish Creek has exposed bedrock along its western bank and low wet areas southeast of the populated harbor region.

Two small groundwater plumes and one larger stream source plume were detected in the interior harbor of Fish Creek. The rocky, exposed shoreline to the southwest gave no indication of any concentrated discharges. Sample 1S taken near a shore-front cottage revealed a very notable phosphorus concentration of 1.1 ppm. Fish Creek stream which drains Button Marsh showed significant nutrient intrusion and boron retention in its alluvial soils, indicating a very probable effluent connection.

Eagle Harbor

Eagle Harbor has a well-developed community in the town of Ephraim, and several small stream discharges provide drainage for Ephraim Swamp, a low-lying wetlands to the southeast. At least three stream sources (samples 5, 9, and 10) carried conductivity (inorganics) well above background, and total phosphorus levels somewhat above normal. Fluorescent scanning of these stream samples confirms a high fluorescence intensity, containing both bog discharge and effluent loadings. The other plume locations marked houses close to shore with distinct algae patches capping rocks in the vicinity of the detected discharge. Their groundwater total phosphorus levels were among the highest measured in the county, all above .092 ppm. The frequency of effluent discharges correlated with the elevated dissolved solids background, again the highest observed for a harbor area.

Sister Bay

Sister Bay, the largest community in northern Door County, has been sewered up to the Liberty Grove town line. Two distinct effluent plumes were located: one in the Sister Bay area in the vicinity of a gray contemporary cottage; and a second in Liberty Grove, a much stronger plume just below the Hotel du Nord, a high-capacity tourist facility. Here, the stone bottom was very slimy with thick algae. A phosphorus level

of .052 ppm and a fecal coliform count exceeding 1000 colonies/100 ml of water mark this as a strongly erupting source.

North Bay

North Bay is surrounded by wetlands and inhabited only along the western shoreline. The plume locations encountered during the continuous scan were found to have quite low total phosphorus (.005 - .018 ppm) and total nitrogen (.06 - .30 ppm) loadings. All samples showed a fluorescence discharge more characteristic of bog than effluent.

Moonlight Bay

Several groundwater nutrient plumes appeared in the vicinity of the delta formed by the creek draining Mud Lake. This region is uninhabited Deford loamy fine sand. A few homes are widely-spaced east and west of the creek, along the shores. Green algae (Cladophora) appeared discretely on a rock groin near the first house (sample 31) west of the creek. The fluorescent scan of creek surface water showed the pattern of bog content. The high ammonia level (~26 ppm) is indication of reducing conditions for decaying organic debris in non-flushed lake bottom sediments. Dwellings just north of highway Q along the creek may be effluent contributors, but it is more likely a broader nonpoint source like road runoff is responsible.

Baileys Harbor

Most of the shoreline of Baileys Harbor has shallow bedrock conditions with thin silt cover. The old sandy beaches to the north are sparsely populated and subject to high groundwater most of the year.

The most notable leachate plume in Baileys Harbor appeared in front of a commercial laundry effluent concrete holding tank. Sample 14 showed elevated conductivity (330 μmho/cm) but surprisingly low phosphorus and nitrogen values. As the nutrient content of underlying shallow groundwater in front of the tank exhibited even lower levels, the source could well be attributed to below-waterline flaws in the concrete tank. Effluent wash water from the tank has a high conductivity of 1800 μmho/cm and it is possible low phosphate detergents were used. A neighboring conduit pipe leading back towards Town Hall showed no sign of effluent and was not flowing.

A second, broad area discharge was confirmed over the known outfall from the Baileys Harbor Yacht Club treatment plant. Transect readings taken at various distances offshore map the pipe's discharge dispersion and substantiate the high bacteria count within this area. Survey water conditions were difficult on the northern shore due to turbid water caused by steady swells rolling in over the shallow sandy swales.

Kangaroo Lake

Kangaroo Lake is the largest freshwater lake in Door County. It is also very shallow and has a dam at the outlet. The areas immediately north and south of the lake are swamp lands of soft peat and muck soils, and were not surveyed. The silt bottom material around the lake is generally very thin, underlain by solid bedrock slabs. No plumes were revealed by the continuous septic survey. Nutrient levels in both the well water and background samples were low (TP below .022ppm and TN below 1.5 ppm). Septic leaching from shoreside dwellings, though highly suspect, could not be confirmed.

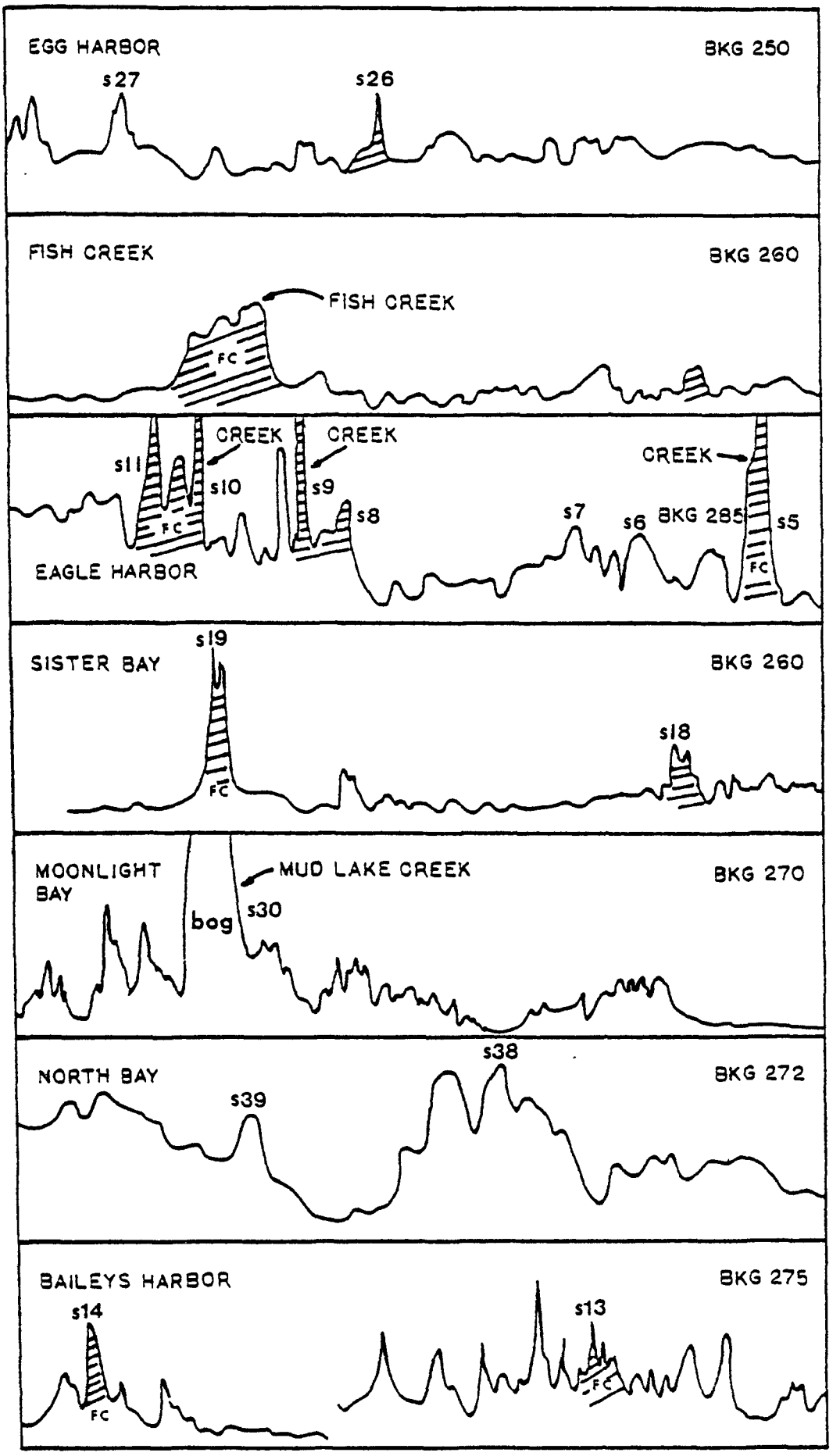


Figure 3. Profiles of equal length shorelines in each harbor, characterizing the frequency of confirmed effluent plumes with the dissolved solids concentration (in μmhos) found in background surface waters.

Figure 3a through k. Mappings of Egg Harbor, Fish Creek, Tennison and Shanty Bays, Eagle Harbor, Sister Bay, North Bay, Moonlight Bay, Baileys Harbor, and Kangaroo Lake showing start and finish of leachate surveys, sampling stations for bacteria, well water, and nutrients, and groundwater flow measurement locations.

Symbol code:

Nutrient sample station

Background nutrient sample station

Bacteria sample station

Well water sample station

Erupting plume

Dormant plume

Stream source plume

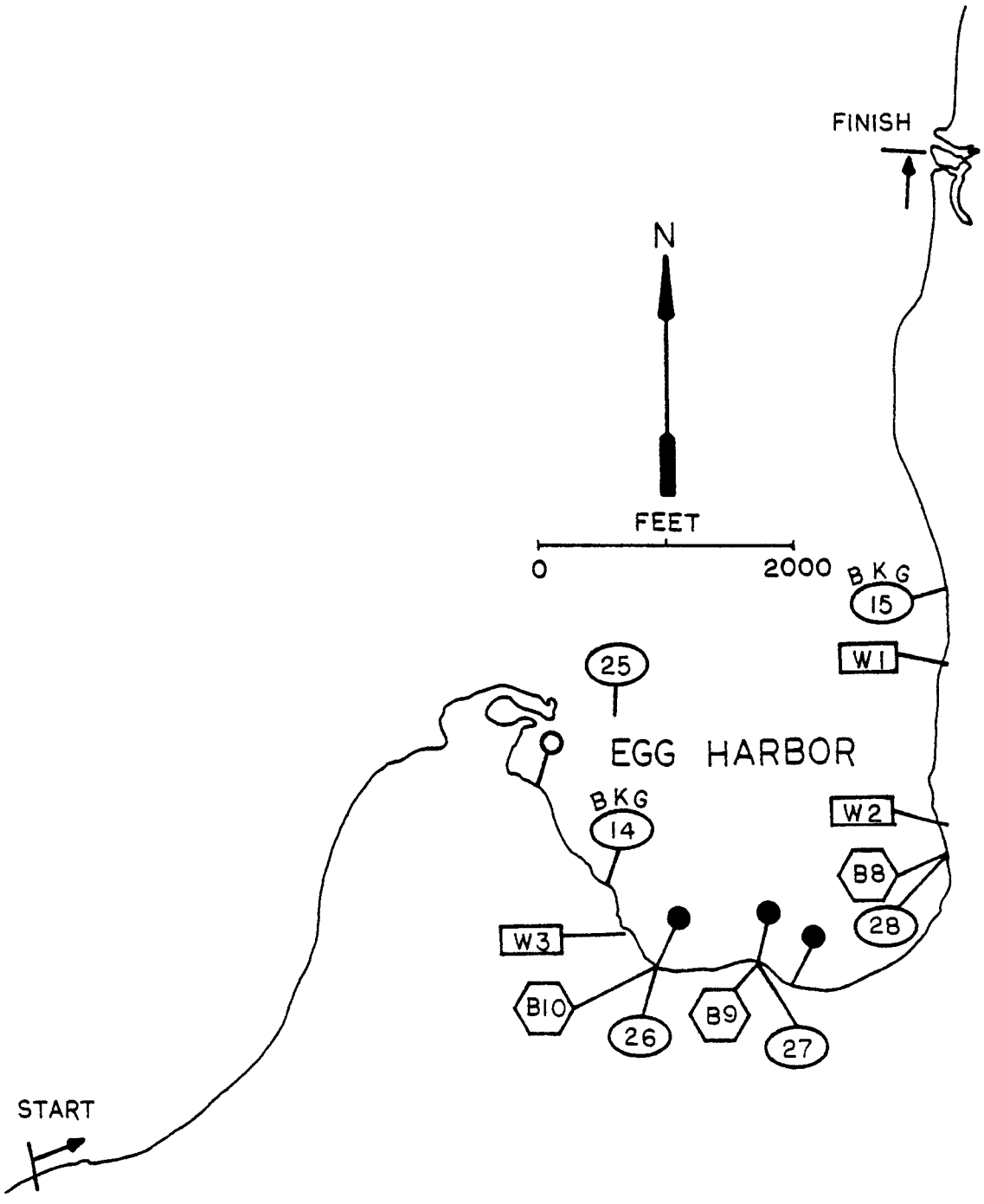

FINISH
N
FEET
0
2000
BKG
15
W1
25
EGG HARBOR
BKG
14
W2
B8
28
W3
B10
26
B9
27
START

Figure 3a

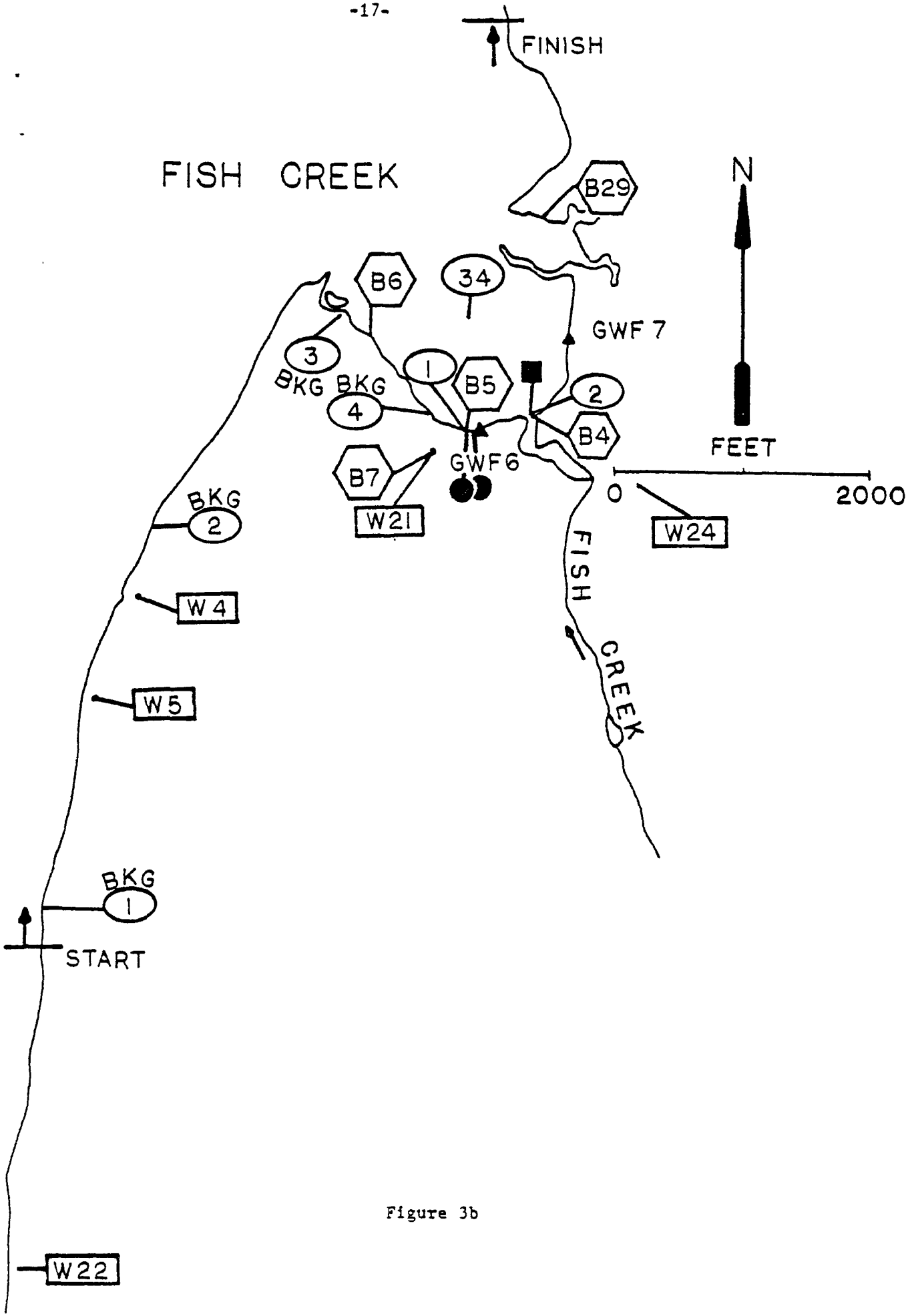

FINISH
FISH CREEK
B29
N
B6
34
GWF 7
3
BKG
BKG
1
B5
2
4
B4
FEET
B7
GWF6
0
2000
BKG
2
W21
W24
FISH
CREEK
W4
W5
BKG
1
START
W22

Figure 3b

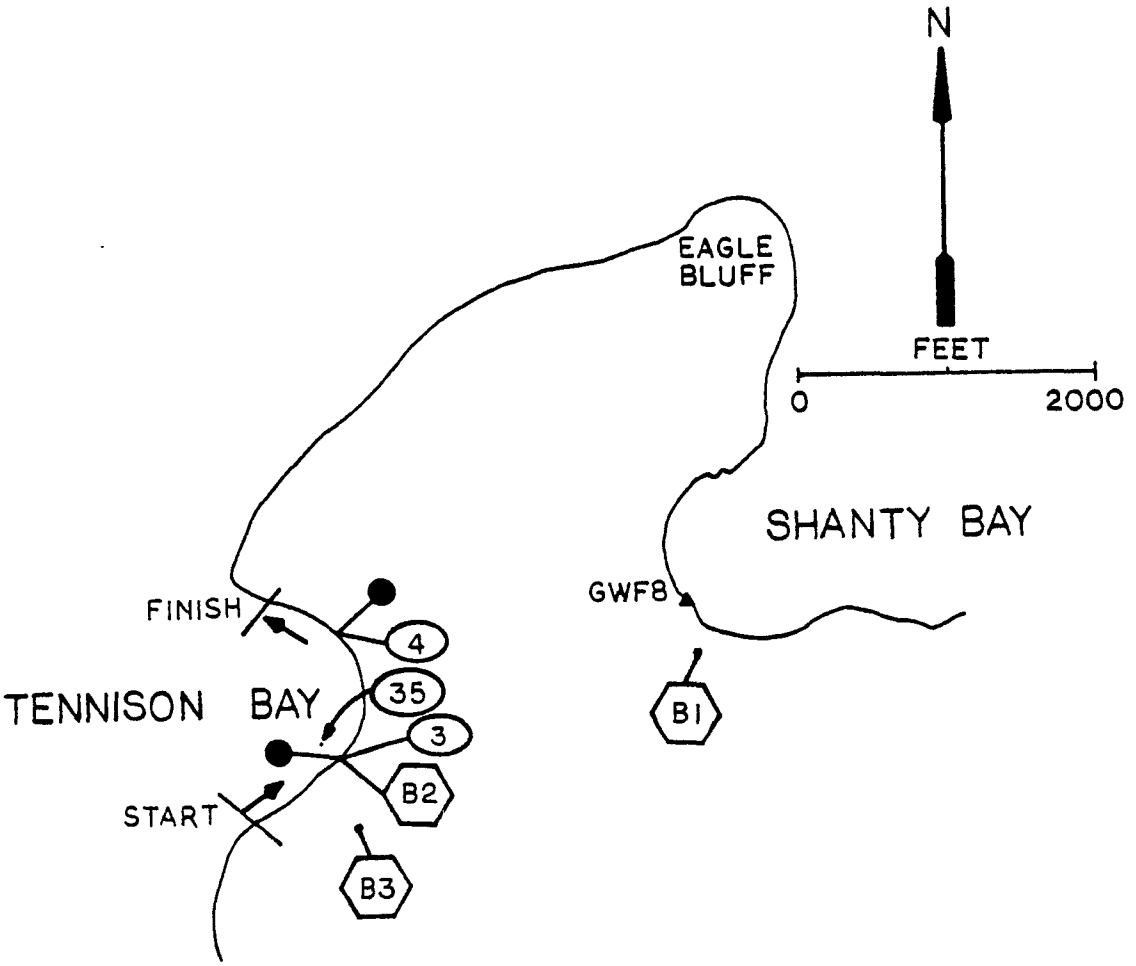

N
EAGLE
BLUFF
FEET
0
2000
SHANTY BAY
GWF8
FINISH
4
35
3
TENNISON BAY
B2
START
B3
B1

Figure 3c

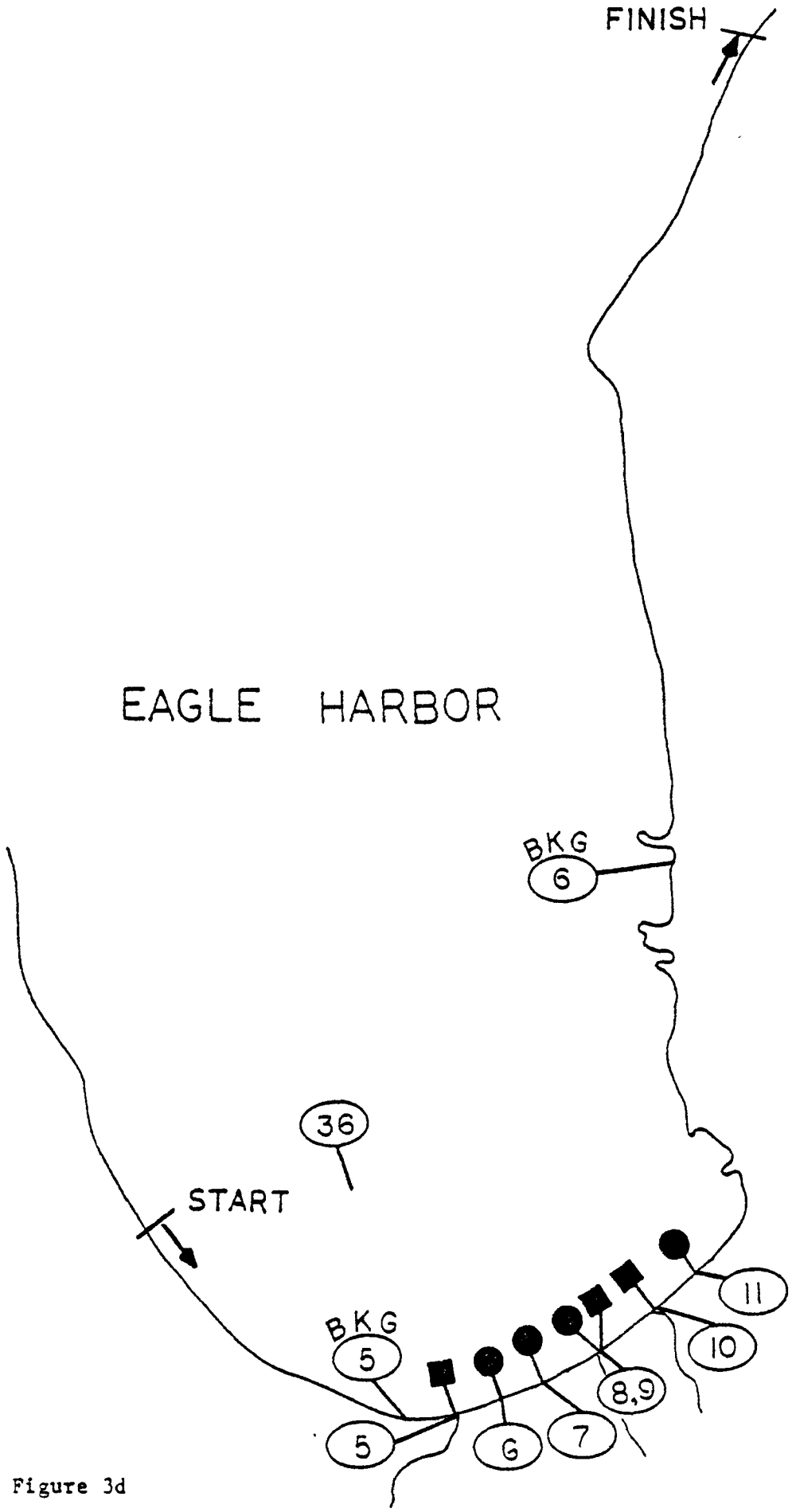


Figure 3d

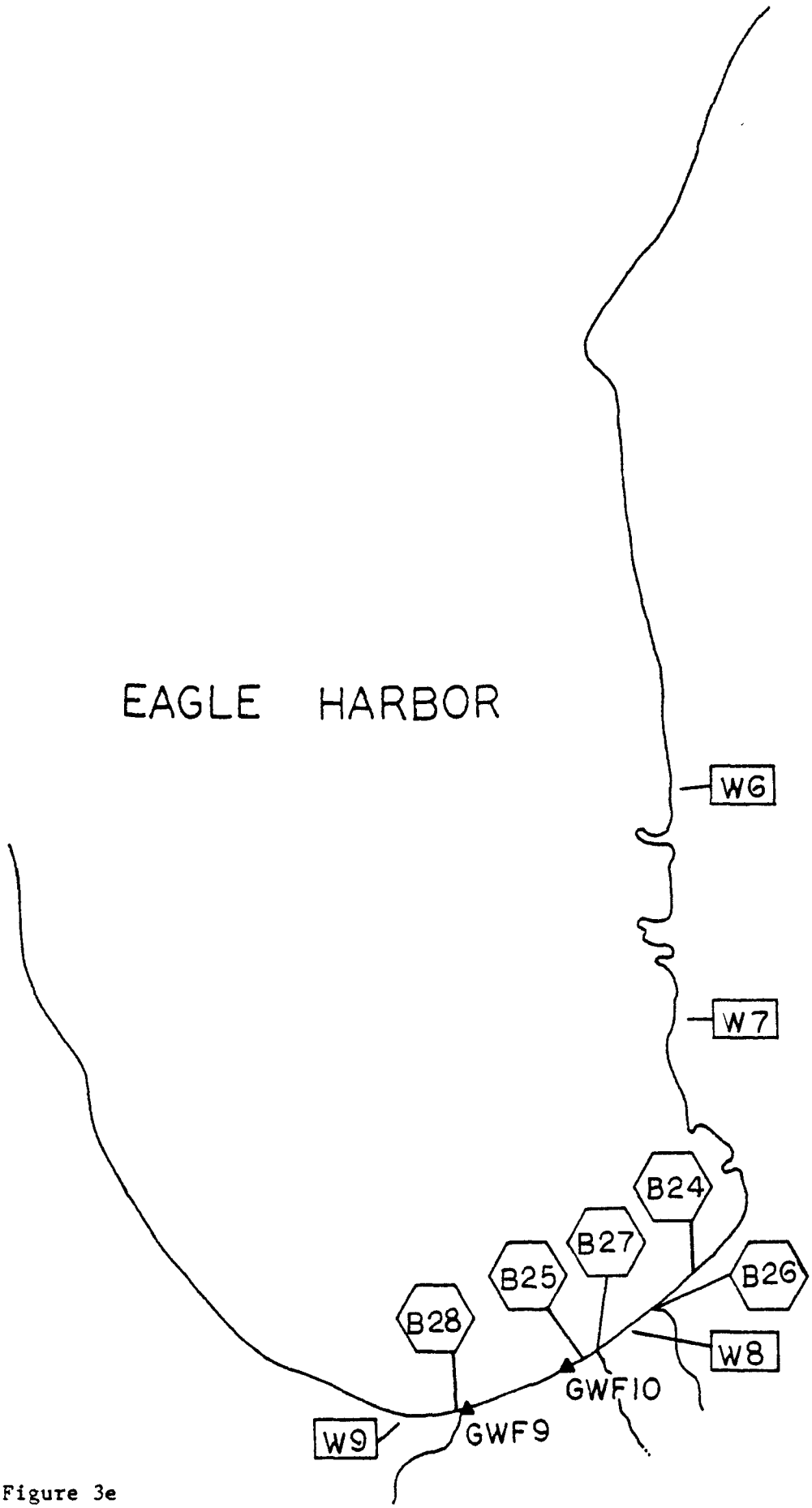


Figure 3e

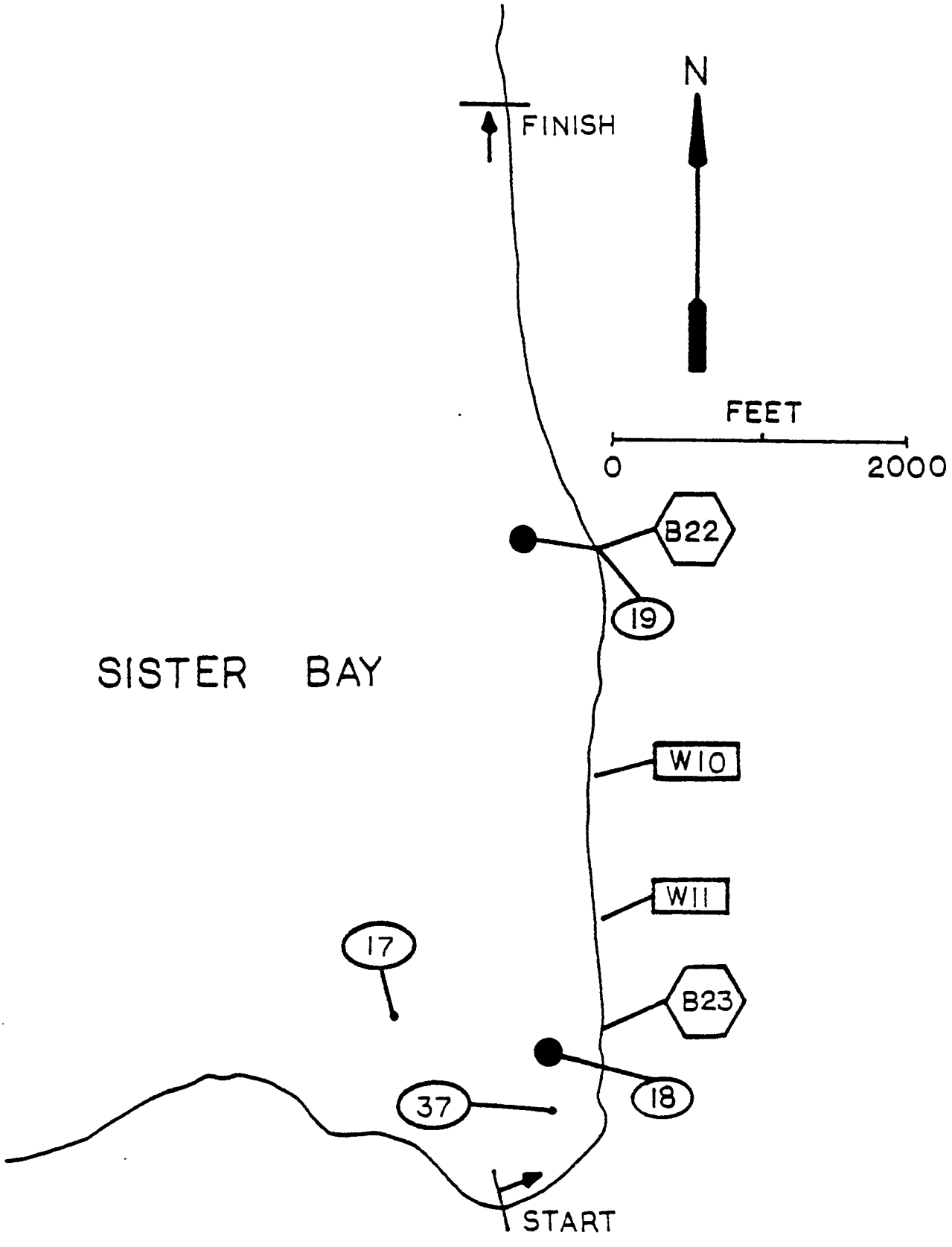

FINISH
N
FEET
0
2000
B22
19
SISTER BAY
W10
W11
17
B23
18
37
START

Figure 3f

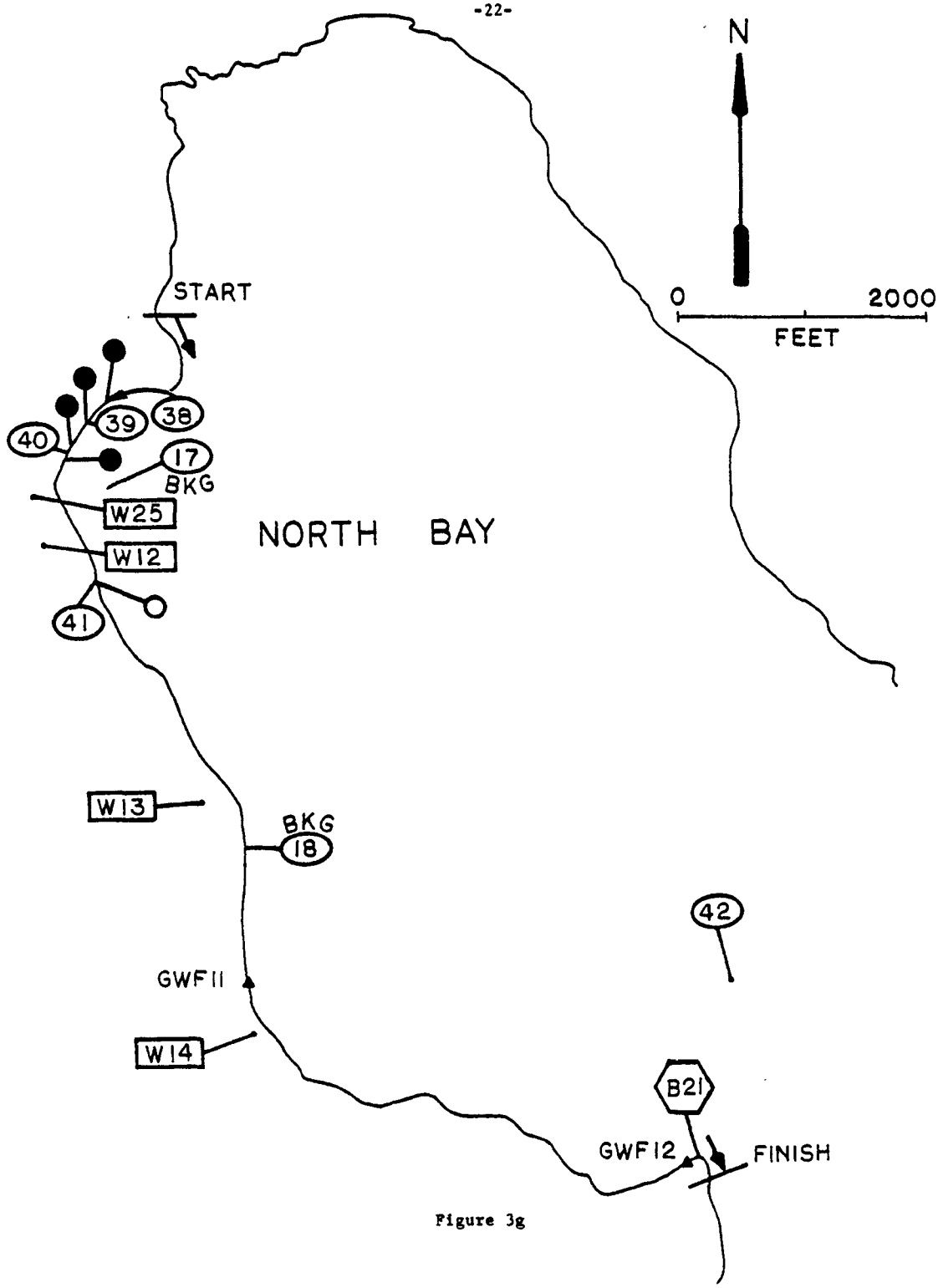

N
0
2000
FEET
START
39
38
40
17
BKG
W25
W12
41
NORTH BAY
W13
BKG
18
42
GWF11
W14
B21
GWF12
FINISH

Figure 3g

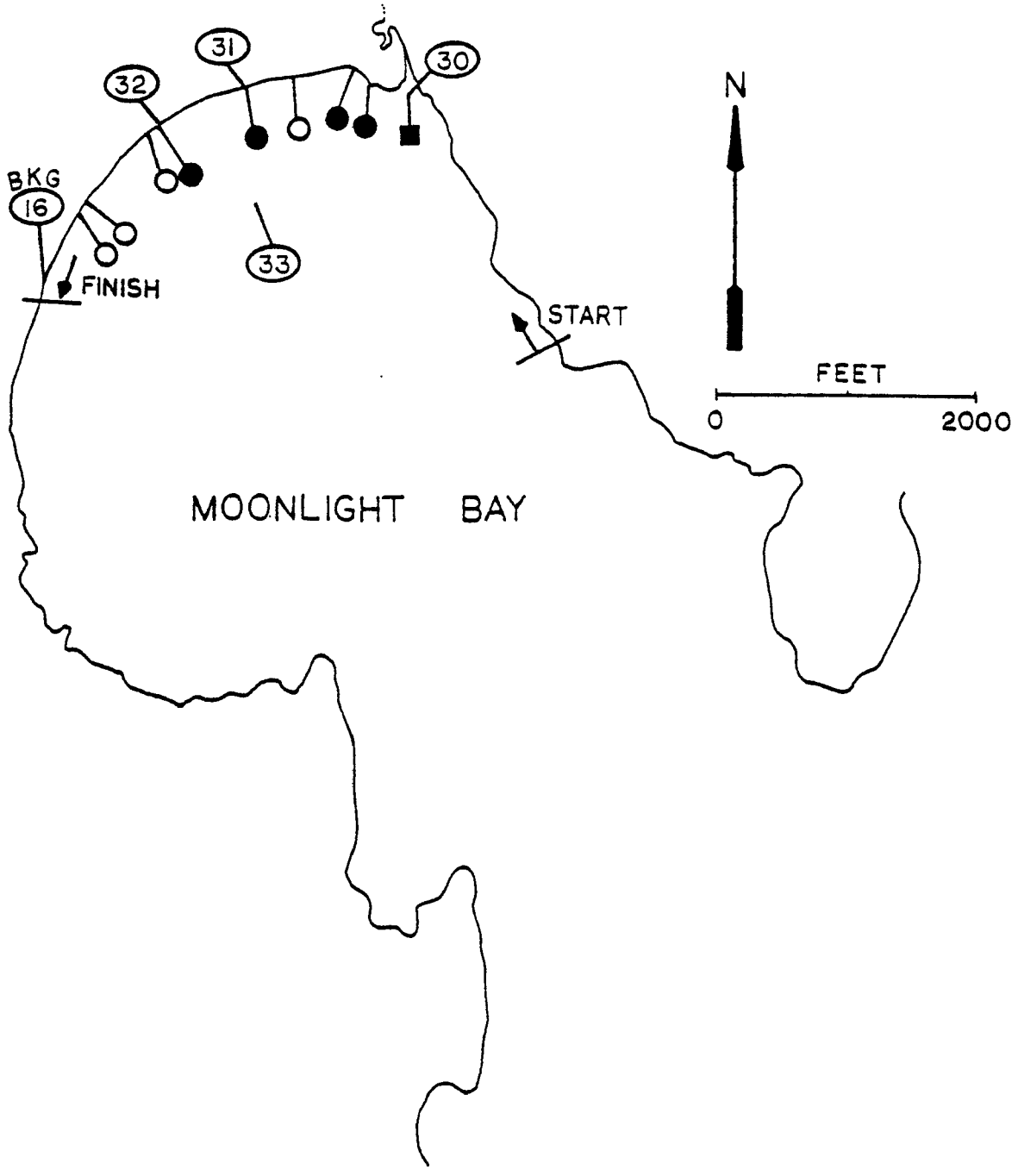


Figure 3h

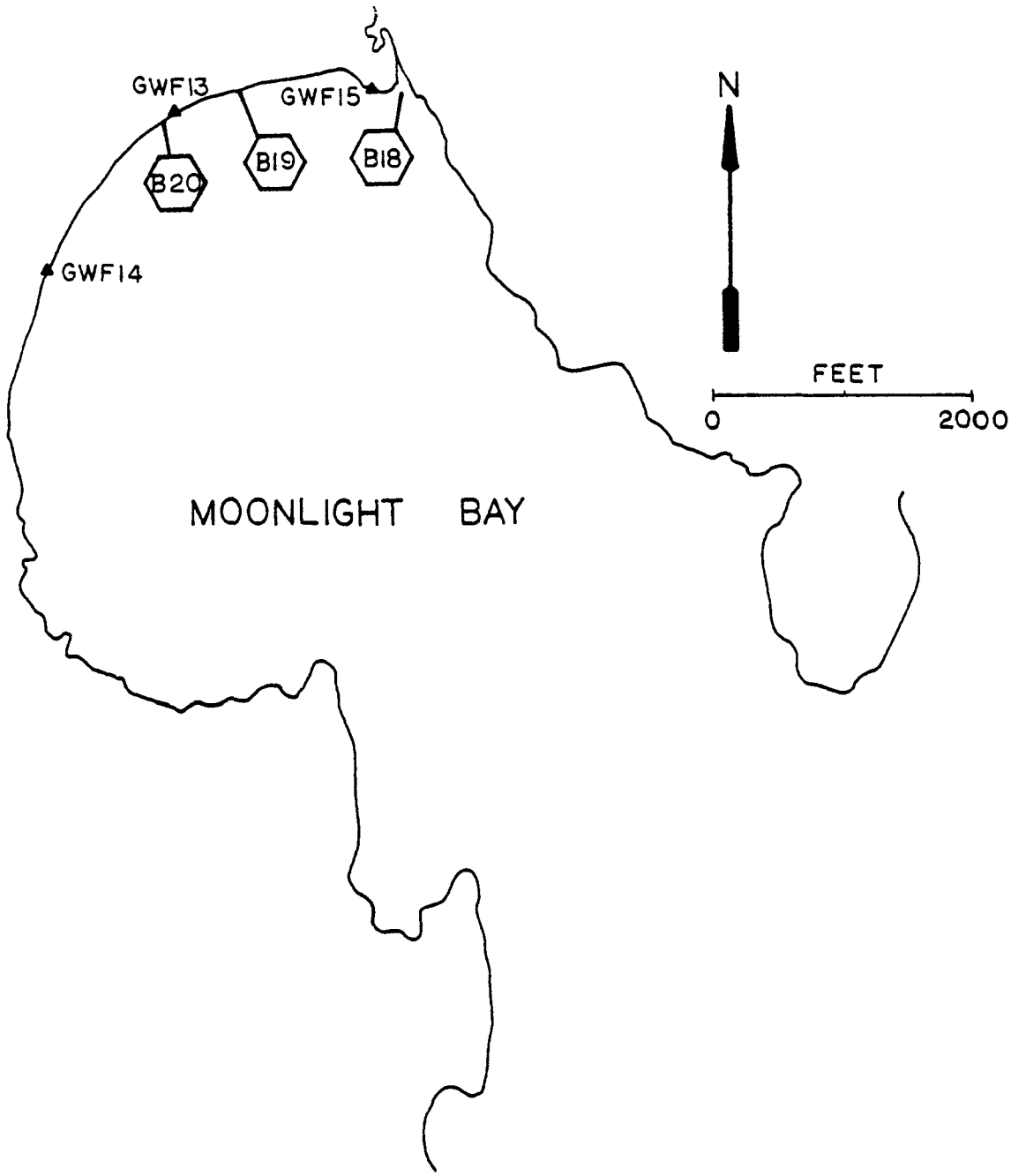


Figure 3i

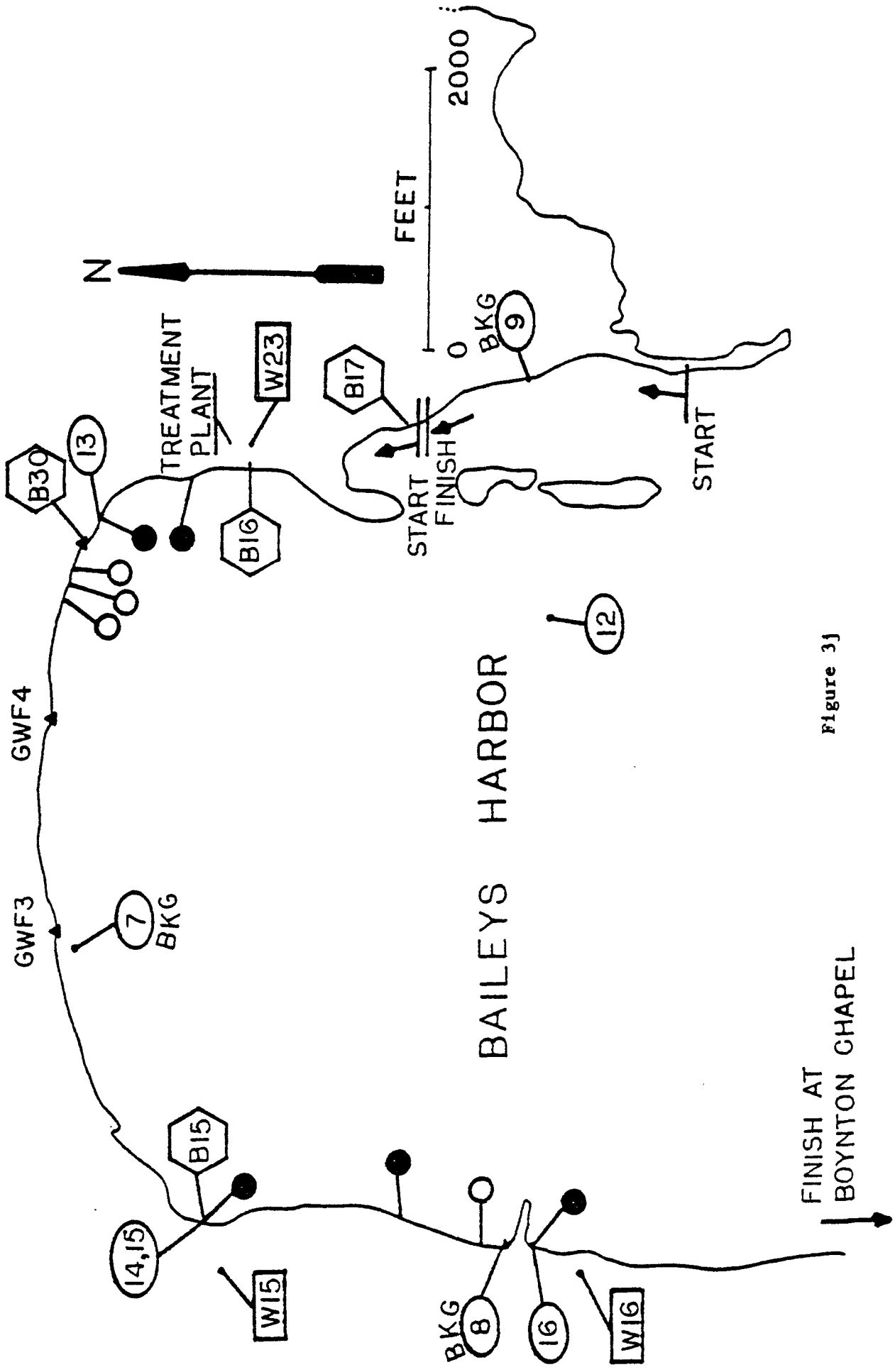

N
FEET
2000
0
BKG
9
START
FINISH
START
B17
W23
TREATMENT
PLANT
B16
B30
13
GWF4
GWF3
7
BKG
BAILEYS HARBOR
12
B15
14,15
W15
BKG
8
16
W16
FINISH AT
BOYNTON CHAPEL

Figure 3j

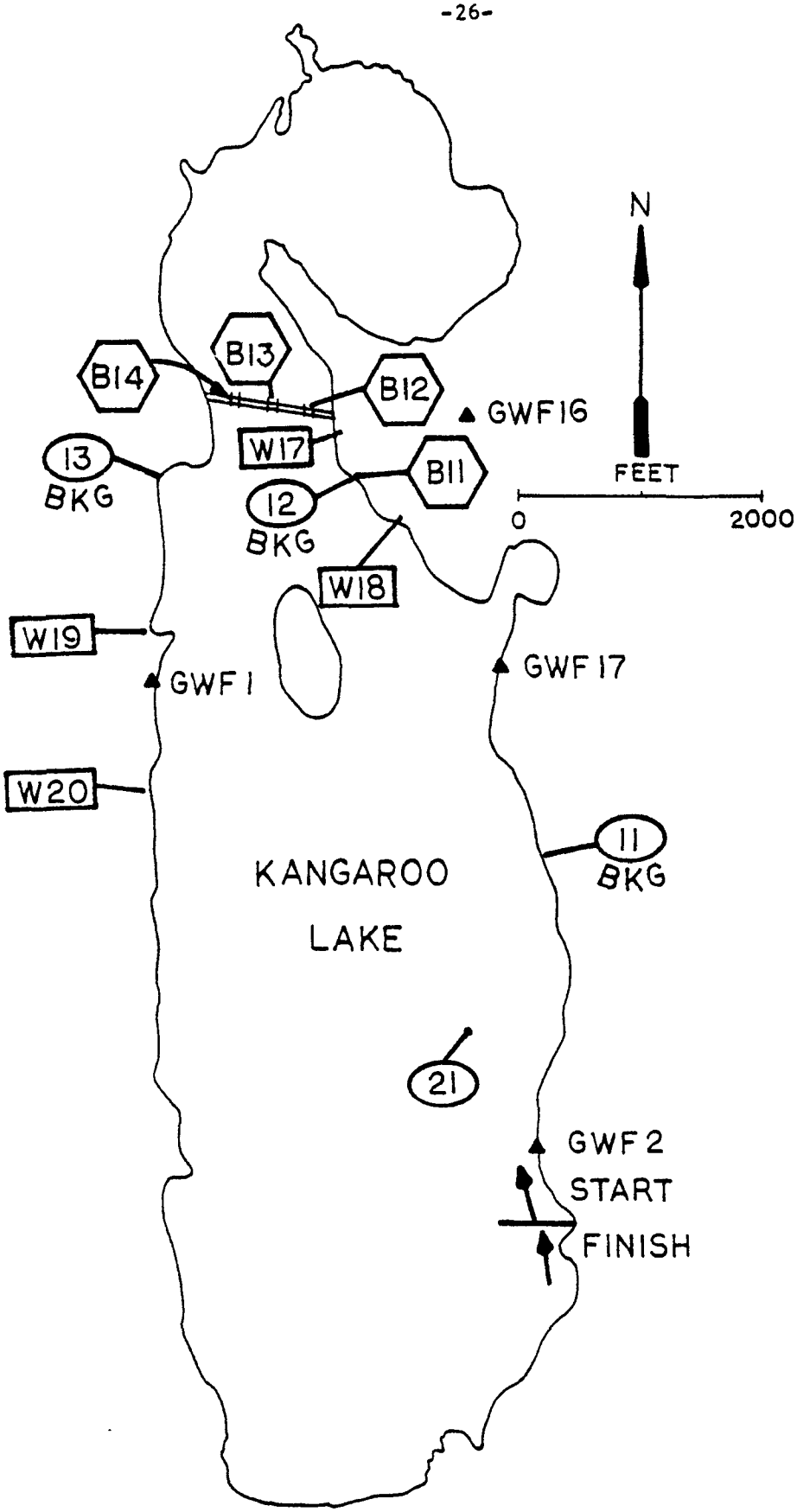

N
B13
B14
B12
GWF16
W17
13
BKG
B11
12
BKG
FEET
0
2000
W18
W19
GWF 1
GWF 17
W20
11
BKG
KANGAROO
LAKE
21
GWF 2
START
FINISH

Figure 3k

4.0 NUTRIENT ANALYSES

Completed analysis of the chemical content of 113 samples taken along the Green Bay and Lake Michigan shorelines of Door County are presented in Table 1. The samples are grouped by community area. The numerical sample codes refer to the shoreline sampling locations as seen on individual area maps (Figure 3a through k). The symbol "S" refers to a surface water sample, the symbol "G" refers to a groundwater sample, and "W" refers to a drinking water well sample. Virtually all groundwater samples were obtained from the sandy interior shores of the harbors and not from the impenetrable rocky shore along the outer exposed shoreline.

The conductivity of the water samples as specific conductance (μmho/cm) is given in the second column. The nutrient analyses for total phosphorus (TP), combined nitrate nitrite nitrogen (NO_3-NO_2-N) and ammonia nitrogen (NH_4-N) are presented in the next three columns in parts-per-million (ppm - mg/l).

Table 1. Analysis of surface water (S) and groundwater (G) samples taken as background (BKG), well water (W), or wastewater plume samples from Egg Harbor, Fish Creek, Tennison Bay, Shanty Bay, Eagle Harbor, Sister Bay, North Bay, Moonlight Bay, Bailys Harbor, and Kangaroo Lake in Door County, Wisconsin.

A. Egg Harbor

Sample Number		Cond. µmho/cm	Total P ppm	NH_4-N ppm	NO_3-N ppm	Ratio ΔC	Ratio ΔTP	Ratio ΔN	% Breakthrough P	% Breakthrough N	Comments
25	S	250	.011	.019	.048						Center
26	S	250	.014	.095	.052						"Maryland Cottage" Alpine Resort
27	S	250	.049	.070	.085						South end Alpine
	G	540	.047	.186	.023	40	.034	.109	13%	13%	Resort
28	S	260	.052	.037	.061						Condominiums
BKG 14	S	260	.011	.076	.055						Tan & brick house
	G	270	.013	.022	.113						
BKG 15	S	260	.008	.021	.052						
W1	G	515	.005	.002	1.889						Driftwood Motel
W2	G	510	.005	.006	2.059						Christiansen
W3	G	490	.004	.016	1.535						#1 - south end

Table 1. (continued)

B. Fish Creek, Tennison Bay, Shanty Bay

Sample Number		Cond. µmho/cm	Total P ppm	NH_4-N ppm	NO_3-N ppm	ΔC	Ratio ΔTP	ΔN	% Breakthrough P	% Breakthrough N	Comments
1	S	240	.029	.173	.031						House #42
	G	875	1.180	5.764	.018	375	1.17	5.2	29%	38%	
2	S	325	.030	.211	.023						Creek entrance
	G (A)	575	.066	2.575	.017	75	.056	2.3	7%	84%	A = 2'
	G (B)	690	.027	4.180	.029	190	.017	4.0	<1%	57%	B = 4'
3	S	290	.027	.124	.016						Rock jetty by
	G	640	.014	.606	.014	140	.004	.400	<1%	8%	paved boat ramp
4	S	285	.012	.164	.008						Tennison Bay
W21	G	2050	.011	.085	.009						Cookery Cabins
W22	G	530	.008	.005	.025						Fraters
W24	G	540	.007	.005	.793						Edge of Park Cottages
34	S	250	.009	.008	.028						Center
35	S	250	.009	.008	.021						Center Tennison Bay
BKG 1	S	260	.011	.042	.027						House #6
BKG 2	S	250	.012	.059	.016						House #26
BKG 3	S	260	.012	.051	.013						
BKG 4	S	270	.011	.071	.027						Head of harbor
	G	700	.409	3.075	.011						
W4	G	500	.004	.005	.007						Mr. Flagg
W5	G	500	.005	.252	.036						Mr. Jageman

Table 1. (continued)

C. Eagle Harbor

Sample Number		Cond. µmho/cm	Total P ppm	NH_4-N ppm	NO_3-N ppm	ΔC	Ratio ΔTP	ΔN	% Breakthrough P	% Breakthrough N	Comments
5	S	500	.053	.319	.039						Texaco station
	G	700	.014	.798	.012	300	.004	.598	1%	5%	stream
6	S	290	.022	.081	.017						2 houses east of
	G	525	.099	.218	.010	125	.08	.02	6%	<1%	Texaco station
7	S	290	.018	.049	.019						White house with
	G	700	.175	.762	.010	300	.165	.56	5%	5%	rock jetty
8	S	300	.015	.075	.012						1st house after
	G	815	.117	.354	.008	415	.107	.13	2%	4%	beach
9	S	390	.032	.122	.017						Culvert (2nd house)
10	S	525	.022	.077	.298						Small stream
11	S	340	.013	.035	.067						2 houses east of
	G	1200	.092	1.715	.013	800	.08	1.5	1%	5%	log house
36	S	250	.005	.036	.048						Center
BKG 5	S	280	.017	.177	.015						Empty lot
	G	725	.032	.065	.021						
BKG 6	S	290	.016	.069	.025						Before jetty
	G	360	.017	.107	.684						
W6	G	910	.004	.268	.013						Anderson "work bench"
W7	G	520	.005	.001	.049						Edgewater
W8	G	470	.005	.008	.325						Kroeger
W9	G	480	.004	.007	.009						Oleson

Table 1. (continued)

D. Sister Bay

Sample Number		Cond. µmho/cm	Total P ppm	NH_4-N ppm	NO_3-N ppm	ΔC	Ratio ΔTP	ΔN	% Breakthrough P	N	Comments
17	S	280	.012	.035	.014						Center
18	S	340	.023	.083	.293						House #6
	G	600	.017	.046	.972	100	.007	.80	<1%	22%	
19	S	280	.052	.293	.084						Vacant lot south of Hotel du Nord
37	S	260	.005	.044	.085						Center
W10	G	500	.005	.000	1.683						Liberty Park
W11	G	540	.013	.012	1.361						Mr. Johnson
Town lagoon effluent		1050	5.634	.287	2.323						

Table 1. (continued)

E. North Bay

Sample Number		Cond. µmho/cm	Total P ppm	NH_4-N ppm	NO_3-N ppm	Comments
38	S	285	.006	.229	.018	"B" on map
	G	375	.011	.813	.054	
39	S	290	.007	.047	.013	South of bright red
	G	730	.007	.005	.037	cabin
40	S	300	.005	.046	.033	Brown house "wilcum"
	G	800	.007	.265	.024	
41	S	280	.005	.041	.023	Holiday House
	G	570	.018	.182	.028	
42	S	260	.009	.056	.038	Center - opposite Gordon Lodge
W25	G		.005	.099	.032	Schroeders #9804
W12	G	2900	.009	.029	.018	L. Raymond - N. Bay Dr.
W13	G	1050	.007	.027	.015	#9591 - Ballantynes
BKG 17	S	275	.034	.005	.055	Offshore - beyond
	G	740	.025	.005	.075	tall grass
BKG 18	S	270	.060	.005	.024	House #9527
	G	290	.067	.013	.096	
W14	G	880	.007	.174	.008	#9451 - Garro & Berg

Table 1. (continued)

F. Moonlight Bay

Sample Number		Cond. µmho/cm	Total P ppm	NH_4-N ppm	NO_3-N ppm	ΔC	Ratio ΔTP	ΔN	% Breakthrough P	% Breakthrough N	Comments
30	S	350	.008	.072	.015						Stream from
	G	700	.017	23.287	.016	200	.007	23.0	<1%	316%	mud lake
31	S	270	.010	.189	.062						First house
	G	525	.021	1.350	.017	25	.01	1.1	4%	121%	past "F"
32	S	260	.009	.059	.089						Lot #8617
	G	520	.036	26.400	.015	20	.026	26.2	12%	3600%	
33	S	250	.009	.043	.104						Center
BKG 16	S	250	.006	.037	.119						100 yds before
	G	685	.005	3.792	.016						lot #8525

Table 1. (continued)

G. Baileys Harbor

Sample Number		Cond. µmho/cm	Total P ppm	NH_4-N ppm	NO_3-N ppm	Comments
12	S	270	.012	.217	.108	Center
13						Lost
14	S	330	.019	.110	.341	In front of laundry's
	G	300	.016	.036	.229	concrete effluent tank
15	S	1800	.323	.293	.286	From laundry effluent tank
16	S	275	.009	.052	.147	South of jetty
BKG 7	S	275	.009	.037	.125	100' offshore of public
	G	520	.007	1.470	.031	beach
BKG 8	S	275	.008	.021	.148	North of jetty
	G	520	.020	.058	.120	
BKG 9	S	300	.010	.038	.065	
W15	G	1150	.005	.020	.021	
W16	G	1650	.007	.039	.267	
W23						Lost
B.H.Y.C. Treatment Plant		3070	2.554	2.579	.061	

Table 1. (continued)

H. Kangaroo Lake

Sample Number		Cond. µmho/cm	Total P ppm	NH_4-N ppm	NO_3-N ppm	Comments
21	S	310	.012	.102	.088	Center
W17	G	740	.007	.112	.151	Happy Landing well water
W18	G	560	.007	.009	.008	#7645 -east shore well water
W19	G	2250	.009	.039	.012	#7698 -west shore well water
W20	G		.008	.022	.694	#7510 - Dvorak well water
BKG 11	S	320	.008	.042	.049	Between houses #10 & #11
	G	430	.008	1.333	.018	
BKG 12	S	320	.008	.081	.020	Green house #35
	G	480	.011	1.356	.042	
BKG 13	S	310	.006	.089	.022	Between houses #44 & #45
	G	440	.022	.175	1.284	

5.0 NUTRIENT RELATIONSHIPS

By the use of a few calculations, the characteristics of wastewater plumes can be described. First, a general background groundwater concentration for conductivity and nutrients is determined. The concentration of nutrients found in a plume is then compared to the background and to municipal wastewater effluent from the lake region to determine the percent breakthrough of phosphorus and nitrogen to the lake water. Because the wellpoint sampler does not always intercept the center of the plume, the nutrient content of the groundwater plume is always partially diluted by surrounding ambient background groundwater or seeping lakewater concentrations. In an attempt to correct for the sampling uncertainty in pinpointing the peak of the groundwater plume, the nutrient concentrations of the sampled plume are corrected to a concentration proportional to adjustment of plume conductivity to the level of undiluted municipal effluent. (Recall section 1.1.1 explained that effluent-saturated soils will likely pass 100% conductivity of any newly-charged effluent.) The percentage of location-corrected nutrient concentration to raw municipal effluent nutrient levels is referred to as "nutrient breakthrough."

For the difference between background (C_o) and observed (C_i) values:

$C_i - C_o = \Delta C_i$ conductivity

$TP_i - TP_o = \Delta TP_i$ total phosphorus

$TN_i - TN_o = \Delta TN_i$ total nitrogen (here, sum of NO_3-N and NH_4-N)

For attenuation during soil passage:

$$100 \times \left(\frac{\Delta C_{ef}}{\Delta C_i}\right) \frac{\Delta TP_i}{TP_{ef}} = \% \text{ breakthrough of phosphorus}$$

$$100 \times \left(\frac{\Delta C_{ef}}{\Delta C_i}\right) \frac{\Delta TN_i}{TN_{ef}} = \% \text{ breakthrough of nitrogen}$$

Where: C_o = conductivity of background groundwater (μmho/cm)

C_i = conductivity of sampled plume groundwater (μmho/cm)

ΔC_{ef} = conductivity of sand-filtered effluent minus the conductivity of background (well) water (μmho/cm)

TP_o = total phosphorus in background groundwater (ppm)

TP_i = total phosphorus of sampled plume groundwater (ppm)

TP_{ef} = total phosphorus concentration of standard effluent (ppm)

TN_o = total nitrogen content of background (well) groundwater, here calculated as NO_3-N + NH_4-N (ppm)

TN_i = total nitrogen content of sampled plume groundwater, here calculated as NO_3-N + NH_4-N (ppm)

TN_{ef} = total nitrogen content of standard effluent (ppm)

TN_o and TP_o are considered insignificantly small compared to TP_{ef} and TN_{ef}.

5.1 Assumed Standard Wastewater Characteristics

Samples of effluent were taken from the treatment lagoons in Sister Bay. Characteristics of the effluent formed the basis of comparison

for all sampled plumes in the Door County study area. A conductance : total phosphorus : total nitrogen ratio of 1050:6:20 was used. Please note that a standard (assumed) value of 20 ppm total nitrogen was substituted for the analytically determined value of 2.6 ppm for purposes of breakthrough computations. It was felt that the sample value was quite uncharacteristically low, though a sound explanation for this condition is lacking. Background levels of surface water conductivity, total phosphorus and total nitrogen were derived from center-of-bay samples taken in each principal harbor or lake area. Likewise, background levels of conductivity, total phosphorus and total nitrogen for groundwater were derived judgementally from consideration of local well water and background station samples.

5.2 Assumed Background Levels

One or more background pair samples were taken from each study area. Additionally, well water sample data were also available. An effort was made to find a consistent value between these two sources for purposes of "breakthrough" calculations. Where shallower wells seem to have conductivities of about 500 μmho/cm, deeper wells can easily exceed 1000 μmho/cm. In most cases, the common value used was: conductivity, 500 μmho/cm; TP, .01 ppm; TN, .20 ppm. So far as possible, background samples were taken away from potential plume areas.

6.0 COLIFORM LEVELS IN SURFACE WATERS

A series of water samples from around the various harbor areas was analyzed for fecal coliform count to confirm the presence of surface runoff or soil shortcircuiting from malfunctioning systems. The membrane filter coliform count indicates the density of coliform organisms. Since these organisms may be of intestinal origin and are numerous in sewage, high numbers are indicative of sewage pollution with its possible hazards to public health. Here, the fecal coliform count was used as a more specific test of recent sewage pollution.

The thin soil cover and fractured bedrock allow groundwater contaminants easy entry to the groundwater system in large areas of Door County. Many chemical and bacteria contaminants enter the Silurian dolomite acquifer system with recharging groundwater. Contamination in the fractured dolomite occurs from point sources, in zones or enclaves that become elongated with the channeled flow of groundwater through the aquifer system. Door County does have a long history of groundwater contamination and particularly bacterial contamination from ineffectively treated septic wastewater disposal. The bacteria problem may be aggravated by the clustering of cottages with older, inadequate treatment facilities in many of the densely populated harbor areas.

Our samplings encompassed stream outlets to the harbor areas, drinking water wells, likely plume areas revealed by the septic leachate

detector, and several special sources such as the commercial laundry at Baileys Harbor.

Fecal coliform levels in Fish Creek, Egg Harbor, Kangaroo Lake, Moonlight and North Bays were well below 100 colonies per 100 ml of water. Two high coliform sites in excess of 200 colonies per 100 ml of water were found in Eagle Harbor area, the higher being from a small stream discharge. Sister Bay was undergoing an extension of the city sewer line into Liberty Grove. Opposite the Hotel du Nord, in this unsewered coastal zone, a substantial coliform count of about 1400 colonies per 100 ml of water was found amongst thickly Cladophora-covered rocks.

Baileys Harbor Laundry, a commercial plant, has a large, poured concrete effluent holding tank located directly on the water's edge. A sample from lakewater directly in front of this holding tank registered a coliform count of about 1400 colonies per 100 ml of water. A second high source in Baileys Harbor may be related to the outfall from the yacht club treatment plant. A value of 460 colonies/100 ml of water was recorded from a sample drawn from in front of the retaining wall in front of the yacht club.

Coliform sample analysis was provided by Badger Laboratories & Engineering Co., Inc., Appleton, Wisconsin.

Table 2. Bacterial content of shoreline samples.

Harbor Area	Station	Fecal Coliforms No/100 ml	Location
Fish Creek	B1	< 1	Shanty Bay - drinking water
	B2	< 1	Tennison Bay boat ramp
	B3	< 1	Tennison Bay drinking water
	B4	23	Stream-north end of town
	B5	75	White house - 2 houses south of town beach
	B6	45	Town docks
	B7	< 1	Cookery Cabins drinking water
	B29	43	Weborg Campground - police boat harbor
Egg Harbor	B8	43	Condominiums south of town dock
	B9	4	Alpine Resort - dock area
	B10	4	Alpine Resort - Maryland College
Kangaroo Lake	B11	9	#35 - green house
	B12	15	Conduit
	B13	75	Conduit
	B14	9	Conduit
Baileys Harbor	B15	1400	Near commercial laundry tank
	B16	460	Yacht club plant outfall
	B17	< 1	House #17, south of condominiums
	B30	43	
Moonlight Bay	B18	4	Creek entrance
	B19	< 1	Beach road house #8688
	B20	< 1	2 houses south of #8688
North Bay	B21	< 1	Gordon Lodge
Sister Bay	B22	1400	Hotel du Nord
	B23	< 1	Grey house north of town docks
Eagle Harbor	B24	240	Residential area
	B25	9	First house after beach
	B26	460	Stream entrance
	B27	15	Culvert
	B28	43	Stream by Texaco station

7.0 GROUNDWATER FLOW PATTERNS

Precipation in the form of rain or melting snow is the principal source of groundwater in Door County. Aquifer systems are found in the glacial drift mantle and the underlying Niagara dolomite, which is of Silurian age. The water can be obtained from gravel seams in the drift where the drift attains thicknesses of 30 feet or more or from vertical bedding joints resulting from fractures and fissures in the bedrock. Some of these fracture zones may be widened by solution allowing for rapid transport of groundwater through the dolomite formations. Piezometric surfaces for groundwater in upper Door County reflects radial flow gradients discharging towards lakes, streams, and bogs, eventually entering either Lake Michigan or Green Bay (Figure 4). The geology of Door County along with its wide area and seasonal water supply variations have been reported in detail by the U.S. Department of Agriculture Soil Survey of Door County and the U.S. Department of the Interior, Groundwater in Door County.

For this septic leachate survey we endeavored to develop information on shallow groundwater flow patterns along discrete coastal shorelines of the study area using the K-V Associates, Inc. Dowser groundwater flow meter. Our ability to generate data with the instrument was limited by difficult pebble and bedrock conditions along much of the exposed shorelines. Flow vectors are presented in Figure 4 and represent very localized indications only. Where these shoreline vectors deviate significantly from broad piezometric gradient, this may be local variations resulting from contact with the large, open water bays.

Table 3. Observed rate of groundwater flow in Door County, Wisconsin.

Station	Location	Flow Direction	Flow Rate FPD
	Kangaroo Lake		
GWF1	-	258°W	5.5
GWF2	East Shorewood Cottages	115°E	4.5
GWF16	Swamp	332°N	3.0
GWF17	Kangaroo Lake Lodge	232°SW	6.0
	Fish Creek		
GWF6	Town beach	301°NW	3.5
GWF7	State park	264°W	2.0
GWF8	Nicolet Bay - concession stand	317°NW	2.5
	Eagle Harbor		
GWF10	Town beach	274°W	1.5

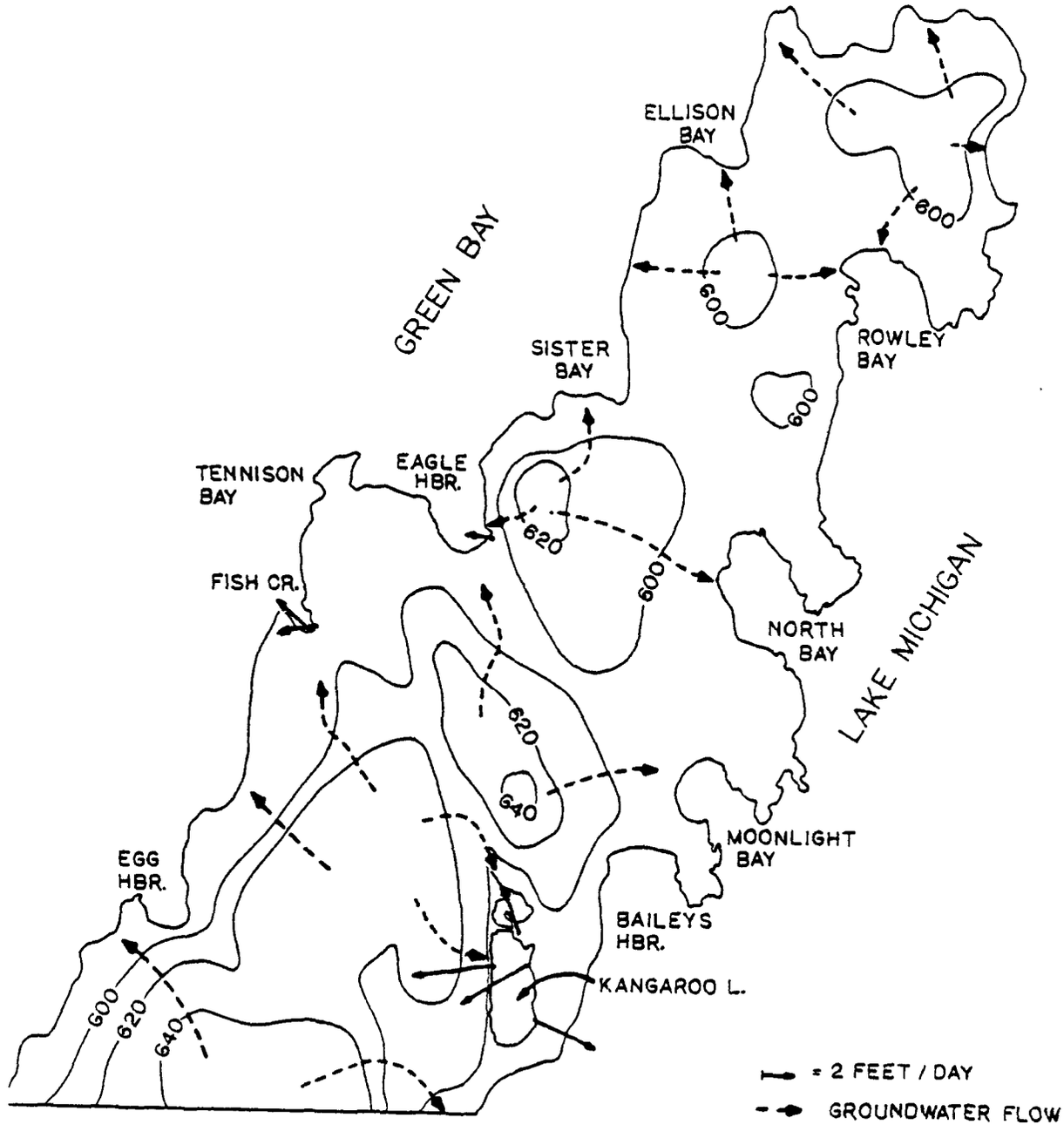


Figure 4. Groundwater flow patterns of the Door County Peninsula based upon existing water table elevations and observed flow measurement.

8.0 CONCLUSIONS

A continuous shoreline septic leachate survey was conducted in the autumn of 1979 in northern Door County, Wisconsin. Seven major harbors and one inland lake were investigated. The following observations were made from the shoreline profiles, fluorescent scans, nutrient and inorganic analysis of surface and well water samples, and groundwater flow measurements:

1) A total of 39 locations exhibited noticeable effluent plume characteristics. Five of these related to surface streams draining wetlands and passing through populous areas. The fractured dolomite substrate tended to fragment plumes so that the individual peaks would not necessarily indicate singular sources.

2) A general correlation existed between the frequency of confirmed wastewater plumes and the dissolved solids content of background surface water samples in harbor areas. For example, Eagle Harbor and Baileys Harbor with background conductivity over 270 μmhos contained numerous fragmented plume sources compared to the low levels of incidence in Egg Harbor and Tennison Bay (ca. 250 μmhos).

3) A number of plumes were found with fecal coliform bacterial levels exceeding 200 colonies/100 ml of water, two locations at Baileys Harbor, one in Sister Bay, and one in Eagle Harbor.

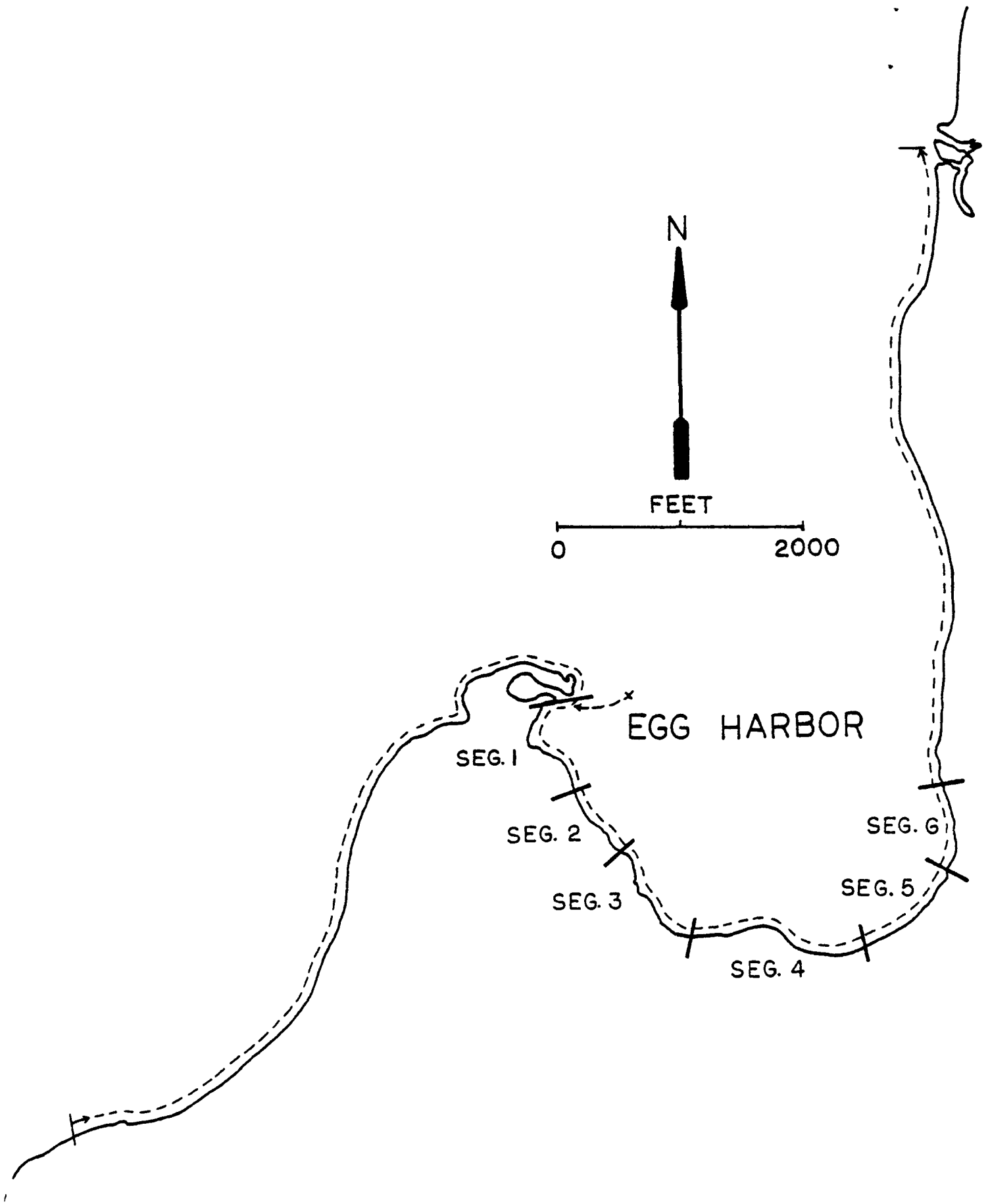
4) The strongest effluent source plumes were associated with surface discharges in harbor areas, one in the rear of Fish Creek Harbor and at least three in Eagle Harbor, while separate bog discharges, such as observed with the Mud Creek inflow in Moonlight Bay, represent additional nonpoint sources of nutrients.

5) Due to the bedrock and shallow soil conditions, on-site groundwater flow measurements were not particularly instructive.

6) Of 25 wells sampled, no significant nitrate contamination was recorded. Three wells tested for bacteria showed no evidence of coliform contamination.

7) Lastly, a problem situation could not be confirmed in Kangaroo Lake, based upon the late season survey of the shoreline. No discharges were observed along the periphery of the lake and all samples showed low total phosphorus content.

APPENDIX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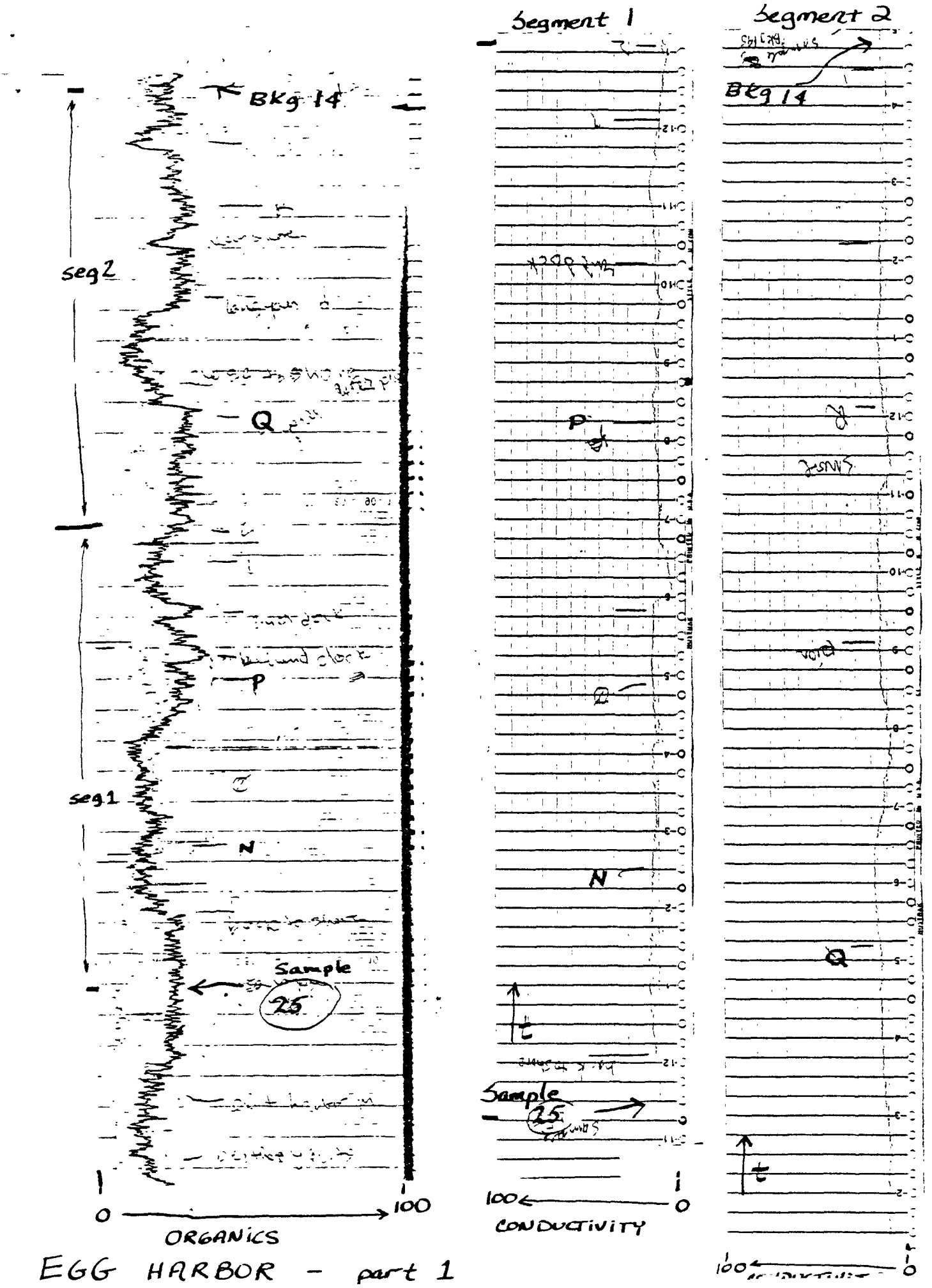
SEG. 6



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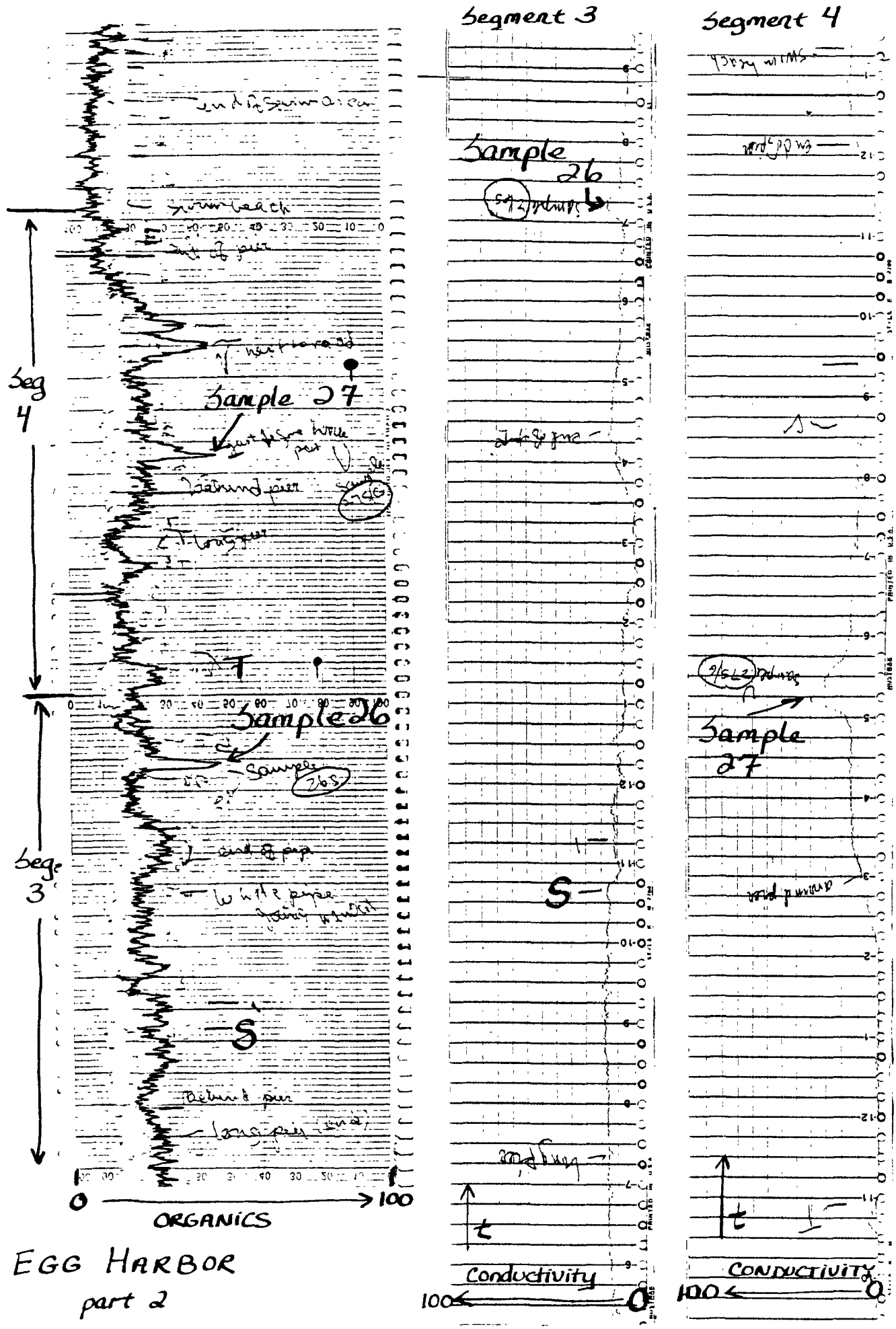

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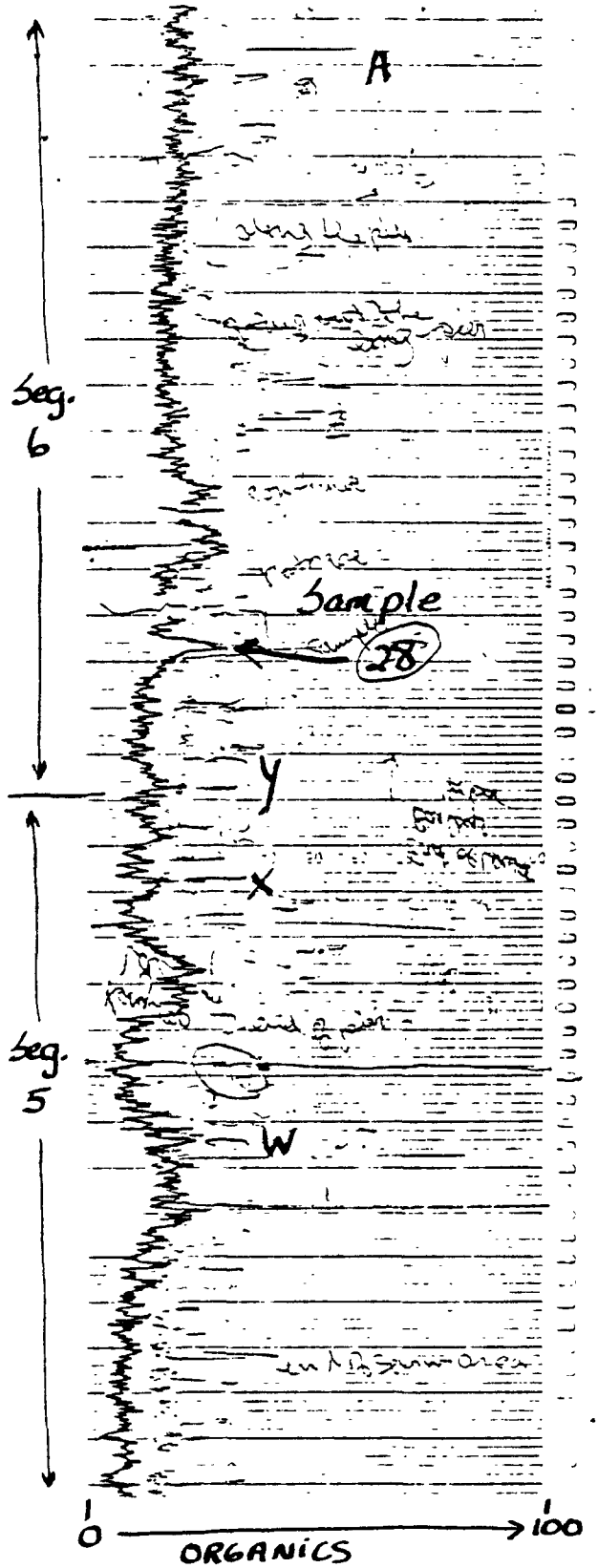

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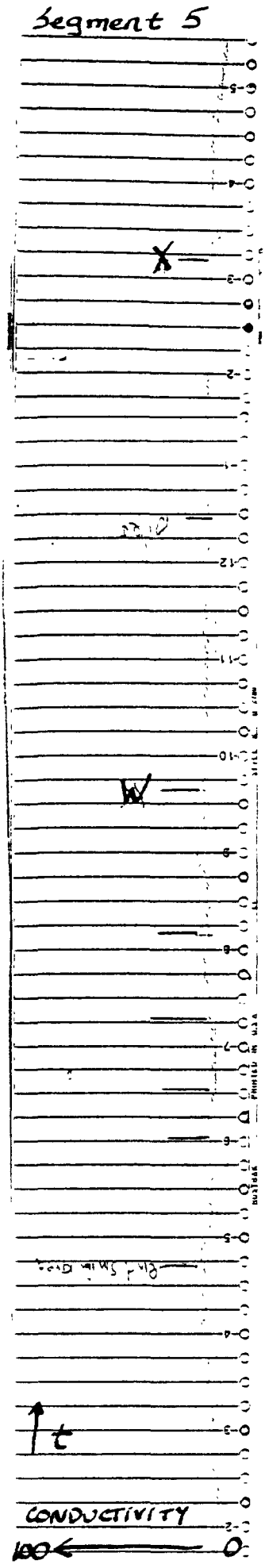

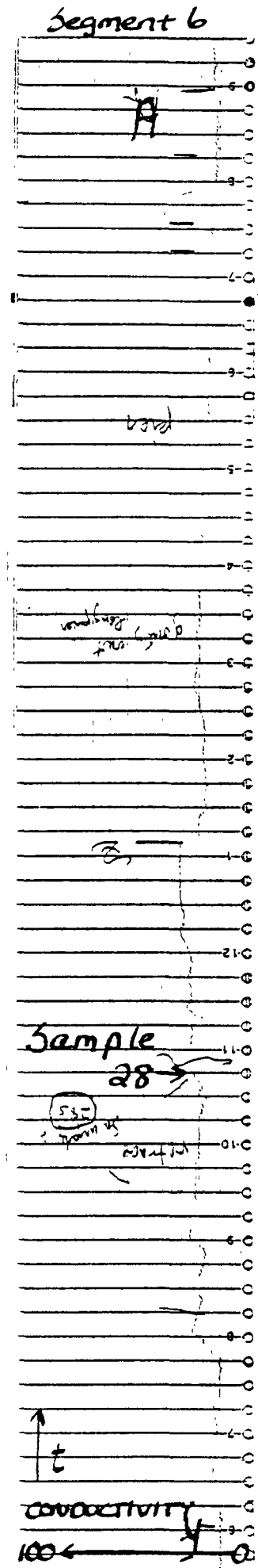

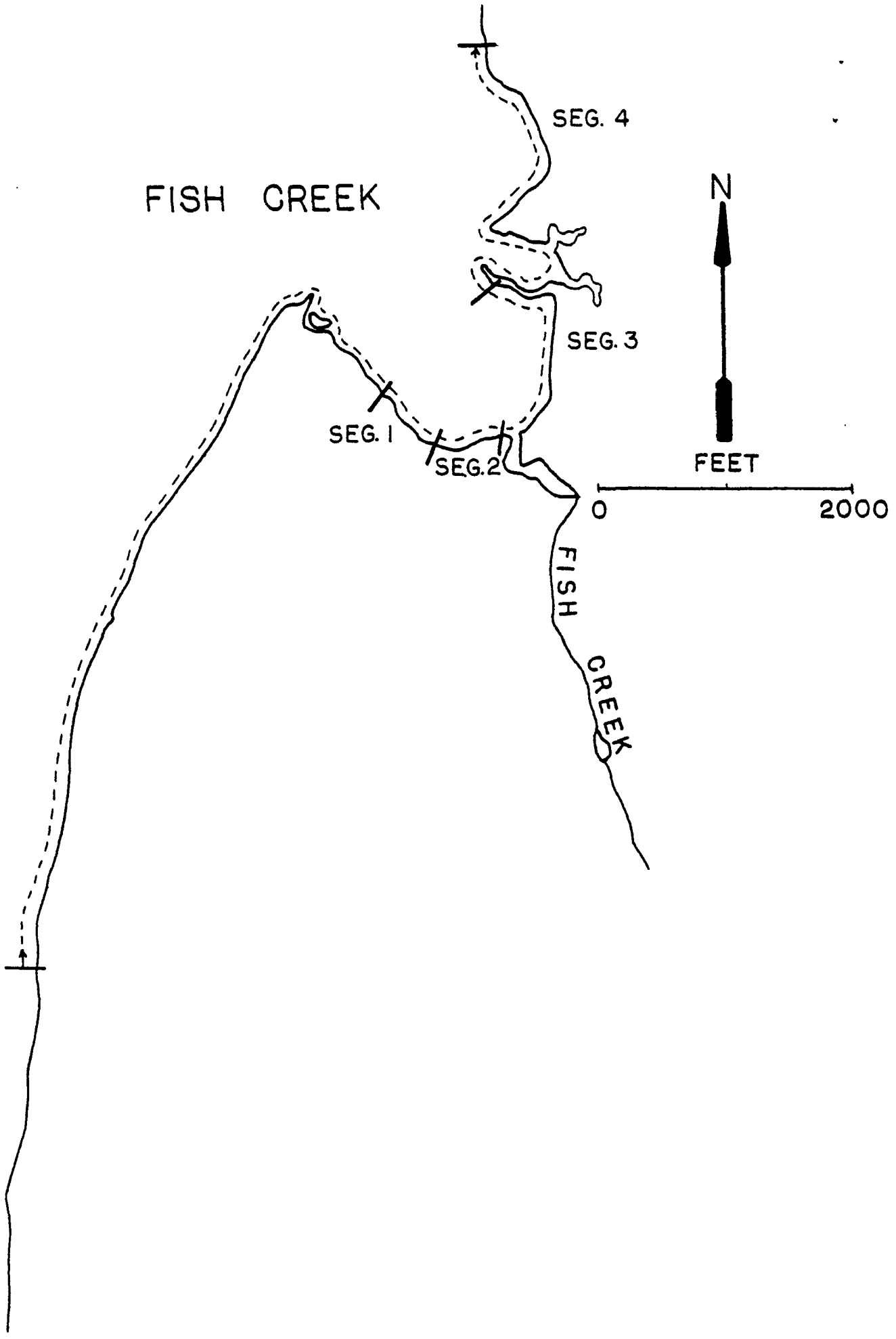
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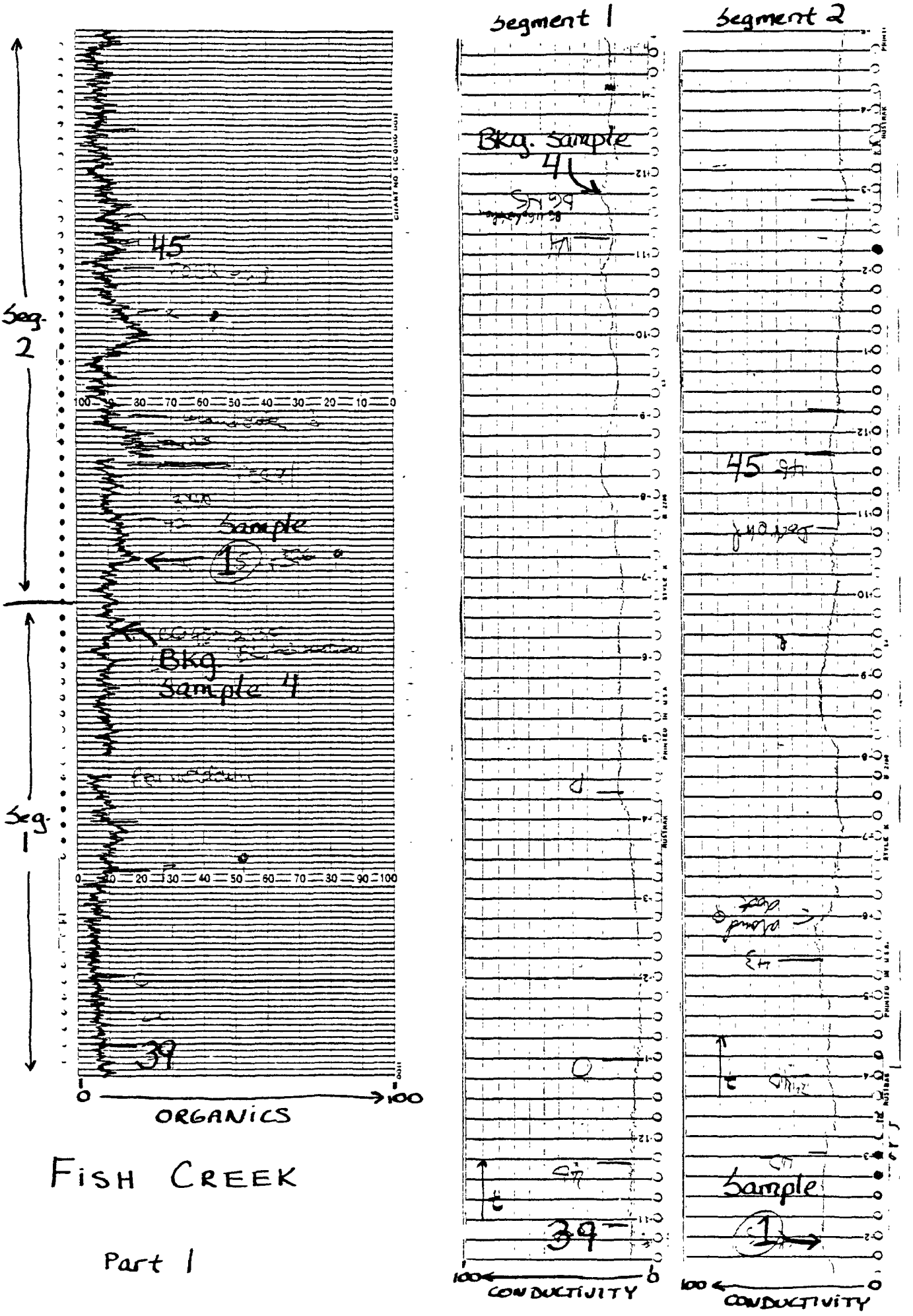

FISH CREEK

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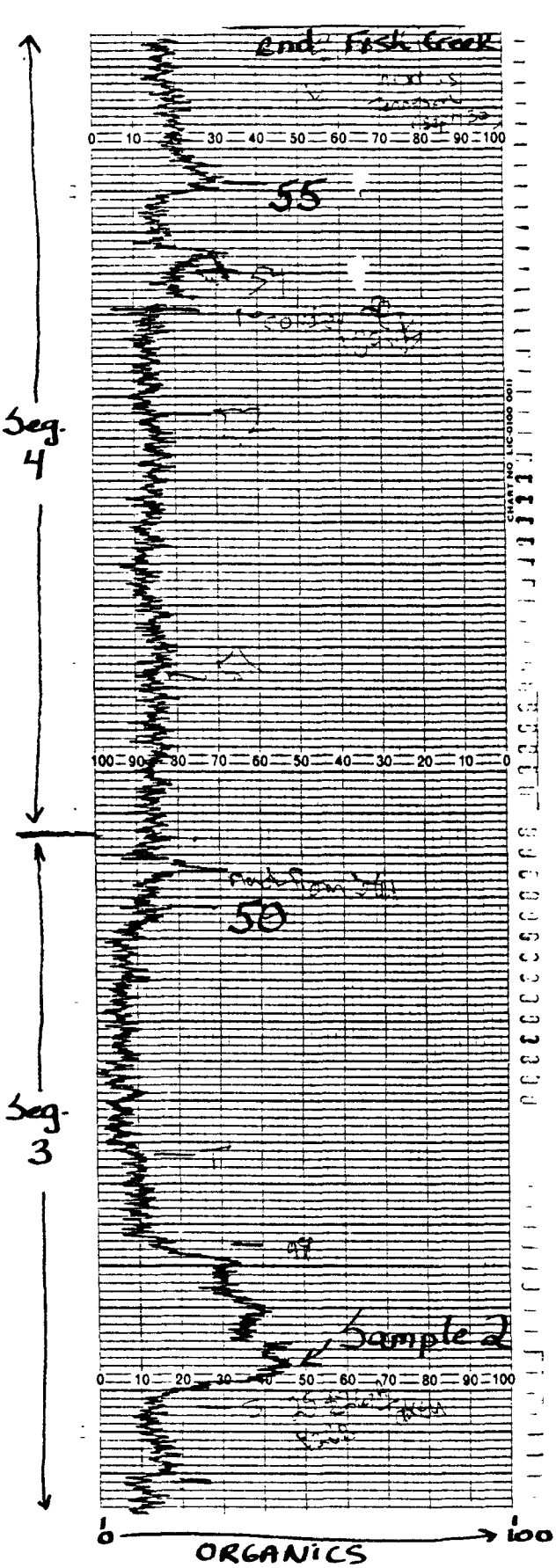

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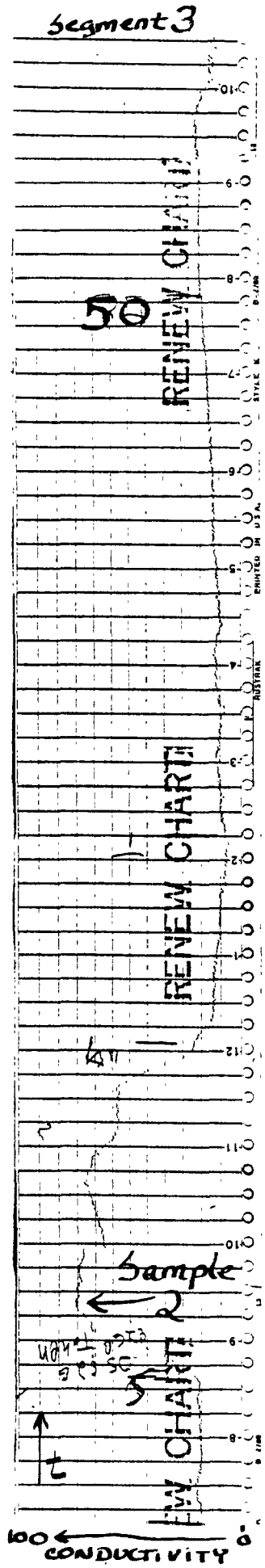

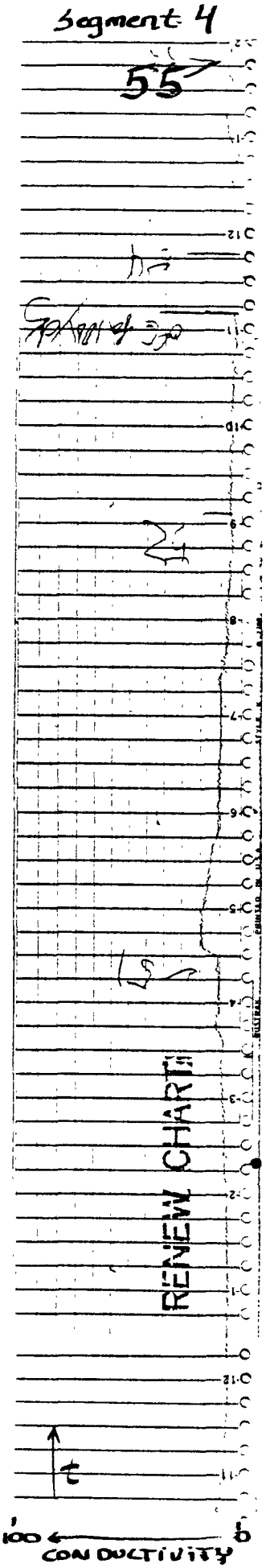

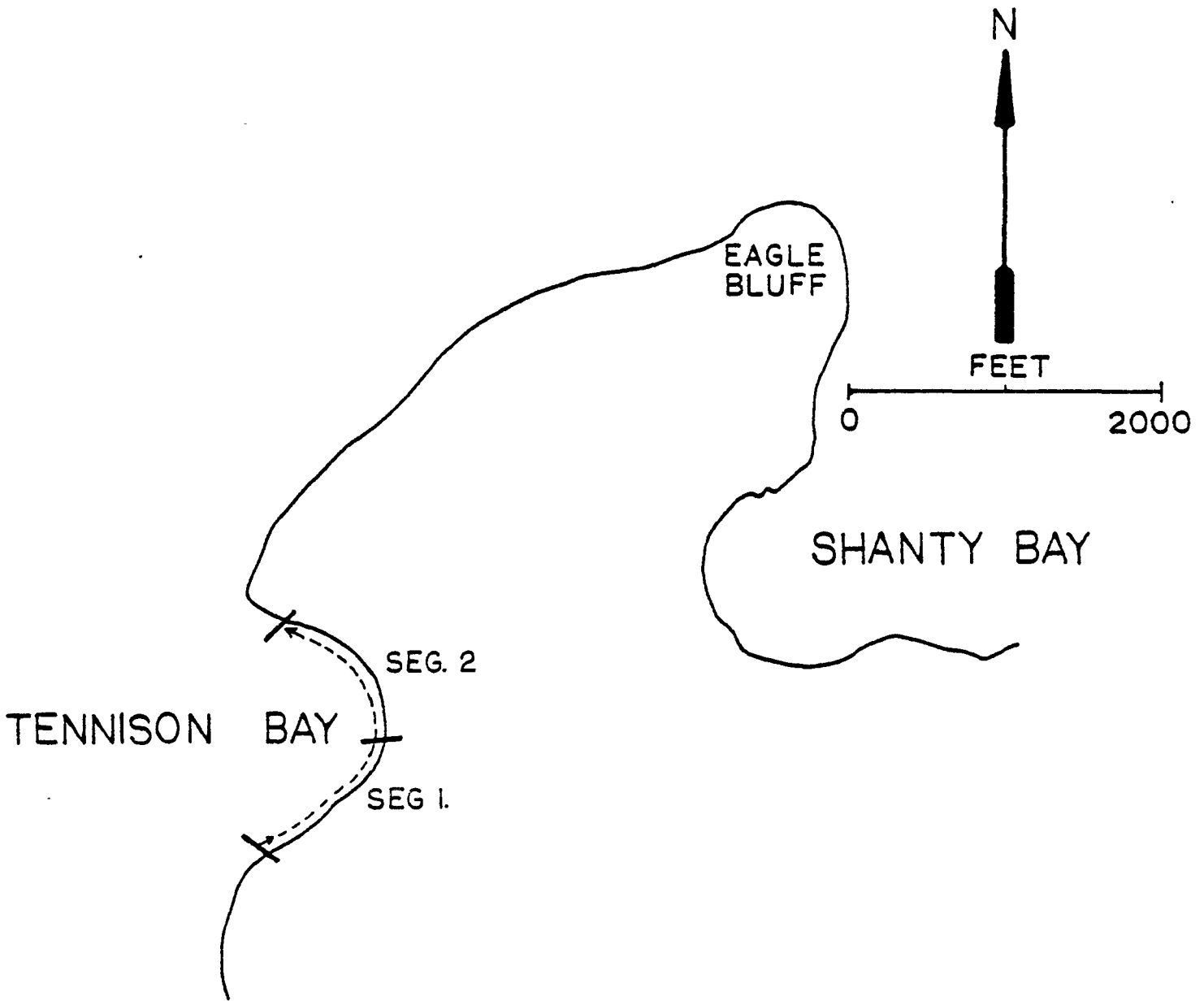
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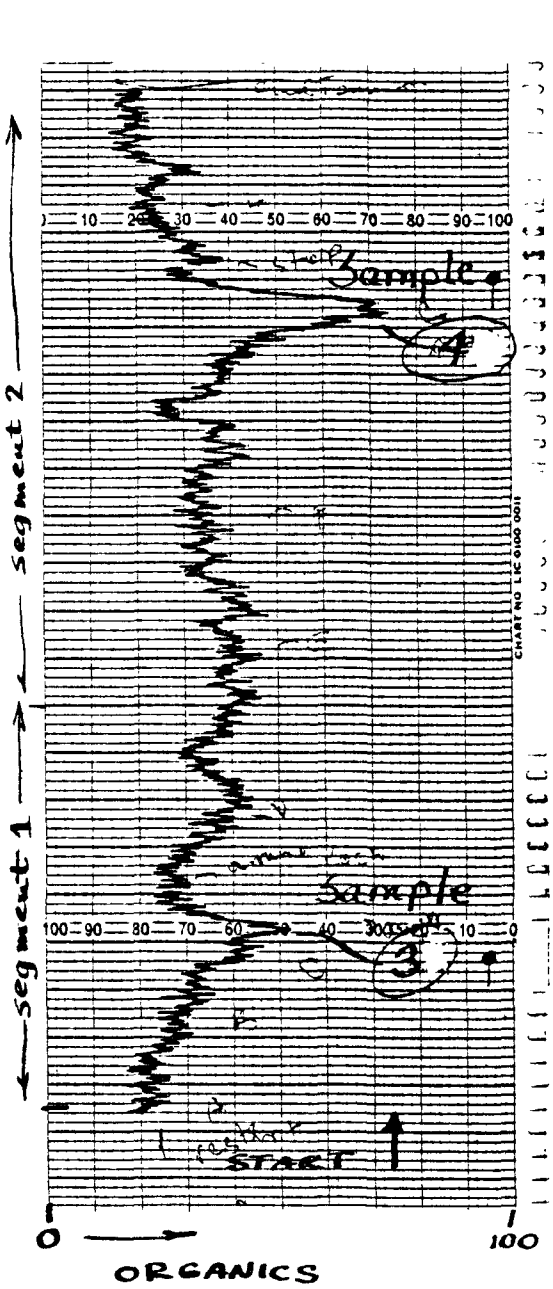
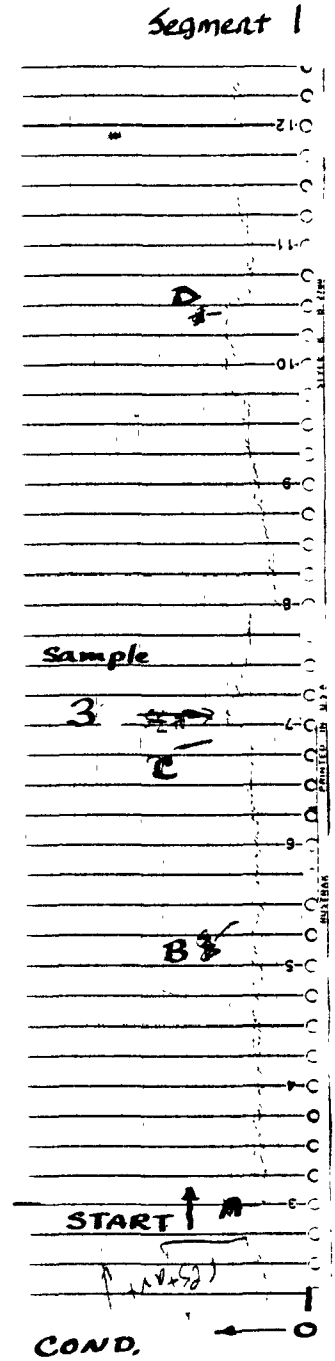
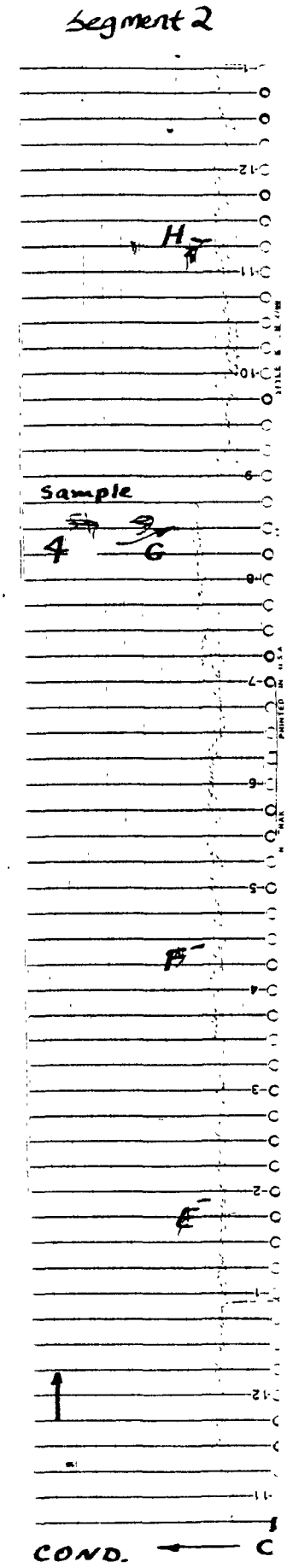
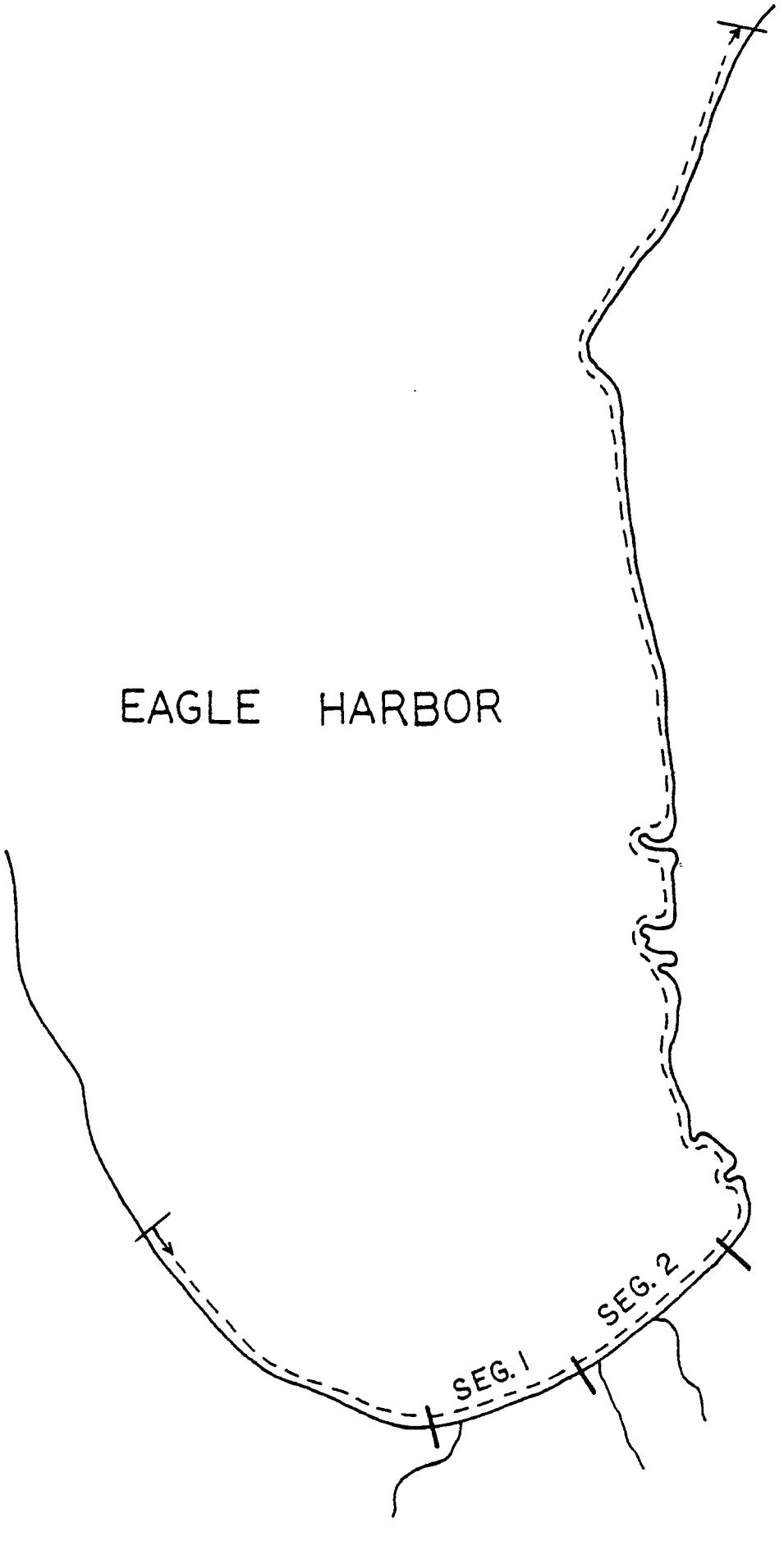
TENNISON BAY
SEG 1.







Tennison Bay,
Peninsula State Park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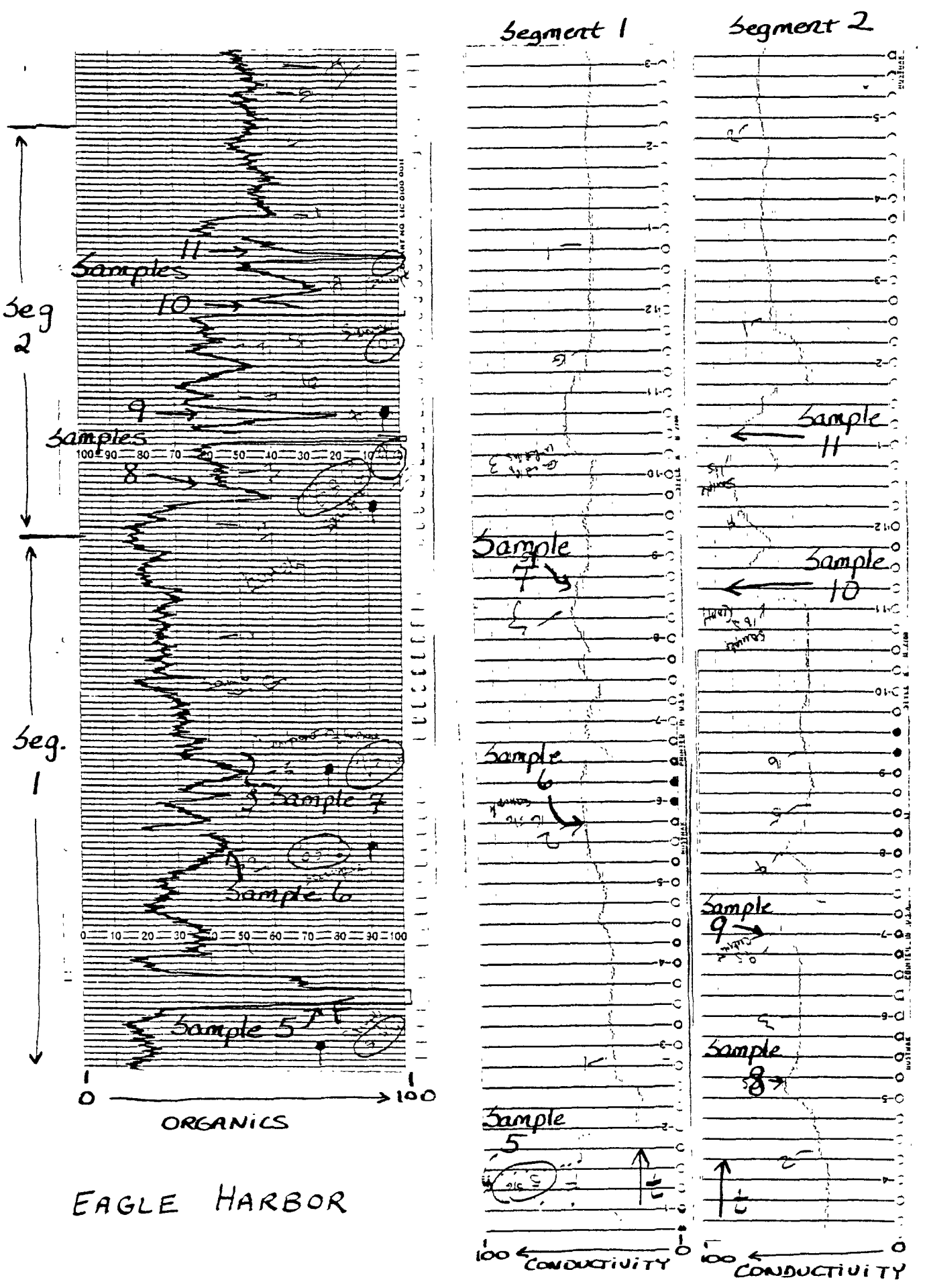
SEG. 2



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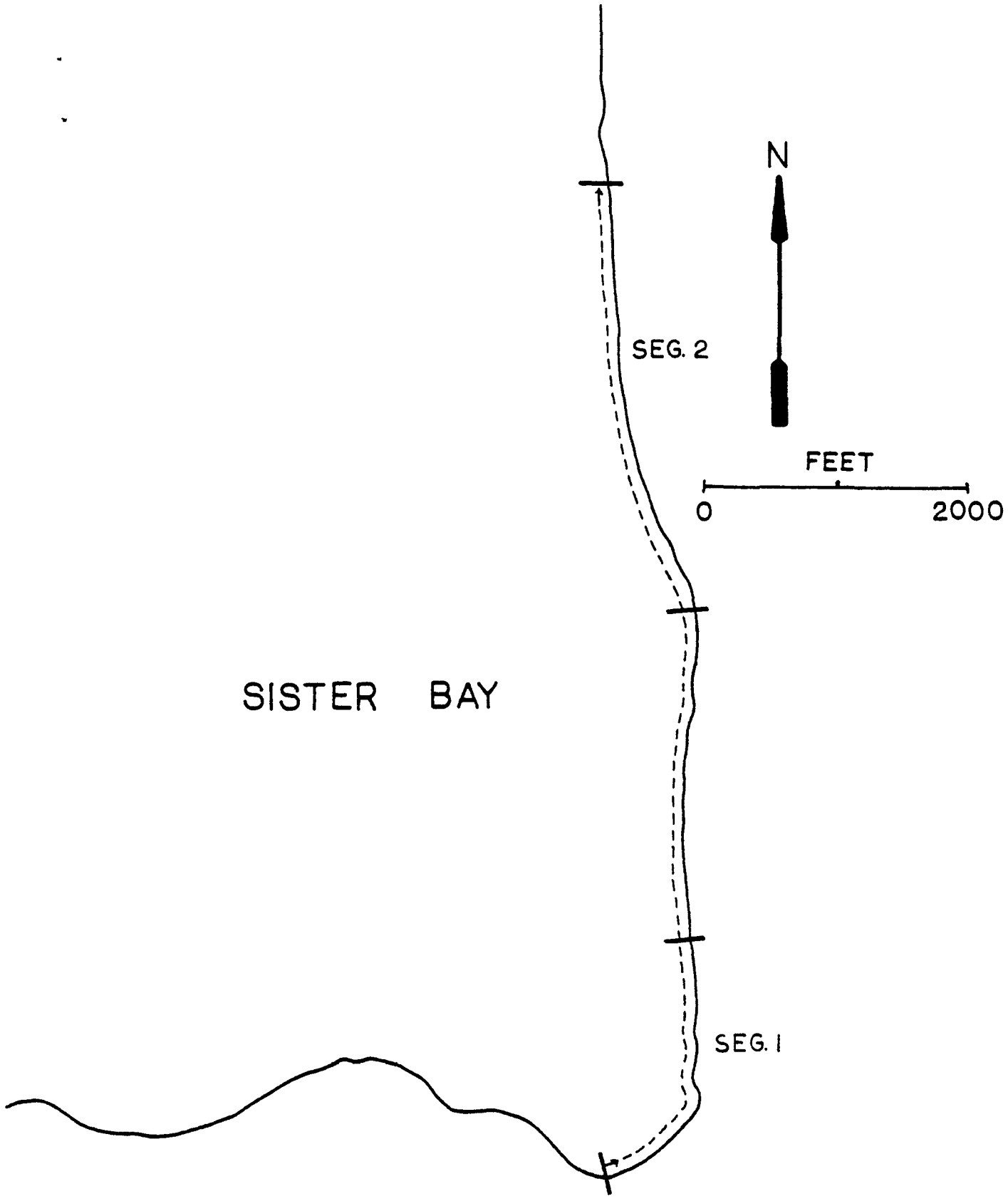
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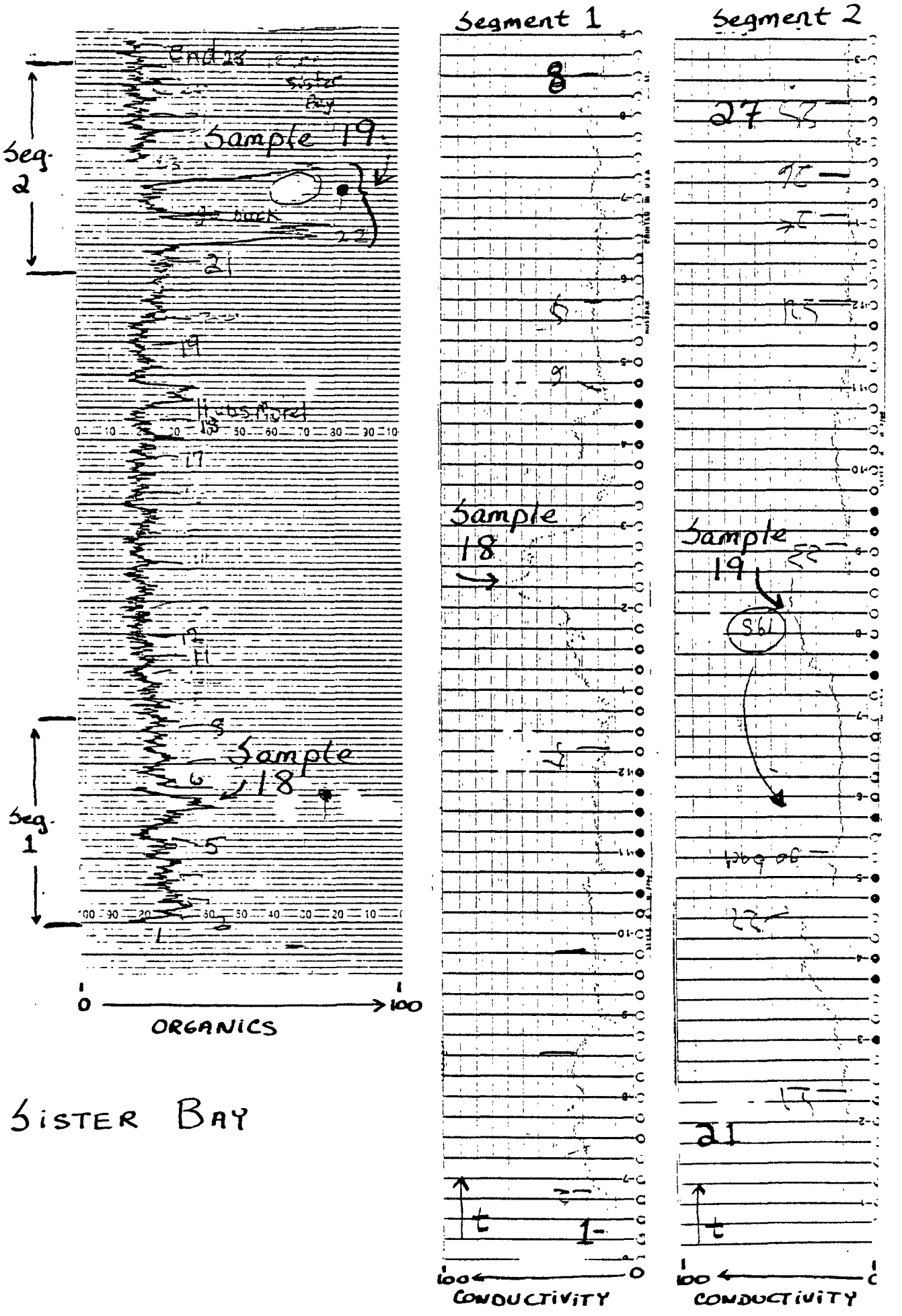
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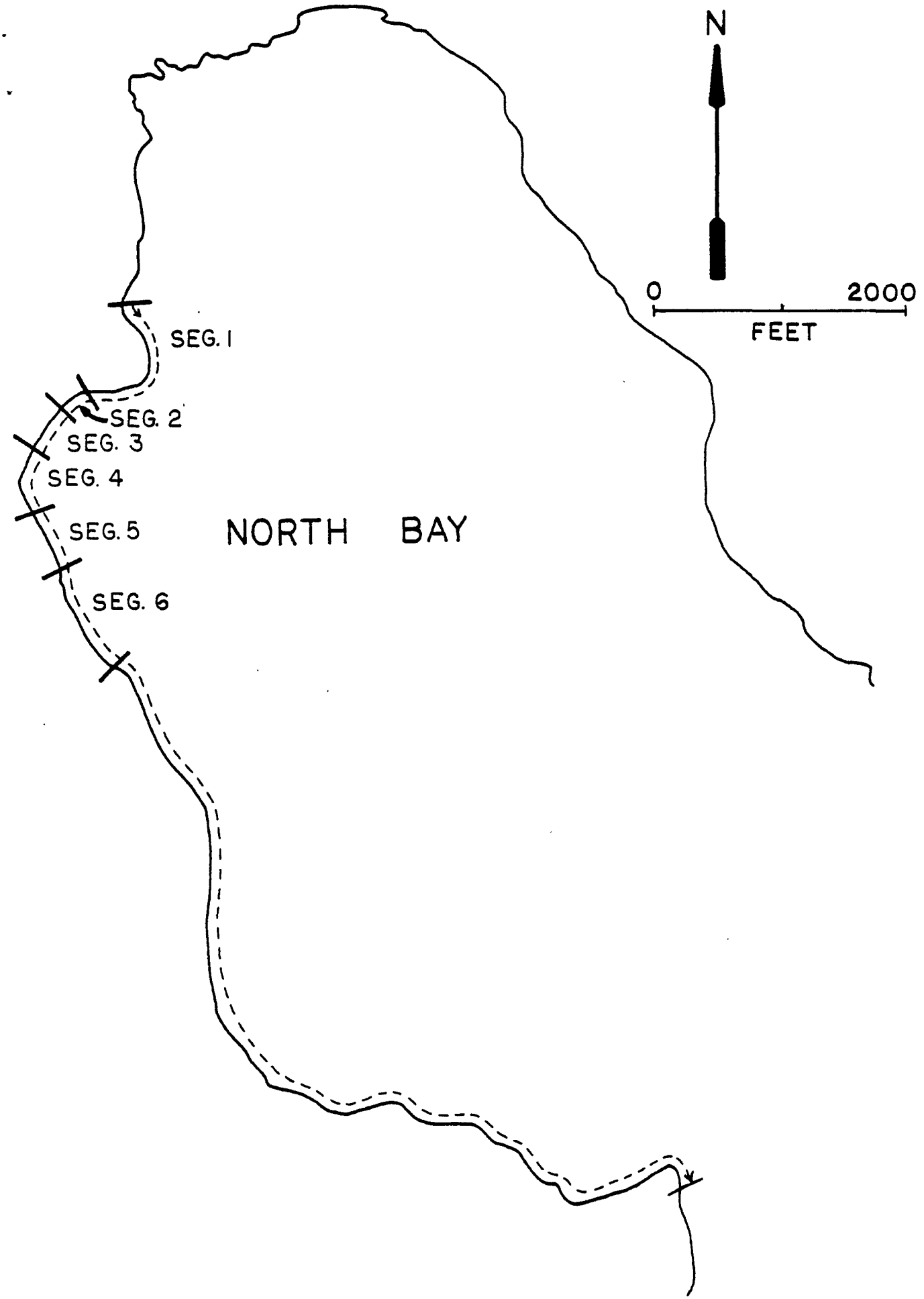
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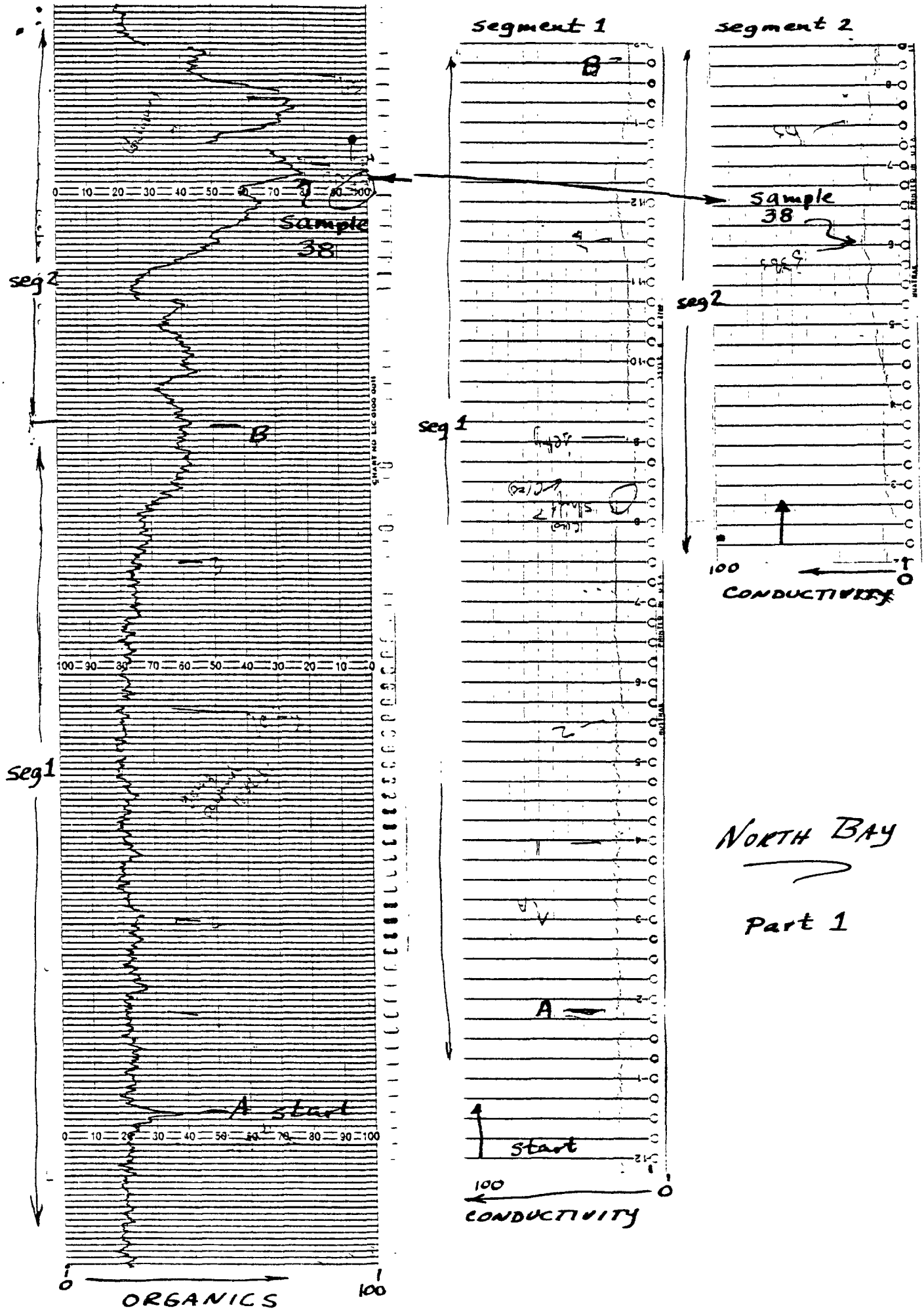
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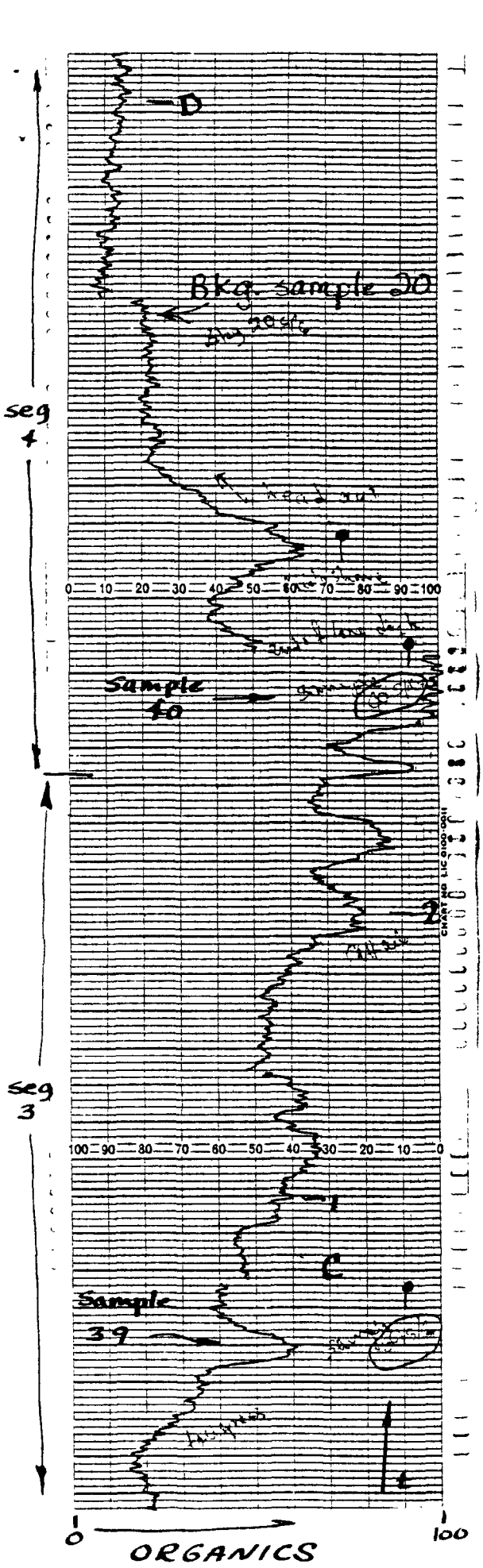
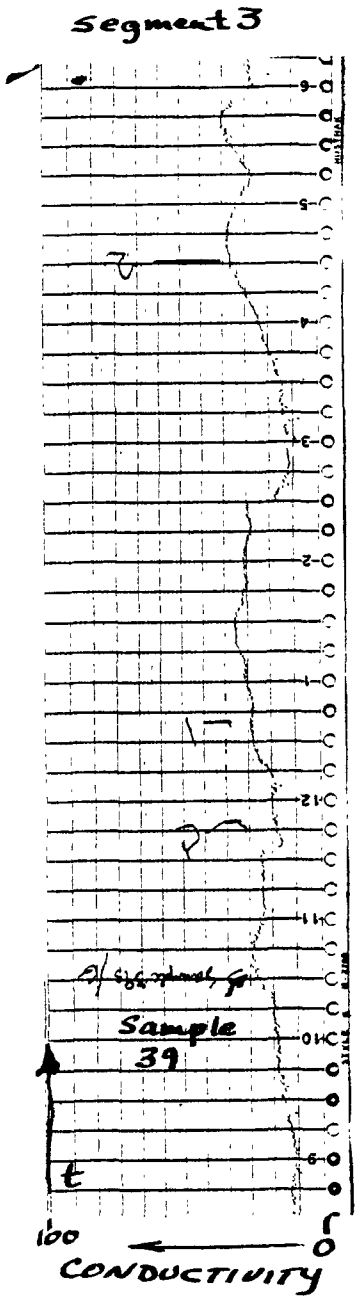
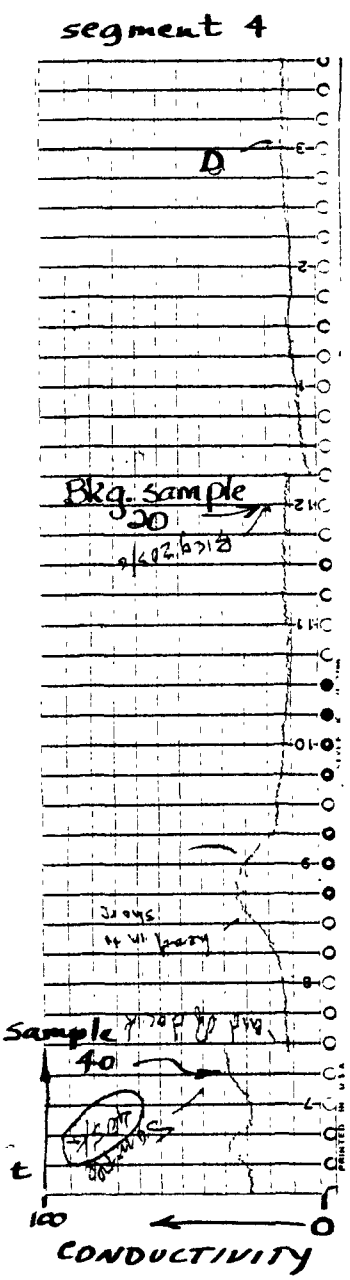
Part 1







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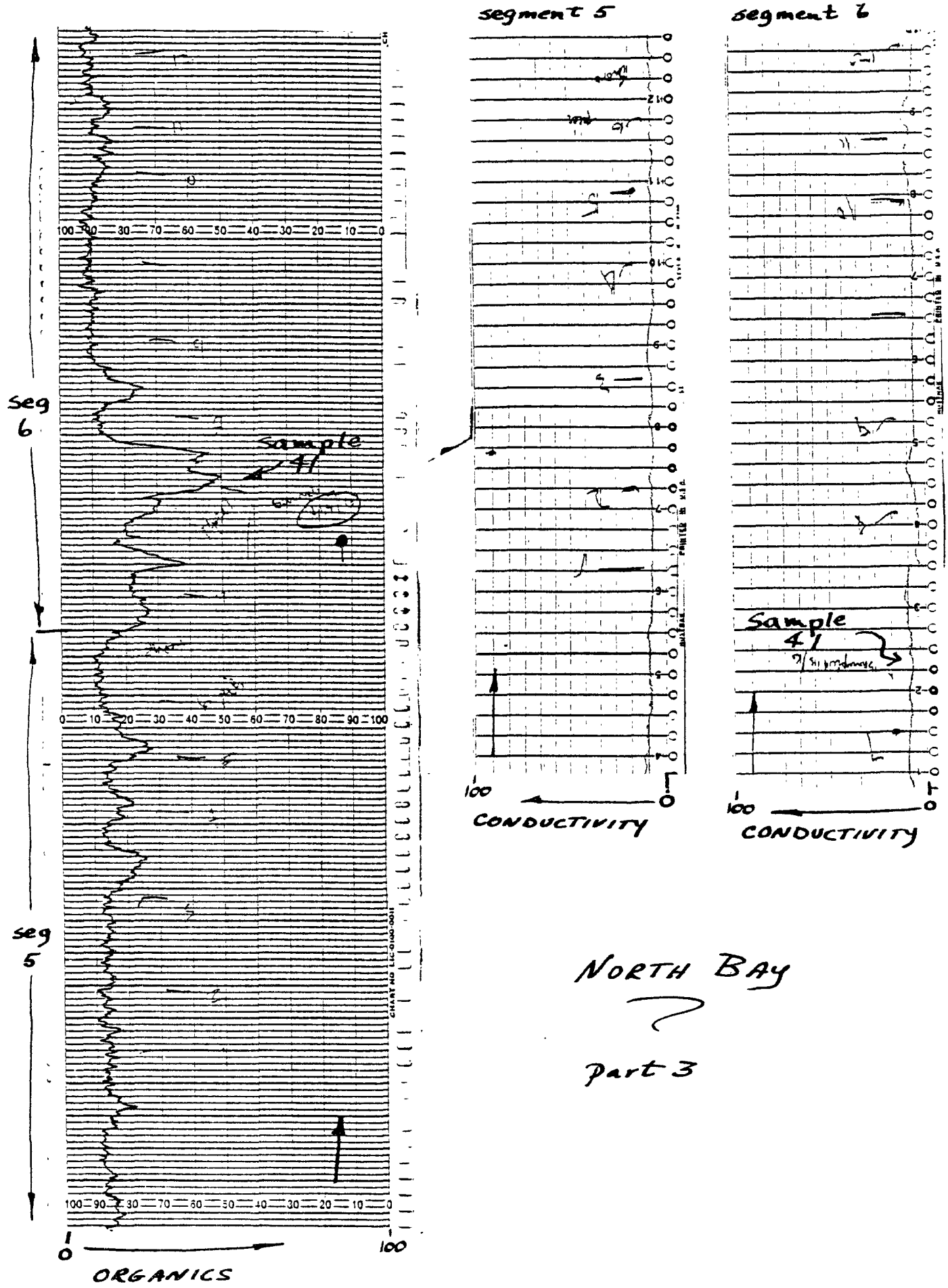

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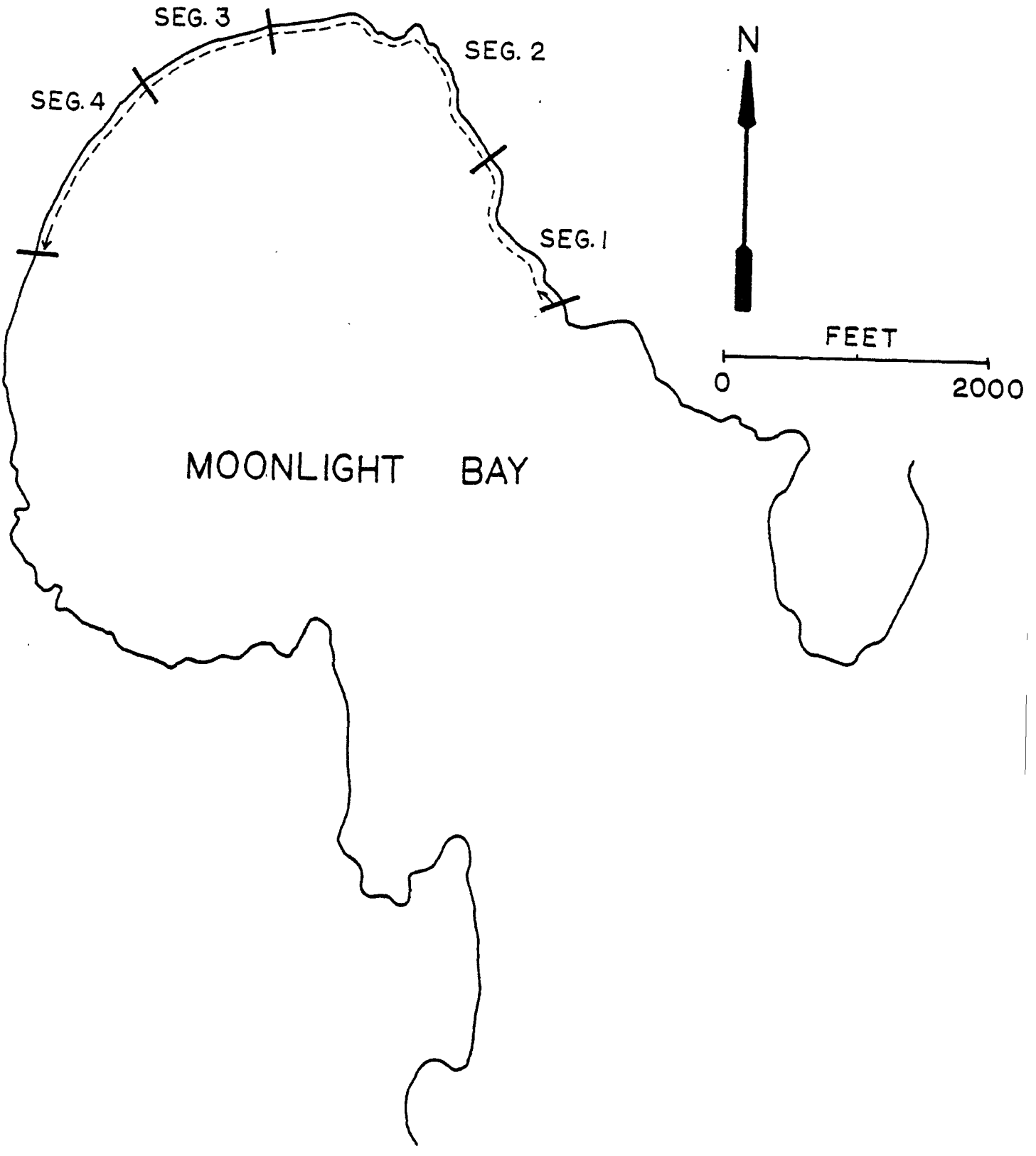
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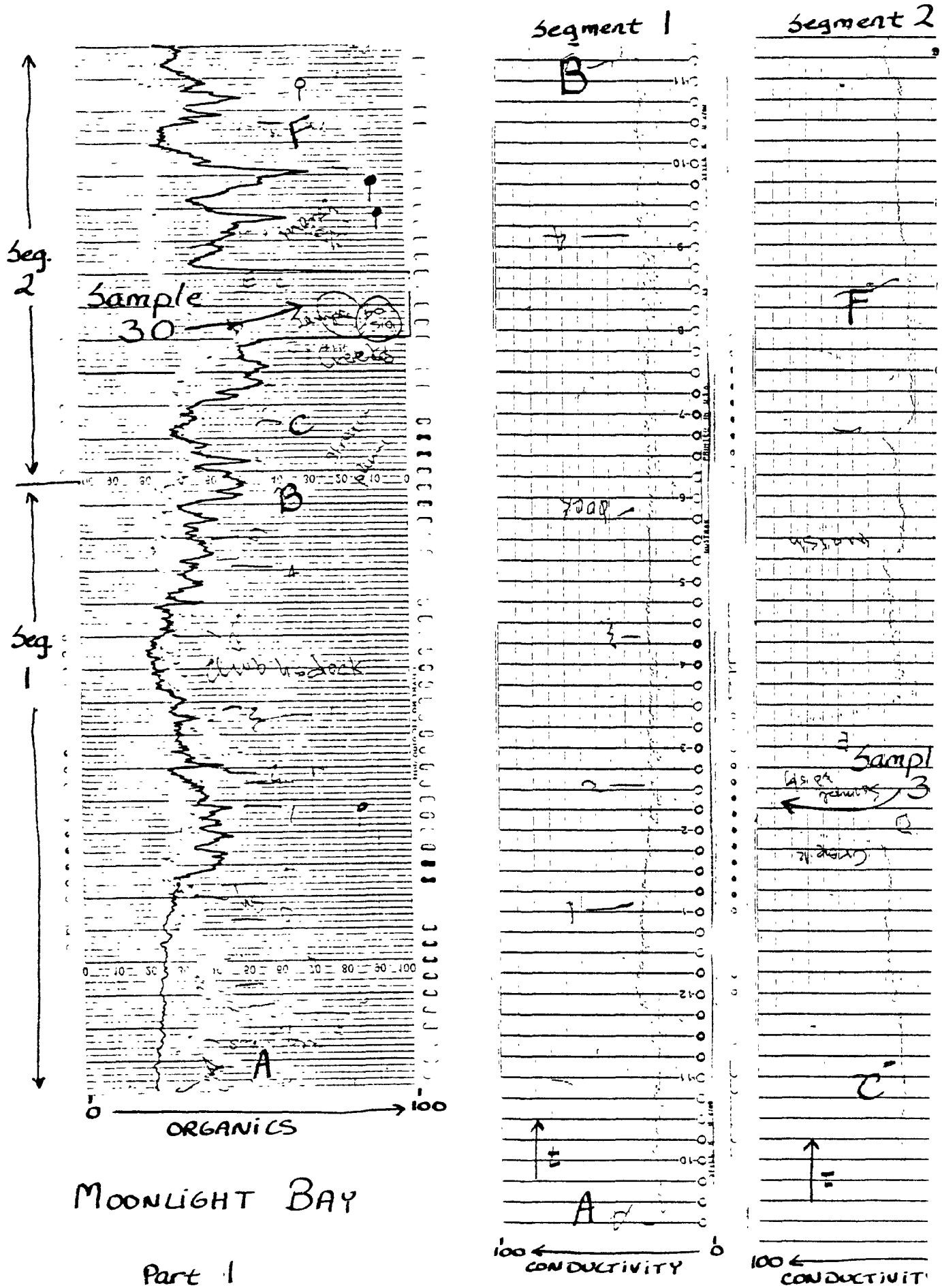

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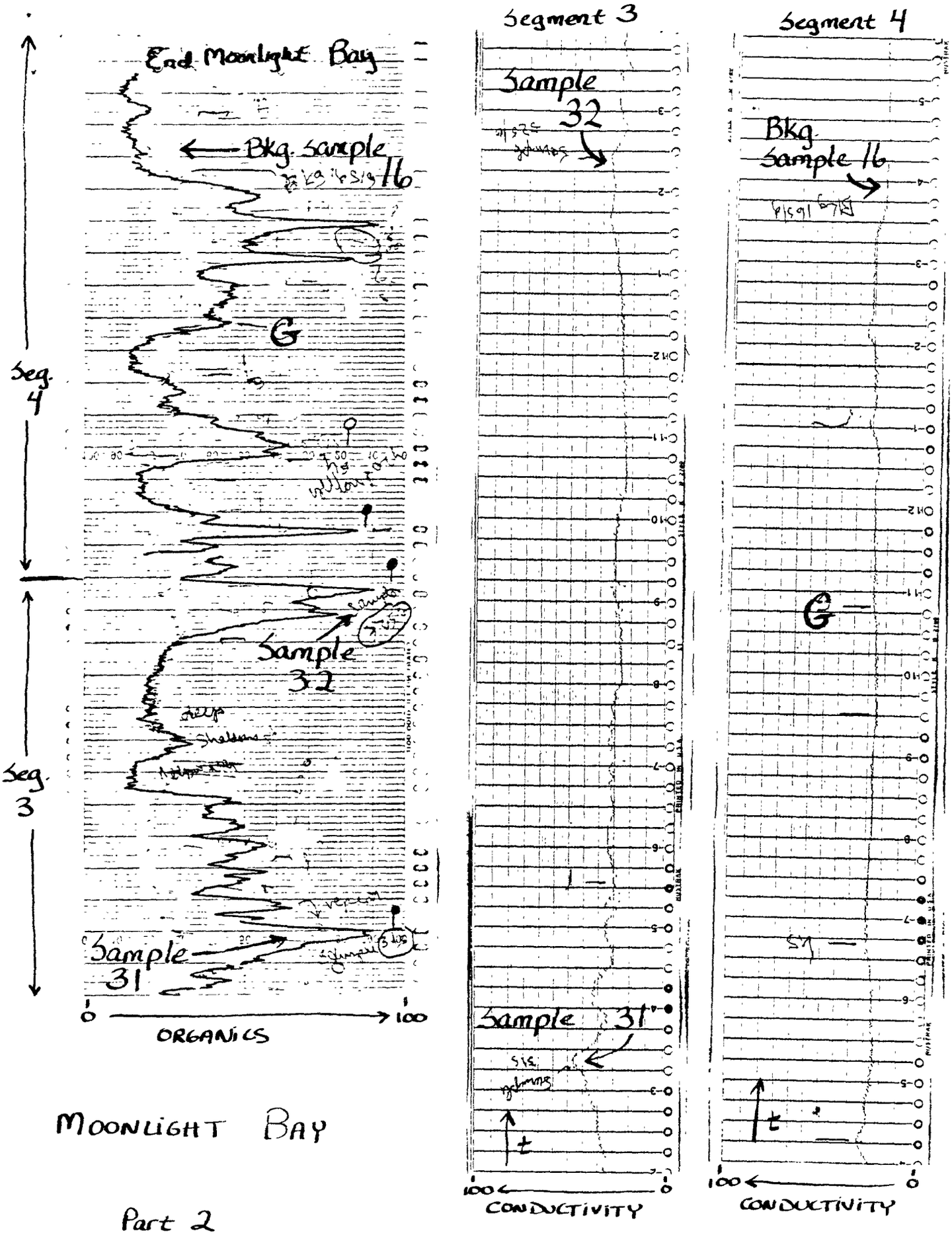

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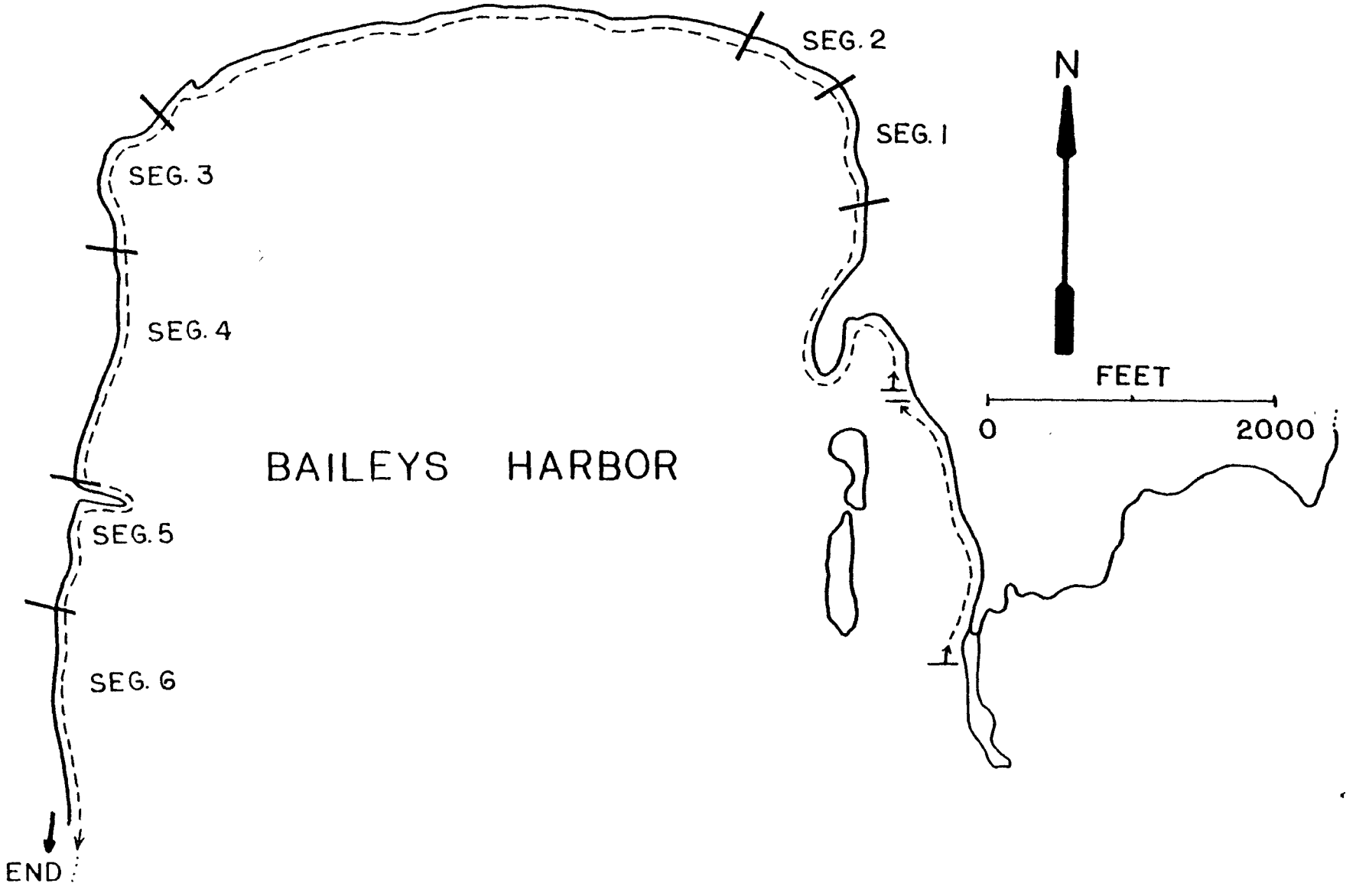
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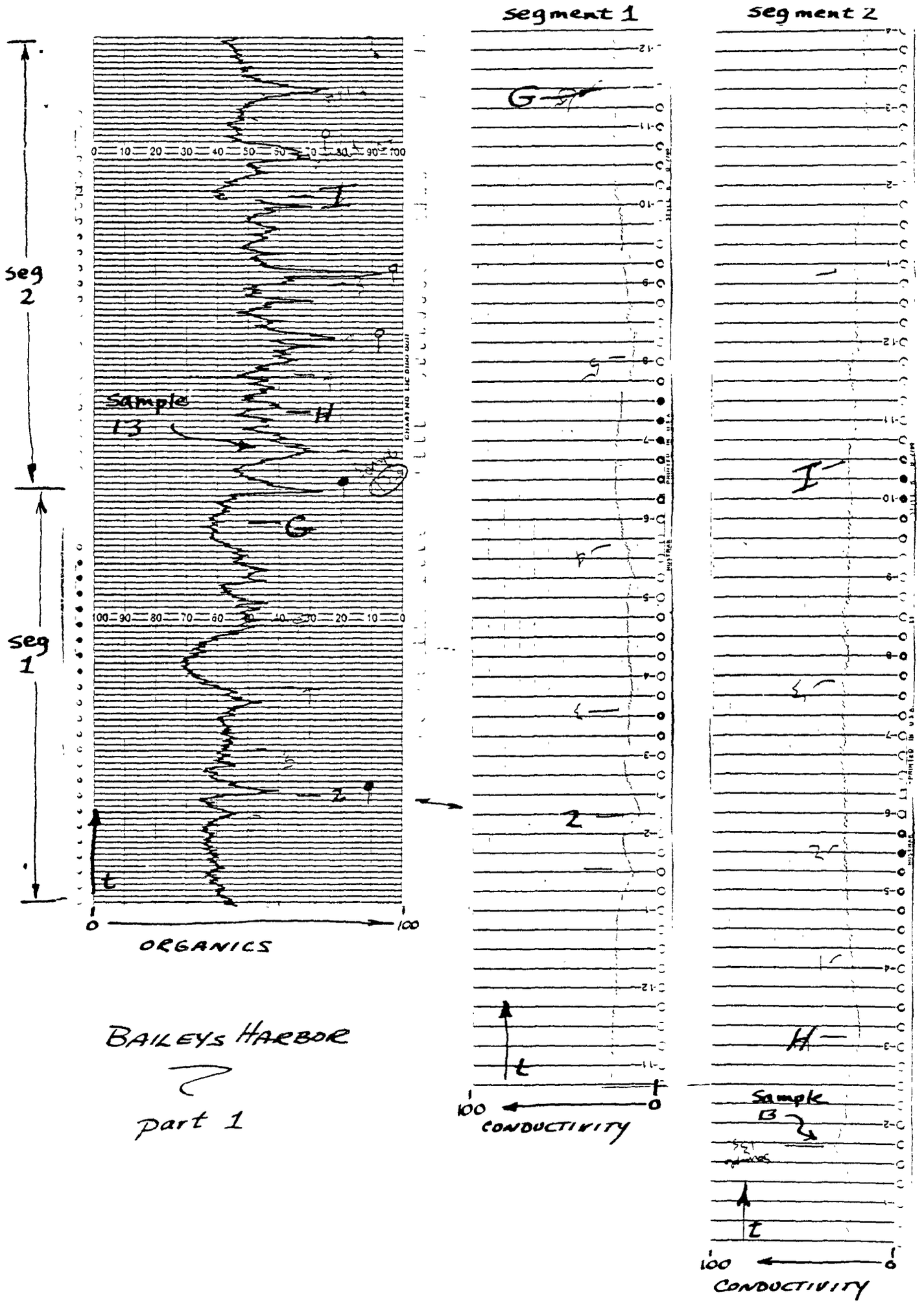

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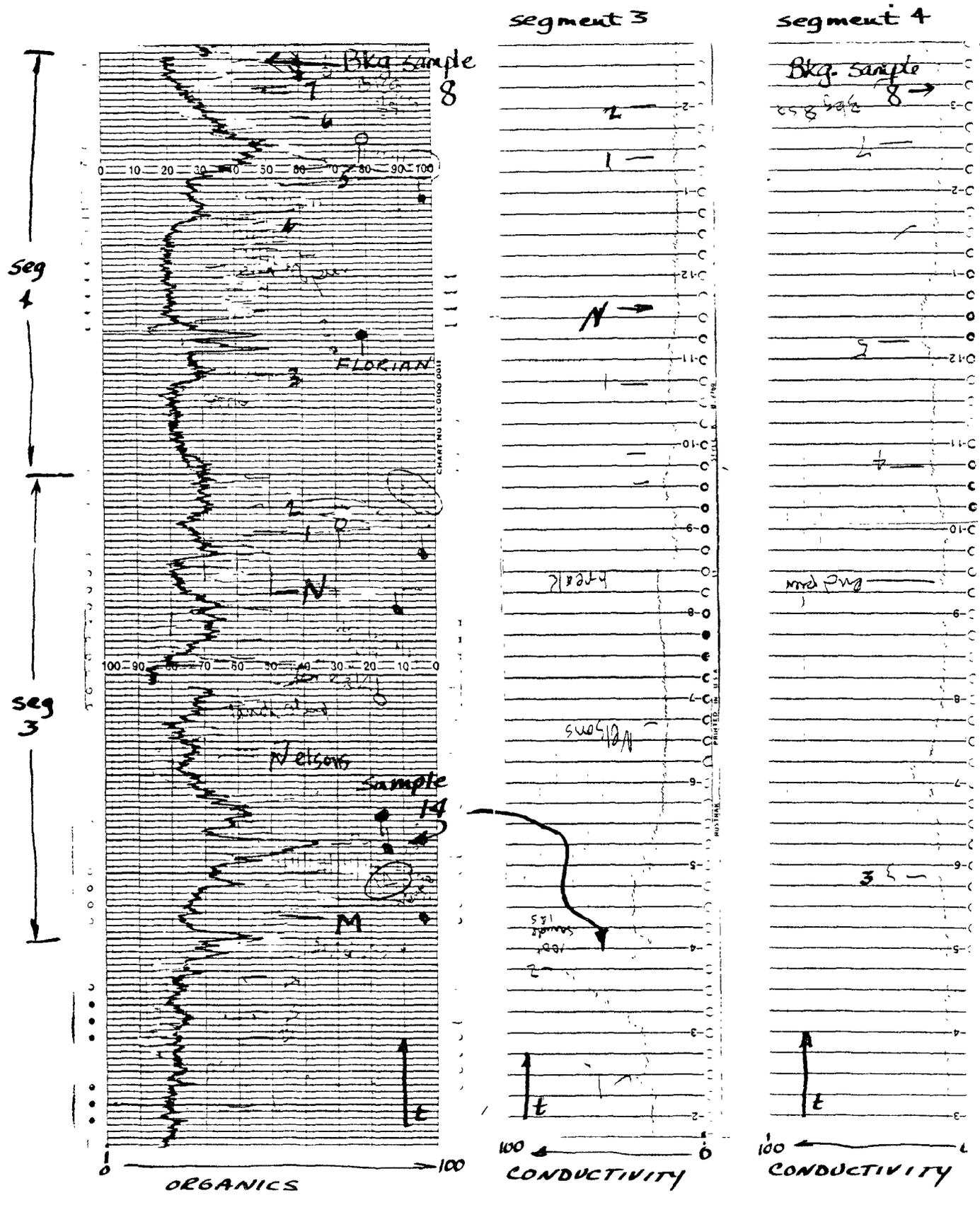

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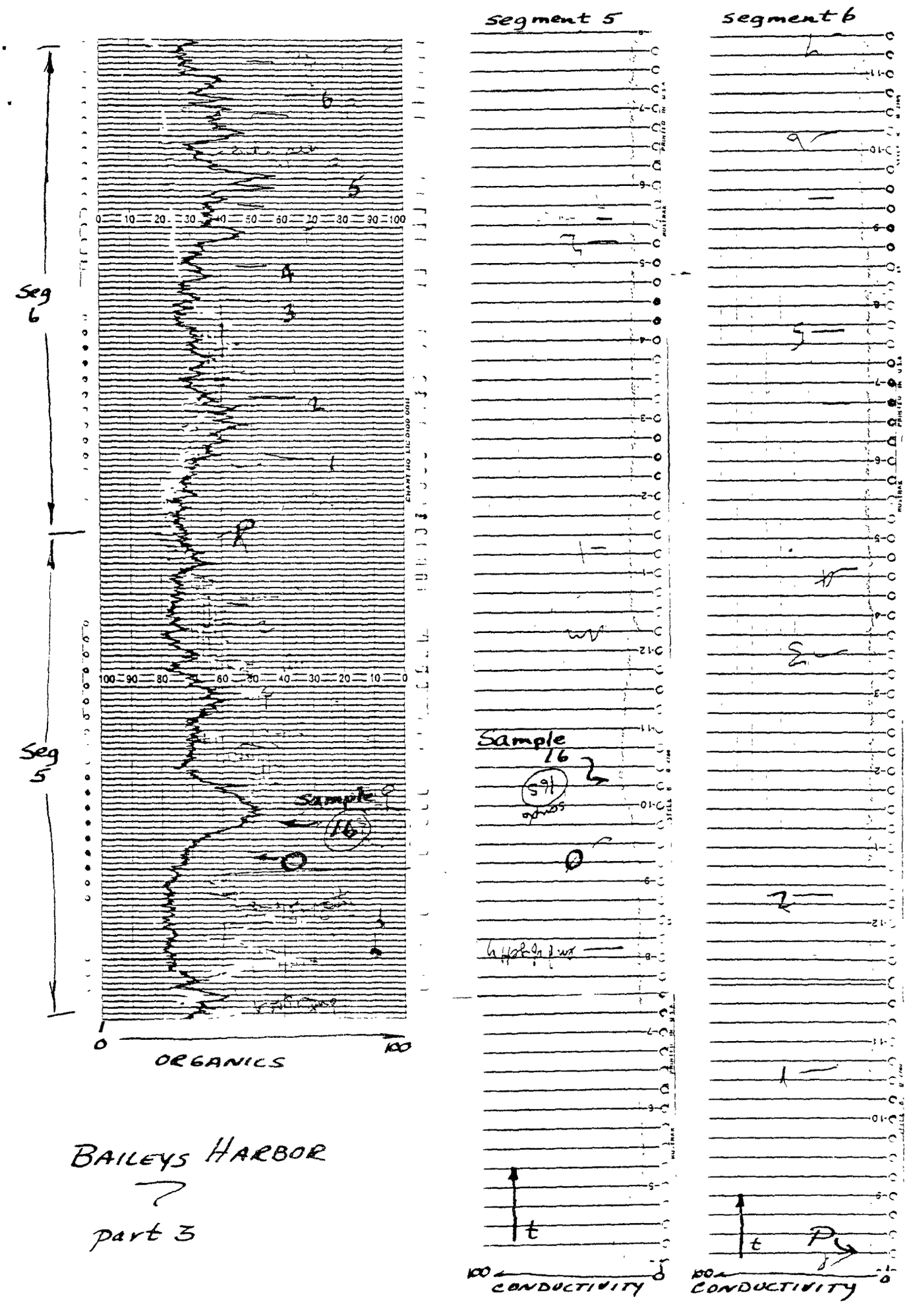

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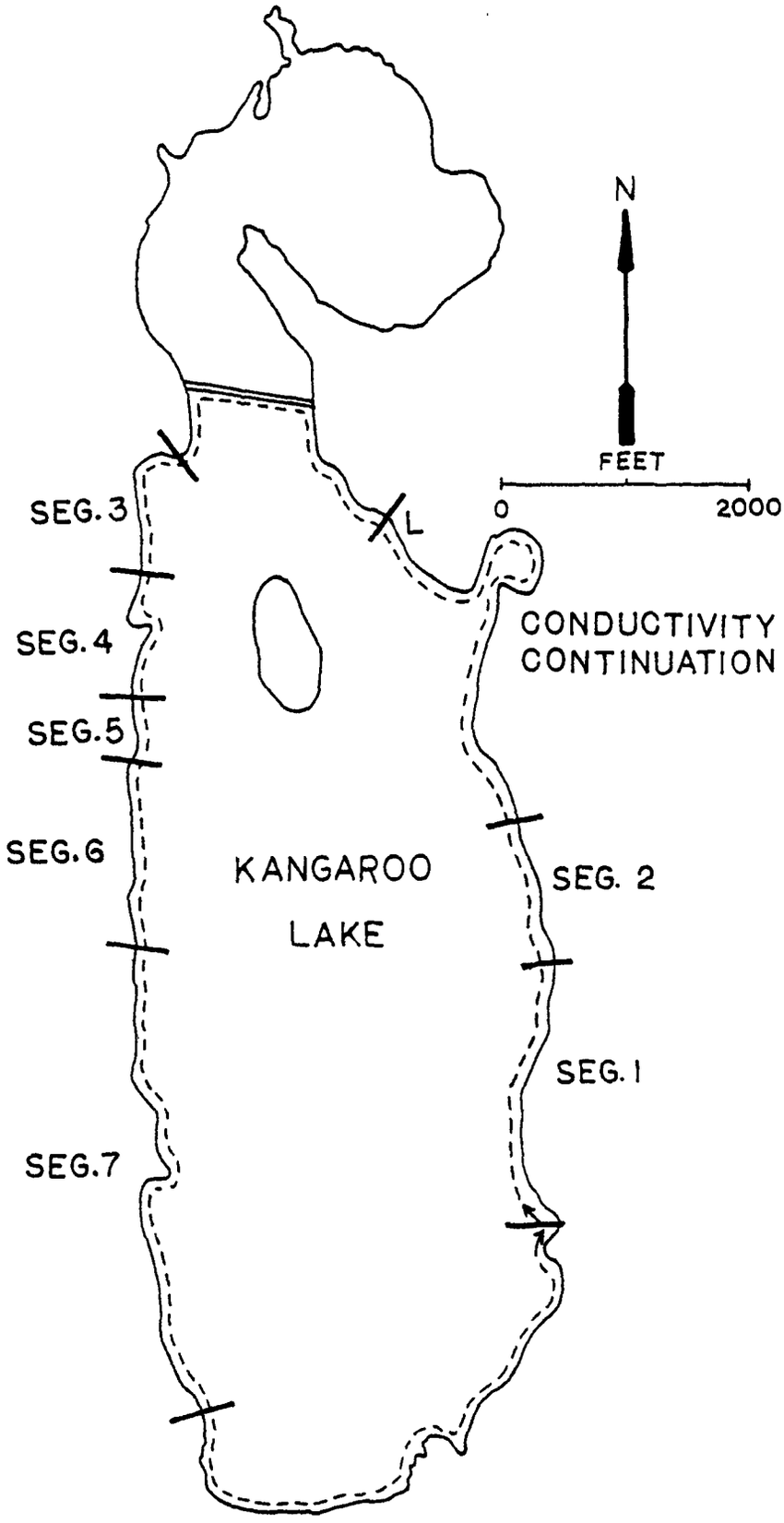
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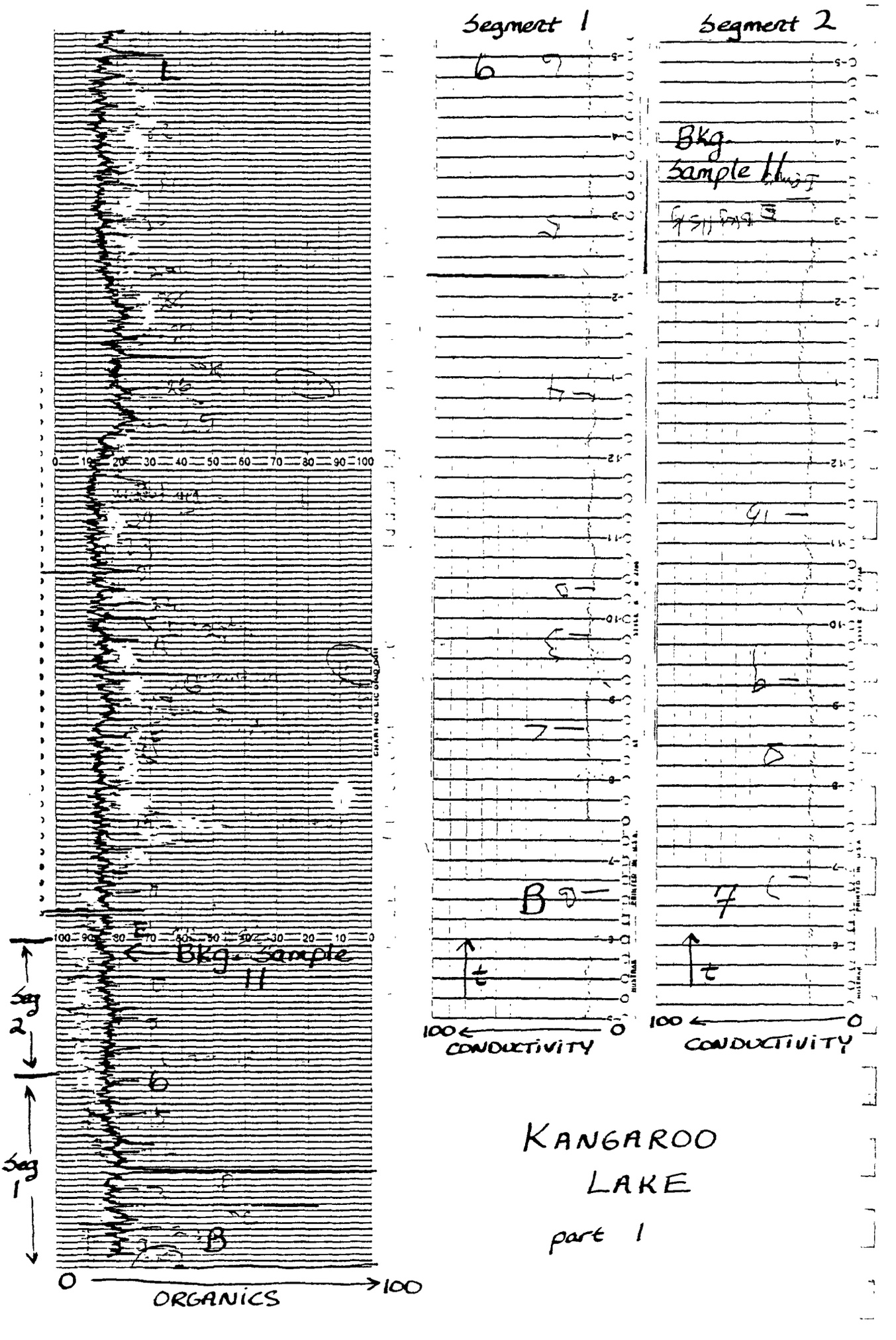

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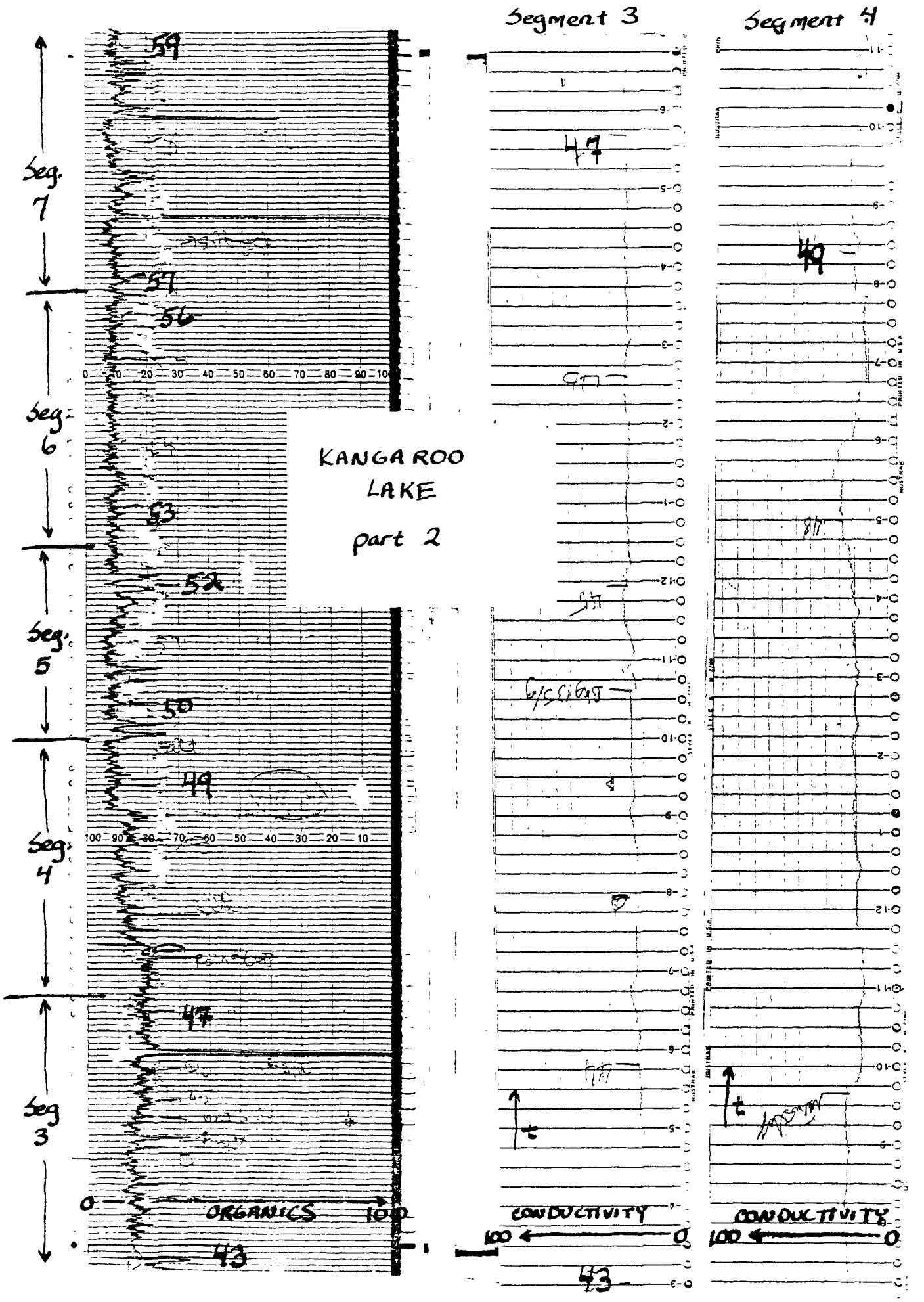

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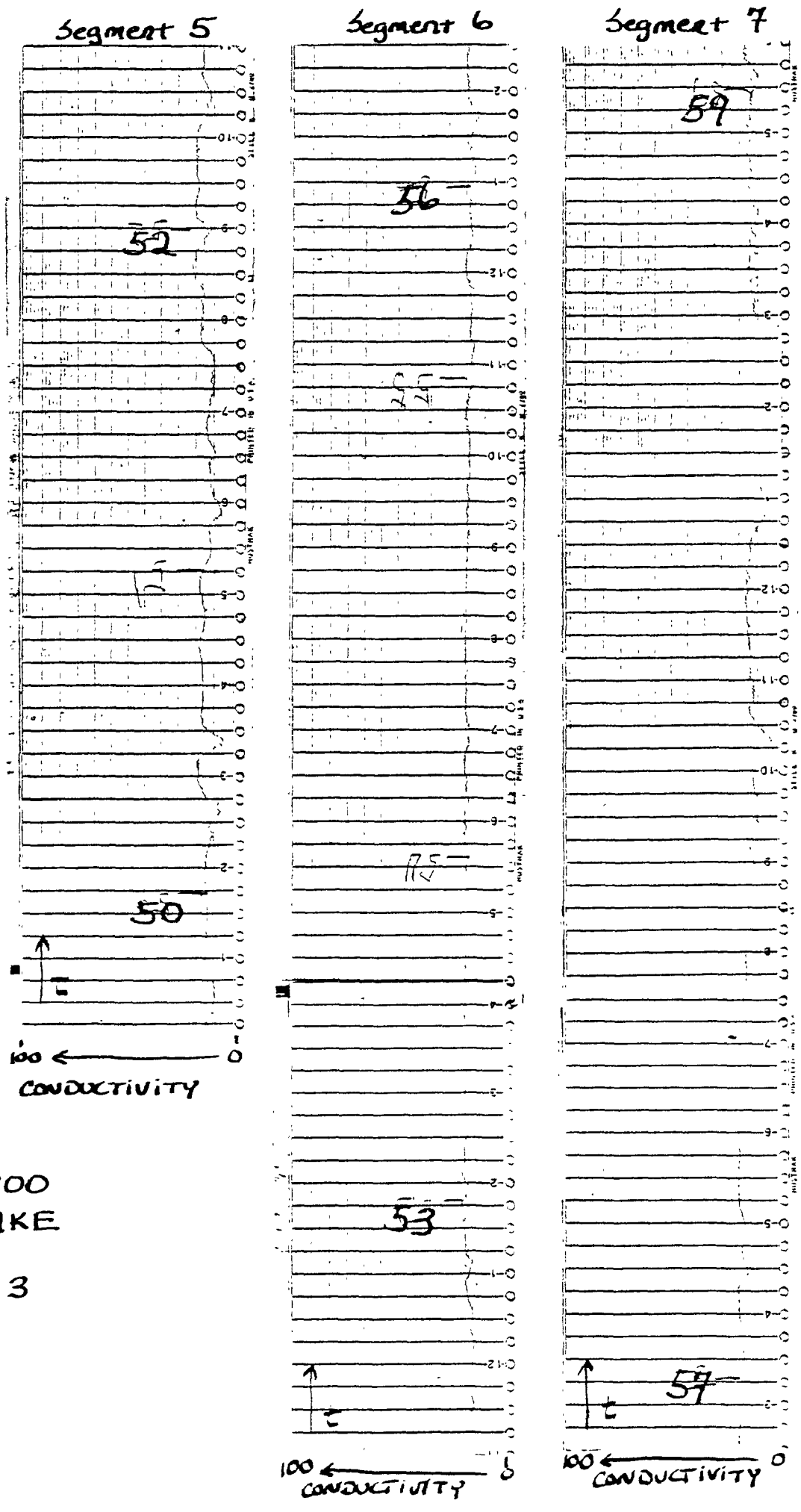

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APPENDIX C

Case History of Bacteriological Contamination of Ground Water In Door County

CASE HISTORY OF BACTERIOLOGICAL CONTAMINATION OF GROUND WATER IN DOOR COUNTY

Introduction

The Door Peninsula is formed by a ridge of resistant Niagara dolomite which is slightly tilted toward the east and is covered by a relatively thin mantle of unconsolidated glacial deposits. Along the rugged Green Bay escarpment in the northern part of Door County, bedrock outcrops are common; to the south and east the drift materials increase in thickness to as much as 60 feet. The dolomite is creviced, fractured, and solution features such as sink holes exist. The water table is relatively deep, over 100 feet in many places, but abundant supplies of ground water can be easily obtained. Unfortunately, the combination of thin glacial cover and large openings in the bedrock result in conditions conducive to ground water contamination. Man-made and natural pollutants can enter the ground water readily and flow freely for great distances. As a result, in parts of Door County, it is difficult to obtain safe drinking water from the shallow part of the saturated zone.

As used in this report, "unsafe" or "safe" drinking water refers to the bacteriological quality of the water as determined by the presence or absence, respectively, of coliform bacteria. Coliforms are indicator organisms; they do not cause disease, but specific bacteria or disease-causing bacteria or viruses may be associated with them. Coliforms are found in soil, water, air, plants, and human and animal excreta. The presence of coliforms is not positive proof that water has been contaminated by man, but it is generally accepted that the absence of coliforms indicates that water is safe for human consumption.

The Private Water Supply Section of the DNR, initially called the Well Drilling Division and then the Section of Well Drilling and Sanitation Services of the State Board of Health, has had a long history of involvement in efforts to ensure safe drinking water supplies in Door County. Only two public water supply systems exist (Sturgeon Bay and Sister Bay), and the majority of the county's year-round residents and many of the summer tourists are served by private water supplies.

Other state and local agencies have, of course, been involved in Door County's ground water problem. However, the history of the Private Water Supply Section's efforts provides an excellent overview of the situation and the corrective measures that have been taken.

The Wisconsin Well Code

In 1936, the Wisconsin Well Construction and Pump Installation Code was promulgated for the first time by the State Board of Health, Division of Well Drilling, pursuant to Chapter 162, Wisconsin Statutes. It was the first well code in the United States and remained the only one for nearly 30 years. It resulted in substantial improvements in well

construction techniques and set forth certain requirements for well locations with respect to potential sources of contaminants. In addition, it established the Well Drilling Division to carry out the provisions of the code.

The code was revised in 1939, but it was not until the 1951 revision that specific minimum casing length requirements were set forth. Therefore, prior to 1951, most drilled rock wells were constructed with only sufficient casing to hold the hole open through unconsolidated surficial materials, and if the water table was substantially below the top of the rock (as it is in many parts of Door County), contaminated surface and near-surface water could easily enter well.

The 1951 revision to the well code set forth detailed casing requirements for different types of geologic conditions. For wells constructed in water-bearing limestone (which is actually dolomite in Door County but is called "limerock" by well drillers), where the unconsolidated material was less than 40 feet thick, well casing pipe had to be seated a minimum of 10 feet into uncreviced rock below the 30 foot depth provided there was no record of sinkholes, test holes, or abandoned wells within a ½-mile radius. In other words, a minimum of 40 feet of casing pipe was required under favorable conditions, but if unfavorable conditions existed such as creviced rock, test holes, abandoned wells, or sink holes, more than 40 feet was required.

Nearly all Door County drillers interpreted the 1951 code quite liberally and installed the minimum of 40 feet of casing, even though there are few places in the county which would qualify. Therefore, in 1957 and again in 1971, drillers were advised by letter that substantially more than 40 feet of casing would be required for wells in Door County. However, many older wells with inadequate casing still exist which allow easy access of surface contaminants to ground water.

The well code was renumbered in 1956, in a program to have uniform numbering of administrative rules, and again in 1968 and 1971 because of reorganization of state agencies. It was revised in 1975 and amended in 1977 and 1978. However, none of the later revisions affected the basic state-wide minimum casing length requirements set forth in the 1951 code.

Early Water Quality Surveys in Door County

The earliest county-wide water quality study in Door County for which records are available was conducted during the summer of 1955 by the U.S. Public Health Service. A team of epidemiological workers sampled 27 private wells supplying water for public consumption (hotels, restaurants, and parks), apparently in an effort to ascertain the cause of the high incidence of dysentery or "summer diarrhea" that was prevalent among the native population as well as summer residents and tourists. The establishments served by the 27 wells were all licensed by the Hotel and Restaurant Division of the State Board of Health, and each well had tested bacteriologically safe earlier in the year. However, it was suspected that the single yearly sample, normally taken in the spring by the well owner, did not give an accurate indication of water quality during the tourist season.

Most of the wells were sampled once a week for ten weeks from June 28 to September 2; a total of 273 samples were collected and analyzed for coliform bacteria. Well owners supplied construction details for the wells, but they were not considered accurate.

Of the 27 wells, 14 (51.9%) tested positive for coliform on at least one occasion during the summer. Fifty-four of the 273 samples tested positive for the coliform group (19.8% of all samples). Intermittent contamination was noted for many wells; there were 46 reversals from a safe to an unsafe condition during the course of the testing period.

As a result of the survey, representatives from the Madison and Green Bay offices of the State Board of Health met in 1956 to discuss methods of ensuring the safety of private water supplies serving the public. Procedures were formalized in an office memorandum dated August 14, 1956 which stated that unsafe or poorly located wells should be reconstructed, but chlorination would be accepted as a temporary expedient if reconstruction was not practical.

Several chlorinators were approved and installed at hotels and restaurants in Door County between the fall of 1955 and the spring of 1957, and the State Board of Health conducted the second county-wide water quality survey in Door County in the summer of 1957 to determine, among other things, the effectiveness of chlorination. All 27 private wells at establishments licensed by the Hotel and Restaurant Inspection Section which had been sampled in 1955 were resampled, and two additional wells were included in the program. Samples were taken once a week over a 10-week period from June 25 to August 27, and a total of 310 samples were obtained. Of these, 39 (12.6%) were bacteriologically unsafe. Eighteen of the 29 wells produced an unsafe sample on at least one occasion (62.1% of all wells).

The survey showed that chlorination was not producing acceptable results due to human error, mechanical failures, and inadequate design and maintenance. Of the 8 wells which had chlorinators, only one produced consistently safe samples; from 10% to 50% of the samples from the other chlorinated wells were bacteriologically unsafe.

In the 1957 survey, the Board of Health made an attempt to determine accurate construction details for the wells, and they found a correlation between the age of the wells, conformance of construction to the well code, and the bacteriological quality of the water. The main conclusions of the survey, contained in a January, 1958 report by the Green Bay District Office of the State Board of Health, were:

1. Unit chlorinators were not a dependable method of obtaining a safe water supply.

2. Increased casing lengths were necessary to provide safe water supplies in Door County.

The 1957 100-Foot Casing Requirement

In November, 1957, largely as a result of the second survey, the Board of Health established a 100-foot casing requirement for all new wells

or reconstructed wells in Door County. Drillers were informed by letter, and a meeting was held to explain the new policy. The 100-foot casing requirement did not require a revision of the drilling code. Since creviced rock extends fairly deep in Door County and sink holes and rock outcrops are common, the Board determined that casing lengths in excess of 40 feet were required. Furthermore, the 1957 survey indicated that wells with casing lengths approaching or greater than 100-feet produced a fairly high percentage of bacteriologically safe samples, and 40 feet of casing was insufficient to shut off the vertical zone of contamination, as required by the well construction code.

In addition to the November, 1957 letter, a guide for well construction was distributed to well drillers in January, 1958. It restated the new casing requirements and also advised that if reconstruction of old wells with 100-feet of casing still resulted in bacteriologically unsafe water samples, chlorination would be considered, but chlorination in lieu of well reconstruction was not an acceptable alternative.

Numerous variances from the 100-foot casing requirement were allowed, and the Drilling Division of the State Board of Health kept a detailed log. In March, 1959, the variance policy was formalized in another letter to Door County drillers, and procedures which the driller or a well owner had to follow in requesting a variance were set forth. An important criterion used in evaluating requests for variances was the bacteriological quality of water from nearby wells and their construction characteristics.

Between February, 1958 and August, 1971, about 200 variances from the 100-foot casing requirement were granted. To compare water quality from wells given variances to those which had 100-feet or more of surface casing, the Board conducted three water quality surveys in Door County during the summers of 1959, 1960, and 1961. The results are shown in Table 1.

Table 1. Results of 1959, 1960, and 1961 Water Quality Surveys in Door County.

	Safe	Unsafe and Percent of all Samples which were Unsafe
1959		
Wells with 100' or more of casing	35	6 (14.6%)
Wells with less than 100' of casing (variances)	3*	3*(50.0%)
All wells	38	9 (19.1%)
1960		
Wells with 100' or more of casing	59	4 (6.3%)
Wells with less than 100' of casing (variances)	21	3 (12.5%)
Unknown casing length	4	0 (0.0%)
All wells	84	7 (7.7%)
1961		
Wells with 100' or more of casing	48	4 (7.7%)
Wells with less than 100' of casing (variances)	33	3 (8.3%)
Unknown casing length	1	0 (0.0%)
All wells	82	7 (7.9%)

*Does not include one well which tested unsafe and then safe.

A relatively high number of all wells produced bacteriologically unsafe samples during the 1959 survey (19.1%), and 3 out of the 6 wells which had been granted variances tested unsafe. However, in 1960 and 1961, the number of unsafe samples was considerably lower than in 1959, possibly due to increased surveillance of drillers in these years, including a grouting inspection program. Wells constructed under variances for less than 100 feet of casing produced a slightly greater percentage of unsafe samples in the second and third years, but the results are very close to the results for the entire group of wells. Of the 47 wells which were sampled in 1959, 43 were resampled in 1960, and all of the nine wells which tested unsafe in 1959 were safe. However, two wells which had been safe in 1959 were unsafe in 1960.

Forty-seven wells were sampled two or more times during the three years. Of these, 15 (31.9%) produced bacteriologically unsafe samples on one or more occasions. For 26 wells with 100 or more feet of casing, 6, or 23.1%, were unsafe on one or more occasions. For 19 wells with less than 100 feet of casing, 8, or 42.1%, were unsafe on one or more occasions. Two wells with unknown casing lengths were sampled more than once, and one of these produced at least one unsafe sample during the survey period.

Migrant Labor Camp Problems and Chlorination Policies

In the early 1960's, the Board of Health undertook an examination of the water supplies at camps which were provided by cherry growers in Door County for the seasonal labor force used to harvest the crop. Several were closed in 1961, 1962, and 1963; by 1964, a total of 20 camps had been closed for unsafe drinking water supplies. Many of the closed camps had other sanitation deficiencies as well.

The closed camps represented housing for about 25% of the labor force needed to harvest the 1964 cherry crop, and the growers were desperate. Representatives of the Board of Health (which enforced migrant labor camp standards and controlled the construction of water supply wells), cherry growers, and the marketing cooperative held a meeting in the spring of 1964 to discuss the problem. As a result, emergency drinking water procedures were established which allowed the camps to reopen using dispensers of chlorinated water for drinking and culinary purposes, provided that they entered into contracts for new wells. Seven camps reopened under these provisions.

None of the owners of the seven camps which operated under the 1964 emergency drinking water procedures drilled new wells, and by the summer of 1965, a total of 36 camps had been closed for unsafe drinking water supplies and other sanitation deficiencies. Dispensers of chlorinated drinking water were again allowed, and 15 camps reopened, although only 2 provided an adequate disinfected water supply. Similar situations developed in 1966, 1967, 1968, and 1969. Although a substantial effort was made by the Well Drilling Division of the State Board of Health to force camp owners to drill new wells, few, if any, actually did. They were apparently reluctant to make the investment in a new well during a period when mechanical harvesters were beginning to replace much of the migrant labor force. In addition, camp owners argued that chlorination was an accepted method of providing bacteriologically safe private water supplies in Door County, pointing out that they knew of chlorinator installations at establishments licensed by the Hotel and Restaurant Section. Subsequent investigation showed that several owners of licensed establishments did, indeed, have chlorinators still installed. Two of these units had been installed as a result of the 1955 U.S. Public Health Service water quality survey and the subsequent temporary chlorination policy introduced by the Board of Health in 1956.

In a December, 1969 letter to the chairman of the Department of Industry, Labor, and Human Relations, (which now controlled the migrant labor inspection program), the Secretary of the DNR reiterated the policy established after the 1956-1957 chlorination "experiment"; chlorinators would only be allowed if well reconstruction or drilling a new well failed to produce a safe water supply. It was requested that no migrant labor camp be allowed to reopen unless the private water supply standards of the state were met. At the same time, action was taken to ensure compliance with the standards at establishments licensed under the hotel and restaurant program.

"Poison in Paradise" and Follow-Up Water Quality Surveys in Door County

In April, 1971, Don Oleson, a Door County summer resident and a writer for the Milwaukee Journal, published an article in the Journal's "Insight" magazine which stirred up unprecedented interest in Door County ground water quality. With the emotional title of "Poison in Paradise," the article presented the results of bacteriological testing of 30 water samples taken from private wells serving the public. Oleson collected the samples himself from bathroom water faucets at public establishments, and although he apparently followed accepted sampling procedures, he took many of the samples without the knowledge of the owners.

Thirty samples were taken--20 in August of 1970 and an additional 10 in March, 1971. Of the 30, 14 (46.7%) were bacteriologically unsafe; however, newer wells which met the 100' casing requirement produced almost uniformly safe water (no actual count was given). Oleson placed most of the blame for the problem on faulty septic systems and called for sewage collection systems and a limit to further development in Door County. However, he did not develop positive evidence of sewage contamination. Coliform bacteria have many non-sewage sources; furthermore, by taking samples at bathroom faucets, Oleson may have been sampling bacteria which were introduced in the plumbing system.

Largely as a result of the article and the ensuing controversies, the Department of Health and Social Services and the Department of Natural Resources undertook a cooperative water quality survey of Door County in the summer of 1971. The DHSS sampled wells at mobile home parks and at establishments licensed by the Hotel and Restaurant Section, whereas DNR's sampling efforts were aimed at quasi-public places such as service stations, taverns, marinas, and airports. In addition, owners of wells used for domestic supply were encouraged to submit samples for bacteriological analysis. The results of this sampling program are listed in Table 2.

Table 2. Results of 1971 Water Quality Survey in Door County

Wells sampled by DNR	Safe	Unsafe
Wells with 100' or more of casing	11	1 (9.1%)
Wells with less than 100' of casing	7	2 (28.6%)
Unknown casing length	33	9 (27.3%)
All wells	51	12 (19.0%)
Wells Sampled by DHSS		
Wells with 100' or more of casing	126	16 (11.3%)
Wells with less than 100' of casing constructed since 1957 (variances)	46	2 (4.2%)
Wells with less than 100' of casing or unknown casing length constructed prior to 1957	615	119 (16.2%)
All wells	787	137 (14.8%)
Wells sampled by owners		
Wells with 100' or more of casing	312	35 (10.1%)
Wells with less than 100" of casing constructed since 1957 (variances)	76	5 (6.2%)
Wells with less than 100' of casing or unknown casing length constructed prior to 1957	637	152 (19.3%)
All wells	1,025	192 (15.8%)

Only 10.4% of all samples taken from wells with 100 or more feet of casing tested bacteriologically unsafe, whereas 16.9% of all samples taken from wells with unknown casing lengths or less than 100 feet of casing tested unsafe. Of the latter category, samples taken from wells which had less than 100 feet of casing but had been drilled since 1957 (variances to the 1957 casing requirement) had a very low incidence of unsafe samples. This was probably due to the fact that, under the 1957 casing requirement, drillers in Door County could only get approval for less than 100 feet of casing in areas where favorable geologic and water quality conditions already existed.

Overall, 15.5% of the 2,204 wells sampled during the 1971 survey in Door County produced unsafe samples. After the survey was completed, DNR began the time-consuming task of notifying well owners of code violations and making follow-up inspections to ascertain corrections.

During the time that the 1971 survey was being conducted, the Private Water Supply Section of the DNR also prepared a proposal in response to a request by the Governor for a DNR program to correct unsafe water supplies in Door County. The proposed program provided for a continued water supply sampling and evaluation for several more years, and included schools and migrant labor camps as well as the establishments licensed by the Hotel and Restaurant Section of the DHSS. In addition, an inventory and sampling of domestic wells would be undertaken, and a well grouting inspection program was planned. The cost of the proposed work would be about $80,000 per year for 6 years. The proposed program was subsequently modified to include only water supplies serving the public, but no budgetary action was taken.

The 1971 170-Foot Casing Requirement

The 1971 water quality studies in Door County indicated that, among other things, 100 feet of casing was not sufficient to ensure safe water supplies in many parts of the county. Therefore, in September, 1971, drillers were advised that, until proposed new casing requirements were formalized, the amount of casing required in new wells would have to be resolved with DNR on a case-by-case basis. In addition, they were informed that grouting procedures would have to be improved to ensure an adequate bond between casing and rock. In general, the drillers were advised that 170 feet of casing would be required in all new or reconstructed wells east of the Niagara escarpment except in the Southeastern portion of the county where consideration would be given to less well casing pipe.

In October, 1971, the procedures requiring a case-by-case evaluation of each new well were replaced, and the county was divided into zones, with different minimum casing requirements in each zone. As shown on the accompanying map, most of Door County was zoned for 170 feet of casing or sufficient casing to extend 30-feet below the static water level at the time of setting the casing (whichever was greater); some smaller areas were zoned for 100 feet of casing or casing extending 30 feet below the static water level (whichever was greater). In other areas, consultation with the DNR would be required to determine casing length, unless the driller proceeded under the most restrictive guidelines. The northern tier of sections in Kewaunee County was also included in the zoning.

To a certain extent, the new casing requirements were based on the results of a testing drilling program initiated by the U.S. Geological Survey in cooperation with the DNR during the summer of 1971. Although the final report was not completed until 1978, preliminary results indicated that more than 100 feet of casing was required to seal off the zone of contamination in most of Door County, and that adequate supplies of high quality ground water were available from deep openings along bedding planes and fractures in the Niagara dolomite.

Water Quality in New Wells Constructed Since Zoning

Since the most recent casing requirements were promulgated, the DNR has kept a careful account of the bacteriological quality of water from the new wells. The lab of Hygiene, which performs nearly all the bacteriological analyses on water from new domestic wells, forwards the results to the Private Water Supply Section. Table 3 summarizes analyses for wells drilled since September, 1971.

Table 3. Bacteriological Quality of Water from New Wells Drilled in Door County between September, 1971 and July, 1978

	Safe	Unsafe
First test results	1,137	79 (6.5%)
Retest results for wells testing unsafe on first test*	42	17 (28.8%)
Retest results for wells testing unsafe on first and second test	7	2 (22.2%)

* Not all wells are retested after an unsafe test or the results aren't reported; retest results for only 59 (42 + 17) of the 79 initial unsafes were reported, and retest results for only 9 (7 + 2) of the 17 wells which tested unsafe on the first two tests were reported.

These results indicate that the new casing requirements have been successful in improving the bacteriological quality of water supplied by Door County wells. Out of the 1,216 new wells tested, 1,186 produced safe samples on either the first test or on retests after disinfection. The percentage of unsafe first tests (6.4%) is probably comparable to new wells in the rest of the state (a direct comparison is impossible to make; results of tests on new wells only are not kept for the rest of the state).

The crackdown on well code violations which resulted from the 1971 water quality survey has also been effective in improving the bacteriological quality of water from private wells serving the public. In the 1975-1976 random survey of water supplies at establishments licensed by the Hotel and Restaurant Section of the DHSS, 40 wells in Door County were sampled. There were no unsafe samples. Only three major violations of the well construction code were noted, and more than one-half (22) of the wells were in complete compliance.

In 1977, an additional 11 private wells serving the public in Door County were sampled as part of the random non-community survey. Only one well produced bacteriologically unsafe water, but it retested safe. No major violations of the well code were noted. However, it is not expected that 100% of the wells in these two categories would produce consistently safe samples. In the older wells, intermittent contamination will still be a problem.

1978 Special Survey of Old Wells

In early 1978, the DNR Board expressed interest in determining the bacteriological quality of water from wells constructed in Door County prior to 1951, when minimum well casing requirements had not been established. The Private Water Supply Section initiated a sampling program for fifty wells with less than 40 feet of casing. Wells constructed prior to 1936 could not be included in the program (construction reports are not available and casing lengths are unknown), and, in order to reach the goal of fifty wells, it was necessary to include three wells with 40 feet of casing and four wells with casing lengths slightly in excess of 40 feet. In addition, one well was never sampled and one well had an unknown casing length and the data was not used. Ultimately, 48 wells were sampled.

The first round of sampling was conducted in May and June, 1978. Of the 48 wells, six (12.2%) were unsafe, but after well disinfection and resampling, only one well still produced an unsafe sample (one unsafe well was never disinfected and resampled).

In order to determine the extent of intermittent contamination, the wells were resampled in August. It was not possible to contact all of the well owners, and seven wells were not resampled. Of the 41 wells, 13 (31.7%) were unsafe.

A correlation between bacteriological quality and pump installation was noted during the survey. Eleven of the sampled wells had fully complying pump installations, and all but one of these produced consistently safe samples. Nineteen wells had major pump installation violations; nine of these produced intermittently unsafe samples, and all of the samples from two noncomplying wells were unsafe. Pump inspections could not be made at nine wells for various reasons, and three of these produced intermittently unsafe samples. At the nine wells which had minor pump installation violations (lack of a sampling faucet), only two produced unsafe samples.

The large number of unsafe samples from the wells in the survey would be expected in any area of creviced rock, and thin soils where wells are cased to a shallow depth. However, even with insufficient casing, the survey results indicate that wells in compliance with the well construction and pump installation code have a greater probability of producing safe samples than those which have major violations. All owners of wells with questionable or non-complying pump installations, as well as those which produced one or more unsafe samples, were advised by letter on how to improve the condition of their water supplies.

Summary and Conclusions

There has been a continual effort on the part of the Private Water Supply Section of the DNR and its predecessors to ensure safe drinking water supplies in Door County. Since the earliest water quality surveys in 1955 and 1957, there has been a steady improvement in the bacteriological quality of water from domestic wells and private wells serving the public. Wells drilled today in the county are nearly always cased through the upper part of the saturated zone, and the bacteriological analyses indicate that the percentage of new wells testing unsafe in Door County is no greater than any other part of the state.

However, ground water quality problems still exist in Door County. The shallow, fractured bedrock and numerous shallow-cased wells allow contaminants in surface and near surface waters to move downward to the water table. In the event that it is necessary to case to even greater depths than presently required, it will still be possible to produce an adequate supply of water from the Niagara aquifer in most of the County. In areas where the Niagara is thin, it may be necessary to obtain water from horizons below the Maquoketa shale. Continued monitoring of water supplies, especially those at public establishments, is necessary to ensure safe drinking water in the County.

APPENDIX D

Report on Investigation, Door County Wells with Limited Casing

REPORT ON INVESTIGATION
DOOR COUNTY WELLS
WITH LIMITED CASING

October 10, 1978

PURPOSE

During the March DNR Board Meeting, board member John Brogan expressed an interest in determining the safety of private wells in Door County which were constructed prior to 1951. During that period, wells were constructed in many cases with less than 40 feet of well casing when rock lay at a depth of less than 40 feet from the ground surface.

Mr. Brogan reasoned that private well owners were not getting the protection in the way of monitoring of water quality that persons who were obtaining water from systems supplying water to licensed establishments and other systems covered by the Federal Safe Drinking Water Act were or would be getting. He felt owners of residential supplies in Door County and in any other similar problem areas of the state should be alerted to the potential hazards of unsafe wells.

Mr. Brogan suggested there should be sampling of a percentage of wells constructed prior to 1951, when the code was not specific as to the minimum casing requirements. He felt that a random survey should be made of 30 to 50 wells constructed prior to 1951 and cased with less than 40 feet of pipe to determine the quality of the water from such wells. The Board supported his thinking and requested through Secretary Earl that such a survey be made.

IMPLEMENTATION PLAN

To carry out the assignment required use of budget ear-marked for other purposes. It also required the services of someone knowledgeable in the standards for private water supplies. Because normal program demands did not permit diversion of staff time from either the central office or district office for the project, it was necessary to find someone who has retired and hopefully had experience in the private water supply program. The assignment did not allow time for training which could not be accomplished adequately in a matter of a few weeks. The assignment had to involve more than mere sample collection, it neccesitated evaluation of the water supplies, also.

We were fortunate to employ Mr. Roderick Kalling, a retired registered sanitarian who was formerly in the Hotel & Restaurant (H&R) Inspection Section of the State Board of Health, and after reorganization of state agencies, with the Division of Health, Department of Health and Social Services. Prior to his retirement he served as Assistant Chief of the H&R Section. He had inspected many water supplies during the long period of time he worked in inspecting licensed establishments. Water supply evaluations in addition to sampling at licensed establishments began in 1954 following training of the H&R staff of the State Board of Health by the Private Water Supply Section.

The assignment was not one involving the simple matter of going out into the county and contacting home owners for permission to sample their well water. It was necessary to review well construction reports in the Department files

to obtain a list of wells with less than 40 feet of casing. It was known that it would be difficult to locate many of these wells in the field because information on the well location entered on the early reports was limited and well ownership was expected to have changed in many cases. It was known that on the reports for the older wells, the location was often referenced by distance from highway intersections rather than by 1/4 Section, Section, Town and Range. The completeness of locations of the wells listed in Table 1 may appear to contradict this but many of the geographic locations given in the table were determined in the field during the survey.

Mr. Kalling began the project on May 15, 1978. He abstracted from the construction reports in the files, information on well locations, ownership at the time of completion of the wells, well construction and geologic data, depth of well casing, depth to static well water level at the time of completion of the well and date of completion of the well. He took data from 138 well reports, a few of which had more than 40 feet of casing, but which were constructed prior to 1951. The goal was to sample at least 50 wells and as it turned out, because of difficulties in finding the properties, locating property owners, finding owners at home, denials of entry and sampling, etc., it was necessary to sample a few wells with slightly more than 40 feet of casing to accomplish that goal.

FIELD SURVEY AND RESULTS

The field survey was begun on May 23, 1978. It is repeated, we were especially fortunate to get Mr. Kalling to do the field work, not only because of his knowledge of the well construction and pump installation code but because of his conscientious attitude, which we knew we could expect from past associations with him. On his own volition, when finding many well owners were absent during the day, he went back in the late afternoon and even worked many evenings to contact owners. Also, he made a special effort to ferret out information to match old wells with present property owners. Not only did he contact Mr. Phil Woerfel, Door County Sanitarian and Mr. John Teichtler, Assistant County Sanitarian, who were most helpful in this regard, but he also contacted Mr. Tom Smith of the County Tax Listing Office and Bert Thorp, Ephriam postmaster. They too were very helpful to Mr. Kalling. In addition, he conferred with several citizens, drillers and pump installers to locate wells.

With dilligence he was able to locate 100 properties out of the 138 for which he had well construction information. He collected 50 samples, one of which he discarded because the owner changed his mind and asked that the sample be dumped. In the goal of collecting samples from at least 50 wells, it was necessary to sample four wells with 40 feet of casing, one well with 41 feer of casing, one with 45.5 feet of casing, one with 46 feet of casing and one with 65 feet of casing. Although the constraints on the type of wells which were to be sampled prevented a truly statistically random sampling, the wells were spread throughout most of the county (Figure 1).

In Mr. Kalling's visit to the 100 properties, he found that 10 wells had been replaced with new wells, the buildings were gone in 5 cases with no well visible, the well owner was never available in 4 cases, no one was home in 10 cases, the wells were not operational in 9 cases, wells were used only for toilets in 2 cases, wells had been reconstructed in 3 cases and he was not allowed to sample wells in 8 cases.

There were 6 (12.2%) unsafe samples collected out of the 49 samples analyzed in May and June (Table 1). The owners of wells producing unsafe samples were advised to disinfect their wells and all of these wells, except for one was resampled in June. On the resampling, 4 of the 5 wells produced safe samples. Because it was reasoned that with the limited amount of well casing existing in these wells there would be some intermittent contamination, a second sampling of the 49 wells was scheduled in August. Mr. Kalling was able to collect samples from only 41 of the 49 wells.

Owners of 2 of the wells initially sampled refused the second sample request, in one case the pump had burned out, and the other 5 home owners were not at home. Ten samples were late in reaching the Madison Laboratory due to an error by the Green Bay Post Office in mailing the samples destined for Madison back to Ephriam, the starting point. By the time they were redirected to and reached Madison, they were too old for analysis. These wells were resampled the following week.

Of the 41 wells sampled in August, 12 (~~31.1~~ 29.3%) produced unsafe samples. A review of Table 1 will show repeated safe samples from several wells with intermittent contamination in others and repeated unsafe samples in 2 cases. An apparent correlation between bacteriological quality and pump installation was noted during the survey.

Eleven of the sampled wells had fully complying pump installations, and all but one of these produced consistently safe samples. Nineteen wells had major pump installation violations; nine of these produced intermittently unsafe samples. All of the samples from two of the 19 wells with non-complying pump installations were unsafe. Pump inspections could not be made at nine wells for various reasons, and three of these produced intermittently unsafe samples. Of the nine wells which had minor pump installation violations (lack of sampling faucet), only two produced unsafe samples. If a proper sampling faucet were installed, sample results may have been different for the two wells.

Possibly in any area of creviced rock with thin soil cover where wells are cased to shallow depths and water occurs at a considerable depth, wells would produce a similarly large number of unsafe samples as collected during the survey. On the other hand, the nature of the geology, the ground elevation and the penninsular configuration of Door County, which is relatively narrow and lends to deeper ground water occurrence, is not duplicated extensively in the state. True, in some of the Coulee County and in other areas of high ground with narrow ridges completely or partially surrounded by deep valleys the ground water may be deep but population density and thus the number of wells is very small.

Even with insufficient casing, the survey indicates that wells with complying pump installations have a greater probability of producing safe samples than those which have major pump installation violations. All owners of wells with questionable or non-complying pump installations, as well as those whose wells produced one or more unsafe samples, are being advised by letter how to possibly improve the condition of their water supplies. Even those property owners whose wells produced safe samples on repeated sampling are being advised to continue to sample periodically.

Because one well had 65 feet of casing, which is considerably more than the 40 feet of casing set as a maximum for the survey, it was not included in Table 1. It produced a safe sample during the initial round of sampling and was not resampled in August.

In a survey of this nature, it is best to sample during a wet period of the year because the probability of a well producing an unsafe sample is greatest during such period if it is intermittently contaminated. Table 2 illustrates precipitation for the period of the survey. The rainfall which occurred during the survey period is considered as being high enough to have caused the type of impact desired on ground water quality to permit an assessment of the dependability of the shallow cased wells to produce safe samples.

The results were not surprising to the Private Water Supply Section staff, considering these wells were selected because they were constructed with limited casing.

Even though the survey brought out the fact that a number of unsafe wells exist, which is something that can be expected with 500,000 plus wells in this state, there is no way in which the Department could conduct similar surveys statewide nor should it be necessary. Owners of wells have a responsibility to themselves to determine the safety of their water supplies if they have a concern about them. It appears to us that well owners in Door County have been amply aware of the need to sample water from their supplies based on information in our files.

In 1971 following the publicity Door County received from the article in the Milwaukee Journal "Insight" magazine, 1,217 well owners collected samples on their own initiative and submitted them to the laboratory; 665 well owners sent in samples to the laboratory in 1972; 478 sent in samples in 1973; 407 sent in samples in 1974, 616 sent in samples in 1975; 401 sent in samples in 1976; 201 sent in samples in 1977; and to date 328 sent in samples in 1978.

The results of this water supply survey and the earlier survey made in 1971 points out the need on occasion to define what constitutes the "vertical zone of contamination" based on a history of failures of wells constructed to existing minimum standards to produce bacteriologically safe water. Chapter NR 112, Wisconsin Administrative Code requires such zone to be cased off.

The "vertical zone of contamination" means that depth of geologic formations, generally near the ground surface, containing connecting pore spaces, crevices or similar openings, including artificial channels, such as unprotected wells, through which contaminated water may gain access to a well or the ground water body. It is generally found that the minimum casing normally needed is much less statewide than is necessary in special problem areas.

The results of this water supply survey and of the 1971 water supply survey prior to establishing the present well construction standards in Door County compared to the high degree of success with safe samples collected from new wells constructed in Door County beginning in late 1971, justifies the present construction standards in Door County.

Our records show that out of 1,216 new wells constructed since that time, 93.5% produced safe samples on initial sampling and that following disinfection and repeated sampling, 97.5% produced safe samples. Also we have no record that 30 of the wells producing initial unsafe samples had been disinfected and resampled. Had they been and based on the results of resampling of the other wells following disinfection, it could be expected that possibly 1/3 or more of the 30 would have produced safe samples. If true, this would bring the number of new wells producing safe samples up to about 98%.

These figures show a very high degree of success, especially considering that construction methods may introduce temporary contamination in a new well which may require a period of time to eliminate. It is believed this record is as good as can be expected with new wells in any county.

Respectfully Submitted,

Thomas A. Calabresa

Thomas A. Calabresa, P.E.
Bureau of Water Quality

TAC:sd

TABLE 1. SPECIAL SURVEY - DOOR COUNTY WATER SUPPLIES

Well Number	Well Location	Casing Depth in ft.	Depth of Well in ft.	Depth to Water at Time of Const., in ft.	Depth to Rock in ft.	Date of Well Construction	Date of Sample Collection	Laboratory Results	Initial or Repeat Sample
1	Gov't Lot 1,S30,T28N,R26E	35	125	2	10	8-1946	6-8-78 8-26-78	Safe Safe	I R
2	SW¼,S13,T31N,R27E	16	150	98	2	8-16-48	6-17-78	Safe	I
3	NW-¼,SW-¼,S36,T34N,R29E	6	93	59	3	6-3-49	6-7-78 8-16-78	Safe Unsafe	I R
4	Gov't Lot 1,S20,T30N,R28E	41	102	35	Surface	Unknown	6-15-78 8-26-78	Safe Safe	I R
5	SW¼,S23,T31N,R27E	10	300	77	Surface	9-17-49	6-28-78	Safe	I
6	SW-¼,SW-¼,S23,T29N,R28E	30	80	--	--	7-24-50	5-23-78 8-26-78	Safe Safe	I R
7	Gov't Lot 3,S13,T31N,R27E	37	95	62	Surface	9-20-50	6-8-78 8-15-78	Safe Safe	I
8	NW-¼,SW-¼,S30,T30N,R28E	28	74	10	17	6-15-49	6-24-78 8-26-78	Safe Safe	I R

Well Number	Well Location	Casing Depth in ft.	Depth of Well in ft.	Depth to Water at Time of Const., in ft.	Depth to Rock in ft.	Date of Well Construction	Date of Sample Collection	Laboratory Results	Initial or Repeat Sample
9	NW-¼,SW-¼,S8,T26N,R24E	25	94	50	16	6-11-48	6-14-78 8-14-78	Safe Safe	I R
10	NW-¼,SW-¼,S36,T32N,R26E	25	80	15	14	11-21-41	6-1-78 8-15-78	Safe Safe	I R
11	NE-¼,S22,T29N,R27E	30	90	--	--	2-25-46	5-24-78	Safe	I
12	SW-¼,S30,T31N,R28E	24	57	22	Surface	11-30-51	6-28-78 8-26-78	Safe Safe	I R
13	SW-¼,SW-¼,S23,T27N,R25E	30	140	--	30	1-20-42	5-25-78 8-17-78	Safe Safe	I R
14	NW¼,NW¼,S20,T30N,R28E	30	45	25	4	7-30-36	5-24-78	Safe	I
15	SE-¼,NE-¼,S13,T27N,R25E	33	170	80	3	6-30-48	5-25-78 8-14-78	Unsafe Unsafe	I R
16	NW-¼,SE-¼,S16,T26N,R27E	20	53.7	3	2	6-1-38	5-23-78 8-26-78	Safe Safe	I R
17	NW-¼,SW-¼,S2,T26N,R24E	45.5	100	16	--	3-1-49	5-30-78 8-14-78	Safe Unsafe	I R
18	SW-¼,SW-¼,S21,T26N,R25E	24	110	16	20	1-3-48	6-27-78 8-16-78	Safe Safe	I R

Well Number	Well Location	Casing Depth in ft.	Depth of Well in ft.	Depth to Water at Time of Const., in ft.	Depth to Rock in ft.	Date of Well Construction	Date of Sample Collection	Laboratory Results	Initial or Reveal Sample
19	Gov't Lot 3, S20,T30N,R28E	40	96	35	0	11-26-53	5-24-78 8-16-78	Safe Safe	I R
20	SE-¼,SW-¼,S18,T28N,R26E	40	175	18	5	11-1-38	5-31-78	Safe	I
21	SW-¼,S12,T31N,R27E	22	104	58	Surface	6-2-50	6-8-78 6-28-78 8-15-78	Unsafe Safe Safe	I R R
22	Gov't Lot 1,S12,T33N,R29E	17	33	15	--	1928	6-29-78 8-16-78	Safe Safe	I R
23	Gov't Lot 1, S27,T27N,R26E	40	58	6	40	6-25-53	6-8-78 8-6-78	Safe Unsafe	I R
24	SE-¼,SE-¼,S9,T27N,R24E	18	65	12	18	10-3-45	5-31-78 8-14-78	Safe Safe	I R
25	SE-¼,SE-¼,S8,T27N,R23E	20	70	20	8	6-3-49	5-31-78 6-14-78 8-14-78	Unsafe Safe Unsafe	I R R
26	Gov't Lot 3,S16,T26N,R23E	15	46	15	24	9-1947	6-14-78 8-14-78	Safe Unsafe	I R
27	NE-¼,S14,T26N,R23E	25	35	10	25	10-1947	6-29-78 8-14-78	Safe Safe	I R

Well Number	Well Location	Casing Depth in ft.	Depth of Well in ft.	Depth to Water at Time of Const., in ft.	Depth to Rock in ft.	Date of Well Construction	Date of Sample Collection	Laboratory Results	Initial or Repeat Sample
28	SW-¼,S8,T26N,R24E	32	100	60	17	10-25-48	6-2-78 6-14-78 8-14-78	Unsafe Safe Safe	I R R
29	Gov't Lot 2, S34,T34N,R30E	36	90	44	5	1951	6-28-78 8-16-78	Safe Unsafe	I R
30	SE-¼,S14,T29N,R27E	40	90	--	--	8-4-48	6-28-78 8-26-78	Safe Unsafe	I R
31	Gov't Lot 2,S12,T33N,R29E	24.5	27	14	16	9-30-43	6-17-78 8-16-78	Safe Safe	I R
32	Gov't Lot 2, S29,T30N,R28E	31	80	6	2	2-4-47	6-15-78 8-16-78	Safe Safe	I R
33	Gov't Lot 4,S2,T33N,R29E	5	72	52	3	9-9-52	6-28-78 8-16-78	Safe Safe	I R
34	NE¼,S26,T31N,R27E	32	215	153	Surface	8-22-49	6-17-78 8-15-78	Safe Safe	I R
35	NE¼,NW¼,S29,T31N,R28E	20.5	45	16	20	1-1949	6-15-78 8-16-78	Safe Safe	I R
36	NE¼,NE¼,S34,T34N,R29E	8.5	123	61	Surface	6-1953	6-7-78 8-16-78	Safe Safe	I R

Well Number	Well Location	Casing Depth in ft.	Depth of Well in ft.	Depth to Water at Time of Const., in ft.	Depth to Rock in ft.	Date of Well Construction	Date of Sample Collection	Laboratory Results	Initial or Repeat Sample
37	NW¼,S11,T27N,R24E	20	37	Flowing	--	7-19-48	6-17-77 8-14-78	Safe Unsafe	I R
38	SE¼,S7,T28N,R27E	30	170	--	--	9-10-48	5-24-78 8-25-78	Safe Safe	I R
39	NE¼,SE¼,S33,T26N,R23E	25	82	12	75	4-28-48	6-2-78 6-14-78 6-29-78 8-14-78	Unsafe Unsafe Unsafe Unsafe	I R R R
40	NW¼,SE¼,S14,T33N,R29E	20'6"	22	5	16	5-1953	6-7-78	Safe	I
41	SE¼,SE¼,S11,T33N,R29E	22	26	14	14	6-24-49	6-17-78 8-16-78	Safe Safe	I R
42	Gov't Lot 5,S11,T33N,R29E	20	30	12	--	1936	6-17-78 8-16-78	Safe	I
43	NW¼,S24,T31N,R27E	22	175	100	6	8-1-51	6-28-78 8-15-78	Safe Safe	I R
44	NW¼,SW¼,S35,T26N,R26E	46	86	5	--	3-25-48	5-31-78 8-26-78	Safe Safe	I R
45	NW¼,S26,T31N,R27E	30	106	80	30	2-18-42	5-31-78 8-26-78	Safe Safe	I R

Well Number	Well Location	Casing Depth in ft.	Depth of Well in ft.	Depth to Water at Time of Const., in ft.	Depth to Rock in ft.	Date of Well Construction	Date of Sample Collection	Laboratory Results	Initial or Repeat Sample
46	SW¼,S35,T27N,R24E	11	62	17	5	6-21-39	5-30-78 6-14-78	Unsafe Safe	I R
47	SE¼,S23,T31N,R27E	18	59	3	18	7-15-48	6-17-78 8-26-78	Safe Unsafe	I R
48	SE¼,S24,T31N,R27E	21	60	18	21	7-14-51	6-8-78 8-15-78	Safe Unsafe	I R

Table 2

Rainfall for the Period of Survey
Sturgeon Bay Vicinity
Courtesy U. of W. Experimental Farm

	Inches		Inches		Inches		Inches
May 8	.58	June 1	.31	July 1	.45	August 1	.03
9	.08	4	.02	2	.42	2	.52
11	.01	5	.22	3	.02	16	.85
12	.85	8	.74	7	.09	18	.02
13	1.38	12	.26	9	.02	19	1.29
14	0.65	15	.01	13	.10	23	.60
15	.03	17	.13	15	.06	24	.58
20	.25	18	.01	18	.73	27	1.84
		20	.08	19	.05	28	.03
		21	.01	21	.14		
		26	.16	22	.03		
				23	.33		
				26	.02		
				29	.04		
Total	3.83		1.95		2.50		5.76

Total Precipitation May through August 26 was
3.83" + 1.95" + 2.50" + 3.89" = 12.17"

Total Precipitation During Field Survey Period May 23 through August 26 was
1.95" + 2.50" + 3.89" = 8.34"

APPENDIX E

COST EFFECTIVENESS ANALYSIS

COST METHODOLOGY

1. Costs for the conventional gravity sewer system were determined from the Facilities Plan Addendum 1 or Unit Price Memorandum (UPM). The general layout of the systems in the Facilities Plan and supplements was used. Costs represented were updated to December 1981 price levels.

2. Costs for the pressure sewer system and onsite system components were either obtained from the UPM from the Facilities Plan Addendum 1, or from cost estimation data published by R.S. Means Co., Inc.

3. Cost for materials, construction, and O&M were updated to December 1981 price levels. Construction costs for treatment units and sewers were based on USEPA indexes for Chicago of 411.6 (STP) and 226 (CUSS), respectively. The Engineering News Record Construction Cost Index of 3,725 for December 1981 also was used.

4. Salvage values were determined using straight-line depreciation for a planning period of 20 years. The service life of land was considered to appreciate by 3 percent. The service life of structures, including buildings, concrete process units, etc., were assumed to be 40 years. The service life of process and auxiliary equipment such as clarifier mechanisms, standby generators, pumps, electric motors, etc was assumed to be 20 years.

5. Capital costs were based on construction costs plus a service factor for engineering, administration, legal and contingencies (Table 2-14).

6. Present worth of salvage value, O&M costs, and average annual equivalent costs were determined for 20 years using a discount rate of 7.625%.

7. Present worth of salvage values was determined using a single payment present worth factor of 0.2300 (Salvage value x 0.2300 = present worth of salvage).

8. Present worth of O&M costs were determined using a uniform or equal payment series factor of 10.0983 (average annual O&M cost x 10.0983 = present worth of O&M).

9. Average annual equivalent costs were determined using a capital recovery factor of 0.0990 (total present worth x 0.0990 = average annual equivalent cost).

References to cost tables

The relation of the various cost tables to the various costs used in the alternatives is as follows:

Regional Alternatives Analysis

Summaries	- Tables E-1 through E-4
Treatment	- Tables E-5 through E-9

Egg Harbor Alternatives

Collection and transmission options	- Summary Table E-10 - Details Table E-11 through E-19
Treatment and discharge options	- Summary Table E-20 - Details Table E-21 through E-28
Onsite systems	- Summary Table E-29 - Details Table E-30 through E-32
Wisconsin Fund grant and local costs	- Table E-86 through E-92
User Costs	- Table E-110 and E-111

Fish Creek Alternatives

Collection	- Summary Table E-33 - Details Table E-34 through E-39
Transmission, treatment, and outfall	- Summary Table E-40 - Details Tables E-41 through E-45
Onsite systems	- Summary Table E-46 - Details Tables E-47 through E-49
Wisconsin Fund grant and local costs	- Table E-93 through E-98
User costs	- Tables E-112 and E-113

Ephraim Alternatives

Collection and transmission	- Summary Table E-50 - Details Tables E-51 through E-54
Treatment and discharge	- Summary Table E-55 - Details Tables E-56 through E-62
Onsite systems	- Summary Table E-63 - Details Tables E-64 through E-66
Wisconsin fund grant and local costs	- Tables E-98 through E-102
User Costs	- Tables E-114 and E-115

Baileys Harbor Alternatives

Collection and transmission	- Summary Table E-67 - Details Tables E-68 through E-74
Treatment and discharge	- Summary Table E-75 - Details Tables E-76 through E-81
Onsite systems	- Summary Table E-82 - Details Tables E-83 through E-85
Wisconsin fund grant and local costs	- Tables E-104 through E-109
User costs	- Tables E-116 and E-117

Table E-1. Regional Alternative 1 - Three separate WWTPs for Egg Harbor, Fish Creek, and Ephraim.

Item	Cost ($1,000x) Construction cost	Salvage value	O&M cost
Egg Harbor			
WWTP	$ 404.6	$118.7	$43.7
Outfall	45.0	22.5	-
Fish Creek			
WWTP	496.7	142.2	48.3
Outfall	45.0	22.5	-
Ephraim			
WWTP	567.0	151.3	54.2
Outfall	45.0	22.5	-
Total	1,603.3	479.7	146.2
Service factor (27%)	432.9		
Total capital cost	2,036.2		
Present worth cost (@ 7 5/8% over 20 years)			
Capital cost	2,036.2		
O&M cost	1,476.4		
Salvage Value	(110.3)		
Total Present Worth	$3,402.3		

Table E-2. Regional Alternative 2 - Two WWTPs -WWTP for Egg Harbor and a WWTP for Fish Creek and Ephraim at Fish Creek.

Item	Cost ($1,000x) Construction Cost	Salvage value	O&M cost
Egg Harbor			
WWTP	$ 404.6	$118.7	$43.7
Outfall	45.0	22.5	-
Ephraim			
Pumping station	232.0	58.0	6.0
Interceptor	946.0	567.6	-
Fish Creek and Ephraim			
WWTP	757.8	204.9	66.7
Outfall	45.0	22.5	-
Total	2,430.4	994.2	116.4
Service factor (27%)	656.2		
Total capital cost	3,086.6		
Present worth cost (@ 7 5/8% over 20 years)			
Capital cost	3,086.6		
O&M cost	1,175.4		
Salvage value	(228.7)		
Total Present Worth	$4,033.3		

Table E-3. Regional Alternative 3 - Two WWTPs - a WWTP for Egg Harbor and Fish Creek in Section 6 (T30N R27E) and a WWTP for Ephraim.

Item	Cost ($1,000x) Construction cost	Salvage value	O&M cost
Egg Harbor			
Pumping station	$ 174.0	$ 43.5	$ 2.5
Interceptor	892.0	535.2	-
Fish Creek			
Pumping station	185.6	46.4	2.5
Interceptor	580.5	348.3	-
Egg Harbor and Fish Creek			
WWTP	567.0	151.3	54.2
Outfall	45.0	22.5	-
Total	3,056.1	1,321.0	113.4
Service factor (27%)	825.1		
Total capital cost	3,881.2		
Present worth cost (@ 7 5/8% over 20 years)			
Capital cost	3,881.2		
O&M cost	1,145.1		
Salvage value	(303.8)		
Total Present Worth	$4,722.5		

Table E-4. Regional Alternative 4 - A regional WWTP for Egg Harbor, Fish Creek, and Ephraim in Section 6 (T30N R27E).

Item	Cost ($1,000x) Construction Cost	Salvage value	O&M cost
Ephraim			
Pumping station	$ 232.0	$ 58.0	$6.0
Interceptor sewer	946.0	567.6	-
Fish Creek			
Pumping station	185.6	46.4	2.5
Interceptor sewer	580.5	348.3	-
Egg Harbor			
Pumping station	174.0	43.5	2.5
Interceptor sewer	892.0	535.2	-
Regional WWTP	863.3	231.3	72.3
Outfall	45.0	22.5	-
Total	3,918.4	1,852.8	83.3
Service factor (27%)	1,057.9		
Total capital cost	4,975.3		
Present worth cost (@ 7 5/8% over 20 years)			
Capital cost	4,975.3		
O&M cost	841.2		
Salvage value	(426.1)		
Total Present Worth	$5,390.4		

Table E-5. Rotating biological contactor (RBC) WWTP for 50,000 GPD design average flow (Regional Alternative Nos. 1 and 2)[1].

Item	Cost ($1,000x) Construction Cost	Salvage value	O&M cost
Preliminary treatment	$ 15.0	$ 3.8	$11.7
Primary clarifier	57.2	14.3	3.0
RBC	79.4	19.8	12.8
Secondary clarifier	67.7	16.9	3.7
Phosphorus removal	-	-	-
Chlorination system	30.1	7.5	6.5
Aerobic digester	45.1	11.3	3.0
Land	10.0	18.1	-
Administration & laboratory building	36.0	10.8	3.0
Service roads and fence	6.7	-	-
Monitoring system, controls, and instrumentation	10.1	-	-
Electrical	16.9	-	-
Process piping	27.0	16.2	3.0
Site Preparation	3.4	-	-
Total	404.6	118.7	43.7
Service factor (27%)	109.2		
Total capital cost	513.8		
Present worth cost (@ 7 5/8% over 20 years)			
Capital cost	513.8		
O&M cost	441.3		
Salvage value	(27.3)		
Total present worth	$927.8		

[1]Total present worth cost does not include costs for liquid sludge hauling and land spreading.

Table E-6. Rotating biological contactor (RBC) WWTP for 100,000 GPD design average flow (Regional Alternative No. 1).[1]

Item	Cost ($1,000x) Construction Cost	Salvage value	O&M cost
Preliminary treatment	$ 18.1	$ 4.5	$12.0
Primary clarifier	63.2	15.8	3.3
RBC	135.4	33.9	13.5
Secondary clarifier	75.2	18.8	3.9
Phosphorus removal	-	-	-
Chlorination system	33.1	8.3	6.9
Aerobic digestor	48.2	12.0	3.0
Land	10.0	18.1	
Administration & laboratory building	36.0	10.8	5.7
Service roads and fence	6.7	-	-
Monitoring system, controls, and instrumentation	12.5	-	-
Electricial	20.8	-	-
Process piping	33.3	20.0	-
Site preparation	4.2	-	-
Total	496.7	142.2	48.3
Service factor (27%)	134.1		
Total capital cost	630.8		
Present worth cost (@ 7 5/8% over 20 years)			
Capital cost	630.8		
O&M cost	487.7		
Salvage value	(32.7)		
Total present worth	$1,085.8		

[1] Total present worth cost does not include costs for liquid sludge hauling and land spreading.

Table E-7. Rotating biological contactor (RBC) WWTP for 150,000 GPD design average flow (Regional Alternative Nos. 1 and 3).[1]

Item	Cost ($1,000x) Construction Cost	Salvage value	O&M cost
Preliminary treatment	$ 22.6	$ 5.6	$12.3
Primary clarifier	72.2	18.0	3.9
RBC	147.5	36.8	14.3
Secondary clarifier	91.8	22.9	4.1
Phosphorus removal	-	-	-
Chlorination system	39.1	9.8	7.8
Aerobic digestor	60.2	15.0	3.8
Land	10.0	18.1	-
Administration & laboratory building	36.0	10.8	8.0
Service roads and fence	6.7	-	-
Monitoring system, controls, and instrumentation	14.3	-	-
Electrical	23.8	-	-
Process piping	38.1	14.3	-
Site Preparation	4.7	-	-
Total	567.0	151.3	54.2
Service factor (27%)	153.1		
Total capital cost	720.1		
Present worth cost (@ 7 5/8% over 20 years)			
Capital cost	720.1		
O&M cost	547.3		
Salvage value	(34.8)		
Total Present Worth	$1,232.6		

[1] Total present worth cost does not include costs for liquid sludge hauling and land spreading.

Table E-8. Rotating biological contactor (RBC) WWTP for 250,000 GPD design average flow (Regional Alternative No. 2).[1]

Item	Cost ($1,000x) Construction Cost	Salvage value	O&M cost
Preliminary treatment	$ 30.1	$ 7.5	$13.4
Primary clarifier	82.8	20.7	4.8
RBC	210.7	52.7	15.8
Secondary clarifier	133.9	33.5	4.6
Phosphorus removal	15.4	-	3.9
Chlorination system	45.1	11.3	9.0
Aerobic digestor	78.3	19.6	4.8
Land	10.0	18.1	-
Administration & laboratory building	36.0	10.8	10.4
Service roads and fence	6.7	-	-
Monitoring system, controls, and instrumentation	19.2	-	-
Electrical	32.0	-	-
Process piping	51.2	30.7	-
Site Preparation	6.4	-	-
Total	757.8	204.9	66.7
Service factor (27%)	204.6		
Total capital cost	962.4		
Present worth cost (@ 7 5/8% over 20 years)			
Capital cost	962.4		
O&M cost	673.5		
Salvage value	(47.1)		
Total Present Worth	$1,588.8		

[1] Total present worth cost does not include costs for liquid sludge hauling and land spreading.

Table E-9. Rotating biological contactor (RBC) WWTP for 300,000 GPD design average flow (Regional Alternative No. 4)[1].

Item	Cost ($1,000x) Construction Cost	Salvage value	O&M cost
Preliminary treatment	$ 33.1	$ 8.3	$13.6
Primary clarifier	90.3	22.6	5.3
RBC	263.0	65.8	16.5
Secondary clarifier	142.9	35.7	5.1
Phosphorus removal	17.3	-	4.8
Chlorination system	49.7	12.4	10.5
Aerobic digestor	90.3	22.6	5.7
Land	10.0	18.1	-
Administration & laboratory building	36.0	10.8	10.8
Service roads and fence	6.7	-	-
Monitoring system, controls, and instrumentation	21.9	-	-
Electrical	36.5	-	-
Process piping	58.3	35.0	-
Site Preparation	7.3	-	-
Total	863.3	251.3	72.3
Service factor (27%)	233.1		
Total capital cost	1,096.4		
Present worth cost (@ 7 5/8% over 20 years)			
Capital cost	1,096.4		
O&M cost	730.1		
Salvage value	(53.2)		
Total present worth	$1,773.3		

[1] Total present worth cost does not include costs for liquid sludge hauling and land spreading.

Table E-10. Summary of Collection and Transmission Costs for Egg Harbor

Item	Initial Cost						Future Construction Cost							Total Present Worth
				Present Worth			Annual	Total	Incremental	Present Worth				
	Capital	Salvage	O&M	Salvage	O&M	Total	Construction	Salvage	Ann. O&M	Constuction	Salvage	O&M	Total	
Subareas 1A, 1B, and 2A														
Transmission to Section 24 T30N R26E[1]														
Conventional Gravity	870,120	375,130	3,677	86,280	37,130	826,970	3,120	32,620	10	31,510	7,500	720	39,730	866,700
STE Gravity	868,440	395,880	4,268	91,050	43,100	820,490	9,031	124,400	38	91,200	28,610	2,740	65,330	1,885,820
Transmission to Section 31 T30N R27E[2]														
Conventional Gravity	979,340	426,730	3,923	98,150	39,620	920,810	3,120	32,620	10	31,510	7,500	720	39,730	960,540
STE Gravity	984,540	447,480	4,514	102,920	45,580	927,200	9,031	124,400	38	91,200	28,610	2,740	65,330	992,530
Subareas 1AN, 1BS, 2AS														
Transmission to Section 24 T30N R26E[1]														
Conventional Gravity	412,130	172,960	2,727	39,780	27,540	399,890	1,372	13,460	5	13,590	3,100	360	10,050	410,740
STE Gravity	428,060	179,740	3,097	41,340	31,270	417,990	4,109	57,180	16	41,490	13,300	1,150	29,340	447,330
Transmission to Section 31 T30N R27E[2]														
Conventional Gravity	530,490	228,880	2,861	52,640	28,490	505,340	1,372	13,460	5	13,590	3,100	360	10,850	516,190
STE Gravity	553,880	235,660	3,231	54,200	32,630	532,310	4,109	57,810	16	41,490	13,300	1,150	29,340	561,650
STE Pressure	650,620	251,410	6,300	57,820	63,620	656,420	5,934	67,720	91	59,920	15,580	6,650	50,900	707,320

[1] WWTP with outfall to Green Bay
[2] Cluster drainfield or land application

Table E-11. Quantities and costs for conventional sewers and transmission to WWTP in Sec. 24 T30N R26E for Egg Harbor Subareas 1A, 1B, 2A.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
Sewer Pipe						
8"	LF	11,050	$16	$ 176,800	$106,080	$ 829
Rock excavation						
4' deep	LF	2,050	12	24,600	24,600	
5' deep	LF	4,800	15	72,000	72,000	
9' deep	LF	800	27	21,600	21,600	
15' deep	LF	1,300	44	57,200	57,200	
Manholes	VF	299	100	29,900		
Road repair	LF	11,050	7.16	79,120		
Lift station						
114 gpm - TDH 46 Ft	EA	1		40,000	12,000	2,048
Force main						
4" Individual trench	LF	2,800	20	56,000	33,600	
4" Common trench	LF	1,200	8	9,600	5,760	
Wye	EA	102	40	4,080	2,450	
Gravity service connection	LF	3,760	15	56,400	33,840	
Pressure lateral	LF	320	10	3,200	1,200	
Grinder-pump	EA	8	6000	48,000	4,800	800
Septic tank abandonment	EA	102	65	6,630	-	-
Subtotal initial cost				685,130	375,130	3,677
Service factor (27%)				184,990		
Subtotal initial capital cost				870,120		
Future connection cost						
Building sewer	LF	915	15	13,730	8,240	
Wye	EA	61	40	2,440	1,460	
Gravity service connection	LF	2360	15	35,400	21,240	
Pressure lateral	LF	80	10	800	480	
Grinder pump	EA	2	6000	12,000	1,200	200
Subtotal future connection costs				64,370	32,620	200
Annual connection costs				3,120		10

Table E-12. Quantities and costs for septic tank effluent gravity sewers and transmission to WWTP in Sec. 24 T30N R26E for Egg Harbor Subareas 1A, 1B, 2A.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
STE sewer pipe						
4"	LF	11,050	$ 13	$ 143,650	$86,190	$ 420
Rock excavation						
4' deep	LF	2,550	12	24,600	24,600	
5' deep	LF	4,300	15	72,000	72,000	
8' deep	LF	800	27	21,600	21,600	
15' deep	LF	1,300	44	57,200	57,200	
Manholes	VF	26	100	2,600	1,560	
Road repair	LF	11,050	7.16	79,120		
Lift Station						
114 gpm - TDH 46 ft	EA	1		40,000	12,000	2,048
Force main						
4" individual trench	LF	2,800	20	56,000	33,600	
4" common trench	LF	1,200	8	9,600	5,760	
Wye	EA	102	40	4,080	2,450	
Gravity service connection	LF	3,760	15	56,400	33,840	
Pressure lateral	LF	320	10	3,200	1,200	
STE pump - simplex	EA	7	2000	14,000	4,200	525
- duplex	EA	1	3890	3,890	1,170	125
Septic tank minor upgrade						
SFD & small commercial	EA	64	150	9,600	5,760	640
Large commercial	EA	10	150	1,500	900	200
Septic tank replacement						
SFD & small commercial	EA	25	1000	25,000	15,000	250
Large commercial	EA	3	2000	6,000	3,600	60
Septic tank rock removal						
SFD & small commercial	EA	15	750	11,250	11,250	-
Large commercial	EA	3	1000	2,000	2,000	-
Subtotal initial cost				643,290	395,880	4,268
Service factor (35%)				225,150		
Subtotal initial capital cost				868,440		
Future Connection cost						
Building sewer	LF	915	15	13,730	8,240	
Wye	EA	61	40	2,440	1,460	
Gravity service connection	LF	2360	15	35,400	21,240	
Pressure lateral	LF	80	10	800	480	
STE Pump - simplex	EA	2	2000	4,000	1,200	150
Septic tanks - new/repl.						
SFD & small commercial	EA	61/16	1000	77,000	46,200	610
Large commercial	EA	0/2	2000	4,000	2,400	-
Septic tank rock removal						
SFD & small commercial	EA	55	750	41,250	41,250	-
Large commercial	EA	2	1000	2,000	2,000	-
Subtotal future connection costs				180,620	124,470	760
Annual connection costs				9,031		38

Table E-13. Quantities and costs for conventional gravity collection and transmission land application site in Sec. 31 T30N R27E for Egg Harbor Subareas 1A, 1B, 2A.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
Sewer pipe						
8"	LF	11,050	$ 16	$ 176,800	$106,080	$ 829
Rock excavation						
4' deep	LF	2,050	12	24,600	24,600	
5' deep	LF	4,800	15	72,000	72,000	
9' deep	LF	800	27	21,600	21,600	
15' deep	LF	1,300	44	57,200	57,200	
Manholes	VF	299	100	29,900		
Road repair	LF	11,050	7.16	79,120		
Lift station						
114 gpm - TDH 46 Ft	EA	1		40,000	12,000	2,294
Force main						
4" individual trench	LF	6,100	20	122,000	73,200	
4" common trench	LF	3,700	8	29,600	17,760	
Wye	EA	102	40	4,080	2,450	
Gravity service connection	LF	3,760	15	56,400	33,840	
Pressure lateral	LF	320	10	3,200	1,200	
Grinder pump	EA	8	6000	48,000	4,800	800
Septic tank abandonment	EA	102	65	6,630	-	-
Subtotal initial cost				771,130	426,730	3,923
Service factor (27%)				208,210		
Subtotal initial capital cost				979,340		
Future connection cost						
Building sewer	LF	915	15	13,730	8,240	
Wye	EA	61	40	2,440	1,460	
Gravity service connection	LF	2,360	15	35,400	21,240	
Pressure lateral	LF	80	10	800	480	
Grinder pump	EA	2	6000	12,000	1,200	200
Sub total future connection cost				64,370	32,620	200
Annual connection costs				3,120		10

Table E-14. Quantities and costs for septic tank effluent gravity sewers and transmission to cluster drainfield in Sec. 31 T30N R27E on land application site in Sec. 30 T30N R27E for Egg Harbor Subareas 1A, 1B, 2A.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
STE sewer pipe						
4"	LF	11,050	$ 13	$ 143,650	$86,190	$ 420
Rock excavation						
4' deep	LF	2,550	12	24,600	24,600	
5' deep	LF	4,300	15	72,000	72,000	
8' deep	LF	800	27	21,600	21,600	
15' deep	LF	1,300	44	57,200	57,200	
Manholes	VF	26	100	2,600	1,560	
Road repair	LF	11,050	7.16	79,120		
Lift station						
114 gpm - TDH 190 Ft	EA	1		40,000	12,000	2,294
Force main						
4" individual trench	LF	6,100	20	122,000	73,200	
4" common trench	LF	3,700	8	29,600	17,760	
Wye	EA	102	40	4,080	2,450	
Gravity service connection	LF	3,760	15	56,400	33,840	
Pressure lateral	LF	320	10	3,200	1,200	
STE pump - simplex	EA	7	2000	14,000	4,200	525
- duplex	EA	1	3890	3,890	1,170	125
Septic tank minor upgrade						
SFD & small commercial	EA	64	150	9,600	5,760	640
Large commercial	EA	10	150	1,500	900	200
Septic tank replacement						
SFD & small commercial	EA	25	1000	25,000	15,000	250
Large commercial	EA	3	2000	6,000	3,600	60
Septic tank rock removal						
SFD & small commercial	EA	15	750	11,250	11,250	-
Large commercial	EA	3	1000	2,000	2,000	
Subtotal initial cost				729,290	447,480	4,514
Service factor (35%)				255,250		
Subtotal initial capital cost				984,540		
Future connection cost						
Building service	LF	915	15	13,730	8,240	
Wye	EA	61	40	2,440	1,460	
Gravity service connection	LF	2360	15	35,400	21,240	
Pressure lateral	LF	80	10	800	480	
STE Pump - Simplex	EA	2	2000	4,000	1,200	150
Septic tanks - new/repl.						
SFD & small commercial	EA	61/16	1000	77,000	46,200	610
Large commercial	EA	0/2	2000	4,000	2,400	-
Septic tank rock removal						
SFD & small commercial	EA	55	750	41,250	41,250	-
Large commercial	EA	2	1000	2,000	2,000	-
Subtotal future connection costs				18,620	124,470	760
Annual connection costs				9,031		38

Table E-15. Quantities and costs for conventional gravity sewers and transmission to WWTP in Sec. 24 T30N R26E for Egg Harbor Subareas 1AN, 1BS, 2AS.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
Sewer pipe						
8"	LF	3,800	$ 16	$ 60,800	$36,480	$ 285
Rock excavation						
4' deep	LF	600	12	7,200	7,200	
5' deep	LF	1,600	15	24,000	24,000	
6' deep	LF	600	18	10,800	10,800	
7' deep	LF	200	21	4,200	4,200	
Manholes	VF	81	100	8,100	4,860	
Road repair	LF	3,800	7.16	27,210		
Lift station						
23 gpm - TDH 41 ft	EA	1		40,000	12,000	2,042
Force main						
4" individual trench	LF	4,000	20	80,000	48,000	
4" common trench	LF	400	8	3,200	1,920	
Wye	EA	47	40	1,880	1,230	
Gravity service connection	LF	1,880	15	28,200	16,920	
Pressure lateral	LF	160	10	1,600	960	
Grinder pump	EA	4	6000	24,000	2,400	400
Septic tank abandonment	EA	51	65	3,320	1,990	
Subtotal initial cost				324,510	172,960	2,727
Service factor (27%)				87,620		
Subtotal initial capital cost				412,130		
Future connection cost						
Building sewer	LF	375	15	5,630	3,380	
Wye	EA	25	40	1,000	600	
Gravity service connection	LF	960	15	14,400	8,640	
Pressure lateral	LF	40	10	400	240	
Grinder pump	EA	1	6000	6,000	600	100
Subtotal future connection costs				27,430	13,460	100
Annual connection costs				1,372		5

Table E-16. Quantities and costs for septic effluent gravity sewers and transmission to WWTP in Sec. 24 T30N R26E for Egg Harbor subareas 1AN, 1BN, 2AS.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
STE sewer pipe						
4"	LF	3,800	$ 13	$49,400	$29,640	$ 145
Rock excavation						
4' deep	LF	600	12	7,200	7,200	
5' deep	LF	1,600	15	24,000	24,000	
6' deep	LF	600	18	10,800	10,800	
7' deep	LF	200	21	4,200	4,200	
Manholes	VF	9	100	900	540	
Road repair	LF	3,800	7.16	27,210		
Lift station						
23 gpm - TDH 41 Ft	EA	1		40,000	12,000	2,042
Force Main						
4" Individual trench	LF	4,000	20	80,000	48,000	
4" Common trench	LF	400	8	3,200	1,920	
Wye	EA	47	40	1,880	1,230	
Gravity service connection	LF	1,880	15	28,200	16,920	
Pressure lateral	LF	160	10	1,600	960	
STE pump - simplex	EA	3	2000	6,000	1,800	225
- Duplex	EA	1	3890	3,890	1,170	125
Septic Tank minor upgrade						
SFD & small commercial	EA	30	150	4,500	2,700	300
Large commercial	EA	4	150	600	360	80
Septic tank replacement						
SFD & small commercial	EA	16	1000	16,000	960	160
Large commercial	EA	1	2000	2,000	1,200	28
Septic tank rock removal						
SFD & small commercial	EA	6	750	4,500	4,500	-
Large commercial	EA	1	1000	1,000	1,000	-
Subtotal initial cost				317,080	179,740	3,097
Service factor (35%)				110,980		
Subtotal initial capital cost				428,060		
Future connection cost						
Building sewer	LF	375	15	5,630	3,380	
Wye	EA	25	40	1,000	600	
Gravity service connection	LF	960	15	14,400	8,640	
Pressure lateral	LF	40	10	400	240	
STE Pump-Simplex	EA	1	2000	2,000	600	75
Septic Tanks new/replace						
SFD & small commercial	EA	25/9	1000	34,000	20,400	250
Large commercial	EA	0/1	2000	2,000	1,200	-
Septic tank rock removal						
SFD & small commercial	EA	29	750	21,750	21,750	-
Large commercial	EA	1	1000	1,000	1,000	-
Subtotal future connection costs				82,180	57,810	325
Annual connection costs				4,109		16

Table E-17. Quantities and costs for conventional gravity sewers and transmission to land treatment site in Sec. 31 T30N R27E for Egg Harbor Subareas 1AN, 1BS, 2AS.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
Sewer pipe						
8"	LF	3,800	$ 16	$ 60,800	$36,480	$ 285
Rock excavation						
4' deep	LF	600	12	7,200	7,200	
5' deep	LF	1,600	15	24,000	24,000	
6' deep	LF	600	18	10,800	10,800	
7' deep	LF	200	21	4,200	4,200	
Manholes	VF	81	100	8,100	4,860	
Road repair	LF	3,800	7.16	27,210		
Lift station						
23 gpm - TDH 41 Ft	EA	1		40,000	12,000	2,176
Force main						
4" individual trench	LF	8,300	20	166,000	99,600	
4" common trench	LF	1,300	8	10,400	6,240	
Wye	EA	47	40	1,880	1,230	
Gravity service connection	LF	1,880	15	28,200	16,920	
Pressure lateral	LF	160	10	1,600	960	
Grinder pump	EA	4	6000	24,000	2,400	400
Septic tank abandonmant	EA	51	65	3,320	1,990	
Subtotal initial cost				417,710	228,880	2,861
Service factor (27%)				112,780		
Subtotal initial capital cost				530,490		
Future connection cost						
Building sewer	LF	375	15	5,630	3,380	
Wye	EA	25	40	1,000	600	
Gravity service connection	LF	960	15	14,400	8,640	
Pressure lateral	LF	40	10	400	240	
Grinder pump	EA	1	6000	6,000	600	100
Subtotal future connection costs				27,430	13,460	100
Annual connection costs				1,372		5

Table E-18. Quantities and costs for septic tank effluent gravity sewers and transmission to cluster drainfield or land application site in Sec. 31 T30N R27E for Egg Harbor Subareas 1AN, 1BS, 2AS.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
STE sewer pipe						
4"	LF	$ 3,800	$ 13	$ 49,400	$29,640	$ 145
Rock excavation						
4' deep	LF	600	12	7,200	7,200	
5' deep	LF	1,600	15	24,000	24,000	
6' deep	LF	600	18	10,800	10,800	
7' deep	LF	200	21	4,200	4,200	
Manholes	VF	9	100	900	540	
Road repair	LF	3,800	7.16	27,210		
Lift station						
23 gpm - TDH 172 Ft	EA	1		40,000	12,000	2,176
Force main						
4" individual trench	LF	8,300	20	166,000	99,600	
4" common trench	LF	1,300	8	10,400	6,240	
Wye	EA	47	40	1,880	1,230	
Gravity service connection	LF	1,880	15	28,200	16,920	
Pressure lateral	LF	160	10	1,600	960	
STE pump - simplex	EA	3	2000	6,000	1,800	225
- duplex	EA	1	3890	3,890	1,170	125
Septic tank minor upgrade						
SFD & small commercial	EA	30	150	4,500	2,700	300
Large commercial	EA	4	150	600	360	80
Septic tank replacement						
SFD & small commercial	EA	16	1000	16,000	9,600	160
Large commercial	EA	1	2000	2,000	1,200	20
Septic tank rock removal						
SFD & small commercial	EA	6	750	4,500	4,500	-
Large commercial	EA	1	1000	1,000	1,000	-
Subtotal initial cost				410,280	235,660	3,231
Service factor (35%)				143,600		
Subtotal initial capital cost				553,880		
Future connection cost						
Building sewer	LF	375	15	5,630	3,380	
Wye	EA	25	40	1,000	600	
Gravity service connection	LF	960	15	14,400	8,640	
Pressure lateral	LF	40	10	400	240	
STE Pump - Simplex	EA	1	2000	2,000	600	75
Septic tanks - new/replc.						
SFD & small commercial	EA	25/9	1000	34,000	20,400	250
Large commercial	EA	0/1	2000	2,000	1,200	-
Septic tank rock removal						
SFD & small commercial	EA	29	750	21,750	21,750	-
Large commercial	EA	1	1000	1,000	1,000	-
Subtotal future connection costs				82,180	57,810	325
Annual connection costs				4,109		16

Table E-19. Quantities and costs for septic tank effluent pressure sewers and transmission to cluster drainfield or land application site in Sec. 31 T30N R27E for Egg Harbor Subareas 1AN, 1BS, 2AS.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
Sewer pipe						
4"	LF	700	$ 13	$ 9,100	$ 5,460	$ 27
STE Pressure pipe	LF	4,600	10	46,000	27,600	87
Cleanouts	EA	12	1000	12,000	7,200	
Rock excavation						
4'	LF	1,100	12	13,200	12,200	
5'	LF	3,400	15	51,000	51,000	
Road repair	LF	3,800	7.16	27,210		
Lift station						
85 gpm - TDH 172 Ft	EA	1		40,000	12,000	2,176
Forcemain						
4" individual trench	LF	6,700	20	134,000	80,400	
Wye	EA	10	40	400	240	
Gravity service connection	LF	400	15	6,000	3,600	
Wye & curb value	EA	42	64	2,690	1,610	
Pressure lateral	LF	1,640	10	16,400	9,840	
STE pump - simplex	EA	36	2000	72,000	21,600	2,700
- duplex	EA	6	3890	23,340	7,000	750
Septic tank minor upgrade						
SFD & small commercial	EA	30	150	4,500	2,700	300
Large commercial	EA	4	150	600	360	80
Septic tank replacement						
SFD & small commercial	EA	16	1000	16,000	960	160
Large commercial	EA	1	2000	2,000	1,200	20
Septic tank rock removal						
SFD & small commercial	EA	6	750	4,500	4,500	-
Large commercial	EA	1	1000	1,000	1,000	-
Subtotal initial cost				481,940	251,410	6,300
Service factor (35%)				168,680		
Subtotal initial capital cost				650,620		
Future connection cost						
Building sewer	LF	375	15	5,630	3,380	
Wye	EA	4	40	160	100	
Gravity service connection	LF	160	15	2,400	1,440	
Wye & curb value	EA	21	64	1,340	810	
Pressure lateral	LF	840	10	8,400	5,040	
STE Pump - Simplex	EA	21	2000	42,000	12,600	1,575
Septic tanks - new/repl.						
SFD & small commercial	EA	25/9	1000	34,000	20,400	250
Large commercial	EA	0/1	2000	2,000	1,200	
Septic tank rock removal						
SFD & small commercial	EA	29	750	21,750	21,750	
Large commercial	EA	1	1000	1,000	1,000	
Subtotal future connection cost				118,690	67,720	1,825
Annual connection costs				5,934		91

Table E-20. Summary of WWTP and discharge costs for Egg Harbor.

Item	Capital	Salvage	O&M	Present Worth Salvage	Present Worth O&M	Present Worth Total
Subareas 1A, 1B, 2A						
Aerated lagoon WWTP	$293,900	$ 60,200	$20,800	$13,846	$210,045	$490,099
RBC WWTP[1]	513,800	118,700	43,700	27,300	441,300	873,200
Land application of effluent	243,500	86,600	6,300	19,918	63,619	287,201
Outfall to Green Bay	148,600	70,200	-	16,146	-	132,454
Cluster drainfield	427,790	66,700	7,100	15,340	71,700	484,150
Subareas 1AN, 1BS 2AS						
Aerated lagoon WWTP	259,800	57,300	15,200	13,179	153,494	400,115
RBC WWTP	352,200	86,500	37,200	19,895	375,657	707,962
Land application of effluent	168,300	49,500	4,500	11,385	45,442	202,357
Outfall to Green Bay	148,600	70,200	-	16,146	-	132,454
Cluster drainfield	266,270	33,400	4,400	7,680	44,430	303,020

[1]Cost same as Regional Alternative 50,000 gal (Table E-5).

Table E-21. Aerated Lagoon WWTP for Egg Harbor Subareas 1A, 1B, 2A or Baileys Harbor Subarea 3.

Item	Cost ($1,000x) Construction Cost	Salvage Value	O&M Cost
Flow meter assembly	$ 10.0	$ -	$2.0
Aerated lagoons	94.8	15.6	9.3
Impermeable liner	11.8	-	-
Chlorination system	30.0	7.5	6.5
Administration & laboratory bldg.	36.0	10.0	3.0
Service roads and fencing	6.7	-	-
Land	10.0	18.0	-
Monitoring, controls, and instrumentation	5.6	-	-
Electrical	9.5	-	-
Process piping	15.1	9.1	-
Site preparation	1.9	-	-
Total	231.4	60.2	20.8
Service factor (27%)	62.5		
Total capital cost	293.9		

Present worth cost (@7 5/8% over 20 years)

Capital cost	293.9
O&M cost	210.0
Salvage cost	(13.8)
Total present worth	490.1

Table E-22. Land application of WWTP effluent for Egg Harbor Subareas 1A, 1B, 2A.

Item	Cost ($1,000x) Construction Cost	Salvage Value	O&M Cost
Lined storage pond	$ 72.7	$18.2	$0.7
Pump station	40.0	12.0	2.1
Field preparation	1.1	1.1	-
Permanent distribution system	23.3	11.6	3.0
Monitoring walls	3.8	1.1	0.5
Additional land	23.6	42.6	-
Additional fence	15.9	-	-
Total	180.4	86.6	6.3
Service factor 35%	63.1		
Total capital cost	243.5		

Present worth cost (@ 7 5/8% over 20 years)

Capital cost	243.5
O&M cost	63.6
Salvage value	(19.9)
Total present worth	287.2

Table E-23. WWTP outfall to Green Bay for Egg Harbor.

Item	Unit	Quantity	Cost	Construction	Salvage	O&M
Sewer Pipe	LF	700	$ 16	$ 11,200	$ 6,720	-
Manhole	VF	8	100	800	480	-
Underwater pipe	LF	500	200	100,000	60,000	-
Outfall structure	EA	1		5,000	3,000	-
Total				117,000	70,200	-
Service factor 27%				31,600		
Total capital cost				148,600		

Present worth cost (@ 7 5/8% over 20 years)

Capital cost	$148,600
O&M cost	-
Salvage value	(16,146)
Total present worth	132,454

Table E-24. Cluster soil absorption system for Egg Harbor Subareas 1A, 1B, 2A.

Item	Quantity	Unit Cost	Construction	Salvage	O&M
Dosing chamber					$2,500
tankage	12,500 gal	$ 1.00	$ 12,500	$ 7,500	-
pumps 450 gpm	4	7,000	21,000	-	-
appurtenances		5,000	5,000	-	-
emergency pump 450 gpm	1	3,000	3,000	-	-
electrical		20,000	20,000	-	-
meters		5,000	5,000	-	-
Value chamber					
vault	2,000 gal	1.00	2,000	1,200	-
values		21,000	21,000	-	-
Storage building	286 sf	35	10,000	4,000	-
Drainfields					1,600
excavation & backfill	6,920 cy	6.00	41,520	-	-
gravel	3,480 cy	6.00	20,880	-	-
distribution pipe	18,800 lf	3.00	56,400	-	-
mainfold pipe	960 lf	6.00	5,760	-	-
delivery pipe	1,690 lf	10.00	16,900	-	-
filter fabric	10,440 sy	2.00	20,880	-	-
seeding	3 ac	1,000	3,000	-	-
Administrative building		36,000	36,000	10,800	3,000
Access road	2,000 lf	6.00	12,000	-	-
Land	12 ac	2,000	24,000	43,200	-
Initial cost			336,840	66,700	7,100
Service factor (35%)			117,890		
Initial capital cost			427,790		
Present worth factors			1.000	0.230	10.0983
Present worth			427,790	15,340	71,700
Total present worth			484,150		

Table E-25. Aerated lagoon WWTP for Egg Harbor Subareas 1AN, 1BS, 2AS.

Item	Cost ($1000x) Construction cost	Salvage value	O&M cost
Flow meter assembly	8.0	-	2.0
Aerated lagoons	82.0	13.7	6.0
Impermeable liner	5.8	-	-
Chlorination system	27.1	6.8	6.0
Administration & laboratory bldg.	36.0	10.8	1.2
Service roads and fencing	6.7	-	-
Land	10.0	18.1	-
Monitoring, controls, and instrumentation	5.0	-	-
Electrical	8.3	-	-
Process piping	13.2	7.9	-
Site preparation	1.7		
Total	203.8	57.3	15.2
Service factor (27%)	55.0		
Total capital cost	259.8		
Present worth cost (@ 7 5/8% over 20 years)			
Capital cost	259.8		
O&M cost	153.5		
Salvage cost	(13.2)		
Total present worth	400.1		

Table E-26. Rotating biological contactor (RBC) WWTP for Egg Harbor Subareas 1AN, 1BS, 2AS.

Item	Cost ($1000x) Construction cost	Salvage value	O&M cost
Preliminary treatment	13.5	3.4	11.4
Primary clarifier	37.6	9.4	1.8
RBC	45.0	11.3	10.5
Secondary clarifier	37.6	9.4	3.6
Phosphorus removal	-	-	-
Chlorination system	22.6	5.6	5.3
Aerobic digestor	30.1	7.5	2.7
Land	10.0	18.1	-
Administration & laboratory building	36.0	10.8	1.9
Service roads and fence	6.7	-	-
Monitoring system, controls, and instrumentation	6.9	-	-
Electrical	11.5	-	-
Process piping	18.3	11.0	-
Site preparation	2.3	-	-
Total[1]	287.1	86.5	37.2
Service factor (27%)	75.1		
Total capital cost	352.2		
Present worth cost (@ 7 5/8% over 20 years)			
Capital cost	352.2		
O&M cost	352.7		
Salvage cost	(19.9)		
Total present worth	708.0		

[1] Costs for liquid sludge hauling and land spreading are not included.

Table E-27. Land application of WWTP effluent for Egg Harbor Subareas 1AN, 1BS, 2AS.

Item	(Cost ($1000x) Construction cost	Salvage value	O&M cost
Lined storage pond	46.6	11.7	0.5
Pump station	40.0	12.0	2.0
Field preparation	0.4	0.4	-
Permanent distribution system	10.6	5.2	1.5
Monitoring wells	3.8	1.1	0.5
Additional land	10.6	19.1	-
Additional fence	12.7	-	-
Total	124.7	49.5	4.5
Service factor 35%	43.6		
Total capital cost	168.3		
Present worth cost (@ 7 5/8% over 20 years)			
Capital cost	168.3		
O&M cost	45.4		
Salvage cost	(11.4)		
Total present worth	202.3		

Table E-28. Cluster soil absorption system for Egg Harbor Subareas 1AN, 1BS, 2AS.

Item	Quantity	Unit Cost	Construction	Salvage	O&M
Dosing chamber					$1,000
tankage	5,000 gal	$ 1.00	$ 5,000	$ 3,000	-
pumps 180 gpm	4	3,000	12,000	-	-
appurtenances		5,000	5,000	-	-
emergency pump 180 gpm	1	2,000	2,000	-	-
electrical		20,000	20,000	-	-
meters		5,000	5,000	-	-
Value chamber					
vault	2,000 gal	1.00	2,000	1,200	-
values		21,000	21,000	-	-
Storage building	286 sf	35	10,000	4,000	-
Drainfields					400
excavation & backfill	2,220 cy	6.00	13,320	-	-
gravel	1,110 cy	6.00	6,660	-	-
distribution pipe	6,000 lf	3.00	18,000	-	-
mainfold pipe	400 lf	6.00	2,400	-	-
delivery pipe	1,120 lf	10.00	11,200	-	-
filter fabric	3,330 sy	2.00	6,660	-	-
seeding	1 ac	1,000	1,000	-	-
Administrative building		36,000	36,000	10,800	3,000
Access road	2,000 lf	6.00	12,000	-	-
Land	4 ac	2,000	8,000	14,400	-
Initial cost			197,240	33,400	4,400
Service factor (35%)			69,030		
Initial capital cost			266,270		
Present worth factors			1.000	0.230	10.0983
Present worth			266,270	7,680	44,430
Total present worth			303,020		

Table E-29. Summary of Onsite Component Costs for Egg Harbor

Item	Initial Cost						Future Construction Cost							Total Present Worth
	Capital	Salvage	O&M	Present Worth Salvage	Present Worth O&M	Present Worth Total	Annual Construction	Total Salvage	Incremental Ann. O&M	Present Worth Constuction	Present Worth Salvage	Present Worth O&M	Present Worth Total	
Subareas 2B,2C,3,4, and 5	306,260	100,550	16,316	23,127	164,764	447,897	22,280	186,580	670	224,990	42,913	48,312	230,389	678,286
Subareas 1AS,1BN,2AN,2B 2C,3,4, and 5	424,410	151,420	19,611	34,827	198,038	587,621	32,564	277,990	1,060	328,841	63,938	76,434	341,337	928,958
Full on Site	659,930	234,640	64,182	53,970	648,130	1,254,090	38,142	335,870	1,499	385,169	77,250	108,089	416,008	1,670,098

Table E-30. Quantities and costs for upgrading and operating onsite systems and holding tanks for Egg Harbor Subareas 2B, 2C, 3, 4, 5.

Item	Quantity	Unit Cost	Construction	Salvage	O&M
Septic tank-SFD & small comm'l					
Upgrade - permanent	36	$ 150	$ 5,400	$ 3,240	$ 504
- seasonal	40	150	6,000	3,600	280
Replacement - permanent	15	1000	15,000	9,000	210
- seasonal	16	1000	16,000	9,600	112
Septic tank - large comm'l					
Upgrade - seasonal	4	150	600	360	60
Replacement - seasonal	1	2000	2,000	1,200	15
Lift pump					
Existing	9	-	-	-	675
New	32	645	20,640	6,190	2,400
Soil absorption sys.-SFD & sm. comm'l					
Replacement-seepage bed	13	1520	19,760	-	-
- mound	23	2170	49,910	-	-
Soil absorption sys.-large comm'l					
Replacement - mound	1	6550	6,550	-	-
Holding tank-SFD & sm. comm'l					
Existing-permanent	1	-	-	-	700
-seasonal	1	-	-	-	155
Replacement-permanent	10	2100	21,000	12,600	7,000
-seasonal	11	2100	23,100	13,860	1,705
Holding tank large comm'l					
Existing - seasonal	1	-	-	-	2,500
Rock removal					
Septic tank-SFD & sm. comm'l	18	750	13,500	13,500	-
Lift pump	19	600	11,400	11,400	-
Holding tank-SFD & sm. comm'l	16	1000	16,000	16,000	-
Subtotal initial cost			226,860	100,550	16,316
Service factor (35%)			79,400		
Subtotal initial capital cost			306,260		
Future systems					
Building sewers - new	91	225	20,480	12,290	-
Septic tank-SFD & sm. comm'l					
New/repl. - permanent	19/10	1000	29,000	17,400	266
- seasonal	30/11	1000	41,000	24,600	210
Septic tank -large comm'l					
New/repl. - seasonal	4/2	2000	16,000	9,600	60
Lift pump					
New	44	645	28,380	8,510	3,300
Soil absorption sys.-SFD & sm. comm'l					
New & repl. - seepage bed	26	1520	39,520	-	-
- mound	50	2170	108,500	-	-
Soil absorption sys. large comm'l					
New & repl. - mound	5	6550	32,750	-	-
Holding tank-SFD & sm. comm'l					
New & repl. - permanent	9	2100	18,900	11,340	6,300
- seasonal	21	2100	44,100	26,460	3,255
Rock removal					
Septic tank - SFD & sm. comm'l	35	750	26,250	26,250	-
- large comm'l	3	1000	3,000	3,000	-
Lift pump	34	600	20,400	20,400	-
Holding tank - SFD & sm. comm'l	27	1000	27,000	27,000	-
Total future costs			455,280	186,580	13,391
Annual future costs			22,764		670

Table E-31. Quantities and costs for upgrading and operating onsite systems and holding tanks for Egg Harbor Subareas 1AS, 1BN, 2AN, 2B, 2C, 3, 4, 5.

Item	Quantity	Unit Cost	Construction	Salvage	O&M
Septic tank-SFD & small comm'l					
Upgrade - permanent	51	$ 150	$ 7,650	$ 4,590	$ 714
- seasonal	47	150	7,050	4,230	329
Replacement - permanent	18	1000	18,000	10,800	252
- seasonal	18	1000	18,000	10,800	126
Septic tank - large comm'l					
Upgrade - permanent	3	150	450	270	90
- seasonal	7	150	1,050	630	105
Replacement - permanent	1	2000	2,000	1,200	30
Lift pump					
Existing	15	-	-	-	1,125
New	37	645	23,870	7,160	2,775
Soil absorption sys.-SFD & sm. comm'l					
Replacement-seepage bed	16	1520	24,320	-	-
- mound	27	2170	58,590	-	-
Soil absorption sys.-large comm'l					
Replacement - mound	2	6550	13,100	-	-
Holding tank-SFD & sm. comm'l					
Existing - seasonal	4	-	-	-	620
Replacement-permanent	15	2100	31,500	18,900	10,500
-seasonal	19	2100	39,900	23,940	2,945
Rock removal					
Septic tank-SFD & sm. comm'l	22	750	16,500	16,500	-
-large comm'l	2	1000	2,000	2,000	-
Lift pump	24	600	14,400	14,400	-
Holding tank-SFD & sm. comm'l	33	1000	33,000	33,000	-
-large comm'l	1	3000	3,000	3,000	-
Subtotal initial cost			314,380	151,420	19,611
Service factor (35%)			110,030		
Subtotal initial capital cost			424,410		
Future systems					
Building sewers - new	127	225	28,580	17,150	-
Septic tank-SFD & sm. comm'l					
New/repl. - permanent	31/13	1000	44,000	26,400	434
- seasonal	42/13	1000	55,000	33,000	294
Septic tank -large comm'l					
New/repl. - permanent	0/1	2000	2,000	1,200	-
- seasonal	4/2	2000	12,000	7,200	60
Lift pump					
New	66	645	42,570	12,770	4,950
Soil absorption sys.-SFD & sm. comm'l					
New & repl. - seepage bed	35	1520	53,200	-	-
- mound	63	2170	136,710	-	-
Soil absorption sys. large comm'l					
New & repl. - seepage bed	1	5060	5,060	-	-
- mound	8	6550	52,400	-	-
Holding tank-SFD & sm. comm'l					
New & repl. - permanent	15	2100	31,500	18,900	10,500
- seasonal	32	2100	67,200	40,320	4,960
Rock removal					
Septic tank - SFD & sm. comm'l	51	750	38,250	38,250	-
- large comm'l	4	1000	4,000	4,000	-
Lift pump	48	600	28,800	28,800	-
Holding tank - SFD & sm. comm'l	50	1000	50,000	50,000	-
Total future costs			651,270	277,990	21,198
Annual future costs			32,564		1,060

Table E-32. Quantities and costs for upgrading and operating onsite systems and holding tanks for all Egg Harbor subareas.

Item	Quantity	Unit Cost	Construction	Salvage	O&M
Septic tank-SFD & small comm'l					
Upgrade - permanent	53	$ 150	$ 7,950	$ 4,770	$ 742
- seasonal	55	150	8,250	4,950	385
Replacement - permanent	24	1000	24,000	14,400	336
- seasonal	22	1000	22,000	13,200	154
Septic tank - large comm'l					
Upgrade - permanent	4	150	600	360	120
- seasonal	11	150	1,650	990	165
Replacement - permanent	1	2000	2,000	1,200	30
- seasonal	2	2000	4,000	2,400	30
Lift pump					
Existing	16	-	-	-	1,200
New	47	645	30,320	9,100	3,525
Soil absorption sys.-SFD & sm. comm'l					
Replacement-seepage bed	21	1520	31,920	-	-
- mound	35	2170	75,950	-	-
Soil absorption sys.-large comm'l					
Replacement - mound	3	6550	19,650	-	-
Holding tank-SFD & sm. comm'l					
Existing-permanent	1	-	-	-	700
-seasonal	5	-	-	-	775
Replacement-permanent	35	2100	73,500	44,100	24,500
-seasonal	24	2100	50,400	30,240	3,720
Holding tank large comm'l					
Existing - seasonal	2	-	-	-	5,000
Replacement-permanent	2	2100	4,200	2,520	14,600
-seasonal	1	2100	2,100	1,260	2,500
Rock removal					
Septic tank-SFD & sm. comm'l	25	750	18,750	18,750	-
-large comm'l	2	1000	2,000	2,000	-
Lift pump	26	600	15,600	15,600	-
Holding tank-SFD & sm. comm'l	46	1000	46,000	46,000	-
-large comm'l	4	3000	12,000	12,000	-
Administration & laboratory			36,000	10,800	5,700
Subtotal initial cost			488,840	234,640	64,182
Service factor (35%)			171,090		
Subtotal initial capital cost			659,930		
Future systems					
Building sewers - new	152	225	34,200	20,520	-
Septic tank-SFD & sm. comm'l					
New/repl. - permanent	32/14	1000	46,000	27,600	448
- seasonal	48/15	1000	63,000	37,800	336
Septic tank -large comm'l					
New/repl. - permanent	0/2	2000	4,000	2,400	0
- seasonal	4/2	2000	12,000	7,200	30
Lift pump					
New	74	645	47,730	14,320	5,550
Soil absorption sys.-SFD & sm. comm'l					
New & repl. - seepage bed	36	1520	54,720	-	-
- mound	74	2170	160,580	-	-
Soil absorption sys. large comm'l					
New & repl. - seepage bed	1	5060	5,060	-	-
- mound	8	6550	52,400	-	-
Holding tank-SFD & sm. comm'l					
New & repl. - permanent	24	2100	50,400	30,240	16,800
- seasonal	44	2100	92,400	55,440	6,820
Rock removal					
Septic tank - SFD & sm. comm'l	61	750	45,750	45,750	-
- large comm'l	5	1000	5,000	5,000	-
Lift pump	56	600	33,600	33,600	-
Holding tank - SFD & sm. comm'l	56	1000	56,000	56,000	-
- large comm'l	0	3000	-	-	-
Total future costs			762,840	335,870	29,984
Annual future costs			38,142		1,499

Table E-33. Summary of Collection Costs for Fish Creek

Item	Initial Cost						Future Construction Cost							Total Present Worth
				Present Worth			Annual Construction	Total Salvage	Incremental Ann. O&M	Present Worth				
	Capital	Salvage	O&M	Salvage	O&M	Total				Constuction	Salvage	O&M	Total	
Subareas 2,3A, and 3B														
Conventional Gravity	1,035,100	417,650	7,313	96,060	73,849	1,012,889	592	7,110	-	5,978	1,635	-	4,343	1,017,232
STE Gravity	1,258,890	326,210	8,577	75,028	86,613	1,270,475	3,455	46,360	9	34,890	10,663	649	24,876	1,295,351
STE Pressure	1,385,030	438,200	17,164	100,786	173,327	1,407,571	5,091	55,470	65	51,410	12,758	4,687	43,339	1,450,910
Subareas 2 and 3A														
Conventional Gravity	951,290	376,220	7,238	86,531	73,092	937,851	592	7,110	-	5,978	2,095	-	3.883	941,734
STE Gravity	1,165,350	493,410	3,439	113,484	34,782	1,086,648	2,967	37,410	9	29,962	8,604	649	22,007	1,108,655
STE Pressure	1,234,720	402,440	16,120	92,561	162,785	1,304,944	4,603	46,520	65	46,483	10,700	4,687	40,470	1,345,414

Table E-34. Quantities and costs for conventional gravity sewers for Fish Creek Subareas 2, 3A, and 3B.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
Sewer pipe						
8"	LF	11,510	$ 16	$ 184,160	$110,500	$ 863
Rock excavation						
3' deep	LF	7,710	3	23,130	23,130	
4.5' deep	LF	2,800	13.50	37,800	37,800	
6' deep	LF	1,000	18	18,000	18,000	
Manholes	VF	364	100	36,400	21,840	
Road repair	LF	11,510	7.16	82,410	-	
Dewatering	LF	7,490	10	74,900	44,900	
River crossing pipe	LF	70	50	3,500	2,100	
Lift station						
Subarea 2		1		40,000	12,000	2,650
Subarea 3		1		40,000	12,000	3,000
Force main						
4" individual trench	LF	300	8	19,040	11,420	
4" common trench	LF	2,380	20	6,000	3,600	
Wye	EA	140	40	5,600	3,360	
Gravity service connection	LF	11,000	15	165,000	99,000	
Pressure lateral	LF	2,200	10	22,000	13,200	
Grinder pump	EA	8	6000	48,000	4,800	800
Septic tank abandonment	EA	140	65	9,100	-	-
Subtotal initial cost				815,040	417,650	7,313
Service factor (27%)				220,060		
Subtotal initial capital cost				1,035,100		
Future connection cost						
Building sewer	LF	135	15	2,030	1,220	
Wye	EA	9	40	360	220	
Gravity service connection	LF	630	15	9,450	5,670	
Subtotal future connection costs				11,840	7,110	
Annual connection costs				592		

Table E-35. Quantities and costs for septic tank effluent gravity sewers for Fish Creek Subareas 2, 3A, and 3B.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
Sewer pipe						
4" - 6"	LF	11,510	$ 13	$ 149,630	$89,780	$ 437
Rock excavation						
2.5' deep	LF	7,710	7.50	57,830	57,830	
3.5' deep	LF	2,800	10.50	29,400	29,400	
5' deep	LF	1,000	15	15,000	15,000	
Manholes	VF	304	100	30,400	18,240	
Road repair	LF	11,510	7.16	82,410	-	
Dewatering	LF	7,490	10	74,900	44,900	
River crossing pipe	LF	70	50	3,500	2,100	
Lift station						
Subarea 2	EA	1		40,000	12,000	2,150
Subarea 3	EA	1		40,000	12,000	2,500
Force main						
4" individual trench	LF	300	20	6,000	3,600	
4" common trench	LF	2,380	80	19,040	11,420	
Wye	EA	140	40	5,600	3,360	
Gravity service connection	LF	11,000	15	165,000	99,000	
Pressure lateral	LF	2,200	10	22,000	13,200	
STE pump - simplex	EA	8	2000	16,000	4,800	600
Septic tank minor upgrade						
SFD & small commercial	EA	28	150	4,200	2,520	280
Large commercial	EA	38	150	5,700	3,420	760
School	EA	1	150	150	90	180
Septic tank replacement						
SFD & small commercial	EA	91	1000	91,000	54,600	910
Large commercial	EA	29	2000	58,000	34,800	580
School	EA	1	9000	9,000	5,400	180
Septic tank rock removal						
SFD & small commercial	EA	9	750	6,750	6,750	
Large commercial	EA	1	1000	1,000	1,000	
Subtotal initial cost				932,510	326,210	8,577
Service factor (35%)				326,380		
Subtotal initial capital cost				1,258,890		
Future connection cost						
Building sewer	LF	135	15	2,030	1,220	
Wye	EA	9	40	360	220	
Gravity service connection	LF	630	15	9,450	5,670	
Septic tanks - new/repl.						
SFD & small commercial	EA	0/25	1000	25,000	15,000	
Large commercial	EA	9/1	2000	20,000	12,000	180
Septic tank rock removal						
SFD & small commercial	EA	7	750	5,250	5,250	-
Large commercial	EA	7	1000	7,000	7,000	-
Subtotal future connection costs				69,090	46,360	180
Annual connection costs				3,455		9

Table E-36. Quantities and costs for septic tank effluent pressure sewers for Fish Creek Subareas 2, 3A, and 3B.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
STE pressure pipe						
2½" - 6"	LF	11,810	$ 10	$ 118,100	$70,860	$ 224
Rock excavation						
2.5" deep	LF	3,800	750	28,500	28,500	
Road repair	LF	11,810	7.16	84,560	-	
Cleanouts	EA	30	1000	30,000	18,000	
Dewatering	LF	3,100	10	31,000	18,600	
River crossing pipe	LF	70	50	3,500	2,100	
Wye & curb value	EA	140	64	8,960	5,380	
Pressure lateral	LF	11,000	10	110,000	66,000	
STE pump - simplex	EA	119	2000	238,000	71,400	8,925
- duplex	EA	41	3890	159,490	47,852	5,125
Septic tank minor upgrade						
SFD & small commercial	EA	28	150	4,200	2,520	280
Large commercial	EA	38	150	5,700	3,420	760
School	EA	1	150	150	90	180
Septic tank replacement						
SFD & small commercial	EA	91	1000	91,000	54,600	910
Large commercial	EA	29	2000	58,000	34,800	580
School	EA	1	9000	9,000	5,400	180
Septic tank rock removal						
SFD & small commercial	EA	9	750	6,750	6,750	
Large commercial	EA	2	1000	2,000	2,000	
Subtotal initial cost				988,910	438,270	17,164
Service factor (35%)				346,120		
Subtotal initial capital cost				1,335,030		
Future connection cost						
Building sewer	LF	135	15	2,030	1,220	
Wye & curb value	EA	9	64	1,220	720	
Pressure lateral	LF	630	10	6,300	3,780	
STE pump - duplex	EA	9	3890	35,010	10,500	1,125
Septic tanks - new/repl.						
SFD & small commercial	EA	0/25	1000	25,000	15,000	
Large commercial	EA	9/1	2000	20,000	12,000	180
Septic tank rock removal						
SFD & small commercial	EA	7	750	5,250	5,250	-
Large commercial	EA	7	1000	7,000	7,000	-
Subtotal future connection costs				101,810	55,470	1,305
Annual Connection costs				5,091		65

Table E-37. Quantities and costs for conventional gravity sewers sewers for Fish Creek Subareas 2, and 3A.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
Sewer pipe						
8"	LF	10,510	$ 16	$ 168,160	$100,900	$ 788
Rock excavation						
3' deep	LF	7,710	3	25,130	25,130	
4.5' deep	LF	2,800	13.50	37,800	37,800	
Manholes	VF	343	100	34,300	20,580	
Road repair	LF	10,510	7.16	75,250	-	
Dewatering	LF	7,490	10	74,900	44,900	
River crossing pipe	LF	70	50	3,500	2,100	
Lift station						
Subarea 2	EA	1		40,000	12,000	2,650
Subarea 3	EA	1		40,000	12,000	3,000
Force main						
4" individual trench	LF	300	20	6,000	3,600	
4" common trench	LF	2,380	8	19,040	11,420	
Wye	EA	133	40	5,320	3,190	
Gravity service connection	LF	9,400	15	141,000	84,600	
Pressure lateral	LF	2,200	10	22,000	13,200	
Grinder pump	EA	8	6000	48,000	4,800	800
Septic tank abandonment	EA	133	65	8,650	-	-
Subtotal initial cost				749,050	376,220	7,238
Service factor (27%)				202,240		
Subtotal initial capital cost				951,290		
Future connection cost						
Building sewer	LF	135	15	2,030	1,220	
Wye	EA	9	40	360	220	
Gravity service connection	LF	630	15	9,450	5,670	
Subtotal future connection costs				11,840	7,110	
Annual connection costs				592		

Table E-38. Quantities and costs for septic tank effluent gravity sewers for Fish Creek Subareas 2, and 3A.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
Sewer pipe						
4" - 6"	LF	10,510	$ 13	$ 136,630	$81,980	$ 399
Rock removal						
2.5' deep	LF	7,710	7.50	57,830	57,830	
3.5' deep	LF	2,800	10.50	29,400	29,400	
Manholes	VF	287	100	28,700	28,700	
Road repair	LF	10,510	7.16	75,250		
Dewatering	LF	7,490	10	74,900	44,900	
River crossing pipe	LF	70	50	3,500	2,100	
Lift station						
Subarea 2	EA	1		40,000	12,000	
Subarea 3	EA	1		40,000	12,000	
Force main						
4" individual tranch	LF	300	20	6,000	3,600	
4" common trench	LF	2,380	8	19,040	11,420	
Wye	EA	133	40	5,320	3,190	
Gravity service connection	LF	9,400	15	141,000	84,600	
Pressure lateral	LF	2,200	10	22,000	13,200	
STE pump - simplex	EA	8	2000	16,000	4,800	600
Septic tank minor upgrade						
SFD & small commercial	EA	26	150	3,900	2,340	260
Large commercial	EA	19	150	2,850	1,710	380
School		1	150	150	90	180
Septic tank replacement						
SFD & small commercial	EA	86	1000	86,000	51,600	860
Large commercial	EA	29	2000	58,000	34,800	580
School	EA	1	9000	9,000	5,400	180
Septic tank rock removal						
SFD & small commercial	EA	9	750	6,750	6,750	
Large commercial	EA	1	1000	1,000	1,000	
Subtotal initial cost				863,220	493,410	3,439
Service factor (35%)				302,130		
Subtotal initial capital cost				1,165,350		
Future connection cost						
Building sewer	LF	135	15	2,030	1,220	
Wye	EA	9	40	360	220	
Gravity service connection	LF	630	15	9,450	5,670	
Septic tanks - new/repl.						
SFD & small commercial	EA	0/25	1000	25,000	15,000	
Large commercial	EA	9/0	2000	18,000	10,800	180
Septic tank rock removal						
SFD & small commercial	EA	6	750	4,500	4,500	
Large commercial	EA	0	1000	-	-	
Subtotal future connection costs				59,340	37,410	180
Annual connection costs				2,967		9

Table E-39. Quantities and costs for septic tank effluent pressure sewers for Fish Creek Subareas 2, and 3A.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
STE pressure pipe						
2½" - 6" installed	LF	10,810	$ 10	$ 108,100	$64,860	$ 205
Rock excavation						
2.5' deep	LF	2,800	7.50	21,000	21,000	-
Road repair	LF	10,810	7.16	72,250	-	
Cleanouts	EA	27	1000	27,000	16,200	
Dewatering	LF	3,100	10	31,000	18,600	
River crossing pipe	EA	70	50	3,500	2,100	
Wye & curb value	EA	133	64	8,510	5,110	
Pressure lateral	LF	9,400	10	94,000	56,400	
STE pump - simplex	EA	113	2000	226,000	67,800	8,475
- duplex	EA	40	3890	155,600	46,680	5,000
Septic tank minor upgrade						
SFD & small commercial	EA	26	150	3,900	2,340	260
Large commercial	EA	19	150	2,850	1,710	380
School	EA	1	150	150	90	180
Septic tank replacement						
SFD & small commercial	EA	86	1000	86,000	51,600	860
Large commercial	EA	29	2000	58,000	34,800	580
School	EA	1	9000	9,000	5,400	180
Septic tank rock removal						
SFD & small commercial	EA	9	750	6,750	6,750	
Large commercial	EA	1	1000	1,000	1,000	
Subtotal initial cost				914,610	402,440	16,120
Service factor (35%)				320,110		
Subtotal initial capital cost				1,234,720		
Future connection cost						
Building sewer	LF	135	15	2,030	1,220	
Wye & curb value	EA	9	64	1,220	720	
Pressure lateral	LF	630	10	6,300	3,780	
STE Pump - duplex	EA	9	3890	35,010	10,500	1,125
Septic tanks - new/repl.						
SFD & small commercial	EA	0/25	1000	25,000	15,000	-
Large commercial	EA	9/0	2000	18,000	10,800	180
Septic tank rock removal						
SFD & small commercial	EA	6	750	4,500	-	
Subtotal future connection costs				92,060	46,520	1,305
Annual connection costs				4,603		65

Table E-40. Summary of WWTP and discharge costs for Fish Creek.

Item	Capital	Salvage	O&M	Present Worth Salvage	Present Worth O&M	Present Worth Total
Fish Creek						
Aerated lagoon WWTP	$ 557,000	$67,800	$28,900	$15,594	$291,841	$ 833,247
Land application of effluent[1]	644,900	333,900	7,400	76,797	74,727	642,830
Outfall to Green Bay	593,600	224,990	2,500	51,748	25,246	567,098
Cluster drainfield[1]	1,099,560	337,460	8,000	77,616	80,786	1,102,730
Cluster mound[1]	898,700	185,800	8,000	42,734	80,786	936,752

[1] Includes transmission costs

Table E-41. Aerated lagoon WWTP for Fish Creek

Item	Cost ($1000x) Construction cost	Salvage value	O&M cost
Flow meter assembly	$ 10.0	$ -	$ 2.0
Aerated lagoons	120.4	19.8	14.3
Impermeable liner	19.8	-	-
Special fill	164.1	-	-
Chlorination system	33.1	8.3	6.9
Administration and laboratory bldg.	36.0	10.8	5.7
Service roads and fencing	6.7	-	-
Land	10.0	18.1	-
Monitoring, controls, and instrumentation	6.8	-	-
Electrical	11.3	-	-
Processing piping	18.1	10.8	-
Site preparation	2.3	-	-
Total	438.6	67.8	28.9
Service factor (27%)	118.4		
Total capital cost	557.0		
Present worth cost (@ 7 5/8% over 20 years)			
Capital cost	557.0		
O&M cost	291.8		
Salvage cost	(15.6)		
Total present worth	833.2		

Table E-42. Transmission to site in Sec. 3 and land application of WWTP effluent for Fish Creek.

Item	Cost ($1000x) Construction cost	Salvage value	O&M cost
Force main	250.1	186.5	-
Lined storage pond	65.7	16.4	0.6
Pump station	40.0	12.0	2.1
Field preparation	2.1	2.1	-
Permanent distribution system	42.4	21.2	4.2
Monitoring walls	3.8	1.1	0.5
Additional land	52.4	94.6	-
Additional fence	21.2	-	-
Total	477.7	333.9	7.4
Service factor 35%	167.2		
Total capital cost	644.9		

Present worth cost (@ 7 5/8% over 20 years)	
Capital cost	644.9
O&M cost	74.7
Salvage cost	(76.8)
Total present worth	642.8

Table E-43. Transmission to WWTP in NENW Section 33 and WWTP outfall to Green Bay for Fish Creek.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
Force main to site						
Pipe-common trench	LF	5,000	8	40,000	24,000	-
Rock excavation						
4' deep	LF	700	12	8,400	8,400	
5' deep	LF	3,200	15	48,000	48,000	
Dewatering	LF	1,100	10	110,000	-	
Lift station	EA	1		40,000	12,000	2,500
Force main from site						
Pipe-common trench	LF	9,200	8	73,600	44,150	
Gravity sewer pipe	LF	100	16	1,600	960	
Manhole	VF	8	100	800	480	
Underwater pipe	LF	700	200	140,000	84,000	-
Outfall structure	EA	1		5,000	3,000	-
Total				467,400	224,990	2,500
Service factor 27%				126,200		
Total capital cost				593,600		
Present worth Cost (@ 7 5/8% over 20 years)						
Capital cost				593,600		
O&M cost				25,246		
Salvage value				(51,748)		
Total present worth				567,098		

Table E-44. Cluster drainfield and transmission to site in Sec. 3 T30N R27E for Fish Creek.

Item	Quantity	Unit Cost	Construction	Salvage	O&M
Force main to Site					
common trench	1,700 LF	$ 8.00	$ 13,600	$ 8,160	-
individual trench	7,270 LF	20.00	145,400	87,200	-
rock excavation 5' deep	6,070 LF	15.00	91,100	91,100	-
Dosing chamber					$3,000
tank	15,000 gal	1.00	15,000	9,000	-
pumps 800 gpm	4	12,000	48,000	-	-
appurtenances		5,000	5,000	-	-
emergency pump 800 gpm	1	5,000	5,000	-	-
electrical		20,000	20,000	-	-
meters		5,000	5,000	-	-
Value chamber					
vault	2,000 gal	1.00	2,000	1,200	-
values		21,000	21,000	-	-
Storage building	286 sf	35.00	10,000	4,000	-
Drainbeds					2,000
excavation & backfill	18,700 sy	6.00	112,200	-	-
gravel	6,230 cy	6.00	37,380	-	-
distribution pipe	33,600 lf	3.00	100,800	-	-
manifold pipe	1,680 lf	6.00	10,080	-	-
delivery pipe					
6"	880 lf	10.00	8,800	-	-
8"	1,210 lf	13.00	15,730	-	-
filter fabric	18,700 sy	2.00	37,400	-	-
seeding	5 ac	1,000.00	5,000	-	-
Administrative and lab building		36,000	36,000	10,800	3,000
Land	20 ac	2,000	70,000	126,000	-
Initial cost			814,490	337,460	8,000
Service factor (35%)			285,070		
Initial capital cost			1,099,560		
Present worth factors			1.000	0.230	10.0983
Present worth			1,099,560	77,616	80,786
Total present worth			1,102,730		

Table E-45. Cluster mound and transmission to site in SWNE Sec. 32 for Fish Creek.

Item	Quantity	Unit Cost	Construction	Salvage	O&M
Force main to Site					
individual trench	2,100 LF	$ 20.00	$ 42,000	$25,200	-
dewatering	1,600 LF	10.00	16,000	9,600	-
Dosing chamber					3,000
tankage	15,000 gal	1.00	15,000	9,000	-
pumps 800 gpm	4	12,000	48,000	-	-
appurtenances		5,000	5,000	-	-
emergency pump 800 gpm	1	5,000	5,000	-	-
electrical		20,000	20,000	-	-
meters		5,000	5,000	-	-
Value chamber					
vault	2,000 gal	1.00	2,000	1,200	
values		21,000	21,000		
Storage building	286 sf	35	10,000	4,000	-
Drainbeds					2,000
plowing	5 ac	100	500	-	-
sand fill	14,800 ac	6.00	88,800	-	-
gravel	3,700 cy	6.00	22,200	-	-
distribution pipe	20,000 lf	3.00	60,000	-	-
manifold pipe	1,000 lf	6.00	6,000	-	-
delivery pipe	1,600 lf	13.00	20,800	-	-
filter fabric	11,100 sy	2.00	22,200	-	-
soil fill	5,920 cy	5.00	29,600	-	-
topsoil	3,000 cy	5.00	15,000	-	-
seeding	5 ac	1,000	5,000	-	-
Site improvements					
access road	2,200 lf	6.00	13,200	-	-
fencing	4,000 lf	5.00	20,000	-	-
Administrative & lab building			36,000	10,800	3,000
Land	35 ac	2,000	70,000	126,000	-
Initial cost			589,300	185,800	8,000
Service factor (35%)			209,400		
Initial capital cost			898,700		
Present worth factors			1.00	0.230	10.0983
Present worth			898,700	42,734	80,786
Total present worth			936,752		

Table E-46. Summary of Onsite Component Costs for Fish Creek

Item	Initial Cost						Future Construction Cost							Total Present Worth
				Present Worth			Annual	Total	Incremental	Present Worth				
	Capital	Salvage	O&M	Salvage	O&M	Total	Construction	Salvage	Ann. O&M	Constuction	Salvage	O&M	Total	
Subareas 1,4,5, and 6	260,270	104,860	16,317	24,118	164,774	400,926	7,644	77,060	497	77,191	17,724	35,837	95,304	496,230
Subareas 1,38,4,5, and 6	297,310	114,755	19,467	26,374	196,584	467,500	7,794	79,260	497	78,706	18,230	35,837	96,313	563,813
Full on Site	720,950	296,910	233,990	68,290	2,362,900	3,015,560	16,162	136,640	1,795	163,209	31,427	129,433	261,215	3,276,776

Table E-47. Quantities and costs for upgrading and operating onsite systems and holding tanks for Fish Creek subareas 1, 4, 5, and 6.

Item	Quantity	Unit Cost	Construction	Salvage	O&M
Septic tank-SFD & small comm'l					
Upgrade - permanent	9	$ 150	$ 1,350	$ 810	$ 126
- seasonal	13	150	1,950	1,170	91
Replacement - permanent	2	1000	2,000	1,200	28
- seasonal	6	1000	6,000	3,600	42
Lift pump					
New	19	645	12,260	3,680	1,425
Soil absorption sys.-SFD & sm. comm'l					
Replacement - mound	19	2170	41,230	-	-
Holding tank-SFD & sm. comm'l					
Existing-permanent	1	-	-	-	700
-seasonal	4	-	-	-	620
Replacement-permanent	13	2100	27,300	16,380	9,106
-seasonal	27	2100	56,700	34,020	4,185
Rock removal					
Septic tank-SFD & sm. comm'l	4	750	3,000	3,000	-
-large comm'l	0	1000	-	-	-
Lift pump	15	600	9,000	9,000	-
Holding tank-SFD & sm. comm'l	32	1000	32,000	32,000	-
Subtotal initial cost			192,790	104,860	16,317
Service factor (35%)			67,480		
Subtotal initial capital cost			260,270		
Future systems					
Building sewers - new	23	225	5,180	3,110	-
Septic tank-SFD & sm. comm'l					
New/repl. - permanent	13/6	1000	19,000	11,400	182
- seasonal	0/7	1000	7,000	4,200	-
Lift pump					
New	18	645	11,610	3,480	1,350
Soil absorption sys.-SFD & sm. comm'l					
New & repl. - seepage bed	4	1520	6,080	-	-
- mound	18	2170	39,060	-	-
Holding tank-SFD & sm. comm'l					
New & repl. - permanent	12	2100	25,200	15,120	8,400
Rock removal					
Septic tank - SFD & sm. comm'l	13	750	9,750	9,750	-
Lift pump	15	600	9,000	9,000	-
Holding tank - SFD & sm. comm'l	12	1000	12,000	12,000	-
Total future costs			152,880	77,060	9,932
Annual future costs			7,644		497

Table E-48. Quantities and costs for upgrading and operating onsite systems and holding tanks for Fish Creek subareas 1, 3B, 4, 5, and 6.

Item	Quantity	Unit Cost	Construction	Salvage	O&M
Septic tank-SFD & small comm'l					
Upgrade - permanent	9	$ 150	$ 1,350	$ 810	$ 126
- seasonal	13	150	1,950	1,170	91
Replacement - permanent	2	1000	2,000	1,200	28
- seasonal	6	1000	6,000	3,600	42
Septic tank - large comm'l					
Upgrade - seasonal	3	150	450	270	45
Lift pump					
New	21	645	13,550	4,065	1,575
Soil absorption sys.-SFD & sm. comm'l					
Replacement - mound	19	2170	41,230	-	-
Soil absorption sys.-large comm'l					
Replacement - mound	2	6550	13,100	-	-
Holding tank-SFD & sm. comm'l					
Existing-permanent	1	-	-	-	700
-seasonal	5	-	-	-	775
Replacement-permanent	17	2100	35,700	21,420	11,900
-seasonal	27	2100	56,700	34,020	4,185
Rock removal					
Septic tank-SFD & sm. comm'l	4	750	3,000	3,000	-
-large comm'l	3	1000	3,000	3,000	-
Lift pump	17	600	10,200	10,200	-
Holding tank-SFD & sm. comm'l	32	1000	32,000	32,000	-
Subtotal initial cost			220,230	114,755	19,467
Service factor (35%)			77,080		
Subtotal initial capital cost			297,310		
Future systems					
Building sewers - new	23	225	5,180	3,110	-
Septic tank-SFD & sm. comm'l					
New/repl. - permanent	13/6	1000	19,000	11,400	182
- seasonal	0/7	1000	7,000	4,200	-
Septic tank -large comm'l					
New/repl. - seasonal	0/1	2000	2,000	1,200	15
Lift pump					
New	18	645	11,610	3,480	1,350
Soil absorption sys.-SFD & sm. comm'l					
New & repl. - seepage bed	4	1520	6,080	-	-
- mound	18	2170	39,060	-	-
Holding tank-SFD & sm. comm'l					
New & repl. - permanent	12	2100	25,200	15,120	8,400
Rock removal					
Septic tank - SFD & sm. comm'l	13	750	9,750	9,750	-
- Large comm'l	1	1000	1,000	1,000	1,000
Lift pump	15	600	9,000	9,000	-
Holding tank - SFD & sm. comm'l	12	1000	12,000	12,000	-
Total future costs			155,880	79,260	9,947
Annual future costs			7,794		497

Table E-49. Quantities and costs for upgrading and operating onsite systems and holding tanks for all Fish Creek subareas.

Item	Quantity	Unit Cost	Construction	Salvage	O&M
Septic tank-SFD & small comm'l					
Upgrade - permanent	24	$ 150	$ 3,600	$ 2,160	$ 336
- seasonal	25	150	3,750	2,250	175
Replacement - permanent	10	1000	10,000	6,000	140
- seasonal	12	1000	12,000	7,200	84
Septic tank - large comm'l					
Upgrade - seasonal	3	150	450	270	45
Lift pump					
New	45	645	29,030	8,710	3,375
Soil absorption sys.-SFD & sm. comm'l					
Replacement-seepage bed	7	1520	10,640	-	-
- mound	31	2170	67,270	-	-
Soil absorption sys.-large comm'l					
Replacement - mound	2	6550	13,100	-	-
Holding tank-SFD & sm. comm'l					
Existing-permanent	4	-	-	-	2,800
-seasonal	12	-	-	-	1,860
Replacement-permanent	51	2100	107,100	64,260	35,700
-seasonal	65	2100	136,500	81,900	10,075
Holding tank large comm'l					
Existing permanent	14	-	-	-	102,200
seasonal	8	-	-	-	20,000
Replacement-permanent	5	2100	10,500	6,300	36,500
-seasonal	6	2100	12,600	7,560	15,000
Rock removal					
Septic tank-SFD & sm. comm'l	6	750	4,500	4,500	-
-large comm'l	5	1000	5,000	5,000	-
Lift pump	25	600	15,000	15,000	-
Holding tank-SFD & sm. comm'l	45	1000	45,000	45,000	-
-large comm'l	4	3000	12,000	12,000	-
Administration & laboratory			36,000	10,800	5,700
Subtotal initial cost			534,040	296,910	233,990
Service factor (35%)			186,910		
Subtotal initial capital cost			720,950		
Future systems					
Building sewers - new	32	225	7,200	4,320	-
Septic tank-SFD & sm. comm'l					
New/repl. - permanent	13/11	1000	24,000	14,400	182
- seasonal	0/12	1000	12,000	7,200	-
Septic tank -large comm'l					
New/repl. - seasonal	0/1	2000	2,000	1,200	-
Lift pump					
New	26	645	16,770	5,030	1,950
Soil absorption sys.-SFD & sm. comm'l					
New & repl. - seepage bed	5	1520	7,600	-	-
- mound	26	2170	56,420	-	-
Holding tank-SFD & sm. comm'l					
New & repl. - permanent	15	2100	31,500	18,900	10,500
- seasonal	5	2100	10,500	6,300	775
Holding tank-large comm'l					
New & repl. - permanent	-	10,000	-	-	-
- seasonal	9	10,000	90,000	27,000	22,500
Rock removal					
Septic tank - SFD & sm. comm'l	15	750	11,250	11,250	-
- large comm'l	1	1000	1,000	1,000	-
Lift pump	15	600	9,000	9,000	-
Holding tank - SFD & sm. comm'l	17	1000	17,000	17,000	-
- large comm'l	9	3000	27,000	27,000	-
Total future costs			323,240	136,640	35,907
Annual future costs			16,162		1,795

Table E-50. Summary of Collection and Transmission Costs for Ephraim.

Item	Initial Cost						Future Construction Cost							Total Present Worth
				Present Worth			Annual	Total	Incremental	Present Worth				
	Capital	Salvage	O&M	Salvage	O&M	Total	Construction	Salvage	Ann. O&M	Constuction	Salvage	O&M	Total	
Subareas 1A,1B,2,3,5 and 6														
Conventional Gravity	3,898,800	1,760,880	14,973	395,802	151,202	3,654,200	9,690	68,260	75	97,853	15,700	5,408	87,561	3,741,761
STE Gravity	3,911,380	1,718,470	16,344	395,248	165,047	3,681,179	24,239	313,260	123	244,773	72,049	8,869	181,593	3,862,772
Subareas 1A, 1B, and 2														
Conventional Gravity	1,399,740	563,730	5,892	129,660	57,500	1,269,580	3,499	24,020	30	35,334	5,525	2,163	31,970	1,301,550
STE Gravity	1,314,490	529,220	7,232	121,720	73,030	1,265,800	7,613	89,870	50	76,878	20,670	3,605	57,810	1,325,610

Table E-51. Quantities and costs for conventional gravity sewers and transmission for Ephraim Subareas 1, 2, 3, 5, and 6.

Item	Unit	Quantity	Cost	Construction	Salvage	O&M
STE sewer pipe						
8"	LF	56280	$ 16	$ 900,480	$540,290	$4,221
Rock excavation						
1' deep	LF	450	3	1350	1350	-
3' deep	LF	2600	9	23,400	23,400	-
4' deep	LF	9010	12	108,120	108,120	-
5' deep	LF	4680	15	70,200	70,200	-
6' deep	LF	6550	18	117,900	117,900	-
7' deep	LF	700	21	14,700	14,700	-
8' deep	LF	450	24	10,800	10,800	-
10' deep	LF	400	30	12,000	12,000	-
12' deep	LF	250	36	9,000	9,000	-
14' deep	LF	2900	42	121,800	121,800	-
19' deep	LF	450	57	25,650	25,650	
Manholes	VF	1440	100	144,000	86,400	-
Road repair	LF	49730	7.16	356,070	-	-
Dewatering	LF	16240	10	162,400	97,440	-
Lift stations						
#1 30 gpm - TDH 92 ft				40,000	12,000	2,029
#2 206 gpm - TDH 33 ft				40,000	12,000	2,083
#3 275 gpm - TDH 13 ft				40,000	12,000	2,401
#4 25 gpm - TDH 13 ft				40,000	12,000	2,003
Force main (2"-4")						
individual trench	LF	5100	20	102,000	61,200	-
common trench	LF	2900	8	23,200	13,920	-
Wye	EA	365	40	14,600	8,760	-
Gravity service connection	LF	34300	15	514,500	308,700	-
Pressure lateral	LF	2200	10	22,000	13,200	-
Grinder pump	EA	22	6000	132,000	13,200	2,200
Septic tank abandonment	EA	365	65	23,730	14,240	-
Subtotal initial cost				3,069,920	1,720,880	14,973
Service factor (27%)				828,880		
Subtotal initial capital cost				3,898,800		
Future connection cost						
Building sewer	LF	1515	15	27,730	13,640	-
Wye	EA	101	40	4,040	2,420	-
Gravity service connection	LF	4300	15	64,500	38,700	-
Pressure lateral	LF	750	10	7,500	4,500	-
Grinder pump	EA	15	6000	90,000	9,000	1,500
Subtotal future connection cost				193,770	68,260	1,500
Annual connection costs				9,690		75

Table E-52. Quantities and costs for septic tank effluent gravity sewers and transmission for Ephraim Subareas 1, 2, 3, 5, and 6.

Item	Unit	Quantity	Cost	Construction	Salvage	O&M
STE sewer pipe						
4" - 6"	LF	54380	$ 13	$ 706,940	$424,160	$2,066
8"	LF	1900	16	30,400	18,240	72
Rock excavation						
2' deep	LF	1800	6	10,800	10,800	-
4' deep	LF	6580	12	78,960	78,960	-
5' deep	LF	6730	15	100,950	100,950	
6' deep	LF	5900	18	88,500	88,500	
7' deep	LF	800	21	16,800	16,800	-
9' deep	LF	200	24	4,800	4,800	-
11' deep	LF	1700	33	56,100	56,100	-
12' deep	LF	2650	36	95,400	95,400	-
15' deep	LF	450	45	162,000	162,000	-
Manholes	VF	140	10	1,400	840	
Road repair	LF	49730	7.16	356,070	-	-
Dewatering	LF	16240	10	162,400	97,440	-
Lift stations						
#1 30 gpm - TDH 92 ft	EA	1		40,000	12,000	2,029
#2 206 gpm - TDH 33 ft	EA	1		40,000	12,000	2,083
#3 275 gpm - TDH 13 ft	EA	1		40,000	12,000	2,401
#4 20 gpm - TDH 13 ft	EA	1		40,000	12,000	2,003
Force main (2" - 4")						
individual trench	LF	5100	20	102,000	61,200	-
common trench	LF	2900	8	23,200	13,920	
Wye	EA	365	40	14,600	8,760	-
Gravity service connection	LF	34,300	15	514,500	308,700	-
Pressure lateral	LF	2,200	10	22,000	13,200	-
STE pump - simplex	EA	22	2000	44,000	132,000	1,650
Septic tank minor upgrade						
SFD & small commercial	EA	255	150	38,250	22,950	2,550
Large commercial	EA	35	150	5,250	3,150	700
Septic tank replacement						
SFD & small commercial	EA	71	1000	71,000	42,600	710
Large commercial	EA	4	2000	2,000	4,800	80
Septic tank rock removal						
SFD & small commercial	EA	28	750	21,000	21,000	-
Large commercial	EA	2	1000	2,000	2,000	
Subtotal initial cost				2,897,320	1,718,470	16,344
Service factor (35%)				1,014,060		
Subtotal initial capital cost				3,911,380		
Future connection cost						
Building sewer	LF	1515	15	27,730	13,640	-
Wye	EA	101	40	4,040	2,420	-
Gravity service connection	LF	4300	15	64,500	38,700	-
Pressure lateral	LF	750	10	7,500	4,500	-
STE Pump - simplex	EA	15	2000	30,000	9,000	1,125
Septic tanks - new & repl.						
SFD & small commercial	EA	68/121	1000	189,000	113,400	680
Large commercial	EA	33/5	2000	76,000	45,600	660
Septic tank rock removal						
SFD & small commercial	EA	96	750	72,000	72,000	-
Large commercial	EA	14	1000	14,000	14,000	-
Subtotal future connection costs				484,770	313,260	2,465
Annual connection costs				24,239		123

Table E-53. Quantities and costs for conventional gravity sewers and transmission for Ephraim Subareas 1A, 1B, and 2.

Item	Unit	Quantity	Cost	Construction	Salvage	O&M
STE sewer pipe						
8"	LF	19870	$ 16	$ 317,920	$190,760	$1,490
Rock excavation						
1' deep	LF	450	3	1,350	1,350	-
3' deep	LF	800	9	7,200	7,200	-
6' deep	LF	1200	18	21,600	21,600	-
7' deep	LF	700	21	14,700	14,700	-
8' deep	LF	450	24	10,800	10,800	-
Manholes	VF	460	100	46,000	27,600	-
Road repair	LF	19870	7.16	142,270	-	-
Dewatering	LF	7570	10	75,700	45,420	-
Lift station						
#1 108 gpm TDH 22 ft	EA	1		40,000	12,000	2,024
#2 200 gpm TDH 86 ft	EA	1		40,000	12,000	2,078
Force main						
4" individual trench	LF	2,500	20	50,000	30,000	-
4" common trench	LF	2,300	8	18,400	11,040	-
Wye	EA	185	40	7,400	4,440	-
Gravity service connection	LF	18,200	15	273,000	164,000	-
Pressure lateral	LF	300	10	3,000	1,800	-
Grinder pump	EA	3	6000	18,000	1,800	300
Septic tank abandonment	EA	185	65	12,030	7,220	-
Subtotal initial cost				1,101,370	563,730	5,892
Service factor (27%)				297,370		
Subtotal initial capital cost				1,399,740		
Future connection cost						
Building sewer	LF	525	15	7,880	4,730	-
Wye	EA	35	40	1,400	840	-
Gravity service connection	LF	1,450	15	21,700	13,050	-
Pressure lateral	LF	300	10	3,000	1,800	-
Grinder pump	EA	6	6000	36,000	3,600	600
Subtotal future connection cost				69,980	24,020	600
Annual connection costs				3,499		30

Table E-54. Quantities and costs for septic tank effluent sewers and transmission for Ephraim Subareas 1A, 1B, and 2.

Item	Unit	Quantity	Cost	Construction	Salvage	O&M
STE sewer pipe						
4" - 6"	LF	18570	$13	$ 24,410	$144,850	$ 706
8"	LF	1300	16	20,800	12,480	49
Rock excavation						
1' deep	LF	800	3	2,400	2,200	-
6' deep	LF	700	18	12,600	12,600	-
7' deep	LF	1150	21	24,150	24,150	
Manholes	VF	77	100	7,700	4,620	
Road repair	LF	19870	7.16	142,270	-	-
Dewatering	LF	7570	10	75,700	45,420	
Lift station						
#1 108 gpm TDH 22 ft	EA	1		40,000	12,000	2,024
#2 200 gpm TDH 86 ft	EA	1		40,000	12,000	2,078
Force main						
4" individual trench	LF	2500	20	50,000	30,000	-
4" common trench	LF	2300	8	18,400	11,040	-
Wye	EA	185	40	7,400	4,400	-
Gravity service connection	LF	18200	15	273,000	164,000	-
Pressure lateral	LF	300	10	3,000	1,800	-
STE pump - simplex	EA	3	2000	6,000	1,800	225
Septic tank minor upgrade						
SFD & small commercial	EA	121	150	18,150	10,890	1,210
Large commercial	EA	27	150	4,050	2,430	540
Septic tank replacement						
SFD & small commercial	EA	34	1000	34,000	20,400	340
Large commercial	EA	3	2000	6,000	3,600	600
Septic tank rock removal						
SFD & small commercial	EA	8	750	6,000	6,000	-
Large commercial	EA	2	1000	2,000	2,000	-
Subtotal initial cost			1,035,030	529,220	7,232	
Service factor (35%)			279,560			
Subtotal initial capital cost			1,314,490			-
Future connection cost						
Building sewer	LF	525	15	7,880	4,730	-
Wye	EA	35	40	1,400	840	
Gravity service connection	LF	1450	15	21,700	13,050	
Pressure lateral	LF	300	10	3,000	1,800	-
STE Pump - simplex	EA	6	2000	12,000	3,600	450
Septic tanks - new & repl.						
SFD & small commercial	EA	15/40	1000	55,000	33,000	150
Large commercial	EA	20/3	2000	46,000	27,600	400
Septic rock removal						
SFD & small commercial	EA	17	750	2,250	2,250	-
Large commercial	EA	3	1000	3,000	3,000	-
Subtotal future connection cost				152,250	89,870	1,000
Annual connection costs				7,613		50

Table E-55. Summary of WWTP and discharge costs for Ephraim.

Item	Capital	Salvage	O&M	Present Worth Salvage	Present Worth O&M	Present Worth Total
Subareas 1A, 1B, 2, 3, 5, and 6						
Aerated lagoon WWTP	$432,300	$ 78,600	$37,700	$18,078	$380,706	$794,928
Discharge to wetland	194,500	66,800	37,200	15,364	375,657	554,793
Outfall to Green Bay	494,000	221,400	2,460	50,922	24,842	467,920
Subareas 1A, 1B, and 2						
Aerated lagoon WWTP	373,800	71,000	31,000	16,330	313,047	670,517
Discharge to wetland	172,400	62,700	35,300	14,421	356,470	514,449
Outfall to Green Bay	859,280	255,960	2,230	58,871	22,519	822,928
Cluster drainfield	797,660	118,000	11,090	27,140	120,170	890,690

Table E-56. Aerated lagoon WWTP for Ephraim Subareas 1, 2, 3, 5, and 6.

Item	Cost ($1,000x) Construction Cost	Salvage Value	O&M Cost
Flow meter assembly	$ 10.0	$ -	$ 2.0
Aerated lagoons	155.0	25.6	17.8
Impermenable liner	32.6	-	-
Chlorination system	42.1	10.5	9.3
Administration & laboratory bldg.	36.0	10.8	8.6
Service roads and fencing	6.7	-	-
Land	10.0	18.1	-
Monitoring, controls, and instrumentation	8.5	-	-
Electrical	14.1	-	-
Process piping	22.6	13.6	-
Site preparation	2.8	-	-
Total	340.4	78.6	37.7
Service factor (27%)	91.9		
Total capital cost	432.3		

Present worth cost (@ 7 5/8% over 20 years)

Capital cost	432.3
O&M cost	380.7
Salvage value	(18.1)
Total present worth	749.7

Table E-57. WWTP discharge to wetland for Ephraim Subareas 1, 2, 3, 5, and 6.

Item	Cost ($1,000x) Construction Cost	Salvage Value	O&M Cost
Intermittent sand filter[1]	$ 49.2	$12.3	$6.1
Pumping station	40.0	12.0	2.2
Force main	9.0	5.4	-
Distribution	30.4	9.1	29.0
Land	15.5	28.0	-
Total	144.1	66.8	37.2
Service factor (35%)	50.4		
Total capital cost	194.5		

Present worth cost (@ 7 5/8% over 20 years)

Capital cost	194.5
O&M cost	375.7
Salvage value	(15.4)
Total present worth	554.8

[1]Located at WWTP for 20 mg/l BOD & 20 mg/l SS discharge.

Table E-58. WWTP outfall to Green Bay for Ephraim Subareas 1, 2, 3, 5, and 6.

Item	Unit	Quantity	Cost	Construction	Salvage	O&M
Lift station	1	EA		40,000	12,000	2,460
Forcemain common trench	LF	12,100	8	96,800	58,080	-
Gravity sewer pipe	LF	400	16	6,400	3,840	-
Manholes	VF	8	100	800	480	-
Underwater pipe	LF	1,200	200	240,000	144,000	-
Outfall	EA	1		5,000	3,000	-
Total				389,000	221,400	2,460
Service factor 27%				105,000		
Total capital cost				494,000		
Present worth cost (@ 7 5/8% over 20 years)						
Capital cost				494,000		
O&M cost				24,842		
Salvage value				(50,922)		
Total present worth				467,920		

Table E-59. Aerated lagoon WWTP for Ephraim Subareas 1A, 1B, and 2.

Item	Cost ($1,000x) Construction Cost	Salvage Value	O&M Cost
Flow meter assembly	$ 10.0	$ -	$ 2.0
Aerated lagoons	132.4	21.8	15.2
Impermeable liner	23.3	-	-
Chlorination system	34.6	8.6	7.1
Administration and laboratory bldg.	36.0	10.8	6.7
Service roads and fencing	6.7	-	-
Land	10.0	18.1	
Monitoring, controls, and instrumentation	7.3	-	-
Electrical	12.2	-	-
Process piping	19.4	11.7	-
Site preparation	2.4	-	-
Total	294.3	71.0	31.0
Service factor (27%)	94.5		
Total capital cost	373.8		

Present worth cost (@ 7 5/8% over 20 years)

Capital cost	373.8
O&M cost	313.0
Salvage value	(16.3)
Total present worth	670.5

Table E-60. WWTP discharge to wetland for Ephraim Subareas 1A, 1B, and 2.

Item	Cost ($1,000x) Construction Cost	Salvage Value	O&M Cost
Intermittent sand filter[1]	$ 32.8	$ 8.2	$4.1
Pumping station	40.0	12.0	2.2
Force main	9.0	5.4	-
Distribution	30.4	9.1	29.0
Land	15.5	28.0	-
Total	127.7	62.7	35.3
Service factor (35%)	44.7		
Total capital cost	172.4		

Present worth cost (@ 7 5/8% over 20 years)

Capital cost	172.4
O&M cost	356.5
Salvage value	14.4
Total present worth	514.5

[1] Located at WWTP for 20 mg/l BOD & 20 mg/l SS discharge

Table E-61. WWTP outfall to Green Bay for Ephraim Subareas 1A, 1B, and 2.

Item	Unit	Quantity	Cost	Construction	Salvage	O&M
Lift station	EA	1		$ 40,000	$12,000	$2,230
Forcemain						
common trench	LF	7,300	$ 8	58,400	35,040	-
individual trench	LF	4,800	20	96,000	57,600	-
Dewatering	LF	23,000	10	230,000	-	-
Gravity sewer pipe	LF	400	16	6,400	3,840	-
Manhole	VF	8	100	800	480	-
Underwater pipe	LF	1,200	200	240,000	144,000	-
Outfall structures	EA	1		5,000	3,000	-
Total				676,600	255,960	2,230
Service factor 27%				182,680		
Total capital cost				859,280		

Present worth cost (@ 7 5/8% over 20 years)

Capital cost	$859,280
O&M cost	22,519
Salvage value	(58,871)
Total present worth	822,928

Table E-62. Cluster soil absorption system for Ephraim Subareas 1A, 1B, and 2.

Item	Quantity	Unit Cost	Construction	Salvage	O&M
Dosing chamber					$4,000
tankage	20,000 gal	$ 1.00	$ 20,000	$12,000	-
pumps 1000 gpm	4	4,000	16,000	-	-
appurtenances		5,000	5,000	-	-
emergency pump 1000 gpm	1	6,300	6,300	-	-
electrical		20,000	20,000	-	-
meters		5,000	5,000	-	-
Value chamber					
vault	2,000 gal	1.00	2,000	1,200	-
values		21,000	21,000	-	-
Storage building	286 sf	35	10,000	4,000	-
Drainfields					
excavation & backfill	16,190 cy	6.00	97,100	-	-
gravel	8,090 cy	6.00	48,570	-	-
distribution pipe	36,300 lf	3.00	108,900	-	-
manifold pipe	2,180 lf	6.00	13,060	-	-
delevery pipe 6" dia	1,900 lf	10.00	19,000	-	-
8" dia	990 lf	13.00	12,870	-	-
filter fabric	24,280 sy	2.00	48,560	-	-
seeding	7 ac	1,000	7,000	-	-
tree removal and disposal	7 ac	5,500	38,500	-	-
Administrative building		36,000	36,000	10,800	3,000
Access road	1000 lf	6.0	6,000	-	-
Land	25 ac	2,000	50,000	90,000	-
Initial cost			590,860	118,000	11,090
Service factor (35%)			206,800		
Initial capital cost			797,660		
Present worth factors			1.000	0.230	10.0983
Present worth			797,660	27,140	120,170
Total present worth			890,690		

Table E-63. Summary of Onsite Component Costs for Ephraim

Item	Initial Cost						Future Construction Cost							Total Present Worth
	Capital	Salvage	O&M	Present Worth Salvage	Present Worth O&M	Present Worth Total	Annual Construction	Total Salvage	Incremental Ann. O&M	Present Worth Constuction	Present Worth Salvage	Present Worth O&M	Present Worth Total	
Subarea 4	110,380	37,970	5,535	8,730	55,890	157,540	7,960	48,770	126	803,825	11,217	9,086	801,690	959,230
Subareas 1,2,3,4,5,6	453,050	104,690	31,612	32,359	319,227	739,918	32,273	309,750	2,400	325,902	692,289	173,058	427,717	1,167,635
Full on Site	813,150	305,080	124,637	70,170	1,258,620	2,001,600	54,226	540,260	7,372	547,590	124,260	512,580	936,910	2,938,510

Table E-64. Quantities and costs for upgrading and operating onsite systems and holding tanks for Ephraim Subarea 4.

Item	Quantity	Unit Cost	Construction	Salvage	O&M
Septic tank-SFD & sm. comm'l					
Upgrade - permanent	28	$ 150	$ 4,200	$ 2,520	$ 392
- seasonal	22	150	3,300	1,980	154
Replacement - permanent	2	1000	2,000	1,200	28
- seasonal	3	1000	3,000	1,800	21
Septic tank - large comm'l					
Replacement - seasonal	1	2000	-	-	-
Lift pump					
Existing	1	-	-	-	75
New	11	645	7,100	2,130	825
Soil absorption sys.-SFD & sm. comm'l					
Replacement-seepage bed	3	1520	4,560	-	-
- mound	10	2170	21,700	-	-
Soil absorption sys.-large comm'l					
Replacement - mound	1	6550	-	-	-
Holding tank-SFD & sm. comm'l					
Existing - seasonal	3	-	-	-	465
Replacement-permanent	4	2100	8,400	5,040	2,800
-seasonal	5	2100	10,500	6,300	775
Rock removal					
Septic tank-SFD & sm. comm'l	4	750	3,000	3,000	-
Lift pump	10	600	6,000	6,000	-
Holding tank-SFD & sm. comm'l	8	1000	8,000	8,000	-
Subtotal initial cost			81,760	37,970	5,460
Service factor (35%)			28,620		
Subtotal initial capital cost			110,380		
Future systems					
Building sewers - new	18	225	4,050	2,430	-
Septic tank-SFD & sm. comm'l					
New/repl. - permanent	8/5	1000	13,000	7,800	112
- seasonal	6/4	1000	10,000	6,000	42
Septic tank -large comm'l					
Lift pump					
New	16	645	10,320	3,100	1,200
Soil absorption sys.-SFD & sm. comm'l					
New & repl. - seepage bed	50	1520	76,000	-	-
- mound	6	2170	13,020	-	-
Holding tank-SFD & sm. comm'l					
New & repl. - permanent	1	2100	2,100	1,260	700
- seasonal	3	2100	6,300	3,780	465
Rock removal					
Septic tank - SFD & sm. comm'l	16	750	12,000	12,000	-
Lift pump	14	600	8,400	8,400	-
Holding tank - SFD & sm. comm'l	4	1000	4,000	4,000	-
Total future costs			159,190	48,770	2,519
Annual future costs			7,960		126

Table E-65. Quantities and costs for upgrading and operating onsite systems and holding tanks for Ephraim Subareas 3,4, 5, and 6.

Item	Quantity	Unit Cost	Construction	Salvage	O&M
Septic tank-SFD & sm. comm'l					
Upgrade - permanent	62	$ 150	$ 9,300	$ 5,580	$ 868
- seasonal	102	150	15,300	9,180	714
Replacement - permanent	13	1000	13,000	7,800	182
- seasonal	24	1000	24,000	7,200	168
Septic tank - large comm'l					
Upgrade - permanent	3	150	450	270	90
- seasonal	1	150	150	90	15
Lift pump					
Existing	2	-	-	-	-
New	44	645	28,380	8,510	3,300
Soil absorption sys.-SFD & sm. comm'l					
Replacement - seepage bed	15	1520	22,800	-	-
- mound	35	2170	75,950	-	-
Soil absorption sys.-large comm'l					
Replacement - seepage bed	1	5060	5,060	-	-
- mound	2	6550	13,100	-	-
Holding tank-SFD & sm. comm'l					
Existing - seasonal	8	-	-	-	1,240
Replacement - permanent	12	2100	25,200	15,120	8,400
- seasonal	17	2100	35,700	21,420	2,635
Holding tank large comm'l					
Existing - seasonal	3	-	-	-	7,500
Replacement-permanent	1	2100	2,100	1,260	2,300
-seasonal	1	2100	2,100	1,260	2,500
Rock removal					
Septic tank-SFD & sm. comm'l	20	750	15,000	15,000	-
Lift pump	30	600	18,000	18,000	-
Holding tank-SFD & sm. comm'l	24	1000	24,000	24,000	-
-large comm'l	2	3000	6,000	6,000	-
Subtotal initial cost			335,590	140,690	31,612
Service factor (35%)			117,460		
Subtotal initial capital cost			453,050		
Future systems					
Building sewers - new	84	225	18,900	11,340	-
Septic tank-SFD & sm. comm'l					
New/repl. - permanent	30/10	1000	40,000	24,000	420
- seasonal	20/20	1000	40,000	24,000	140
Septic tank -large comm'l					
New/repl. - permanent	3/2	2000	12,000	7,200	90
- seasonal	3/0	2000	6,000	3,600	45
Lift pump					
New	60	645	38,700	11,710	4,500
Soil absorption sys.-SFD & sm. comm'l					
New & repl. - seepage bed	30	1520	45,600	-	-
- mound	51	2170	110,670	-	-
Soil absorption sys. large comm'l					
New & repl. - seepage bed	4	5060	20,240	-	-
- mound	3	6550	19,650	-	-
Holding tank-SFD & sm. comm'l					
New & repl. - permanent	16	2100	33,600	20,160	11,200
- seasonal	29	2100	60,900	36,640	4,495
Holding tank-large comm'l					
New & repl. - permanent	2	10,000	20,000	12,000	14,600
- seasonal	5	10,000	50,000	30,000	12,500
Rock removal					
Septic tank - SFD & sm. comm'l	52	750	39,000	39,000	-
- large comm'l	2	1000	2,000	2,000	-
Lift pump	47	600	28,200	28,200	-
Holding tank - SFD & sm. comm'l	39	1000	39,000	39,000	-
- large comm'l	7	3000	21,000	21,000	-
Total future costs			645,460	309,750	47,990
Annual future costs			32,273		2,400

Table E-66. Quantities and costs for upgrading and operating onsite systems and holding tanks for all Ephraim Subareas.

Item	Quantity	Unit Cost	Construction	Salvage	O&M
Septic tank-SFD & small comm'l					
Upgrade - permanet	95	150	14,250	8,550	1,330
- seasonal	152	150	22,800	13,680	1,064
Replacement - permanent	28	1000	28,000	16,800	392
- seasonal	33	1000	33,000	19,800	231
Septic tank - large comm'l					
Upgrade - permanent	5	150	750	450	150
- seasonal	5	150	750	450	75
Replacement - permanent	0	2000	-	-	-
- seasonal	2	2000	4,000	2,400	30
Lift pump					
Existing	4	-	-	-	300
New	61	645	39,350	11,810	4,575
Soil absorption sys.-SFD & sm comm'l					
Replacement-seepage bed	28	1520	42,560	-	-
- mound	47	2170	101,990	-	-
Soil absorption sys.-large comm'l					
Replacement-seepage bed	3	5060	15,180	-	-
-mound	4	6550	26,200	-	-
Holding tank-SFD & sm. comm'l					
Existing-permanent	1	-	-	-	700
-seasonal	17	-	-	-	2,635
Replacement-permanent	26	2100	54,600	32,760	18,200
-seasonal	41	2100	86,100	51,660	6,355
Holding tank large comm'l					
Existing permanent	4	-	-	-	29,200
seasonal	16	-	-	-	40,000
Replacement-permanent	3	2100	6,300	3,780	21,900
-seasonal	4	2100	8,400	5,040	10,000
Rock removal					
Septic tank-SFD & sm comm'l	26	750	19,500	19,500	-
-large comm'l	1	1000	1,000	1,000	-
Lift pump	36	600	21,600	21,600	-
Holding tank-SFD & sm comm'l	31	1000	31,000	31,000	-
-large comm'l	3	3000	9,000	9,000	-
Administration & laboratory			36,000	10,800	5,700
Subtotal initial cost			602,330	305,080	124,637
Service factor (35%)	x	xxxx	210,820	xxx,xxx	xx,xxx
Subtotal initial capital cost			813,150		
Future systems					
Building sewers - new	119	225	26,100	15,660	
Septic tank-SFD & sm. comm'l					
New/repl. - permanent	36/20	1000	56,000	33,600	504
- seasonal	20/32	1000	52,000	31,200	140
Septic tank -large comm'l					
New/repl. - permanent	4/2	2000	16,000	9,600	120
- seasonal	3/2	2000	16,000	6,000	45
Lift pump					
New	76	645	49,020	14,710	5,700
Soil absorption sys.-SFD & sm. comm'l					
New repl. - seepage bed	41	1520	62,320	-	-
- mound	65	2170	141,050	-	-
Soil absorption sys large comm'l					
New repl. - seepage bed	7	5060	35,420	-	-
- mound	5	6550	32,750	-	-
Holding tank-SFD & sm comm'l					
New & repl. - permanent	33	2100	69,300	41,580	23,100
- seasonal	46	2100	96,600	57,960	7,130
Holding tank-large comm'l					
New & repl. - permanent	9	10000	90,000	54,000	65,700
- seasonal	18	10000	180,000	108,000	45,000
Rock removal					
Septic tank - SFD & sm. comm'l	61	750	45,750	45,750	-
- large comm'l	4	1000	4,000	4,000	-
Lift pump	52	600	31,200	31,200	-
Holding tank - SFD & sm comm'l	57	1000	57,000	57,000	-
- large comm'l	10	3000	30,000	30,000	-
Total future costs			1,084,510	540,260	147,439
Annual future costs			54,226		

Table E-67. Summary of Collection and Transmission Costs for Baileys Harbor

Item	Initial Cost						Future Construction Cost							Total Present Worth
				Present Worth			Annual	Total	Incremental	Present Worth				
	Capital	Salvage	O&M	Salvage	O&M	Total	Construction	Salvage	Ann. O&M	Constuction	Salvage	O&M	Total	
Subareas 3 and 6														
Conventional Gravity	1,422,970	790,690	3,977	181,860	40,160	1,281,270	1,947	23,360	-	19,660	5,370	-	14,290	1,295,560
STE Gravity	1,595,930	783,330	4,169	180,170	42,100	1,457,850	9,684	134,910	25	97,790	31,030	1,800	68,560	1,526,420
Subarea 3														
Conventional Gravity	1,056,250	494,380	3,124	113,710	31,550	974,090	1,050	12,600	-	10,600	2,900	-	7,700	981,790
STE Gravity	1,195,600	588,240	4,159	135,300	42,000	1,064,500	5,375	77,060	15	54,280	17,720	1,080	37,640	1,102,140
STE Pressure	1,292,420	501,910	13,099	115,440	132,280	1,309,260	7,684	93,000	98	77,600	21,390	7,070	63,280	1,453,540
Transmission														
FM to Wetland Section 9	310,640	180,600	-	41,540	-	269,100	-	-	-	-	-	-	-	269,100
FM to WWTP Section 17	124,460	66,000	-	15,180	-	109,290	-	-	-	-	-	-	-	109,290
FM to Wetland Section 7	431,930	245,700	-	56,510	-	375,420	-	-	-	-	-	-	-	375,420

Table E-68. Quantities and costs for conventional gravity sewer for Baileys Harbor Subareas 3 and 6.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
Sewer pipe						
8"	LF	22,400	$16	$ 358,400	$215,040	$1,680
Rock excavation						
4' deep	LF	750	12	9,000	9,000	
5' deep	LF	11,050	15	165,750	165,750	
6' deep	LF	1,050	18	18,900	18,900	
7' deep	LF	3,000	21	63,000	63,000	
8' deep	LF	1,450	21	34,800	34,800	
9' deep	LF	1,250	27	33,750	33,750	
10' deep	LF	650	30	19,500	19,500	
12' deep	LF	1,550	36	55,800	55,800	
Manholes	VF	522	100	52,200	33,120	
Road repair	LF	22,400	7.16	16,380		
Dewatering	LF	6,700	10	67,000	40,200	
Lift station						
133 gpm - TDH 107 ft				40,000	12,000	2,194
Wye	EA	173	40	6,920	4,150	
Gravity service convention	LF	10,320	15	154,800	92,880	
Pressure lateral	LF	700	10	7,000	4,200	
Grinder pump	EA	1	6000	6,000	600	100
Septic tank abandonment	EA	173	65	11,250		
Subtotal initial cost				1,120,450	790,690	3,977
Service factor (27%)				302,520		
Subtotal initial capital cost				1,422,970		
Future connection cost						
Building sewer	LF	675	15	10,130	6,080	
Wye	EA	45	40	1,800	1,080	
Gravity service connection	LF	1,800	15	27,000	16,200	
Subtotal future connection costs				38,930	23,360	
Annual connection costs				1,947		

Table E-69. Quantities and costs for septic tank effluent gravity sewer for Baileys Harbor Subareas 3 and 6.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
STE sewer pipe						
4" - 6"	LF	22,050	$ 13	$ 286,650	$171,990	$ 838
8"	LF	350	16	5,600	3,360	13
Rock excavation						
4' deep	LF	750	12	9,000	9,000	
5' deep	LF	10,800	15	162,000	162,000	
6' deep	LF	4,450	18	80,100	80,100	
7' deep	LF	2,500	21	52,500	52,500	
8' deep	LF	950	24	22,800	22,800	
9' deep	LF	1,250	27	33,750	33,750	
Manholes	VF	70	100	7,000	4,200	
Road repair	LF	22,400	7.16	160,380	-	
Dewatering	LF	4,900	10	49,000	29,400	
Lift station						
133 gpm - TDH 107 Ft				40,000	12,000	2,194
Wye	EA	173	40	6,920	4,150	
Gravity service connection	LF	10,320	15	154,800	92,880	
Pressure lateral	LF	700	10	7,000	4,200	
STE pump - Duplex	EA	1	3890	3,890	1,170	125
Septic tank minor upgrade						
SFD & small commercial	EA	107	150	16,050	9,630	1,070
Large commercial	EA	10	150	1,500	900	200
Septic tank replacement						
SFD & small commercial	EA	56	1000	56,000	33,600	560
Large commercial	EA	1	2000	2,000	1,200	20
Septic tank rock removal						
SFD & small commercial	EA	26	750	19,500	19,500	-
Large commercial	EA	1	1000	1,000	1,000	-
Subtotal initial cost				1,182,170	783,330	4,169
Service factor (35%)				413,760		
Subtotal initial capital cost				1,595,930		
Future connection cost						
Building sewer	LF	675	15	10,130	6,080	
Wye	EA	45	40	1,800	1,080	
Gravity service connection	LF	1800	15	27,000	16,200	
Septic tanks - new/repl.						
SFD & small commercial	EA	41/29	1000	100,000	60,000	410
Large commercial	EA	4/0	2000	8,000	4,800	80
Septic tank rock removal						
SFD & small commercial	EA	57	750	42,750	42,750	
Large commercial	EA	4	1000	4,000	4,000	
Subtotal factor connection costs				193,680	134,910	490
Annual connection costs				9,684		25

Table E-70. Quantities and costs for conventional gravity sewers for Baileys Harbor Subarea 3.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
Sewer pipe						
8"	LF	13,650	$16	$ 218,400	$131,040	$1,024
Rock excavation						
5' deep	LF	6,600	15	99,000	99,000	
6' deep	LF	450	18	8,640	8,640	
7' deep	LF	550	21	9,900	9,900	
8' deep	LF	1,450	24	34,800	34,800	
9' deep	LF	1,200	27	32,400	32,400	
10' deep	LF	650	30	19,500	19,500	
12' deep	LF	1,550	36	55,800	55,800	
Manholes	VF	238	100	23,800	14,280	
Road repair	LF	13,650	7.16	97,730		
Dewatering	LF	4,700	10	47,000	28,200	
Lift station						
100 gpm-TDH 70 ft	EA	1		40,000	12,000	2,100
Wye	EA	144	40	5,760	3,460	
Gravity service connection	LF	8,640	15	129,600	77,760	
Septic tank abandonment	EA	144	65	9,360		
Subtotal initial cost				831,690	494,380	
Service factor (27%)				224,560		
Subtotal initial capital cost				1,056,250		
Future connection cost						
Building sewer	LF	360	15	5,400	3,240	
Wye	EA	24	40	1,200	720	
Gravity service connection	LF	960	15	14,400	8,600	
Subtotal future connection costs				21,000	12,600	
Annual connection costs				1,050		

Table E-71. Quantities and costs for septic tank effluent gravity collection for Baileys Harbor Subarea 3.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
STE sewer pipe						
4" - 6"	LF	13,650	$ 13	$ 177,450	$106,470	$ 519
Rock excavation						
5' deep	LF	6,600	15	99,000	99,000	
6' deep	LF	450	18	8,640	8,640	
7' deep	LF	3,200	21	67,200	67,200	
8' deep	LF	300	24	72,000	72,000	
9' deep	LF	1,250	27	33,750	33,750	
10' deep	LF	650	30	19,500	19,500	
Manholes	VF	49	100	4,900	2,940	
Road repair	LF	13,650	7.16	97,730		
Dewatering	LF	4,700	10	47,000	28,200	
Lift station						
100 gpm - TDH 70 Ft	EA	1		40,000	12,000	2,100
Wye	EA	144	40	5,760	3,460	
Gravity service connection	LF	8,640	15	129,600	77,760	
Septic tank minor upgrade						
SFD & small commercial	EA	85	150	12,750	7,660	850
Large commercial	EA	9	150	1,350	810	180
Septic tank replacement						
SFD & small commercial	EA	49	1000	49,000	29,400	490
Large commercial	EA	1	2000	2,000	1,200	20
Septic tank rock removal						
SFD & small commercial	EA	23	750	17,250	17,250	
Large commercial	EA	1	1000	1,000	1,000	
Subtotal initial cost				885,630	588,240	4,159
Service factor (35%)				309,970		
Subtotal initial capital cost				1,195,600		
Future connection cost						
Building sewer	LF	360	15	5,400	3,240	
Wye	EA	24	40	1,200	720	
Gravity service connection	LF	960	15	14,400	8,600	
Septic tanks - new/repl.						
SFD & small commercial	EA	21/26	1000	47,000	28,200	210
Large commercial	EA	4/0	2000	8,000	4,800	80
Septic tank rock removal						
SFD & small commercial	EA	38	750	28,500	28,500	-
Large commercial	EA	3	1000	3,000	3,000	
Subtotal future connection costs				107,500	77,060	290
Annual connection costs				5,375		15

Table E-72. Quantities and costs for septic tank effluent pressure sewer for Baileys Harbor Subarea 3.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
STE pressure sewer						
2½" to 6"	LF	13,650	$ 10	$ 136,500	$ 81,900	$ 259
Rock excavation						
5' deep	LF	10,150	15	152,250	152,250	
Cleanouts	EA	34	1000	34,000	30,400	
Road repair	LF	13,650	7.16	97,730	-	
Dewatering	LF	5,100	10	51,000	30,600	
Wye & curb valve	EA	144	64	9,220	5,530	
Pressure lateral	LF	8,640	10	86,400	51,840	
STE pump - simple	EA	134	2000	268,000	80,400	19,050
- duplex	EA	10	3890	38,900	11,670	1,250
Septic tank minor upgrade						
SFD & small commercial	EA	85	150	12,750	7,660	850
Large commercial	EA	9	150	1,350	810	180
Septic tank replacement						
SFD & small commercial	EA	49	1000	49,000	29,400	490
Large commercial	EA	1	2000	2,000	1,200	20
Septic tank rock removal						
SFD & small commercial	EA	23	750	17,250	17,250	
Large commercial	EA	1	1000	1,000	1,000	
Subtotal initial cost				957,350	501,910	13,099
Service factor (35%)				335,070		
Subtotal initial capital cost				1,292,420		
Future connection cost						
Building sewer	LF	360	15	5,400	3,240	
Wye & curb valve	EA	24	64	1,540	920	
Pressure lateral	LF	960	10	9,600	5,760	
STE pump - simplex	EA	21	2000	42,000	12,600	1,575
- duplex	EA	3	3890	3,890	1,170	375
Septic tanks - new/replace						
SFD & small commercial	EA	21/26	1000	47,000	28,200	
Large commercial	EA	3/0	2000	6,000	3,600	
Septic tank rock removal						
SFD & small commercial	EA	47	750	35,250	35,250	
Large commercial	EA	3	1000	3,000	3,000	
Subtotal future connection costs				153,680	93,700	1,950
Annual connection costs				7,684		98

Table E-73. Quantities and costs for transmission to WWTP in Sec. 8 for wetlands discharge in Sec. 8 for Baileys Harbor.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
Force main						
Common trench	LF	250	$ 8	$ 2,000	$ 1,200	-
Individual trench	LF	7,000	20	140,000	84,000	-
Rock excavation						
5' deep	LF	3,000	15	45,000	45,000	-
6' deep	LF	2,200	18	39,600	39,600	-
Dewatering	LF	1,800	10	18,000	10,800	-
Subtotal initial cost				244,600	180,600	
Service factor (27%)				66,040		
Subtotal initial capital cost				310,640		

Table E-74. Quantities and costs for transmission to WWTP in Sec. 17 for Baileys Harbor.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
Force main						
Common trench	LF	250	$ 8	$ 2,000	$ 1,200	-
Individual trench	LF	3000	20	60,000	36,000	-
Dewater	LF	1800	10	18,000	10,800	-
Rock excav. 6' deep	LF	1000	18	18,000	18,000	-
Subtotal initial cost				98,000	66,000	
Service factor (27%)				26,460		
Subtotal initial capital cost				124,460		

Table E-75. Quantities and costs for transmission to WWTP in Sec. 7 for wetlands discharge in Sec. 7.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
Force main						
Common trench	LF	250	$ 8	$ 2,000	$ 1,200	-
Individual trench	LF	10,100	20	202,000	121,200	-
Rock excavation						
4' deep	LF	1,100	12	13,200	13,200	-
5' deep	LF	4,500	15	67,500	67,500	-
6' deep	LF	1,300	18	23,400	23,400	-
Dewatering	LF	3,200	10	32,000	19,200	-
Subtotal initial cost				340,100	245,700	
Service factor (27%)				91,230		
Subtotal initial capital cost				431,930		

Table E-76. Summary of WWTP and discharge costs for Baileys Harbor.

Item	Capital	Salvage	O&M	Present Worth		
				Salvage	O&M	Total
Subareas 3 and 6						
Aerated lagoon WWTP	$321,200	$ 64,200	$23,500	$14,766	$237,310	$543,744
Recirculating sand filter WWTP	526,200	140,300	34,600	32,369	349,401	843,232
Discharge to wetland	111,700	26,500	24,800	6,095	250,438	355,443
Outfall to Lake Michigan	997,970	431,760	2,130	99,305	21,509	920,174
Subarea 3						
Aerated lagoon WWTP[1]	293,900	60,200	20,800	13,846	210,045	490,099
Recirculating sand filter WWTP	526,200	140,300	34,600	32,369	394,401	843,232
Discharge to wetland	107,500	25,800	24,500	5,934	247,408	348,974
Outfall to Lake Michigan	997,970	431,760	2,130	99,305	21,509	920,174

[1] Same as Egg Harbor aerated lagoon WWTP serving Subareas 1A, 1B, and 2A.

Table E-77. Aerated lagoon WWTP for Baileys Harbor Subareas 3 and 6.

Item	Cost ($1,000x) Construction Cost	Salvage Value	O&M Cost
Flow meter assembly	$ 10.0	$ -	$ 2.0
Aerated lagoons	105.4	17.4	11.3
Imparmeable liner	17.5	-	-
Chlorination system	32.0	7.9	6.6
Administration & Laboratory Bldg.	36.0	10.8	3.0
Service roads and fencing	6.7	-	-
Land	10.0	18.1	-
Monitoring, controls, and instrumentation	6.2	-	-
Electrical	10.4	-	-
Process piping	16.6	10.0	-
Site preparation	12.1	-	-
Total	252.9	64.2	23.5
Service factor (27%)	68.3		
Total capital cost	321.2		
Present worth cost (@7 5/8% over 20 years)			
Capital cost	321.2		
O&M Cost	237.3		
Salvage Cost	(14.8)		
Total present worth	543.7		

Table E-78. Recirculating sand filter WWTP for Baileys Harbor[1].

Item	Cost ($1,000x) Construction Cost	Salvage Value	O&M Cost
Preliminary treatment	$ 15.0	$ 3.8	$11.7
Primary clarifier	57.2	14.3	3.0
Recirculating sand filter (filters, building, pumps)	153.6	57.5	7.3
Chlorination system	32.0	7.9	6.6
Aerobic digestor	45.1	11.3	3.0
Land	10.0	18.1	-
Administration & laboratory building	36.0	10.8	3.0
Service roads and fence	6.7	-	-
Monitoring system, controls, and instrumentation	10.4	-	-
Electrical	17.3	-	-
Process piping	27.6	16.6	-
Site preparation	3.5	-	-
Total	414.3	140.3	34.6
Service factor (27%)	111.9		
Total capital cost	526.2		
Present worth cost (@ 7 5/8% over 20 years)			
Capital cost	526.2		
O&M cost	394.4		
Salvage value	(32.4)		
Total Present Worth	843.2		

[1] Total present worth cost does not include costs for liquid sludge hauling and land spreading.

Table E-79. WWTP discharge to wetland for Baileys Harbor Subareas 3 and 6.

Item	Cost ($1,000x) Construction Cost	Salvage Value	O&M Cost
Intermittent sand filter[1]	$ 16.4	$ 4.1	$ 2.0
Pumping station	40.0	6.0	2.1
Force main	9.0	5.4	-
Distribution	16.9	5.0	20.7
Land (9ac)[2]	-	-	-
Total	82.3	26.5	24.8
Service factor (35%)	28.8		
Total capital cost	111.1		
Present worth cost (@ 7/58% over 20 years)			
Capital cost	111.1		
O&M cost	250.4		
Salvage value	(6.1)		
Total present worth	355.4		

[1] Located at WWTP for 20 mg/l BOD & 20 mg/l 55 discharge.

[2] Located on publicly owned land.

Table E-80. WWTP outfall to Lake Michigan for Baileys Harbor.

Item	Unit	Quantity	Unit Cost	Construction	Salvage	O&M
Lift station	EA	1		$ 40,000	$12,000	$2,130
Force main						
Common trench	LF	1,100	$ 8	8,800	5,280	-
Individual trench	LF	10,900	20	218,000	130,800	-
Rock excavation						
6 deep	LF	4,900	18	88,200	88,200	-
Dewater	LF	10,500	10	105,000	-	-
Manhole	VF	8	100	800	480	-
Underwater pipe	LF	1,600	200	320,000	192,000	-
Outfall structure	EA	1		5,000	3,000	-
Total				785,800	431,760	2,130
Service factor (27%)				212,270		
Total capital cost				997,970		
Present worth cost (@ 7 5/8% over 20 years)						
Capital cost				997,970		
O&M cost				21,509		
Salvage value				(99,305)		
Total present worth				920,174		

Table E-81. WWTP discharge to wetland for Baileys Harbor Subarea 3.

Item	Cost ($1,000x) Construction Cost	Salvage Value	O&M Cost
Intermittent sand filter[1]	$ 13.7	$ 3.4	$1.7
Pumping station	40.0	12.0	2.1
Force main	9.0	5.4	-
Distribution	16.9	5.0	20.7
Land (9ac)[2]	-	-	-
Total	79.6	25.8	24.5
Service factor (35%)	27.9		
Total capital cost	107.5		
Present worth cost (@ 7 5/8% over 20 years)			
Capital cost	107.5		
O&M cost	274.4		
Salvage value	(4.9)		
Total present worth	349.0		

[1] Located at WWTP (20 mg/l BOD & 20 mg/l SS discharge).

[2] Located on public owned land.

Table E-82. Summmary of On Site Component Costs for Baileys Harbor

Item	Initial Cost						Future Construction Cost							Total Present Worth
				Present Worth			Annual	Total	Incremental	Present Worth				
	Capital	Salvage	O&M	Salvage	O&M	Total	Construction	Salvage	Ann. O&M	Constuction	Salvage	O&M	Total	
Subareas 1,2,4,5,7 and 8	862,140	261,190	46,938	60,070	473,990	1,276,060	42,829	357,160	2,322	432,500	82,177	167,433	517,787	1,793,850
Subareas 1,2,4,5,6,7 and 8	929,040	294,410	51,475	67,714	519,809	1,381,136	48,483	420,800	2,771	489,595	96,784	199,809	592,622	1,973,758
Full On Site	1,495,690	511,700	149,517	117,690	1,508,520	2,886,520	57,464	534,530	4,224	580,288	122,941	304,582	761,930	3,648,450

Table E-83. Quantities and costs for upgrading and operating on-site systems and holding tanks for Baileys Harbor Subareas 1, 2, 4, 5, 7, and 8.

Item	Quantity	Unit Cost	Construction	Salvage	O&M
Septic tank - SFD & sm. comm'l.					
Upgrade - permanent	69	$ 150	$ 10,330	$ 6,210	$ 966
- seasonal	122	150	18,300	10,980	854
Replacement - permanent	21	1000	21,000	12,600	294
- seasonal	27	1000	27,000	16,200	189
Septic tank - large comm'l.					
Upgrade - seasonal	1	150	150	90	15
Replacement - seasonal	2	2000	4,000	1,200	30
Lift pump					
Existing	7	-	-	-	525
New	83	645	53,540	16,060	5,225
Soil absorption sys. - SFD & sm. comm'l.					
Replacement - seepage bed	38	1520	57,760	-	-
Replacement - mound	64	2170	138,880	-	-
Soil absorption sys. - Large comm'l.					
Replacement - seepage bed	1	5060	5,060	-	-
Replacement mound	1	6550	6,550	-	-
Holding tank - SFD & small comm'l					
Existing - permanent	1	-	-	-	700
- seasonal	27	-	-	-	4,185
Replacement - permanent	22	2100	46,200	27,720	15,400
- seasonal	81	2100	170.100	102,060	12,555
Holding tank - large comm'l.					
Existing - seasonal	1	-	-	-	2,500
Replacement - seasonal	2	2100	4,200	2,520	2,500
Rock removal					
Septic tank - SFD & sm. comm'l.	17	750	12,750	12,750	-
Septic tank - Large comm'l.	1	1000	1,000	1,000	-
Lift pump	23	600	13,800	13,800	-
Holding tank - SFD & sm. comm'l.	45	1000	45,000	45,000	-
Holding tank - large comm'l	1	3000	3,000	3,000	-
Subtotal initial cost			638,620	261,190	46,938
Service factor (35%)			223,520		
Subtotal initial capital cost			862,140		
Future Systems					
Building sewer - new	170	225	38,250	22,950	-
Septic tank - SFD small comm'l					
New/repl. - permanent	54/19	1000	73,000	43,800	756
- seasonal	50/25	1000	75,000	45,000	350
Lift pump					
New	103	645	66,440	19,930	7,725
Soil absorption sys. - SFD & sm. comm'l					
New & repl. - seepage bed	68	1520	103,360	-	-
- mound	89	2170	193,130	-	-
Holding tank-SFD & sm. comm'l					
New & repl. - permanent	26	2100	54,600	32,760	18,200
- seasonal	62	2100	130,200	78,120	9,600
Holding tank - large comm'l					
New & repl. - permanent	1	10,000	10,000	6,000	7,300
- seasonal	1	10,000	10,000	6,000	2,500
Rock removal					
septic tank -SFD & sm. comm'l	40	750	30,000	30,000	-
Lift pump	36	600	21,600	21,600	-
Holding tank - SFD & sm. comm'l	48	1000	48,000	48,000	-
- large comm'l	1	3000	3,000	3,000	-
Total future costs			856,580	357,160	46,431
Annual future costs			42,829		2,322

Table E-84. Quantities and costs for upgrading and operating on-site systems and holding tanks for Baileys Harbor Subareas 1, 2, 4, 5, 6, 7, and 8.

Item	Quantity	Unit Cost	Construction	Salvage	O&M
Septic Tank - SFD & sm. comm'l					
Upgrade - permanent	$ 81	$ 150	$ 12,150	$ 7,290	$1,134
- seasonal	123	150	18,450	11,070	861
Replacement - permanent	26	1000	26,000	15,600	364
- seasonal	28	1000	28,000	16,800	196
Septic tank - large comm'l					
Upgrade - permanent	1	150	150	90	30
- seasonal	1	150	150	90	15
Replacement - seasonal	2	2000	4,000	2,400	30
Lift pump					
Existing	7	-	-	-	525
New	90	645	58,050	17,420	6,750
Soil absorption sys. SFD & sm. comm'l					
Replacement - seepage bed	42	1520	63,840	-	-
- mound	69	2170	149,730	-	-
Soil absorption sys. - large comm'l					
Replacement - sepage bed	1	5060	5,060	-	-
- mound	1	6550	6,550	-	-
Holding tank - SFD & small comm'l					
Existing - permanent	2	-	-	-	1,400
- seasonal	31	-	-	-	4,805
Replacement - permanent	25	2100	52,500	31,500	17,500
- seasonal	83	2100	174,300	104,580	12,865
Holding tank large comm'l					
Existing - seasonal	1	-	-	-	2,500
Replacement - seasonal	2	2100	4,200	2,520	2,500
Rock removal					
Septic tank - SFD & sm. comm'l	19	750	14,250	14,250	-
- large comm'l	1	1000	1,000	1,000	-
Lift pump	28	600	16,800	16,800	-
Holding tank - SFD & sm. comm'l	50	1000	50,000	50,000	-
- large comm'l	1	3000	3,000	3,000	-
Subtotal initial cost			688,180	294,410	51,475
Service factor (35%)			240,860		
Subtotal initial capita cost			929,040		
Future Systems					
Building sewers - new	190	225	42,750	25,650	-
Septic tank - SFD & sm. comm'l					
New/repl. - permanent	59/21	1000	80,000	48,000	826
- seasonal	52/25	1000	77,000	46,200	364
Lift pump					
New	116	645	74,820	22,440	8,700
Soil absorption sys. - SFD & sm. comm'l					
New & repl. - sepage bed	69	1520	59,780	-	-
- mound	118	2170	256,060	-	-
Soil absorption sys. - large comm'l					
New & repl. - seepage bed	0	5060	-	-	-
- mound	0	6550	-	-	-
Holding tank - SFD & sm comm'l					
New & repl. - permanent	34	2100	71,400	42,840	23,800
- seasonal	77	2100	16,700	97,020	11,935
Holding tank - large comm'l					
New & repl. - permanent	1	10,000	10,000	6,000	7,300
- seasonal	1	10,000	10,000	6,000	2,500
Rock removal					
Septic tank-SFD & sm. comm'l	47	750	35,250	35,250	-
- large comm'l	0	1000	-	-	-
Lift pump	44	600	26,400	26,400	-
Holding tank -SFD & sm. comm'l	59	1000	59,000	59,000	-
- large comm'l	2	3000	6,000	6,000	-
Total future costs			969,660	420,800	55,425
Annual future costs			48,483		2,771

Table E-85. Quantities and costs for upgrading and operating on-site systems and holding tanks for all Baileys Harbor Subareas.

Item	Quantity	Unit Cost	Construction	Salvage	O&M
Septic Tank - SFD & sm. comm'l					
Upgrade - permanent	114	$ 150	$ 17,100	$10,260	$1,596
- seasonal	128	150	19,200	11,520	986
Replacement - permanent	51	1000	51,000	30,600	714
- seasonal	38	1000	38,000	22,800	266
Septic tank - large comm'l					
Upgrade - permanent	1	150	150	90	30
- seasonal	1	150	150	90	15
Replacement - seasonal	2	2000	4000	2,400	30
Lift pump					
Existing	7	-	-	-	525
New	130	645	83,850	25,160	9,750
Soil absorption sys. - SFD & sm. comm'l					
Repl. - seepage bed	54	1520	82,080	-	-
- mound	104	2170	225,680	-	-
Soil absorption sys. - large comm'l					
Repl. - seepage bed	1	5060	5,060	-	-
- mound	1	6550	6,550	-	-
Holding tank - SFD & sm. comm'l					
Existing - permanent	2	-	-	-	1,400
- seasonal	36	-	-	-	5,580
Repl. - permanent	67	2100	140,700	84,420	46,900
- seasonal	95	2100	199,500	119,700	14,725
Holding tank - large comm'l					
Existing - permanent	2	-	-	-	14,600
- seasonal	5	-	-	-	12,500
Repl. - permanent	4	2100	8,400	5,040	29,200
- seasonal	2	2100	4,200	2,520	5,000
Rock removal					
Septic tank - SFD & sm. comm'l	29	750	21,750	21,750	-
- large comm'l	1	1000	1,000	1,000	-
Lift pump	63	600	37,800	37,800	-
Holding tank - SFD & sm. comm'l	90	1000	90,000	90,000	-
- large comm'l	5	3000	15,000	15,000	-
Administration & laboratory			36,000	10,800	5,700
Subtotal initial cost			1,107,920	511,700	149,517
Service factor (35%)			378,770		
Subtotal initial capital cost			1,495,690		
Future Systems					
Building sewers - new	211	225	47,480	28,496	-
Septic tank - SFD & sm. comm'l					
New/repl. - permanent	61/32	1000	93,000	55,800	854
- seasonal	55/27	1000	82,000	49,200	385
Lift pump					
New	125	645	80,630	24,190	9,375
Soil absorption sys. - SFD & sm. comm'l					
New & repl. - seepage bed	71	1520	107,920	-	-
- mound	107	2170	232,190	-	-
Holding tank - SFD & sm. comm'l					
New & repl. - permanent	58	2100	121,800	73,080	40,600
- seasonal	72	2100	151,200	90,720	11,160
Holding tank - large comm'l					
New & repl. - permanent	2	10,000	20,000	12,000	14,600
- seasonal	3	10,000	30,000	18,000	7,500
Rock removal					
Septic tank - SFD & sm. comm'l	67	750	50,250	50,250	-
- large comm'l.	0	1000	-	-	-
Lift pump	53	600	31,800	31,800	-
Holding tank - SFD & sm. comm'l	86	1000	86,000	86,000	-
- large comm'l	5	3000	15,000	15,000	-
Total future costs			1,149,270	534,530	84,474
Annual future costs			57,464		4,224

ASSUMPTIONS ON ELIGIBILITY OF INITIAL CAPITAL COSTS FOR FUNDING WITH THE WISCONSIN FUND[a]

1. Offsite systems

Homeowner ineligible costs - For conventional gravity sewer collection systems the individual homeowner (or business) will be responsible for the installation the connecting sewer located on private property originating at the building and terminating at the sewer service connection located at the boundary of the street right-of-way.

Eligible-ineligible costs - Initial capital costs eligible for the Wisconsin Fund are estimated to be to 75% of the total estimated collection, transmission, treatment, and disposal costs after deduction of the homeowner ineligible costs (based on user charge analysis in Foth and Van Dyke, 1982). The remaining 25% of the estimated initial capital costs are not eligible for the Wisconsin Fund and must be paid by the local community.

2. Onsite systems

Eligible costs - The following items are considered eligible for Wisconsin fund grants (based on a review of NR128.08 and a telephone conversation WAPORA to John Hario WDNR, 19 October 1982):

- For permanent (principal) residences, and seasonal and permanent commercial connections with dry weather flows less than 25,000 gpd:
  - Septic tank replacement
  - Lift pumps (to disposal area)
  - Soil absorption systems (seepage bed and mounds)
  - Holding tanks
  - Rock removal.

Ineligible costs - The remainder of the estimated initial capital costs not included in the eligible costs above are ineligible costs. They include the following:

- Minor upgrade of septic tanks
- For seasonal (non-principal) residences and commercial connections with dry weather flows greater than 25,000 gpd:
  - Septic tank replacement
  - Soil absorption systems (seepage bed and mounds)
  - Holding tanks
  - Rock removal.

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aThe Wisconsin Fund provides a grant of 60% of eligible initial capital costs.

Table E-86. Wisconsin Fund grant and local share of costs for Egg Harbor Alternative 2A (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant	
			State[b]	Local
Offsite component				
Homeowner ineligible				
Collection	22.9			22.9
Eligible - ineligible				
Collection & transmission	847.2	3.7		
Treatment	293.9	20.8		
Discharge	148.6	-		
Subtotal	1,289.7			
Eligible 75%	967.3		580.4	386.9
Ineligible 25%	322.4			322.4
Onsite component				
Eligible	139.9		83.9	56.0
Ineligible	166.4	16.3	-	166.4
Total	1,618.9	40.8	664.3	954.6

[a] Local capital costs with no grant

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-87. Wisconsin Fund grant and local share of costs for Egg Harbor Alternative 2B (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant	
			State[b]	Local
Offsite component				
Homeowner ineligible				
Collection	$ 22.9	-		$ 22.9
Eligible - ineligible				
Collection & transmission	847.2	$ 3.7		
Treatment	513.8	43.7		
Discharge	148.6			
Subtotal	1,509.6			
Eligible 75%	1,132.2		$679.3	452.9
Ineligible 25%	377.14			377.4
Onsite component				
Eligible	139.9	-	83.9	56.0
Ineligible	164.4	16.3	-	164.4
Total	1,836.8	63.7	763.2	1,073.6

[a] Local capital costs with no grant

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-88. Wisconsin Fund grant and local share of costs for Egg Harbor Alternative 3 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant State[b]	Wisconsin Fund Grant Local
Offsite component				
Eligible - Ineligible				
Collection & transmission	$ 868.4	$4.3		
Discharge	427.8	7.1		
Subtotal	1,296.2			
Eligible 75%	972.2		588.3	388.9
Ineligible 25%	324.0			324.0
Onsite Component				
Eligible	139.9	-	83.9	56.0
Ineligible	164.4	16.3	-	164.4
Total	1,600.5	27.7	667.2	933.3

[a] Local capital costs with no grant

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-89. Wisconsin Fund grant and local share of costs for Egg Harbor Alternative 4 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant	
			State[b]	Local
Offsite component				
Homeowner ineligible				
Collection	$ 10.6	-		$ 10.6
Eligible - ineligible				
Collection & transmission	401.5	$ 2.7		
Treatment	259.8	15.2		
Discharge	148.6	-		
Subtotal	809.9			
eligible 75%	607.4	-	$364.4	243.0
ineligible 25%	202.5			202.5
Onsite component				
Eligible	263.5	-	156.2	107.5
Ineligible	160.7	19.6	-	160.7
Total	1,244.9	37.5	520.6	724.3

[a] Local capital costs with no grant

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-90. Wisconsin Fund grant and local share of costs for Egg Harbor Alternative 5 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant State[b]	Wisconsin Fund Grant Local
Offsite component				
Eligible - ineligible				
Collection & transmission	$ 553.9	$ 3.2		
Discharge	226.3	33.4		
Subtotal	670.3			
Eligible 75%	502.7		301.6	201.1
Ineligible 25%	167.6			167.6
Onsite component				
Eligible	263.7	-	156.2	107.5
Ineligible	160.7	19.6	-	160.7
Total	1,094.7	56.2	457.8	636.9

[a] Local capital costs with no grant

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-91. Wisconsin Fund grant and local share of costs for Egg Harbor Alternative 6 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant State[b]	Local
Offsite component				
Homeowner ineligible				
Collection	$ 10.6	-		$ 10.6
Eligible - ineligible				
Collection	519.9	$ 2.4		
Treatment	259.8	15.2		
Discharge	168.3	49.5		
Subtotal	948.0			
Eligible 75%	711.0		$426.6	284.4
Ineligible 25%	237.0			237.0
Onsite component				
Eligible	263.7	-	156.2	107.5
Ineligible	160.7	19.6	-	160.7
Total	1,383.0	86.7	582.8	800.2

[a] Local capital costs with no grant

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-92. Wisconsin Fund grant and local share of costs for Egg Harbor Alternative 7 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant	
			State[b]	Local
OnSite systems				
Eligible	$465.0	-	$279.0	$186.0
Ineligible	194.9	$54.0	-	194.9
Total	659.9	54.0	279.0	380.9

[a] Local capital costs with no grant

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-93. Wisconsin Fund grant and local share of costs for Fish Creek Alternative 2 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant	
			State[b]	Local
Offsite component				
Homeowner ineligible				
Collection	$ 105.0			$105.0
Eligible - ineligible				
Collection	930.1	$ 7.3		
Treatment	557.0	37.8		
Discharge & transmission	593.6	2.5		
Subtotal	2,080.7			
Eligible 75%	1,560.5		$936.3	$624.4
Ineligible 25%	520.2			520.2
Onsite component				
Eligible	139.2	-	83.5	55.7
Ineligible	121.1	16.3	-	121.1
Total	2,446.0	63.9	1,019.8	1,426.2

[a] Local capital costs with no grant.

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-94. Wisconsin Fund grant and local share of costs for Fish Creek Alternative 3 (costs in $1,000).

System Component	Total Capital[a]	Total O&M Local Cost	Wisconsin Fund Grant State[b]	Wisconsin Fund Grant Local
Offsite component				
Homeowner ineligible				
Collection	$ 99.8			$99.8
Eligible - Ineligible				
Collection	851.5	$ 7.2		
Treatment	557.0	28.9		
Discharge & transmission	593.6	2.5		
Subtotal	2,002.1			
Eligible 75%	1,501.6		900.9	600.7
Ineligible 25%	500.5			500.5
Onsite Component				
Eligible	175.2	-	105.1	70.1
Ineligible	122.1	19.5	-	122.1
Total	2,399.2	58.1	1006.0	1,393.2

[a] Local capital costs with no grant

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-95. Wisconsin Fund grant and local share of costs for Fish Creek Alternative 4 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant State[b]	Wisconsin Fund Grant Local
Offsite component				
Eligible - Ineligible				
Collection	$1,165.4	$ 3.4		
Discharge & transmission	898.7	8.0		
Subtotal	2,064.1			
Eligible 75%	1,548.1		928.9	$619.2
Ineligible 25%	516.0			516.0
Onsite component				
Eligible	175.2	-	105.1	70.1
Ineligible	122.1	19.5	-	122.1
Total	2,361.4	30.9	1,034.0	1,327.4

[a] Local capital costs with no grant

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-96. Wisconsin Fund grant and local share of costs for Fish Creek Alternative 5 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant State[b]	Wisconsin Fund Grant Local
Offsite component				
Eligible - Ineligible				
Collection	$1,165.4	$ 3.5		
Discharge & transmission	1,099.6	8.0		
Subtotal	2,265.0			
Eligible 75%	1,698.8		$1,019.3	679.5
Ineligible 25%	566.2			566.2
Onsite component				
Eligible	175.2	-	105.1	70.1
Ineligible	122.1	19.5	-	122.1
Total	2,562.3	30.9	1,124.4	1437.9

[a] Local capital costs with no grant

[b] 60% of eligible capital coats funded by Wisconsin Fund.

Table E-97. Wisconsin Fund grant and local share of costs for Fish Creek Alternative 6 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant State[b]	Wisconsin Fund Grant Local
Offsite component				
Homeowner ineligible				
Collection	$ 99.8			$ 99.8
Eligible - Ineligible				
Collection	851.5	$ 7.2		
Treatment	557.0	28.9		
Discharge & transmission	644.9	7.4		
Subtotal	2,053.4			
Eligible 75%	1,540.1		924.0	616.1
Ineligible 25%	513.3			513.3
Onsite component				
Eligible	175.2	-	105.1	70.1
Ineligible	122.1	19.5	-	122.1
Total	2,450.5	63.0	1029.1	1,421.4

[a] Local capital costs with no grant.

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-98. Wisconsin Fund grant and local share of costs for Fish Creek Alternative 7 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant	
			State[b]	Local
Onsite systems				
Eligible	$472.9	-	$283.7	$189.2
Ineligible	248.1	$234.0		248.1
Total	721.0	234.0	283.7	437.3

[a] Local capital costs with no grant.

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-99. Wisconsin Fund grant and local share of costs for Ephraim Alternative 2 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant State[b]	Wisconsin Fund Grant Local
Off-site component				
Homeowner-ineligible				
Collection	$ 410.6			$ 410.6
Eligible-Ineligible				
Collection & transmission	3,488.2	$14.9		
Treatment	432.3	37.7		
Discharge	494.0	2.5		
Subtotal	4,414.5			
Eligible 75%	3,310.9		$1,986.5	1,324.4
Ineligible 25%	1,103.6			1,103.6
Onsite component				
Eligible	63.5	-	38.1	25.4
Ineligible	46.9	5.5	-	46.9
Total	4,935.5	55.1	2,024.5	2,910.9

[a] Local capital costs with no grant.

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-100. Wisconsin Fund grant and local share of costs for Ephraim Alternative 3 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant	
			State[b]	Local
Offsite component				
Homeowner ineligible				
Collection	$ 209.1			$209.1
Eligible-Ineligible				
Collection & transmission	1,191.6	$ 5.9		
Treatment	373.8	31.0		
Discharge	859.3	2.2		
Subtotal	2,424.7			
Eligible 75%	1,819.5		$1,091.1	727.4
Ineligible 25%	606.2			606.2
Onsite component				
Eligible	272.4	-	163.5	108.9
Ineligible	180.6	31.6	-	180.6
Total	3,086.8	70.7	1,254.5	1,832.2

[a] Local capital costs with no grant

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-101. Wisconsin Fund grant and local share of costs for Ephraim Alternative 4 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant	
			State[b]	Local
Offsite component				
Homeowner ineligible				
Collection	$ 209.1			$ 209.1
Eligible - Ineligible				
Collection & transmission	1,191.6	$ 5.9		
Treatment	373.8	31.0		
Discharge	172.4	35.3		
Subtotal	1,737.8			
Eligible 75%	1,303.4		$782.0	521.4
Ineligible 25%	434.4			434.4
Onsite component				
Eligible	272.4	-	163.5	108.9
Ineligible	180.6	31.6	-	180.6
Total	2,399.9	103.8	945.5	1,454.4

[a] Local capital costs with no grant.

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-102. Wisconsin Fund grant and local share of costs for Ephraim Alternative 5 (costs in $1,000).

System Component	Total Capital[a]	Total O&M Local Cost	Wisconsin Fund Grant	
			State[b]	Local
Offsite component				
Eligible - ineligible				
Collection & transmission	$1,032.5	$ 7.2		
Discharge	797.7	11.1		
Subtotal	1,830.2			
Eligible 75%	1,372.7		$823.6	$549.1
Ineligible 25%	457.5			457.5
Onsite component				
Eligible	272.4	-	163.5	108.9
Ineligible	180.6	31.6	-	180.6
Total	2,283.2	49.9	987.1	1,296.1

[a] Local capital costs with no grant.

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-103. Wisconsin Fund grant and local share of costs for Ephraim Alternative 6 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant	
			State[b]	Local
Onsite systems				
Eligible	$523.3	-	$314.0	$209.3
Ineligible	289.9	$124.6	-	289.9
Total	813.2	124.6	314.0	499.2

[a] Local capital costs with no grant.

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-104. Wisconsin Fund grant and local share of costs for Baileys Harbor Alternative 2A (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant State[b]	Wisconsin Fund Grant Local
Offsite component				
Homeowner ineligible				
Collection	$ 90.8			$ 90.8
Eligible-Ineligible				
Collection	1,332.1	$ 4.0		
Transmission	310.6			
Treatment	312.2	23.5		
Discharge	111.1	24.5		
Subtotal	2,066.0			
Eligible 75%	1,549.5		929.7	619.8
Ineligible 25%	516.5			516.5
Onsite component				
Eligible	462.3	-	277.4	184.9
Ineligible	399.8	46.9	-	399.8
Total	3,018.9	98.9	1,207.1	1,811.8

[a] Local capital costs with no grant.

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-105. Wisconsin Fund grant and local share of costs for Baileys Harbor - Alternative 2B (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant State[b]	Wisconsin Fund Grant Local
Offsite component				
Homeowner ineligible				
Collection	$ 90.8			$ 90.8
Eligible - Ineligible				
Collection	1,332.1	$ 4.0		
Transmission	310.6	-		
Treatment	526.2	34.6		
Discharge	111.1	24.5		
Subtotal	2,280.0			
Eligible 75%	1,710.0		1,026.0	684.0
Ineligible 25%	570.0			570.0
Onsite component				
Eligible	462.3	-	277.4	184.9
Ineligible	399.8	46.9	-	399.8
Total	3,232.9	110.0	1,202.4	1,929.5

[a] Local capital costs with no grant.

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-106. Wisconsin Fund grant and local share of costs for Baileys Harbor Alternative 3 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant	
			State[b]	Local
Offsite component				
Homeowner ineligible				
Collection	$ 90.8			$ 90.8
Eligible - Ineligible				
Collection	1,332.1	$ 4.0		
Transmission	431.9	-		
Treatment	321.2	23.5		
Discharge	107.5	24.5		
Subtotal	2,192.7			
Eligible 75%	1,644.5		$986.7	657.8
Ineligible 25%	548.2			548.2
Onsite component				
Eligible	462.3	-	277.4	184.9
Ineligible	399.8	46.9	-	399.8
Total	3,145.6	98.9	1,264.1	1,881.5

[a] Local capital costs with no grant.

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-107. Wisconsin Fund grant and local share of costs for Baileys Harbor - Alternative 4 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant State[b]	Wisconsin Fund Grant Local
Offsite component				
Homeowner ineligible				
Collection	$ 75.6			$ 75.6
Eligible - Ineligible				
Collection	980.7	$ 3.1		
Transmission	124.5	-		
Treatment	293.9	20.8		
Discharge	997.9	2.1		
Subtotal	2,297.0			
Eligible 75%	1,722.8		$1,033.7	689.1
Ineligible 25%	574.2			574.2
Onsite component				
Eligible	506.1	-	303.7	202.4
Ineligible	422.9	51.5	-	422.9
Total	3,301.6	77.5	1,337.4	1,964.2

[a] Local capital costs with no grant.

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-108. Wisconsin Fund grant and local share of costs for Baileys Harbor Alternative 5 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant State[b]	Wisconsin Fund Grant Local
Offsite component				
Homeowner ineligible				
Collection	$ 75.6			$ 75.6
Eligible - Ineligible				
Collection	980.7	$ 3.1		
Transmission	431.9	-		
Treatment	293.9	20.8		
Discharge	107.5	24.5		
Subtotal	1,814.0			
Eligible 75%	1,360.5		$816.3	544.2
Ineligible 25%	453.5			453.5
Onsite component				
Eligible	506.1	-	303.7	202.4
Ineligible	422.9	51.5	-	422.9
Total	2,818.6	99.9	1,120.0	1,698.6

[a] Local capital costs with no grant.

[b] 60% of eligible capital costs funded by Wisconsin Fund.

Table E-109. Wisconsin Fund grant and local share of costs for Baileys Harbor Alternative 6 (costs in $1,000).

System Component	Total Capital[a]	Total O&M (Local Cost)	Wisconsin Fund Grant	
			State[b]	Local
Onsite systems				
Eligible	$ 953.5	-	$572.1	$381.4
Ineligible	542.2	$149.4	-	542.2
Total	1,495.7	149.5	572.1	923.6

[a]Local capital costs with no grant.

[b]60% of eligible capital costs funded by Wisconsin Fund.

Table E-110. Annual population equivalent (PE) user-costs for state and local distribution of costs for Egg Harbor.

Alternative	Cost ($1,000 x) Capital Cost	State Share	Local Share	Annual Equivalent of Local Share[a]	Annual Oper. and Maintenance	Total Equivalent Annual Cost	1980 PE[b]	Monthly Cost per PE ($)	Annual Cost per PE ($)
2A	1,618.9	664.3	954.6	94.5	40.8	135.3	1275	8.84	106.12
2B	1,836.8	763.2	1,073.6	106.3	63.7	170.0	1275	11.11	133.33
3	1,600.5	667.2	933.3	92.4	27.7	120.1	1275	7.85	94.20
4	1,244.9	520.6	724.3	77.7	37.5	109.2	1275	7.14	85.65
5	1,094.7	457.8	636.9	63.1	56.2	119.3	1275	7.80	93.57
6	1,383.0	582.8	800.2	79.2	86.7	165.9	1275	10.84	130.12
7	659.9	279.0	380.9	37.7	54.0	91.7	1275	5.99	71.92

[a] Local share amortized at 7 5/8% interest for 20 years.

[b] Permanent, seasonal and seasonal transient population (Section 4.1.3.).

Table E-111. Annual population equivalent (PE) user costs without any government grants for Egg Harbor.

Alternative	Cost ($1,000 x) Capital Cost (local cost)	Annual Equivalent of Local Share[a]	Annual Oper. and Maintenance	Annual Equivalent Annual Cost	1980 PE[b]	Monthly Cost Per PE	Annual Cost Per PE
2A	1,618.9	160.3	40.8	201.1	1275	13.14	57.73
2B	1,836.8	181.9	63.7	245.6	1275	16.05	192.63
3	1,600.5	158.5	27.7	185.2	1275	12.10	145.25
4	1,244.9	123.3	37.5	160.8	1275	10.51	126.12
5	1,094.7	108.4	56.2	164.6	1275	10.76	129.10
6	1,383.0	137.0	86.7	223.7	1275	14.62	175.45
7	659.9	65.4	54.0	119.4	1275	7.80	93.65

[a] Local share amortized at 7 5/8% interest for 20 years.

[b] Permanent, seasonal and seasonal transient population (Section 4.1.3).

Table E-112. Annual population equivalent (PE) user-costs for state and local distribution of costs for Fish Creek.

Alternative	Cost ($1,000 x) Capital Cost	State Share	Local Share	Annual Equivalent of Local Share[a]	Annual Oper. and Maintenance	Total Equivalent Annual Cost	1980 PE[b]	Monthly Cost per PE ($)	Annual Cos per PE ($)
2	2,446.0	1,019.8	1,426.2	141.2	63.9	205.1	1159	14.75	177.95
3	2,399.2	1,006.0	1,392.2	137.9	58.1	196.0	1159	14.09	169.11
4	2,361.4	1,034.0	1,327.4	131.5	30.9	162.4	1159	11.68	140.12
5	2,562.3	1,124.4	1,437.9	142.4	30.9	173.3	1159	12.46	149.53
6	2,450.5	1,029.1	1,421.4	140.8	63.0	203.8	1159	14.65	175.84
7	721.0	283.7	437.3	43.3	234.0	277.3	1159	19.94	239.26

[a] Local share amortized at 7 5/8% interest for 20 years.

[b] Permanent, seasonal and seasonal transient population (Section 4.1.3.).

Table E-113. Annual population equivalent (PE) user costs without any government grants for Fish Creek.

Alternative	Cost ($1,000 x) Capital Cost (local cost)	Annual Equivalent of Local Share[a]	Annual Oper. and Maintenance	Annual Equivalent Annual Cost	1980 PE[b]	Monthly Cost Per PE	Annual Cost Per PE
2	2,446.0	242.2	63.9	305.1	1159	21.94	263.24
3	2,399.2	237.6	58.1	295.7	1159	21.26	255.13
4	2,361.4	233.8	30.9	264.7	1159	19.23	230.72
5	2,562.3	256.7	30.9	284.6	1159	20.45	245.55
6	2,450.5	242.7	63.0	305.7	1159	21.98	263.76
7	721.0	71.4	234.0	305.4	1159	21.96	263.50

[a] Local share amortized at 7 5/8% interest for 20 years.

[b] Permanent, seasonal and seasonal transient population (Section 4.1.3).

Table E-114. Annual population equivalent (PE) user-costs for State and local distribution of costs for Ephraim.

Alternative	Cost ($1,000 x) Capital Cost	State Share	Local Share	Annual Equivalent of Local Share[a]	Annual Oper. and Maintenance	Total Equivalent Annual Cost	1980 PE[b]	Monthly Cost per PE ($)	Annual Cost per PE ($)
2	4,935.5	2,024.5	2,910.9	288.3	55.1	343.4	1791	15.99	191.74
3	3,086.8	1,254.5	1,832.2	181.4	70.7	252.1	1791	11.73	140.76
4	2,399.9	945.5	1,454.4	144.0	103.8	247.8	1791	11.53	138.36
5	2,283.2	981.7	1,296.1	128.4	49.9	178.3	1791	8.30	99.55
6	813.2	314.0	499.2	49.4	124.6	174.0	1791	8.10	97.15

[a] Local share amortized at 7 5/8% interest for 20 years.

[b] Permanent, seasonal and seasonal transient population (Section 4.1.3.).

Table E-115. Annual population equivalent (PE) user costs without any government grants for Ephraim.

Alternative	Cost ($1,000 x) Capital Cost (local cost)	Annual Equivalent of Local Share[a]	Annual Oper. and Maintenance	Annual Equivalent Annual Cost	1980 PE[b]	Monthly Cost Per PE	Annual Cost Per PE
2	4,935.5	488.8	55.1	543.9	1791	25.31	303.69
3	3,086.8	305.7	70.7	376.4	1791	17.51	210.16
4	2,399.9	237.7	103.8	341.5	1791	15.89	190.69
5	2,283.2	226.10	49.9	276.0	1791	12.94	154.10
6	813.2	80.5	124.6	205.1	1791	9.54	114.52

[a] Local share amortized at 7 5/8% interest for 20 years.

[b] Permanent, seasonal and seasonal transient population (Section 4.1.3).

Table E-116. Annual population equivalent (PE) user-costs for state and local distribution of costs for Baileys Harbor.

	Cost ($1,000 x)								
Alternative	Capital Cost	State Share	Local Share	Annual Equivalent of Local Share[a]	Annual Oper. and Maintenance	Total Equivalent Annual Cost	1980 PE[b]	Monthly Cost per PE ($)	Annual Cost per PE ($)
2A	3,018.9	1,207.1	1,811.8	179.4	98.9	278.3	1297	17.88	214.57
2B	3,232.9	1,303.4	1,929.5	191.1	110.0	301.1	1297	19.35	232.15
3	3,145.6	1,264.1	1,881.5	186.3	98.9	285.2	1297	19.32	219.89
4	3,301.6	1,337.4	1,964.2	194.5	77.5	272.0	1297	17.48	208.71
5	2,818.6	1,120.0	1,698.6	168.2	99.9	268.1	1297	17.22	206.71
6	1,495.7	572.1	923.6	91.5	149.5	241.0	1297	15.48	185.81

[a] Local share amortized at 7 5/8% interest for 20 years.

[b] Permanent, seasonal and seasonal transient population (Section 4.1.3.).

Table E-117. Annual population equivalent (PE) user costs without any government grants for Baileys Harbor.

Alternative	Cost ($1,000 x) Capital Cost (local cost)	Annual Equivalent of Local Share[a]	Annual Oper. and Maintenance	Annual Equivalent Annual Cost	1980 PE[b]	Monthly Cost Per PE	Annual Cost Per PE
2A	3,018.9	299.0	98.9	397.9	1297	25.57	306.78
2B	3,232.9	320.1	110.0	430.1	1297	27.63	331.61
3	3,145.6	311.5	98.9	410.4	1297	25.37	316.42
4	3,301.6	327.0	77.5	404.5	1297	25.99	311.87
5	2,818.6	279.1	99.9	379.0	1297	24.35	292.21
6	1,495.7	148.1	149.2	297.3	1297	19.10	229.22

[a] Local share amortized at 7 5/8% interst for 20 years.

[b] Permanent, seasonal and seasonal transient population (Section 4.1.3.).

APPENDIX F

Climatological Data

Climatological data for Green Bay, Wisconsin for the period from 1941 to 1970 (NOAA 1977a).

Month	Temperature (F°) Daily Maximum	Daily Minimum	Monthly Mean	Mean No. of Days[a] Maximum 32°	Minimum 32°	Precipitation (inches)	Relative Humidity (%)[a] Midnight	6 AM	Noon	6 PM	Mean Wind Speed (mph)[b]	Mean Wind Direction[a]
January	23.9	6.9	15.4	23	31	1.09	76	77	70	73	11.1	SW
February	27.2	8.8	18.0	20	28	1.01	75	78	68	70	10.9	SW
March	37.1	20.1	28.6	9	27	1.68	77	81	66	68	10.9	NE
April	54.1	33.5	43.8	1	14	2.69	75	79	58	60	11.6	NE
May	65.8	43.1	54.5	0	3	3.10	76	79	55	58	10.6	NE
June	75.8	53.2	64.5	0	0	3.41	81	82	59	61	9.3	SW
July	80.7	57.7	69.2	0	0	3.09	82	85	57	59	8.4	SW
August	79.1	56.3	67.7	0	0	2.62	85	88	59	63	8.1	SW
September	69.8	48.0	58.9	0	1	3.24	86	88	61	69	9.2	SW
October	59.6	38.7	49.2	0	8	1.93	80	84	62	70	10.1	SW
November	41.8	26.4	34.1	4	21	1.88	81	83	70	76	11.2	SW
December	28.6	13.2	20.9	20	29	1.27	81	81	73	77	10.8	SW
Annual Average	53.6	33.8	43.7	76	162	27.01	80	82	63	67	10.2	SW

[a] Length of record is 16 years.

[b] Length of record is 28 years.

Average monthly temperature and precipitation at Sturgeon Bay[a] WI and Green Bay[b] WI (NOAA 1977b).

Month	Average Monthly Temperature (F°)		Average Monthly Precipitation (inches)	
	Sturgeon Bay	Green Bay	Sturgeon Bay	Green Bay
January	19.1	15.4	1.34	1.09
February	19.2	18.0	1.33	1.01
March	28.2	28.6	1.76	1.68
April	41.2	43.8	2.43	2.69
May	52.1	54.5	2.46	3.10
June	62.6	64.5	3.20	3.41
July	69.0	69.2	2.75	3.09
August	67.4	67.7	2.86	2.62
September	59.3	58.9	3.25	3.24
October	48.7	49.2	2.16	1.93
November	35.0	34.1	2.36	1.88
December	23.8	20.9	1.32	1.27
Annual Average	43.8	43.7	27.22	27.01

[a] Period of record: 1931-1955.

[b] Period of record: 1941-1970.

APPENDIX G

Air Quality

National ambient air quality standards (USEPA 40 CFR 50.4 - 50.11).

Pollutant	Time of Average	Primary Standard[a]	Secondary Standard[a]
Particulate matter	Annual (Geometric mean)	75 ug/m³ [b]	60 ug/m³ [b]
	24 hour	260 ug/m³ [b]	150 ug/m³
Sulfur oxides (SO_x) (measured as SO_2)[x]	Annual (Arithmetic mean)	80 ug (0.03 ppm) [b]	
	24 hour	365 ug (0.14 ppm) [b]	
	3 hour		1300 ug (0.5 ppm) [b]
Carbon monoxide (CO)	8 hour	10 mg (9 ppm) [b]	Same as primary
	1 hour	40 mg (35 ppm) [b]	Same as primary
Hydrocarbons (HC) (nonmethane measured as CH_4)	3 hour (6 to 9 AM)	160 ug (0.24 ppm) [b]	Same as primary
Nitrogen Dioxide (NO_2)	Annual (Arithmetic mean)	100 ug (0.05 ppm)	Same as primary
Ozone (O_3)	1 hour	240 ug (0.12 ppm) [c]	Same as primary
Lead (Pb^{+2})	Calendar quarter	1.5 ug	Same as primary

[a] Concentration in weight per cubic meter (corrected to 25°C and 760 mm Hg).

[b] Concentration not to be exceeded more than once per year.

[c] Concentration not to be exceeded more than one day per year.

Point sources of atmospheric emissions in Door County WI, in tons per year (USEPA 1978a).

Source	Location	Particulates	SO_2[a]	NO_x[b]	CO[c]	HC[d]
Door County Highway Department	Sturgeon Bay	145.48	1.46	11.20	3.92	2.80
Municipal Incinerator	Sturgeon Bay	120.00	10.00	12.00	14.00	6.00

[a] Sulfur dioxide.

[b] Nitrogen oxide.

[c] Carbon monoxide.

[d] Hydrocarbons.

Ambient air quality data for Fish Creek (Peninsula State Park) WI, 1975-1977, in micrograms per cubic meter (WDNR 1977).

Year	Pollutant	No. of Samples	Maximum 24-Hour Average	Minimum 24-Hour Average	Annual Mean[a]
1977	Particulate matter	12	74	7	22.5 (G)
	Sulfur dioxide	12	40	5	9.3 (A)
	Nitrogen dioxide	5	34	5	13.8 (A)
1976	Particulate matter	27	76	5	18.9 (G)
	Sulfur dioxide	23	21	5	7.7 (A)
	Nitrogen dioxide	24	17	5	6.2 (A)
1975	Particulate matter	8	35	10	21.6 (G)
	Sulfur dioxide	9	19	5	8.6 (A)
	Nitrogen dioxide	10	18	5	9.2 (A)

[a] (G) = geometric mean
(A) = arithmetic mean.

APPENDIX H

Criteria for Selection of Permeability Class

Soil criteria for selection of permeability class. (The limiting factors are underlined.)

SCS Soil Mapping Symbol	Surface Texture[a]	Depth to Bedrock (inches)	Depth to Water Table (inches)	Flood Frequency and Duration	Permeability of Soil Material[b] (in/hr)	Recommended Permeability Class[c]
Ada	ls	>60	6-18 (Nov-May)	Rare	6-20(26").06-0.2	Unsuited
ApC	gsl	>60	>60	None	>20	1
Ax	l	>60	0-12 (Oct-Jun)	Frequent, Long	0.2-0.6(25")0.2-0.6	Unsuited
Be	s					Unsuited
Bn	l	~20-40	12-36 (Sep-Jun)	None	0.6-2	Mound
Bo	fsl	~10-20	12-36 (Sep-Jun)	None	-	Unsuited
Bp	l	~20-40	0-12 (Sep-Jun)	None	0.6-2	Unsuited
BrB	ls	>60	>60	None	2-6(33") 20	2
BrC	ls	>60	>60	None	2-6(33") 20	2
BrD	ls	>60	>60	None	2-6(33") 20	Unsuited
Ca	muck to 60 in.	>60	0-12 (Sep-May)	Frequent, Long	0.6-6	Unsuited
CcB	sl	>60	>60	None	>20	1
CcC2	sl	>60	>60	None	>20	1
Cm	muck to 30 in.	>60	0-12 (Nov-Jun)	Frequent, Long	0.2-2	Unsuited
Cp	muck to 27 in.	~20-40	0-12 (Sep-May)	Frequent, Long	0.2-2	Unsuited
De	lfs	>60	0-12 (Jan-May)	Frequent, Brief	6-20	Unsuited
DuB	ls	~20-40	>60	None	>6	Mound

Soil criteria (continued).

SCS Soil Mapping Symbol	Surface Texture[a]	Depth to Bedrock (inches)	Depth to Water Table (inches)	Flood Frequency and Duration	Permeability of soil material[b] (in/hr)	Recommended Permeability Class[c]
Dv	sl	~24-40	0-36 (Sep-Jun)	None	6-20	Mound
EmA	sl	>60	>30	None	2-6(24")0.6-2(34")2-6	2 or 3
EmB	sl	>60	>30	None	2-6(24")0.6-2(34")2-6	2 or 3
EmC2	sl	>60	>30	None	2-6(24")0.6-2(34")2-6	2 or 3
EmD2	sl	>60	>30	None	2-6(24")0.6-2(34")2-6	Unsuited
EmE	sl	>60	>30	None	2-6(24")0.6-2(34")2-6	Unsuited
Fa	sil	>60	18-24 (Nov-May)	Rare	>20	Mound
Fu	-	>60	0-12 (Jan-Dec)	Frequent, Very Long	-	Unsuited
KhA	sil	>60	>36 (Nov-May)	None	.06-0.6(28")0.2-0.6	Mound
KhB	sil	>60	>36 (Nov-May)	None	.06-0.6(28")0.2-0.6	Mound
KhC2	sil	>60	>36 (Nov-May)	None	.06-0.6(28")0.2-0.6	Mound
KkD3	sicl	>60	>36 (Nov-May)	None	.06-0.6(28")0.2-0.6	Unsuited
KmB	sl	>60	>60	None	>20	1
KmC	sl	>60	>60	None	>20	1
KoA	sil	~20-40	>60	None	.06-0.6(33")0.2-2	Mound
KoB	sil	~20-40	>60	None	.06-0.6(33")0.2-2	Mound
KoC2	sil	~20-40	>60	None	.06-0.6(33")0.2-2	Mound
KvB	l	~12-20	>60	None	-	Unsuited
KvC2	l	~12-20	>60	None	-	Unsuited

Soil criteria (continued).

SCS Soil Mapping Symbol	Surface Texture[a]	Depth to Bedrock (inches)	Depth to Water Table (inches)	Flood Frequency and Duration	Permeability of soil material[b] (in/hr)	Recommended Permeability Class[c]
LoA	l	~20-40	>60	None	0.6-6	Mound
LoB	l	~20-40	>60	None	0.6-6	Mound
LoC	l	~20-40	>60	None	0.6-6	Mound
McA	sil	>60	12-36 (Nov-Jun)	Occasional, Brief	0.6-0.2	Mound
MeB	ls	>60	>30	None	6-20(34").06-0.2	Mound
Mk	muck to 28 in.	>60	0-12 (Nov-Jun)	Frequent, Long	0.2-6(28")6-20	Unsuited
NaB	l	~5-12	>60	None	-	Unsuited
NaC	l	~5-12	>60	None	-	Unsuited
Nv	l	~5-12	12-36 (Nov-Jun)	None	-	Unsuited
OmB	sl	>60	>60	None	0.6-2	3 or 4
OmC	sl	>60	>60	None	0.6-2	3 or 4
OmD	sl	>60	>60	None	0.6-2	Unsuited
OvB	sl	>60	12-36 (Sep-May)	None	0.6-2	Mound
OzB	sil	>60	>36 (Nov-May)	None	.06-0.6(30")0.6-2	Mound
Pn	lfs	>60	0-12 (Dec-May)	Common, Long	6-20(30").06-0.2	Unsuited
Po	sicl	>60	0-12 (Nov-Jul)	Frequent, Long	.06-0.2	
Ra	rock	0	-	-	-	Unsuited
Rb	rock/l	0-12	>60	None	-	Unsuited
Rn	muck to 26 in.	>60	0-12 (Jan-Dec)	Frequent, Long	0.2-6(26")<0.2	Unsuited

Soil criteria (continued)

SCS Soil Mapping Symbol	Surface Texture[a]	Depth to Bedrock (inches)	Depth to Water Table (inches)	Flood Frequency and Duration	Permeability of soil material[b] (in/hr)	Recommended Permeability Class[c]
RoB	fs	>60	>30 (Mar-May)	None	6-20	Mound
RoC	fs	>60	>30 (Mar-May)	None	6-20	Mound
RpC	fs	>60	30-60 (Mar-May)	None	6-20	Mound
RpD	fs	>60	30-60 (Mar-May)	None	6-20	Unsuited
RrB	fs	>60	0-30 (Jan-May)	None/Frequent, Brief	6-20	Mound
Sa	muck to 60 in.	>60	3-12 (Jan-Dec)	Frequent, Very long	0.2-6	Unsuited
SnA	fsl	>60	>60	None	0.6-2	3 or 4
SnB	fsl	>60	>60	None	0.6-2	3 or 4
SoA	l	>60	12-36 (Mar-Jul)	Occasional, Brief	0.6-2	Mound
Su	muck to 33 in.	>60	0-12 (Nov-May)	Frequent, Very long	2-6(33")<.06	Unsuited
SvA	l	~10-20	>60	None	-	Unsuited
SvB	l	~10-20	>60	None	-	Unsuited
SvC	l	~10-20	>60	None	-	Unsuited
SvD	l	~10-20	>60	None	-	Unsuited

Soil criteria (concluded).

SCS Soil Mapping Symbol	Surface Texture[a]	Depth to Bedrock (inches)	Depth to Water Table (inches)	Flood Frequency and Duration	Permeability of soil material[b] (in/hr)	Recommended Permeability Class[c]
Ud	s	>60	>60	None	6-20	1
Uo	cobbly gravel	>60	>60	None	>20	Unsuited
Wa	lfs	>60	12-24 (Nov-May)	Rare	6-20	Mound
YaA	fsl	>60	12-36 (Nov-May)	Rare	0.6-2	Mound
Yv	sil	>60	0-12 (Mar-Jun)	Frequent, Brief	0.6-2	Unsuited

[a] ls - loamy sand
gsl - gravelly sandy loam
l - loam
fsl - fine sandy loam
sil - silt loam
sicl - silty clay loam
ls - loamy sand
lfs - loamy fine sand
fs - fine sand
sl - sandy loam

[b] Permeability ranges are given for the soil material between 18 and 60 inches depth. Where the permeability range differs within this depth, the permeability range of the upper material is given first, then the depth in inches where the break occurs, and then the permeability range to a depth of 60 inches.

[c] Classes correspond with permeability classes identified in Table 4 of the Facilities Planners' Memorandum.

APPENDIX I

Scientific Equivalents of Common Names of Plants

Scientific equivalents of the common names of plants cited in the text. Nomenclature follows that of Fernald (1950).

Common Name	Scientific Name
Alder	*Alnus* spp.
American beech	*Fagus grandifolia*
American elm	*Ulmus americana*
Apple	*Malus* spp.
Arrow-wood	*Viburnum recognitum*
Balsam fir	*Abies balsamea*
Basswood	*Tilia americana*
Beaked hazel	*Corylus cornuta*
Beggar-ticks	*Bidens coronata*
Black ash	*Fraxinus nigra*
Bluegrass	*Poa* spp.
Bluejoint	*Calamagrostis canadensis*
Brome-grass	*Bromus* spp.
Cherry	*Prunus* spp.
Corn	*Zea mays*
Dwarf juniper	*Juniperus communis*
Fescue	*Festuca* spp.
Goldenrod	*Solidago* spp.
Green ash	*Fraxinus pennsylvanica*
Hemlock	*Tsuga canadensis*
Horizontal juniper	*Juniperus horizontalis*
Eastern hophornbeam	*Ostrya virginiana*
Kentucky bluegrass	*Poa pratensis*
Lovegrass	*Eragrostis* spp.
Meadow fescue	*Festuca* spp.
Northern red oak	*Quercus rubra*
Oats	*Avena* spp.
Orchard grass	*Dactylis glomerata*
Pussy willow	*Salix discolor*
Red maple	*Acer rubrum*
Red-osier dogwood	*Cornus stolonifera*
Red pine	*Pinus resinosa*
Bulrush	*Scirpus* spp.
Solomon's seal	*Polygonatum* spp.
Sugar maple	*Acer saccharum*
Sumac	*Rhus* spp.
Switchgrass	*Panicum virgatum*
Trembling aspen	*Populus tremuloides*
Twisted stalk	*Streptopus* spp.
White ash	*Fraxinus americana*
White birch	*Betula papyrifera*
White cedar	*Chamaecyparis thyoides*
White pine	*Pinus strobus*
Yellow birch	*Betula alleghaniensis*

APPENDIX J

Unofficial List of Endangered and Threatened Plants In Door County

Unofficial list of endangered and threatened species of vascular plants in Door County, Wisconsin (WDNR 1976a). An asterisk indicates that the species also is included in the official list. E indicates endangered, T indicates threatened, and U indicates unknown.

Scientific Name	Common Name	Status
Adlumia fungosa	Allegheny-vine	T
Asplenium viride	Green spleenwort	U*
Carex backii	No common name	T
Carex capillaris	No common name	E
Carex concinna	No common name	E*
Carex crawei	No common name	T
Carex garberi	No common name	E
Cypripedium arietinum	Ram's-head lady's slipper	E*
Cypripedium calceolus	Small yellow lady's slipper	T
Cypripedium reginae	Showy lady's slipper	T
Draba lanceolata	No common name	U*
Festuca occidentalis	Western fescue	E*
Gentiana procera	Narrow-leaved fringed gentian	T
Geocanlon lividum	Northern comandra	E*
Gymnocarpium robertianum	Northern oak fern	E
Habenaria hookeri	Hooker's orchid	T
Iris lacustris	Dwarf lake iris	E
Orchis rotundifolia	Small round-leaved orchis	E*
Orobanche uniflora	One-flowered broom-rape	T
Osmorhiza chilensis	Chilean sweet cicely	T
Parnassia parviflora	Grass-of-parnassus	U*
Primula mistassinica	Birds eye primrose	T
Pterospora andromedea	Pine-drops	E*
Ranunculus gmelini	Yellow water crow foot	U
Ribes oxycanthoides	No common name	U
Satureja glabella	Low calamint	E
Selaginella selaginoides	Northern spikemoss	E
Senecio congestus	Marsh fleabane	E
Solidago spathulata	Dune goldenrod	E*
Tanacetum huronense	Lake Huron tansey	E*
Tiarella cordifolia	Foamflower	E
Tofieldia glutinosa	False asphodel	E
Triglochin palustre	Slender bog arrow-grass	E
Trisetum melicoides	No common name	E
Viola rostrata	Long-spurred violet	T

APPENDIX K

Amphibians, Reptiles, Birds, and Mammals with Ranges that Include the Project Area

Species of amphibians with ranges that include the project area (Conant 1975; Pentecost and Vogt 1976; WDNR 1974b).

Order/Family	Scientific Name	Common Name	Status[a,b]
CAUDATA			
Necturidae	*Necturus maculosus stictus*	Lake Winnebago mud puppy	
Ambystomatidae	*Ambystoma laterale*	Blue-spotted salamander	C (U)
	Ambystoma maculatum	Spotted salamander	
	Ambystoma tigrinum tigrinum	Eastern tiger salamander	
Salamandridae	*Notopthalmus viridescens louisianensis*	Central newt	
Plethodontidae	*Plethodon cinereus*	Red-back salamander	A, (C)
	Hemidactylium scutatum	Four-toed salamander	C
ANURA			
Bufonidae	*Bufo americanus*	American toad	A, (C)
Hylidae	*Hyla crucifer crucifer*	Northern spring peeper	A, (U)
	Hyla versicolor and		
	Hyla chrysoscelis	Gray treefrog	(U)
	Pseudacris triseriata triseriata	Western chorus frog	(U)
Ranidae	*Rana catesbeiana*	Bullfrog	
	Rana clamitans melanota	Green frog	A
	Rana sylvatica	Wood frog	C, (U-R)
	Rana pipiens	Northern leopard frog	A, (R)
	Rana palustris	Pickerel frog	

[a] Status in Lake Michigan Drainage Basin according to Pentecost and Vogt (1976). A = abundant, C = common.

[b] Status of amphibians that may be found in Newport State Park. (C) = common, (R) = rare, (U) = uncommon.

Species of reptiles with ranges that include the project area (Conant 1975; Pentecost and Vogt 1976; WDNR 1974b).

Order/Family	Scientific Name	Common Name	Status[a,b]
TESTUDINES			
Chelydridae	*Chelydra serpentina serpentina*	Common snapping turtle	A
Emydidae	*Chrysemys picta marginata*	Midland painted turtle	
SQUAMATA			
Scincidae	*Eumeces fasciatus*	Five-lined skink	
Colubridae	*Nerodia sipedon sipedon*	Northern water snake	A, (U)
	Storeria dekayi	Brown snake	C, (U)
	Storeria occipitomaculata occipitomaculata	Northern red-bellied snake	(U)
	Thamnophis sirtalis sirtalis	Eastern garter snake	A, (C)
	Thamnophis sauritus septentrionalis	Northern ribbon snake	
	Heterodon platyrhinos	Eastern hognose snake	
	Diadophis punctatus edwardsi	Northern ringneck snake	C
	Opheodrys vernalis vernalis	Eastern smooth green snake	(P)
	Elaphe vulpina vulpina	Western fox snake	(U)
	Pituophis melanoleucus sayi	Bullsnake	
	Lampropeltis triangulum triangulum	Eastern milk snake	

[a] Status in Lake Michigan Drainage Basin according to Pentecost and Vogt (1976). A = abundant, C = common.

[b] Status of reptiles that may be found in Newport State Park. (C) = common, (P) = probable, (U) = uncommon.

Species of birds that have been observed in or near the project area since 1969 (WDNR n.d., 1974a, 1975).

Order/Family	Scientific Name	Common Name
GAVIIFORMES		
Gaviidae	Gavia immer	Common loon
PODICIPEDIFORMES		
Podicipedidae	Podilymbus podiceps	Pied-billed grebe
PELECANIFORMES		
Phalacrocoracidae	Phalacrocorax auritus	Double-crested cormorant
CICONIIFORMES		
Ardeidae	Ardea herodias	Great blue heron
	Butorides striatus	Green heron
	Casmerodius albus	Great egret
	Ixobrychus exilis	Least bittern
	Botaurus lentiginosus	American bittern
ANSERIFORMES		
Anatidae	Anas platyrhynchos	Mallard
	Anas rubripes	Black duck
	Anas strepera	Gadwall
	Anas acuta	Pintail
	Anas crecca	Green-winged teal
	Anas discors	Blue-winged teal
	Anas americana	American wigeon
	Anas clypeata	Northern shoveler
	Aythya marila	Greater scaup
	Bucephala clangula	Common goldeneye
	Bucephala albeola	Bufflehead
	Clangula hyemalis	Oldsquaw
	Mergus merganser	Common merganser
	Mergus serrator	Red-breasted merganser
FALCONIFORMES		
Cathartidae	Cathartes aura	Turkey vulture
Accipitridae	Buteo jamaicensis	Red-tailed hawk
	Buteo platypterus	Broad-winged hawk
	Circus cyaneus	Marsh hawk
Falconidae	Falco sparverius	American kestrel
GALLIFORMES		
Tetraonidae	Bonasa umbellus	Ruffed grouse
Gruiformes	Porzana carolina	Sora
	Gallinula chloropus	Common gallinule
	Fulica americana	American coot

Species of birds (continued).

Order/Family	Scientific Name	Common Name
CHARADRIIFORMES		
Charadriidae	Charadrius vociferus	Killdeer
Scolopacidae	Actitis macularia	Spotted sandpiper
	Tringa flavipes	Lesser yellowlegs
Laridae	Larus argentatus	Herring gull
	Larus delawarensis	Ring-billed gull
	Sterna hirundo	Common tern
	Sterna caspia	Caspian tern
	Chlidonias nigra	Black tern
COLUMBIFORMES		
Columbidae	Zenaida macroura	Mourning dove
CUCULIFORMES		
Cuculidae	Coccyzus americanus	Yellow-billed cuckoo
	Coccyzus erythropthalmus	Black-billed cuckoo
STRIGIFORMES		
Strigidae	Otis asio	Screech owl
	Bubo virginianus	Great horned owl
	Strix varia	Barred owl
CAPRIMULGIFORMES		
Caprimulgidae	Caprimulgus vociferus	Whip-poor-will
	Chordeiles minor	Common nighthawk
APODIFORMES		
Apodidae	Chaetura pelagica	Chimney swift
Trochilidae	Archilochus colubris	Ruby-throated hummingbird
Alcedinidae	Megaceryle alcyon	Belted kingfisher
PICIFORMES		
Picidae	Colaptes auratus	Common flicker
	Dryocopus pileatus	Pileated woodpecker
	Melanerpes erythrocephalus	Red-headed woodpecker
	Sphyrapicus varius	Yellow-bellied sapsucker
	Picoides villosus	Hairy woodpecker
	Picoides pubescens	Downy woodpecker
PASSERIFORMES		
Tyrannidae	Tyrannus tyrannus	Eastern kingbird
	Sayornis phoebe	Eastern phoebe
	Empidonax alnorum	Alder flycatcher
	Empidonax minimus	Least flycatcher
	Contopus virens	Eastern wood pewee
	Nuttallornis borealis	Olive-sided flycatcher
Alaudidae	Eremophila alpestris	Horned lark

Species of birds (continued).

Order/Family	Scientific Name	Common Name
PASSERIFORMS (cont.)		
Hirundinidae	Iridoprocne bicolor	Tree swallow
	Riparia riparia	Bank swallow
	Stelgidopteryx ruficollis	Rough-winged swallow
	Hirundo rustica	Barn swallow
	Petrochelidon pyrrhonota	Cliff swallow
	Progne subis	Purple martin
Corvidae	Cyanocitta cristata	Blue jay
	Corvus brachyrhynchos	Common crow
Paridae	Parus atricapillus	Black-capped chickadee
Sittidae	Sitta carolinensis	White-breasted nuthatch
	Sitta canadensis	Red-breasted nuthatch
Certhiidae	Certhia familiaris	Brown creeper
Troglodytidae	Troglodytes aedon	House wren
	Troglodytes troglodytes	Winter wren
	Cistothorus palustris	Long-billed marsh wren
	Cistothorus platensis	Short-billed marsh wren
Mimidae	Dumetella carolinensis	Gray catbird
	Toxostoma rufum	Brown thrasher
Turdidae	Turdus migratorius	American robin
	Hylocichla mustelina	Wood thrush
	Catharus guttatus	Hermit thrush
	Catharus minimus	Gray-cheeked thrush
	Catharus fuscescens	Veery
	Sialia Sialis	Eastern bluebird
Sylviidae	Regulus calendula	Ruby-crowned kinglet
	Bombycilla cedrorum	Cedar waxwing
Sturnidae	Sturnus vulgaris	Starling
Vireonidae	Vireo flavifrons	Yellow-throated vireo
	Vireo olivaceus	Red-eyed vireo
	Vireo gilvus	Warbling vireo
Parulidae	Mniotilta varia	Black-and-white warbler
	Vermivora ruficapilla	Nashville warbler
	Parula americana	Northern parula
	Dendroica petechia	Yellow warbler
	Dendroica magnolia	Magnolia warbler
	Dendroica coronata	Yellow-rumped warbler
	Dendroica virens	Black-throated green warbler

Species of birds (concluded).

Order/Family	Scientific Name	Common Name
	Dendroica cerulea	Cerulean warbler
	Dendroica fusca	Blackburnian warbler
	Dendroica pensylvanica	Chestnut-sided warbler
	Dendroica striata	Blackpoll warbler
	Dendroica pinus	Pine warbler
	Dendroica palmarum	Palm warbler
	Oporornis philadelphia	Mourning warbler
	Geothylpis trichas	Common yellowthroat
	Wilsonia canadensis	Canada warbler
	Setophaga ruticilla	American redstart
	Passer domesticus	House sparrow
Icteridae	Sturnella magna	Eastern meadowlark
	Agelaius phoeniceus	Red-winged blackbird
	Icterus galbula	Northern oriole
	Quiscalus quiscula	Common grackle
	Molothrus ater	Brown-headed cowbird
Thraupidae	Piranga olivacea	Scarlet tanager
Fringillidae	Cardinalis cardinalis	Cardinal
	Passerina cyanea	Indigo buntin
	Carpodacus purpureus	Purple finch
	Carduelis pinus	Pine siskin
	Carduelis tristis	American goldfinch
	Pipilo erythrophthalmus	Rufous-sided towhee
	Passerculus sandwichensis	Savannah sparrow
	Pooecetes gramineus	Vesper sparrow
	Junco hyemalis	Dark-eyed junco
	Spizella passerina	Chipping sparrow
	Zonotrichia albicollis	White-throated sparrow
	Melospiza georgiana	Swamp sparrow
	Melospiza melodia	Song sparrow

Species of birds that may be present in or near the project area but for which no documented sightings have been reported during the past decade (WDNR n.d., 1974a, 1974b, 1975).

Order/Family	Scientific Name	Common Name
PODICIPEDIFORMES		
Podicipedidae	Podiceps grisegena	Red-necked grebe
	Podiceps auritus	Horned grebe
	Podiceps nigricollis	Eared grebe
PELECANIFORMES		
Pelecanidae	Pelecanus erythrorhynchos	White pelican
CICONIIFORMES		
Ardeidae	Nycticorax nycticorax	Black-crowned night heron
	Ixobrychus exilis	Least bittern
ANSERIFORMES		
Anatidae	Olor columbianus	Whistling swan
	Branta canadensis	Canada goose
	Branta bernicla	Brant
	Anser albifrons	White-fronted goose
	Chen caerulescens	Snow goose
	Anas penelope	Eurasian widgeon
	Aix sponsa	Wood duck
	Aythya collaris	Ring-necked duck
	Aythya affinis	Lesser scaup
	Melanitta fusca	White-winged scoter
	Lophodytes cucullatus	Hooded merganser
FALCONIFORMES		
Accipitridae	Accipiter gentilis	Goshawk
	Accipiter striatus	Sharp-skinned hawk
	Accipiter cooperii	Cooper's hawk
	Buteo lineatus	Red-shouldered hawk
	Buteo swainsoni	Swainson's hawk
	Aquila chrysaetos	Golden eagle
	Haliaeetus leucocephalus	Bald eagle
Falconidae	Falco rusticolus	Gyrfalcon
	Falco peregrinus	Peregrine falcon
	Falco columbarius	Merlin
GALLIFORMES		
Phasianidae	Phasianus colchicus	Ring-necked pheasant
Meleagrididae	Meleagris gallopavo	Turkey
GRUIFORMES		
Rallidae	Rallus elegans	King rail
	Rallus limicola	Virginia rail
	Coturnicops noveboracensis	Yellow rail

Species of birds (continued).

Order/Family	Scientific Name	Common Name
CHARADRIIFORMES		
Charadriidae	Charadrius semipalmatus	Semipalmated plover
	Charadrius melodus	Piping plover
	Pluvialis dominica	American golden plover
	Pluvialis squatarola	Black-bellied plover
	Arenaria interpres	Ruddy turnstone
Scolopacidae	Philohela minor	American woodcock
	Capella gallinago	Common snipe
	Numenius phaeopus	Whimbrel
	Bartramia longicauda	Upland sandpiper
	Actitis macularia	Spotted sandpiper
	Tringa solitaria	Solitary sandpiper
	Tringa melanoleuca	Greater yellowlegs
	Catoptrophorus semipalmatus	Willet
	Calidris canutus	Red knot
	Calidris fusciollis	White-rumped sandpiper
	Calidris bairdii	Baird's sandpiper
	Calidris minutilla	Least sandpiper
	Calidris alpina	Dunlin
	Calidris pusilla	Semipalmated sandpiper
	Calidris mauri	Western sandpiper
	Calidris alba	Sanderling
	Micropalama himantopus	Stilt sandpiper
	Tryngites subruficollis	Buff-breasted sandpiper
	Limosa fedoa	Marbled godwit
	Limosa haemastica	Hudsonian godwit
Recurvirostridae	Recurvirostra americana	American avocet
Phalaropodidae	Phalaropus fulicarius	Red phalarope
	Phalaropus tricolor	Wilson's phalarope
	Phalaropus lobatus	Northern phalarope
Stereorariidae	Stercorarius parasiticus	Parasitic jaeger
Laridae	Larus hyperboreus	Glaucous gull
	Larus pipixcan	Franklin's gull
	Larus philadelphia	Bonaparte's gull
	Sterna forsteri	Foster's tern
STRIGIFORMES		
Strigidae	Nyctea scandiaca	Snowy owl
	Surnia ulula	Hawk owl
	Asio otus	Long-eared owl
	Asio flammeus	Short-eared owl
	Aegolius funereus	Boreal owl
	Aegolius acadicus	Saw-whet owl

Species of birds (concluded).

Order/Family	Scientific Name	Common Name
PASSERIFORMES		
Paridae	Parus hudsonicus	Boreal chickadee
Mimidae	Mimus polyglottos	Mockingbird
	Myadestes townsendi	Townsend's solitaire
Sylviidae	Regulus satrapa	Golden-crowned kinglet
Motacillidae	Anthus spinoletta	Water pipit
Bombycillidae	Bombycilla garrulus	Bohemian waxwing
Laniidae	Lanius excubitor	Northern shrike
Vireonidae	Vireo philadelphicus	Philadelphia vireo
Parulidae	Vermivora chrysoptera	Golden-winged warbler
	Vermivora peregrina	Tennessee warbler
	Vermivora celata	Orange-crowned warbler
	Dendrioca tigrina	Cape May warbler
	Dendroica caerulescens	Black-throated blue warbler
	Dendroica castanea	Bay-breasted warbler
	Seiurus noveboracensis	Northern water thrush
	Wilsonia pusilla	Wilson's warbler
Icteridae	Dolichonyx oryzivorus	Bobolink
	Sturnella neglecta	Western meadowlark
	Xanthocephalus xanthocephalus	Yellow-headed blackbird
	Euphagus cyanocephalus	Brewer's blackbird
Fringillidae	Pheucticus ludovicianus	Rose-breasted grosbeak
	Spiza americana	Dickcissel
	Hesperiphona vespertina	Evening grosbeak
	Pinicola enucleator	Pine grosbeak
	Carduelis flammea	Common redpoll
	Loxia curvirostra	Red crossbill
	Loxia leucoptera	White-winged crossbill
	Ammodramus savannarum	Grasshopper sparrow
	Ammospiza leconteii	LeConte's sparrow
	Ammospiza caudacuta	Sharp-tailed sparrow
	Spizella arborea	Tree sparrow
	Spizella pallida	Clay-colored sparrow
	Zonotrichia querula	Harris' sparrow
	Zonotrichia leucophyrs	White-crowned sparrow
	Passerella iliaca	Fox sparrow
	Melospiza lincolnii	Lincoln's sparrow
	Calcarius lapponicus	Lapland longspur
	Calcarius pictus	Smith's longspur
	Plectrophenax nivalis	Snow bunting

Species of mammals that have been observed in the project area and/or Newport State Park (Burt and Grossenheider 1976; Long 1974; WDNR 1974a, 1974b).

Order/Family	Scientific Name	Common Name	Status[a]	Observed in Project Area
INSECTIVORA				
Soricidae	Sorex cinereus	Masked shrew	C	
	Blarina brevicauda	Shorttail shrew	C	
CHIROPTERA				
Vespertilionidae	Myotis lucifugus	Little brown myotis	C	
	Myotis keenii	Keen's myotis	U, M	
	Lasionycteris noctivagans	Silver-haired bat	R, M	
	Eptesicus fuscus	Big brown bat	U	
	Lasiurus borealis	Red bat	R, M	
	Lasiurus cinereus	Hoary bat	R, M	
CARNIVORA				
Procyonidae	Procyon lotor	Raccoon	C	
Mustelidae	Mustela erminea	Shorttail weasel	U	
	Mustela frenata	Longtail weasel	U	
	Mustela vison	Mink	R	
	Lutra canadensis	River otter		
	Mephitis mephitis	Striped skunk	U	X
Canidae	Canis latrans	Coyote	VR	
	Vulpes fulva	Red fox	U	
RODENTIA				
Sciuridae	Marmota monax	Woodchuck	U	X
	Citellus tridecemlineatus	Thirteen-lined ground squirrel	U	
	Tamias striatus	Eastern chipmunk	C	
	Sciurus carolinensis	Eastern gray squirrel	U	
	Tamiasciurus hudsonicus	Red squirrel	U	X
	Glaucomys sabrinus	Northern flying squirrel	U	
Castoridae	Castor canadensis	Beaver		X

Species of mammals (concluded).

Order/Family	Scientific Name	Common Name	Status[a]	Observed in Project Area
RODENTIA (cont.)				
Cricetidae	Peromyscus leucopus	White-footed mouse		X
	Peromyscus maniculatus	Deer mouse	C	
	Clethrionomys gapperi	Boreal redback vole	U	
	Microtus pennsylvanicus	Meadow vole	C	
	Ondatra zibethicus	Muskrat		X
Muridae	Rattus norvegicus	Norway rat	R	
	Mus musculus	House mouse	R	
Zapodidae	Napaeozapus insignis	Woodland jumping mouse		X
Erethizontidae	Erethizon dorsatum	Porcupine	C	X
Leporidue	Lepus americanus	Snowshoe hare	U	X
	Sylvilagus floridanus	Eastern cottontail	U	
ARTIODACTYLA				
Cervidae	Odocoileus virginianus	Whitetail deer	C	X

[a] Status as indicated for Newport State Park area. C = common, M = migratory, R = rare, U = uncommon, VR = very rare.

APPENDIX L

Water Quality Data

Wisconsin water quality standards (Wisconsin Administrative Code, NR 102.2).

Classification	Intended Use	Parameter	Standard (Criteria)
Fish and Aquatic Life	Support of balanced communities of fish and aquatic life	Dissolved oxygen	Warmwater fisheries - 5 mg/l Trout streams - 6 mg/l except during spawning seasons, when it should be 7 mg/l.
		Temperature	No changes that may adversely affect aquatic life; maintain daily and seasonal fluctuations; rise at edge of mixing zone not to exceed 5° F for streams and 3° F for lakes; not to exceed 89° F for warm water fish. No artificial increase is allowed in trout waters.
		pH	6.0 - 9.0 with no change greater than 0.5 units outside estimated natural seasonal maximum and minimum.
		Other	Unauthorized concentrations of substances are not permitted that alone or in combination with other materials present are toxic to fish or other aquatic life.
	Recreation	Bacteriological guidelines	Membrane filter fecal coliform count not to exceed 200 per 100 ml as geometric mean based on not less than 5 samples per month, or 400 per 100 ml in more than 10% of all samples during any month.
	Public Water Supply	In addition to above:	
		Dissolved solids	Not to exceed 500 mg/l as a monthly average, or 750 mg/l at any time.
		Other	Must meet Public Health Service Drinking Water Standards, 1962. Concentrations of other constituents must not be hazardous to health.

. Wisconsin water standards (concluded).

Classification	Intended Use	Parameter	Standard (Criteria)
Intermediate aquatic life (waters not capable of supporting a balanced aquatic community).		Dissolved oxygen	Daily average not less than 3 mg/l.
		Bacteriological guidelines	(As above)
		Chlorine	When used as a disinfectant, not greater than 0.75 mg/l at any point in the receiving water.
		Ammonia nitrogen (as N)	Not greater than 3 mg/l during warm temperature conditions or 6 mg/l during cold temperatures.
		pH	6.0 - 9.0
Marginal surface (effluent channels, wetlands, diffuse surface waters, and others capable of supporting only tolerant species).		Dissolved oxygen	Not less than 2 mg/l.
		Bacteriological guidelines	(As above)
		Chlorine	When used as a disinfectant, not greater than 0.75 mg/l at any point in the receiving water.

Selected water quality data for Kangaroo Lake (WDNR 1978b). Samples were taken between July 1973 and May 1975. Measurements in mg/l unless otherwise noted.

Parameter	Number of Samples	Maximum (Surface)	Maximum (any depth)	Minimum (Surface)	Minimum (any depth)	Mean (Surface)	Standard Deviation
Temperature[a]	8	23.9	23.9 (Surface)	1.1	1.1 (Surface)	11.4	7.4
Dissolved Oxygen (DO)	8	14.4	14.4 (Surface)	5.3	5.1 (10 ft)	10.7	2.9
pH[b]	8	8.4	8.5 (10 ft)	8.0	8.1 (11 ft)	8.2	0.02
Ammonia (NH_3)-N	8	0.38	0.46 (11 ft)	0.03	0.03 (10 ft)	0.12	0.11
NO_2	8	0.016	0.016 (Surface)	0.002	0.002 (Surface)	0.006	0.004
NO_3	8	0.59	0.59 (Surface)	0.0	0.0 (Surface)	0.24	0.21
Total Nitrogen	8	1.9	1.9 (Surface)	0.61	0.61 (Surface)	0.99	0.38
Total Phosphorus	8	0.11	0.15 (10 ft)	0.01	0.01 (Surface)	0.045	0.032
Conductivity[c]	8	384.0	483.0 (11 ft)	283.0	280.0 (10 ft)	320.0	35.0
Alkalinity[d]	8	212.0	218.0 (10 ft)	152.0	152.0 (Surface)	171.0	20.0
Turbidity[e]	8	5.1	6.9 (11 ft)	0.73	0.73 (Surface)	2.4	1.2

[a] Temperature in degrees centigrade.

[b] pH in pH units.

[c] In mmhos.

[d] As $CaCO_3$.

[e] In Jackson turbidity units.

Selected water quality data for Fish Creek (USEPA 1978b). Samples were taken between March 1976 and June 1976. Measurements are in mg/l unless otherwise noted.

Parameter	Number of Samples	Maximum	Minimum	Mean	Standard Deviation
Temperature[a]	4	17.5	0.0	8.4	7.6
Dissolved Oxygen (DO)	4	8.6	7.6	8.3	0.46
BOD_5	4	2.5	2.4	2.4	0.06
pH[b]	3	8.1	7.9	8.0	0.12
Ammonia (NH_3)-N	4	0.15	0.05	0.077	0.048
NO_2 and NO_3	4	0.21	0.02	0.067	0.095
Total Phosphorus	4	0.03	0.015	0.023	0.007
Fecal Coliform[c]	4	18.0	10.0	52.5	85.0

[a] Temperature in degrees centigrade.

[b] pH in pH units.

[c] Fecal coliform in colonies/100ml.

Selected water quality data for Heins Creek (USEPA 1978b). Samples were taken between March and August 1976. Measurements are in mg/l unless otherwise noted.

Parameter	Number of Samples	Maximum	Minimum	Mean	Standard Deviation
Temperature[a]	6	18.1	5.0	13.8	5.5
Dissolved Oxygen (DO)	6	9.5	3.0	7.1	2.8
BOD_5	5	4.0	1.2	2.5	1.0
pH[b]	4	8.0	7.5	8.1	0.19
Ammonia (NH_3)-N	6	0.50	0.09	0.23	0.014
NO_2 and NO_3	6	0.50	0.07	0.21	0.17
Total Phosphorus	6	0.04	0.01	0.02	0.012
Fecal Coliform[c]	6	120.0	10.0	31.6	44.0

[a] Temperature in degrees centigrade.

[b] pH in pH units.

[c] Fecal coliform in colonies/100ml.

Selected water quality data for Rieboldts Creek (USEPA 1978b). Samples were taken between March 1976 and December 1976. Measurements are in mg/l unless otherwise noted.

Parameter	Number of Samples	Maximum	Minimum	Mean	Standard Deviation
Temperature[a]	11	22.0	4.0	12.2	6.5
Dissolved Oxygen (DO)	10	10.0	5.5	7.5	1.3
BOD_5	8	5.3	2.4	3.2	0.87
pH[b]	9	8.6	7.4	8.1	0.41
Ammonia (NH_3)-N	10	1.5	0.06	0.262	0.44
NO_2 and NO_3	10	0.23	0.02	0.073	0.066
Total Phosphorus	10	0.14	0.008	0.032	0.038
Fecal Coliform[c]	10	30.0	10.0	12.0	6.3

[a] Temperature in degrees centigrade.

[b] pH in pH units.

[c] Fecal coliform in colonies/100ml.

APPENDIX M

Aquatic Plants

Aquatic plants observed in Lake Michigan bays adjacent to, or near, the project area (Salamun and Stearns 1978).

Common Name	Scientific Name
Arrowhead	*Sagittaria latifolia*
Blue-joint	*Calamagrostis canadensis*
Bullrush	*Scirpus validus*
Bur-reed	*Sparganium eurycarpum*
Common cattail	*Typha latifolia*
Duckweed	*Lemna minor*
Eel grass	*Vallisneria americana*
Manna grass	*Glyceria borealis*
Pondweed	*Potamogeton* sp.
Reed	*Phragmites communis*
Reed canary grass	*Phalaris arundinacea*
Rushes	*Juncus* spp.
Sedges	*Carex* spp.
Spike rush	*Eleocharis* spp.
Water milfoil	*Myriophyllum* spp.
Water plantain	*Alisma plantago-aquatica*
Water smartweed	*Polygonum natans*
Wild rice	*Zizania aquatica*
Yellow water lily	*Nuphar variegatum*

APPENDIX N

Fish Species Present in the Project Area

Species of fish with distributional ranges that include project area waters (Becker 1976).

Common Name	Scientific Name
Silver lamprey	*Ichthyomyzon unicuspis*
Sea lamprey	*Petromyzon marinus*
Lake sturgeon	*Acipenser fulvescens*
Alewife	*Alosa pseudoharengus*
Lake herring	*Coregonus artedii*
Lake whitefish	*Coregonus clupeaformis*
Bloater	*Coregonus hoyi*
Coho salmon	*Oncorhynchus kisutch*
Chinook salmon	*Oncorhynchus tshawytscha*
Rainbow trout	*Salmo gairdneri*
Brown trout	*Salmo trutta*
Brook trout	*Salvelinus namaycush*
Round whitefish	*Prosopium cylindraceum*
Rainbow smelt	*Osmerus mordax*
Central mudminnow	*Umbra limi*
Northern pike	*Esox lucius*
Lake chub	*Couesius plumbeus*
Carp	*Cyprinus carpio*
Golden shiner	*Notemigonus crysoleucas*
Common shiner	*Notropis cornutus*
Spottail shiner	*Notropis hudsonius*
Sand shiner	*Notropis stramineus*
Mimic shiner	*Notropis volucellus*
Northern redbelly dace	*Phoxinus eos*
Bluntnose minnow	*Pimephales notatus*
Fathead minnow	*Pimiphales promelas*
Longnose dace	*Rinichthys cataractae*
Creek chub	*Semotilus atromaculatus*

Species of fish (concluded).

Common Name	Scientific Name
Longnose sucker	*Catostomus catostomus*
White sucker	*Catostomus commersoni*
Black bullhead	*Ictalurus melas*
Brown bullhead	*Ictalurus nebulosus*
Channel catfish	*Ictalurus punctatus*
Burbot	*Lota lota*
Banded killifish	*Fundulus diaphanus*
Brook stickleback	*Culaea inconstans*
Ninespine stickleback	*Pungitius pungitius*
Rock bass	*Ambloplites rupestris*
Pumpkinseed	*Lepomis gibbosus*
Bluegill	*Lepomis macrochirus*
Smallmouth bass	*Micropterus dolomieui*
Largemouth bass	*Micropterus salmoides*
Black crappie	*Pomoxis nigromaculatus*
Iowa darter	*Etheostoma exile*
Johnny darter	*Etheostoma nigrum*
Yellow perch	*Perca flavescens*
Walleye	*Stizostedion vitreum vitreum*
Mottled sculpin	*Cottus bairdi*
Fourhorn sculpin	*Myoxocephalus quadricornis*

APPENDIX O

Recreational Resources

Public and private recreational resources in the project area (Door County Chamber of Commerce 1978)

Activity	Baileys Harbor Township	Egg Harbor Township	Egg Harbor Village	Ephraim Village	Gibraltar Township	Total
Theater					1	1
Music	1				1	2
Amusement park		1			1	2
Museum		1	1			2
Fishing	1	1	1	1	1	5
Horseback riding		2			1	3
Tennis (public)	2			1	1	4
Charter boats	1					1
Bicycle rental	2	1	1	1	3	8
Driving ranges					1	1
Miniature golf				1	1	2
Golf	1		1	1		3
Boat-motor rentals	4			1	1	6
Marinas/docking	1			1		2
Boat ramps	3	1	1	1	3	9
Swimming pools (public)[a]						

[a] There are swimming pools located at most motels and resorts in the project area.

APPENDIX P

Archaeological Sites
and
Field Survey Investigations

Location of known archaeological sites in the study area (State Historical Society of Wisconsin n.d.). Exact location within the section is not disclosed to insure site integrity.

Site Number	Township	Range	Section
DR 1	29N	28E	6
DR 2	29N	28E	6
DR 3	30N	28E	16
DR 7	30N	26E	25
DR 11	31N	27E	16
DR 12	31N	27E	32
DR 72	30N	28E	17
DR 73	31N	28E	34
DR 90	30N	26E	25

APPENDIX P

Preliminary Field Evaluation of the Archaeological Potential of Nine Sites in Door County, Wisconsin

1.0. INTRODUCTION

In October 1982, a preliminary archaeology study was conducted in middle Door County, Wisconsin to assess the potential for archaeological resources in the project area. Background information on the environmental setting and cultural resources of the region was gathered from existing documentation and a literature search was conducted to identify existing aboriginal sites. Interviews were conducted with academic and state authorities and local residents to gather further information, seek additional existing site locations, and examine cultural materials representative of the area. Finally, an onsite inspection was made at each of the nine alternative treatment plant locations examined in the ER to observe specific environmental conditions and to examine the ground surface, when visible, for exposed cultural debris.

The scope of the investigation was cursory and did not employ detailed field reconnaissance or testing to determine the presence of cultural materials. When favorable environmental conditions and knowledge of prehistoric settlement patterns indicated the likelihood that a site could exist at a specific location, the site was designated an archaeologically "sensitive area." If actual physical evidence of cultural activity was found, the location was designated a "site."

2.0. ENVIRONMENTAL SETTING

Details of the climate, geology, soils, water resources and flora and fauna of the project area are presented in the ER (Section 3.0.). Evaluation of this information suggests that the project area was favorable for settlement by aborginal peoples.

Four environmental factors influenced settlement patterns in the project area. First, glacial activity on the Door Peninsula created a physical setting where micro-environments flourished. These diverse biological communities attracted and supported prehistoric groups. Secondly, old beach ridges, isolated inland beaches (fossil beaches) and sand dunes left by fluctuating lake levels were principal choices as habitation sites. Access to water was a third factor affecting prehistoric settlement of the area. Coastal occupations along shallow bays and inlets had easy access to water transportation routes and offered safe havens from foul weather and turbulent waters. A fourth consideration for settlement was climate. Conditions on the Lake Michigan side of the peninsula are and were more moderate and, therefore, more attractive for habitation, especially in winter.

3.0. CULTURAL SETTING

Archaeological studies of North American divide cultural history into the following phases:

Paleo-Indian	15,000 BC to 8,000 BC
Archaic	8,000 BC to 700 BC
Woodland	700 BC to 800 AD
Late Prehistoric	800 AD to 1634 AD
Historic	1634 AD to 1850 AD

A literature review was conducted to identify previously recorded cultural resources within the study area and to identify any archaeological investigations that had taken place in the vicinity. It included a review of the National Register of Historic Places, the records of the State Historic Preservation Division of the State Historical Society of Wisconsin, archaeological data at Lawrence University in Appleton, Wisconsin, and other relevant documentation for the area.

There are nine previously recorded archaeological sites located in, or adjacent to the project area (Table 1 and ER Figure 3-15). The Middle Woodland phase (200 BC to 500 AD) is the earliest cultural affiliation identified in the study area (Mero Site).

Table 1. Previously recorded archaeological sites within the study area.

Site Number	Site Name	Vicinity	Site Type	Cultural Affiliation
DR1	Heins Creek Burial	Baileys Harbor	Burial	**
DR2	Heins Creek Site	Baileys Harbor	Village	Late Woodland to Late Prehistoric
DR3	Mud Bay Site	Baileys Harobr	Village	**
DR7	-	Egg Harbor	Cache	**
DR11	Shanty Bay Campsite	Fish Creek	Camp	**
DR72	-	Baileys Harbor	Camp	**
DR73	Erickson Village Site	Baileys Harbor	Village	**
DR90	-	Egg Harbor	Camp	Historic (Potawatomie Indian)
DR83*	Mero Site	North Bay	Prehistoric	Middle Woodland to Late Prehistoric

* Site located just north of the project area.

** Prehistoric of unknown orgin.

Except for the interest of a few avocational archaeologists, exploration of the Door Peninsula was neglected until Dr. Ronald J. Mason and Carol Irwin Mason began excavation at the Mero and Heins Creek sites in the early 1960's. Archaeological investigations that have included the project area are a coastal zone management study of the Lake Michigan shoreline in Wisconsin (Fay 1978) and a coastal corridor study of Green Bay (Overstreet 1980). Other smaller reconnaissance surveys have been undertaken in the region for wastewater facilities plans, highways, and US Army Corps of Engineer projects. No surveys specific to the upper Door Peninsula have been conducted (By telephone Mr. William Green, Archaeologist, Wisconsin State Historic Preservation Office, and Ms. Joan Freeman, Curator of Anthropology, State Historical Society of Wisconsin, to Ms. L. Scheurer, WAPORA, Inc.).

In April 1982, M. L. Staab conducted an archaeological investigation at a proposed treatment plant location as part of the 1982 Facilities Plan Addendum. The site is located east of Fish Creek (community) on the level upland overlooking Fish Creek (stream). Several flint and stone flashes were discovered during a preliminary survey, but later testing of the site did not locate any further evidence of occupation. The project was recommended for clearance at this location.

Based on the existing information on archaeological sites in the project area and a general review of the cultural setting of the Great Lakes Region (Mason 1981, Mason 1966, Bertrand 1976, Caldwell 1978 and Brose 1976), it was concluded that in upland areas it is most probable that archaeological evidence will be small isolated finds of cultural materials. Coastal areas, however, will produce sites that are long term, intermittent occupations, and represent a variety of different uses. Sand ridges and fossil beaches seem to have been preferred as habitation sites.

Based on the environmental and cultural setting, it is likely that the nine previously recorded sites represent only a small percentage of those existing on the Door Peninsula.

4.0. FIELD INSPECTION

On October 12, 1982, a personal visit was made to interview Dr. Ronald J. Mason at Lawrence University in Appleton, Wisconsin. The existing archaeological excavations on the Door Peninsula were discussed and material from the excavations were carefully examined for the cultural attributes. Other personal interviews were conducted with local residents, Door County Sheriff's Deputy Al Birnschein, and State Forester Harry Porter. Ray Lukes, Resident Manager of the Ridges Santuary and the librarian at the Gibraltar Library and Community Center are local authorities on the history of the project area, but attempts to contact them failed.

On October 13 and 14, 1982, the field inspecton was performed. Weather conditions were excellent. A total of nine sites were inspected - three near Egg Harbor, three near Fish Creek, one near Ephraim, and two near Baileys Harbor.

Land use at the sites included a white pine plantation, agriculture, oldfields, upland and wetland forests, fossil beaches, and sand ridges. Surface visibility in the forested areas, oldfields, plantations and covered agricultural land was poor (Sites No. 1, 3, 4, 5, 6, 7, and 9). The agricultural land planted in corn and the old beach areas had good surface visibility (Sites No. 2 and 8). A summary of the present land use, archaeological potential and recommendations for further investigation of each site are presented in Table 2.

5.0. ARCHAEOLOGICAL SITES AND SENSITIVE AREAS

Based on the background data and the field inspections, one site was identifed as an archaeological site and two were identified as sensitive areas.

Table 2. Summary of archaeological evaluation of alternate wastewater treatment plant locations.

Number	Village Name	Landform	Elevation A.S.L.*	Soil Type	Current Land Use	Surface Visibility	Archaeologically Sensitive Areas	Recommendations	
								Survey	Testing
1	Egg Harbor	Exposed bedrock & rocky surface	580'	Bedrock and rocks	Forest	Fair - poor	Yes	Yes	Yes
2	Egg Harbor	Level upland	750'	Loamy-glacial till	Agriculture	Good	No	No	No
3	Egg Harbor	Level upland	750'	Loamy-glacial till	Agriculture	Poor	No	No	No
4	Fish Creek	Level upland	640'	Loamy-glacial till	Agriculture	Poor	No	No	No
5	Fish Creek	Level upland	640'	Loamy-glacial till	Oldfield	Poor	No	No	No
6	Fish Creek	Level upland	640'	Loamy-glacial till	White Pine plantation & oldfield	Poor	No	No	No
7	Ephraim	Level upland	600'	Loamy-glacial till	Forest	Poor	No	No	No
8	Baileys Harbor	Fossil beach	600'	Beach sand	Oldfield	Good	Site	No	Yes
9	Baileys Harbor	Fossil beach	600'	Sandy loam	Oldfield	Poor	Yes	Yes	Yes

* A.S.L. - above sea level

Baileys Harbor Site

Site No. 8 is located just north of the community of Baileys Harbor along the west side of Route 57 and near the center of Section 7. It is an area of exposed beach sand with sparse vegetation of primarily small white pines. In the west, the site slopes down to a forested wetland known as the Baileys Harbor Swamp. Approximately 0.25 miles to southeast is the Ridges Sanctuary, a National Natural Landmark.

Surface visibility was good for most of the site area. Where vegetation was not present, erosion of the ground surface had created depressions. Cultural material was observed in nearly all of the depressions checked.

The sand was white except in isolated spots where it appeared red to yellowish brown in color. These spots were presumed to have been burned because charcoal is known to have been available in the vicinity.

An assortment of cultural debris was noted at the site including large mammals bones, fish bones, chert flakes (some utilized), thinning flakes, decortification flakes, and vast quantities of local chert. No prehistoric ceramics or diagonostic artifacts were found. Historic glass and metal also occurred on the surface with the lithic and bone debris.

Dr. Mason had indicated during the interview (personal communication, to Ms. L. Scheurer, WAPORA, Inc., October 1982) that this area is archaeologically sensitive and could produce archaeological materials.

Because historic debris was observed, local authorities were contacted for information on dumping sites and possible historic disturbances. The Deputy Sherrif and a State Forester knew of no historic occupation or disturbance in this area.

The location of site No. 8 is being filed with the State Historical Society of Wisconsin as a designated archaeological site.

Baileys Harbor Sensitive Area

Site No. 9 is located just north of the community of Baileys Harbor between Route 57 and County Road Q in the south central part of Section 9. A heavily forested, rocky, fossil beach lies to the east just above Baileys Harbor Swamp. It rises in several separate progressions to a level open area. Recent gravel roads have been constructed on the level areas, possibly for future development. A few residences are scattered at the forest edge.

Vegetation prevented a good view of the ground surface. Environmental conditions indicate that it is a favorable area for prehistoric occupation, therefore, this area was designated as archaeologically sensitive.

Egg Harbor Sensitive Area

Site No. 1 is located approximately 1.0 mile north of the Village of Egg Harbor in Section 24. It is east of Route 42 and west of the residential road that runs along the coast between Egg Harbor and Judd Bay.

At Site No. 1, the land surface is very rocky and barely forested. To the west is the shear face of the glacial escarpment. To the east are residential structures that have frontage on Green Bay. A cache of flint tools was discovered a short distance from this location indicating prehistoric man's presence in the immediate area. Environmental conditions indicate it might have been attractive site for habitation. It has therefore been designated as an archaeologally sensitive area.

6.0. SUMMARY

A literature search identified nine known archaeological sites in the project area. None of these will be affected by any of the proposed alternatives. No systematic survey to locate and identify archaeological resources has been conducted in the area. Based on the environmental and cultural setting there is good reason to believe that the known sites represent only a small percentage of those existing on the Door Peninsula.

A field inspection was made of the nine treatment plant locations evaluated in the ER as part of this preliminary archaeological study. The onsite inspections discovered one archaeological site just north of Baileys Harbor (Site No. 8). Two areas were identified as archaeologically sensitive and have the potential for producing cultural materials: one in the vicinity of Egg Harbor (Site No. 1) and another near Baileys Harbor (Site No. 9). The other six proposed treatment plant sites do not demonstrate any archaeological potential.

7.0. LITERATURE CITED

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APPENDIX Q

Sites of Historical or Architectural Significance

Sites of historical or architectural significance in the project area (Department of Interior, Heritage Conservation and Recreation Service 1979; State Historical Society of Wisconsin n.d.; Land Plans Inc. 1973)

Site Number	Site Name	Site Location
1	Cana Island Lighthouse	Cana Island, 4 miles NE of Baileys Harbor
2	Eagle Bluff Lighthouse	Eagle Bluff, 3.5 miles N of Fish Creek
3	Levi Thorp (Cupola) House	7836 Egg Harbor Rd., Egg Harbor
4	St. John the Baptist Catholic Church	Egg Harbor Rd, S of School St. Egg Harbor
5	Inverson House	Cherry and Moravia Sts., Ephraim
6	Moravian Church	Moravia St., S of Cherry St. Ephraim
7	Pioneer School House	Moravia St., Ephraim
8	Round-log House	Norway St., Ephraim
9	Anderson Store	STH 42 near Anderson Lane, Ephraim
10	Anderson House	STH 42 near Anderson Lane, Ephraim
11	Village Hall	STH 42 at Pioneer Lane, Ephraim
12	Moravian Cemetery	Willow and Norway Sts., Ephraim
13	White Gull Inn	Main St., Fish Creek
14	Church of the Atonement	Main St. and Cottage Row, Fish Creek
15	Asa Thorp House/Cabin	Main St., Fish Creek
16	Frame Inn	Main St., Fish Creek

Sites of historical or architectural significance (concluded).

Site Number	Site Name	Site Location
17	Noble House	STH 42, Fish Creek
18	Horseshoe Bay Farm-Barn	Sec 3, T29N, R26E, Town of Egg Harbor
19	Stone outbuilding	NE¼ of NE¼, Sec 2, T29N, R27E, Town of Jacksonport
20	Large Log Barn	SE¼ of SW¼, Sec 5, T29N, R27E, Town of Jacksonport
21	Log house	NE¼ of SE¼, Sec 36, T30N, R26E, Town of Egg Harbor
22	Peninsula Players Theatre	NW¼ of SE¼, Sec 7, T30N, R27E, Town of Gibraltar
23	Buckbinder House	SE¼, Sec 7, T30N, R27E, Town of Gibraltar
24	Two farm outbuildings of vertical logs	SW¼ of SW¼, Sec 8, T30N, R27E, Town of Gibraltar
25	Log outbuilding	SE¼ of NW¼, Sec 8, T30N, R27E, Town of Gibraltar
26	Early picturesque stone house	SE¼ of NW¼, Sec 10, T30N, R27E, Town of Gibraltar
27	Log outbuildings	NW¼ of NE¼, Sec 23, T30N, R27E, Town of Baileys Harbor
28	Fieldstone barn	SW¼ of SW¼ Sec 23, T30N, R27E, Town of Baileys Harbor
29	Site of School #1	SW¼ of NW¼, Sec 36, T30N, R27E, Town of Baileys Harbor
30	Barn with stovewood wing	NE¼ of SE¼, Sec 31, T30N, R27E, Town of Egg Harbor
31	Vertical log farm outbuildings	NE¼ of NW¼, Sec 31, T30N, R27E, Town of Egg Harbor
32	Carrington (Toft) House	STH 57, Baileys Harbor
33	Log house	SE¼ of NW¼, Sec 31, T30N, R28E, Town of Baileys Harbor
34	Boynton House and Chapel (Bjorkbinden Chapel)	NW¼ of NW¼, Sec 32, T30N, R28E, Town of Baileys Harbor

Sites of historical or architectural significance (continued).

Site Number	Site Name	Site Location
35	Large gambrel-roofed log barn	NE¼ of SE¼, Sec 36, T31N, R27E, Town of Gibraltar
36	Ridges Sanctuary-Tofts Point-Mud Lake Area	E½, Sec 17, T30N, R28E, Town of Baileys Harbor
37	Craft Mart	NE¼ of SE¼, Sec 18, T31N, R28E, Town of Liberty Grove
38	Lime kiln	NW¼ of SW¼, Sec 18, T31N, R28E, Town of Liberty Grove
39	Dorn Farm	NW¼ of SW¼, Sec 29, T31N, R28E, Town of Liberty Grove
40	Stovewood and log house	NE¼ of SE¼, Sec 30, T31N, R28E, Town of Liberty Grove
41	Log house	NW¼ of NW¼, Sec 35, T31N, R28E, Town of Baileys Harbor
42	Stovewood barn	SW¼ of NE¼, Sec 31, T31N, R28E, Town of Baileys Harbor
43	Toft stovewood barn	Baileys Harbor
44	Partial log house	Baileys Harbor
45	Stovewood barn	Baileys Harbor
46	Barn	Baileys Harbor
47	Barn	Baileys Harbor
48	Store (circa 1880)	Baileys Harbor
49	Store	Baileys Harbor
50	Schram Saloon	Baileys Harbor
51	Hotel (circa 1875)	Baileys Harbor
52	Blacksmith shop (circa 1900)	Baileys Harbor
53	Zahn House (circa 1900)	Baileys Harbor
54	Langs Resort (1880s grocery store)	Ephraim

Sites of historical or architectural significance (continued).

Site Number	Site Name	Site Location
55	Edgewater Hotel	Ephraim
56	Oneson Cottage (circa 1853)	Ephraim
57	First post office (circa 1872)	Ephraim
58	Sohn's Grocery (originally blacksmith shop)	Ephraim
59	Lutheran Church	Ephraim
60	Kendall Property	Ephraim
61	Original site of Moravian Church	Ephraim
62	Hillside Resort	Ephraim
63	Hannah Valentine Home	Ephraim
64	First Ephraim school	Ephraim
65	Iverson Stone Wall	Ephraim
66	Evergreen Beach Hotel	Ephraim
67	Evenson Home Site	Ephraim
68	Olson Home (circa 1860)	Ephraim
69	Langhoer Home	Ephraim
70	Zacharis Home site	Ephraim
71	Former Lutheran Cemetery Site	Ephraim
72	Former Pier site	Ephraim
73	Peterson Home site	Ephraim
74	Water supply spring	Ephraim
75	Pilot Island Lighthouse	Pilot Island, Baileys Harbor
76	Indian Memorial Pole	Peninsula State Park
77	Baileys Harbor Tower and Range Residence	Ridges Sanctuary

Sites of historical or architectural significance (concluded).

Site Number	Site Name	Site Location
78	Founder's Square	Fish Creek
79	Proud Mary Hotel	Fish Creek
80	Alpine Resort	Egg Harbor
81	Toft Log House and Outbuildings	SE½ of NW¼, Sec 15, T30N, R28E, Town of Baileys Harbor
82	Log house	SW¼ of SW¼, Sec 32, T30N, R27E, Town of Egg Harbor
83	Stovewood barn	NE¼ of SW¼, Sec 1, T30N, R27E, Town of Gibraltar
84	Fieldstone barns	SW¼ of SW¼, Sec 20, T31N, R28E Town of Liberty Grove
85	Log barns	SE¼ of NE¼, Sec 33, T31N, R27E Town of Gibraltar

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