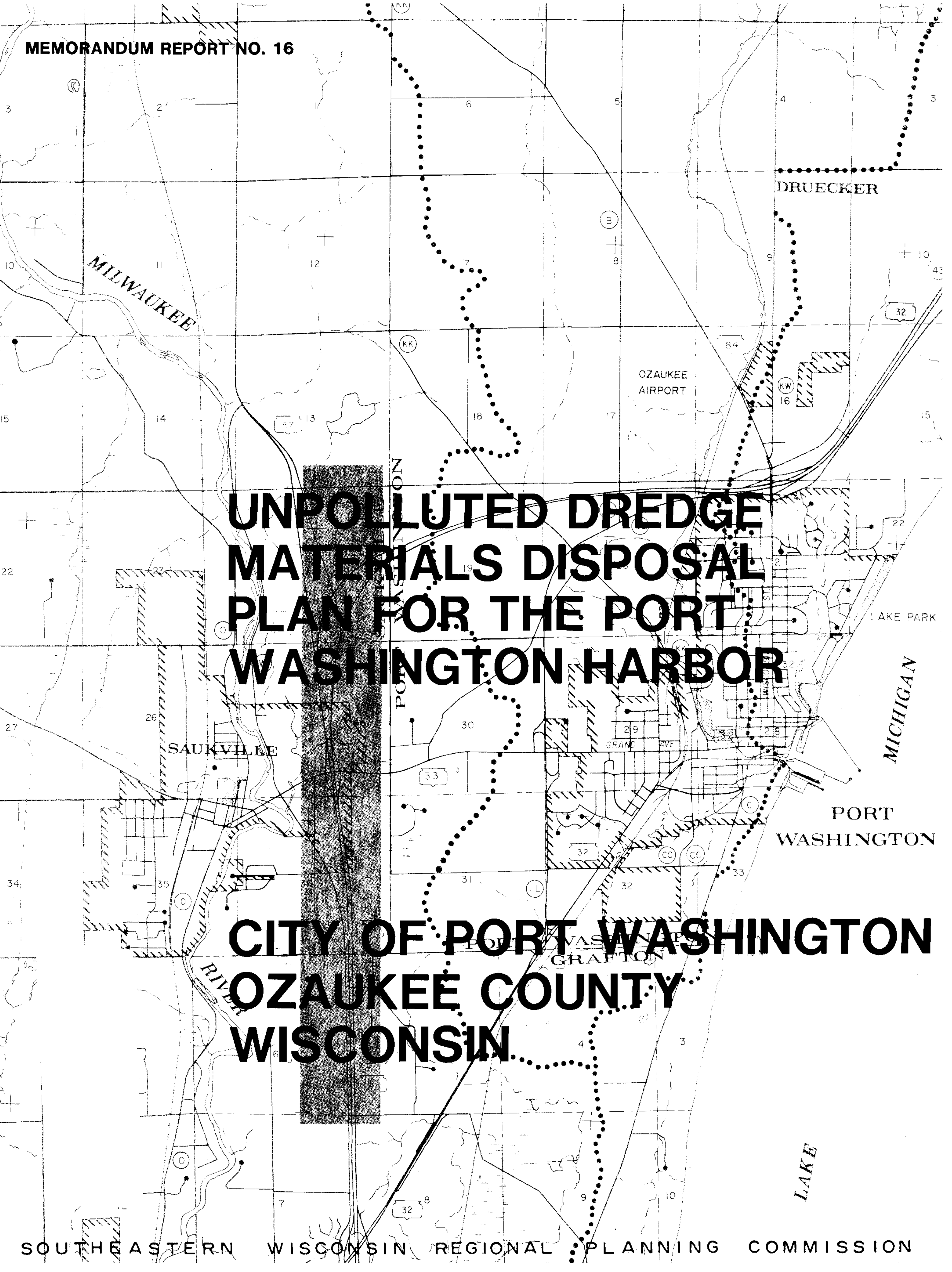
MEMORANDUM REPORT NO. 16

UNPOLLUTED DREDGE MATERIALS DISPOSAL PLAN FOR THE PORT WASHINGTON HARBOR



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MEMORANDUM REPORT NUMBER 16

UNPOLLUTED DREDGE MATERIALS DISPOSAL PLAN FOR THE PORT WASHINGTON HARBOR

CITY OF PORT WASHINGTON OZAUKEE COUNTY, WISCONSIN

Prepared by the

Southeastern Wisconsin Regional Planning Commission
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May 1987

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SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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May 21, 1987

Mr. Robert R. Dreblow
Director of Public Works
City of Port Washington
100 W. Grand Avenue
P. O. Box 179
Port Washington, Wisconsin 53074-0179

Dear Mr. Dreblow:

On January 17, 1986, and on June 5, 1986, respectively, the Wisconsin Coastal Council and the City of Port Washington requested the Southeastern Wisconsin Regional Planning Commission to undertake a study of the Port Washington Harbor, leading to the preparation of a 10-year unpolluted dredged materials disposal plan—a plan which would recommend potential upland and nearshore alternatives for the disposal or beneficial use of unpolluted materials dredged from the Port Washington Harbor. Acting in response to that request, and working in cooperation with the City and the Wisconsin Department of Natural Resources, the Commission staff has now completed the requested disposal plan for the Port Washington Harbor. The findings of the study are presented in this report.

This report sets forth the need for, and purpose of, the study; describes the physical characteristics of the Port Washington Harbor; and presents a brief summary of historic dredging and dredged material disposal practices. Basic data required for the location of upland and nearshore disposal sites for unpolluted dredged materials are presented, including data on the natural and cultural features of the area concerned, the composition and quantity of the dredged materials to be accommodated, and the existing federal and state regulations pertaining to the disposal of dredged materials in upland and nearshore sites. A general evaluation of the methods for disposing of unpolluted dredged materials at upland and nearshore sites is provided, together with a description of the procedures followed and criteria used to evaluate potential upland and nearshore disposal sites. Alternative methods and locations for the disposal of unpolluted dredged material from the Port Washington Harbor are evaluated, attendant costs estimated, and a disposal plan recommended.

The inventory information, alternatives assessment, and recommendations presented in this report constitute a necessary first phase in the investigation of feasible methods for disposal of unpolluted dredged materials from the Port Washington Harbor. The ultimate selection of a specific method, or combination of methods, for the disposal and/or reuse of unpolluted dredged materials from the Port Washington Harbor will require the conduct of more detailed engineering studies to evaluate the recommended means for disposal or reuse of the dredged material. The Regional Planning Commission stands ready to assist the City of Port Washington Harbor Commission in the implementation of the recommended plan herein described.

Respectfully submitted,

Kurt W. Bauer
Executive Director

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Chapter I

INTRODUCTION AND BACKGROUND

Lake Michigan contributes significantly to the economy and well being of the Southeastern Wisconsin Region. Many commercial, industrial, and recreational activities depend directly on coastal locations to maintain their viability. Ports and harbors play an important role in this regard by providing facilities which enhance the capabilities of the Region to benefit from many water based activities, including interstate and international trade, commercial and sport fishing, outdoor recreation, and tourism.

Most harbors require occasional dredging to maintain conditions conducive to commercial and recreational navigation. Commercial vessels cannot operate at full capacity if shallower waters, which are the result of sediment accumulation in the channels, mooring basin, and outer harbor, must be navigated. The frequency and magnitude of dredging for maintenance of navigation is influenced by the rate of sedimentation and by lake water levels. If sedimentation is relatively low, or if the elevation of the lake is relatively high, maintenance dredging can be performed on a less frequent basis than if the sedimentation rates are high or the lake levels are low.

Despite fluctuations in the timing and magnitude of the dredging, whenever dredging occurs, a need arises to properly dispose of dredged materials. Adverse impacts of dredged material disposal range from the obvious aesthetics to the complex, long-term and often hidden ecological effects. Ecological changes are both indirect--through physiological reactions of plants and animals to changes in water quality, and direct--such as loss of food supplies and breeding areas for fish and wildlife because wetlands were filled with dredged material. Health concerns include contamination of water supplies due to open water disposal of contaminated materials or to leaching of contaminants from land disposal sites into groundwater.

In this respect, in 1977 the United States Environmental Protection Agency (EPA) developed guidelines for evaluating the pollutant content of sediments. According to EPA guidelines, sediments can be classified as unpollutd, moderately polluted, or heavily polluted. While the Wisconsin Department of Natural Resources (DNR) recognizes these guidelines, they are not presently being used for sediment quality analysis of dredged material in Wisconsin. Rather, the DNR has issued interim guidelines with respect to metals, organic pollutants, and other contaminants in order to assess the pollutant content of dredged material as it relates to potential disposal options and the environmental impacts associated with the various disposal options.[1]

These environmental impacts can be lessened or eliminated by careful planning based on an understanding of the consequences and a knowledge of the various safe--even beneficial--uses or techniques for disposal of dredged materials. No single disposal option can be presumed suitable for all dredging projects. The cumulative impacts of dredged material disposal methods require disposal methods to change as environmental conditions change. Thus, dredging and disposal plans offer opportunities for environmental protection, cost-effective disposal, and public understanding of dredged material disposal and its impacts.

Accordingly, on January 17, 1986, and on June 5, 1986, respectively, the Wisconsin Coastal Council and the City of Port Washington requested the Southeastern Wisconsin Regional Planning Commission to undertake a study of the Port Washington harbor, leading to the preparation of a 10-year unpolluted dredged materials disposal plan, which plan is intended to satisfy the requirements set forth in the proposed Section 30.205 of the Wisconsin Statutes. The planning effort includes an assessment of the natural resource base, water quality data, and sediment quality data from the Port Washington harbor area, and results in the recommendations of environmentally and economically sound disposal options for materials dredged from the harbor. Cost estimates for each of the recommendations are provided in the report.

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[1]Wisconsin is presently in the process of revising NR 347 of the Wisconsin Administrative Code to include the EPA guidelines for evaluating sediments.

History of Sedimentation Problems and Dredging Activities for Port Washington Harbor

The fluctuation of Lake Michigan water levels affects the need for dredging to maintain an adequate water depth for navigation. High lake levels--such as the record high levels of 1985 and 1986--reduce the need for dredging to provide adequate water depths, whereas, low lake levels--such as the record low levels experienced in 1964--increase the need for such dredging.

Bottom soundings are conducted annually by the U.S. Department of the Army, Corps of Engineers to measure the elevation of the sediments in the Port Washington Harbor. These soundings indicate the elevation of sediments at cross sections located at approximately 100-foot intervals. Based on these sounding data, lake level information, navigation-related data, and the availability of funds, the Corps of Engineers sets priorities for dredging, and identifies which areas should be dredged to the established project depths during a given year.

Dredging records available from the Corps of Engineers for the period between 1960 and 1986 indicate that the harbor was dredged 11 times on an irregular basis ranging from one to five-year intervals. Table 1 presents data regarding the years in which dredging occurred and the amount of material removed during each dredging episode. From 1960 to 1971, dredged material removed from the Port Washington Harbor was loaded into scows, transported to the deep water portion of Lake Michigan and dumped. However, in the early 1970s, the Wisconsin Department of Natural Resources adopted regulations prohibiting the open lake dumping of dredged material into State waters, citing the need for further evaluation of the environmental impacts of dredging and the disposal of dredged materials on navigation, fish and other aquatic life, water quality, and the general public interest. Between 1972 and 1981, dredged materials from Port Washington Harbor have been loaded onto scows and towed to the Port of Milwaukee where they were subsequently deposited in the confined disposal facility adjacent to the Milwaukee harbor area. In addition, materials were dredged from the harbor in 1981 and 1982 as part of a new marina development. The coarse materials that were dredged were stockpiled by the City of Port Washington for future use as sewer trench backfill. Dredged materials which were not suitable for use as backfill were transported to and disposed of in a floodplain site located approximately five miles west of the harbor.

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Table 1

DREDGING HISTORY FOR PORT WASHINGTON HARBOR:1960-1986

Year	Amount Dredged ($yards^3$)
1960	21,000
1962	9,600
1965	9,300
1967	15,000
1968	15,000
1969	11,500
1971	8,500
1977	14,000
1981	16,400
1981	12,140*
1982	62,500*

*Dredging conducted by private firms under contract to the City of Port Washington.

Source: Wisconsin Department of Natural Resources

Present Sediment and Dredged Material Disposal Problems

High Lake Michigan water levels in 1985 and 1986 combined with a relatively low sedimentation rate for Port Washington Harbor--approximately 1.3 inches per year--have reduced the present need for dredging. However, as lake levels decrease and the need for dredging arises, the need for determining the proper means of, and location for, the deposition of dredged material will be of concern. Presently, the City of Port Washington does not have a plan to facilitate the disposal of material dredged from Port Washington Harbor. This plan is intended to provide the City of Port Washington with various options regarding the disposal of dredged material and thereby serve as a practical guide to the safe disposal of unpolluted dredged materials from Port Washington Harbor.

Proposed Harbor Improvements

At present, the City of Port Washington has tentative plans to modify and improve the harbor for additional recreational boat use. Such proposed improvements include the placement of structures in the harbor to attenuate wave action in the north and west harbor slips and the modification of the north slip to serve as a small boat marina. Both proposed developments may require the dredging of additional bottom sediments from the Port Washington Harbor to facilitate construction of the necessary structures.

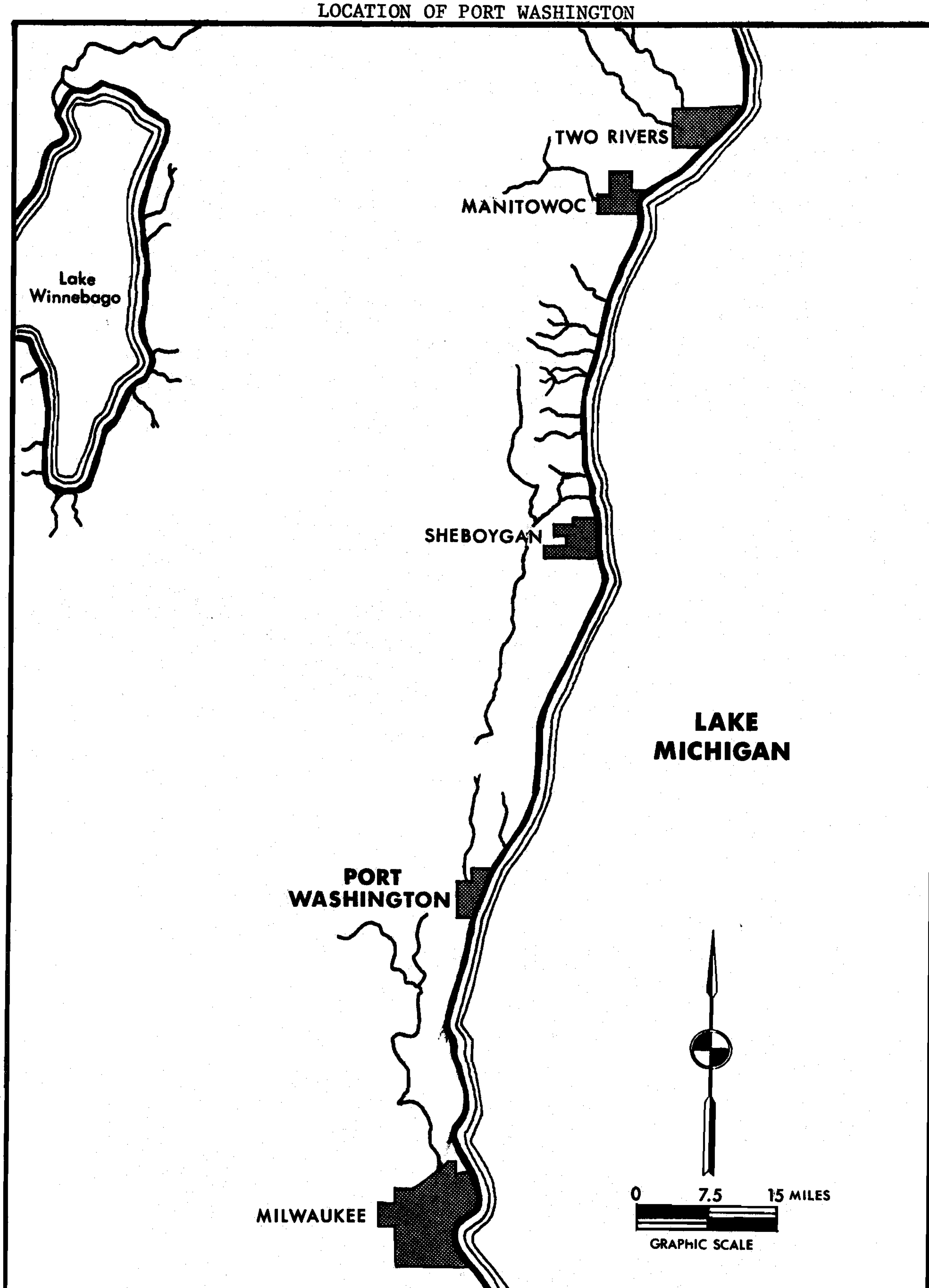
Geographic Location

The City of Port Washington is located on the west shore of Lake Michigan in the Town of Port Washington in Ozaukee County, and provides the only port facilities between the City of Milwaukee, Wisconsin, approximately 30 miles south, and the City of Sheboygan, Wisconsin, approximately 30 miles north (see Map 1).

The Port Washington Harbor is comprised of two distinct units: the inner harbor and the outer harbor, as shown on Map 2. The inner harbor has depths ranging from 7 feet to 21 feet and a surface area of approximately 8.3 acres. The outer harbor has depths ranging from 3 feet to 27 feet and has a surface area of approximately 62.4 acres.

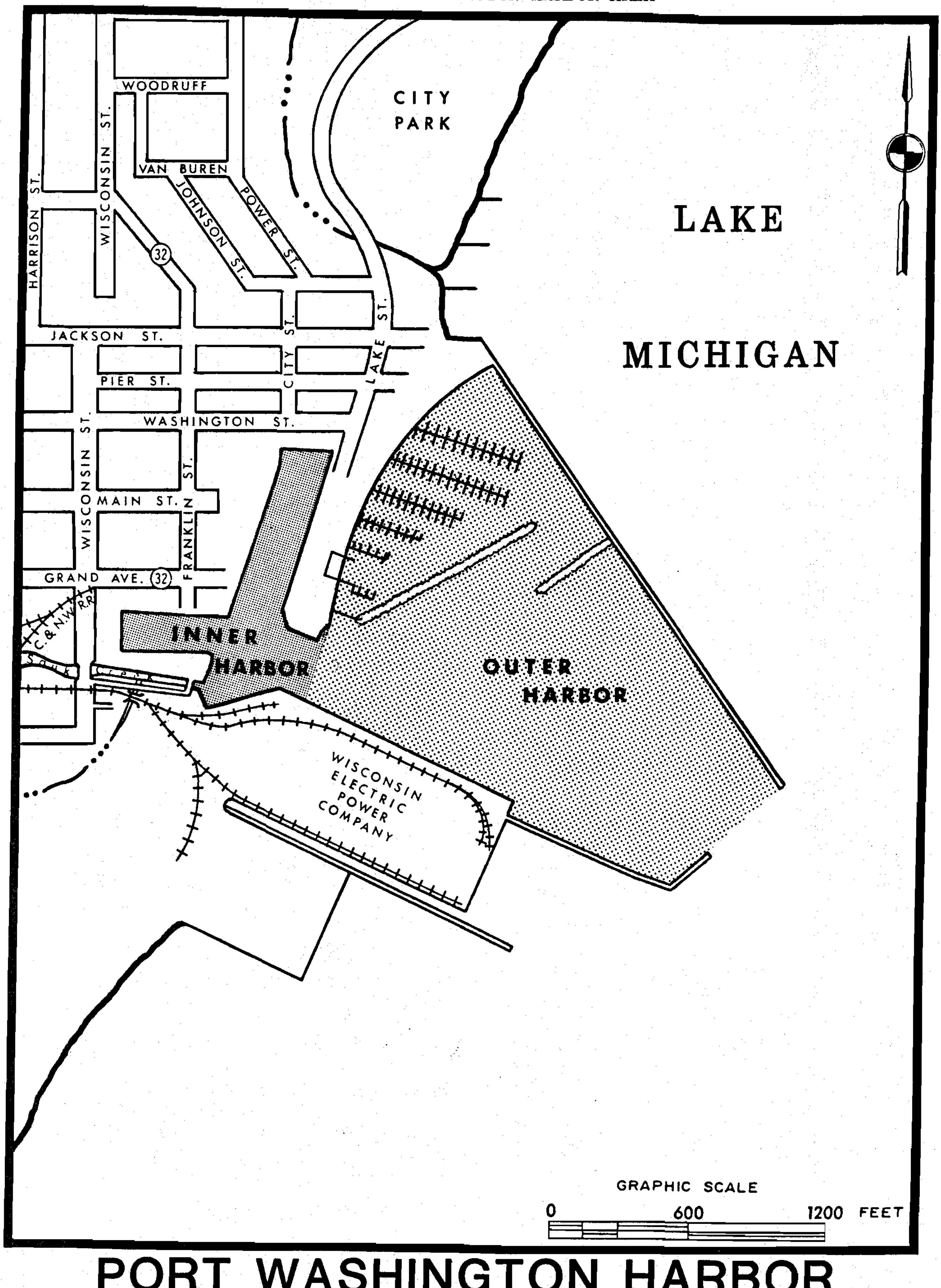
Map 1

LOCATION OF PORT WASHINGTON



Map 2

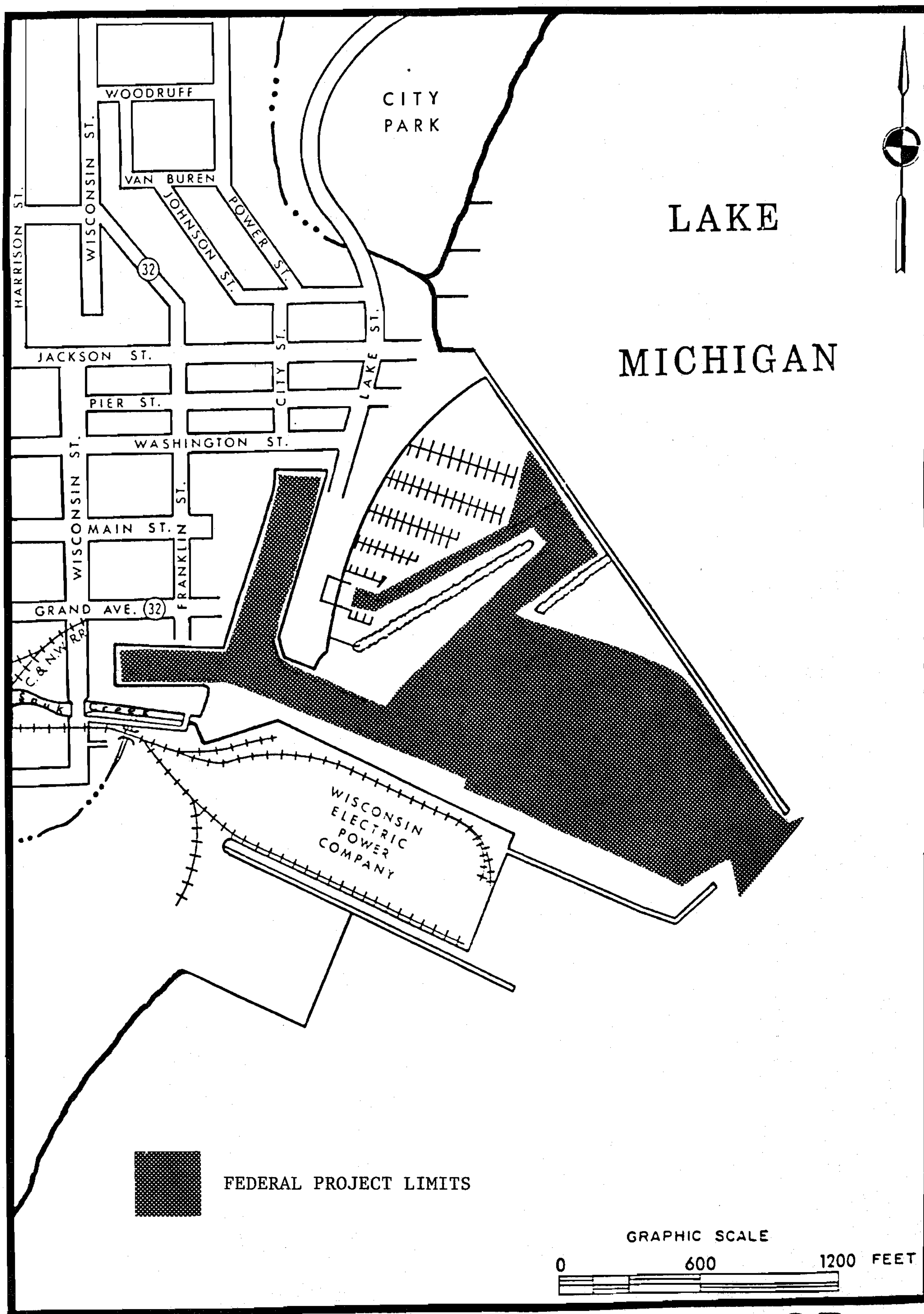
THE PORT WASHINGTON HARBOR AREA



Political Jurisdiction

The Port Washington harbor is managed by the Port Washington Harbor Commission. The Harbor Commission, which assumes responsibility for the maintenance of facilities within and related to the harbor, is comprised of seven members appointed by the Mayor of the City of Port Washington. In addition, the Commission assumes responsibility for harbor planning and development. Within the federal project limits of the harbor (see Map 3), the Corps of Engineers has responsibility for dredging to maintain conditions conducive to navigation within the harbor. The Corps of Engineers also assumes responsibility for disposal of the dredged material that results from their dredging efforts. The City of Port Washington assumes responsibility for all dredging which occurs outside the federal project limits and for the disposal of that dredged material.

Map 3
FEDERAL PROJECT LIMITS WITHIN
THE PORT WASHINGTON HARBOR AREA



PORT WASHINGTON HARBOR

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Chapter II

INVENTORY FINDINGS

This chapter summarizes the inventory data pertinent to the sound evaluation of potential disposal sites for the dredged materials from the Port Washington harbor. Included within this chapter is a description of the natural and man-made features of the Port Washington Harbor area, a description of existing land use in the Region and of the supporting transportation system; a summary of the existing water quality management practices of the Sauk Creek watershed; and a description of the composition and characteristics of bottom materials from the Port Washington Harbor.

In addition to forming the basis of this specific report, this chapter is intended to provide the City of Port Washington, the Port Washington Harbor Commission, and other agencies with a knowledge of available data and data sources which could be used in the conduct of more detailed disposal area siting studies.

NATURAL FEATURES

Sauk Creek is the only direct tributary to the Port Washington Harbor and, as such, may significantly impact water quality conditions in the Port Washington Harbor. The Sauk Creek watershed is a natural surface water drainage unit of approximately 33 square miles in areal extent located in the northern portion of the Region. The boundaries of the basin, together with the locations of the main channels of Sauk Creek, are shown on Map 4. The main stem of Sauk Creek originates two miles northeast of the Village of Fredonia in north-central Ozaukee County and discharges directly into Port Washington Harbor, and subsequently into Lake Michigan.

The topography within the Sauk Creek watershed is gently rolling and is underlain by soils generally classified as silt loams. Table 2 presents a list of soil types found within the watershed. Most of the soils are relatively fertile and produce high crop yields if managed properly. If not managed properly, runoff from these soils may result in contributions of high sediment and nutrient levels in stream waters, and ultimately in Port Washington Harbor.

Map 4

THE SAUK CREEK WATERSHED

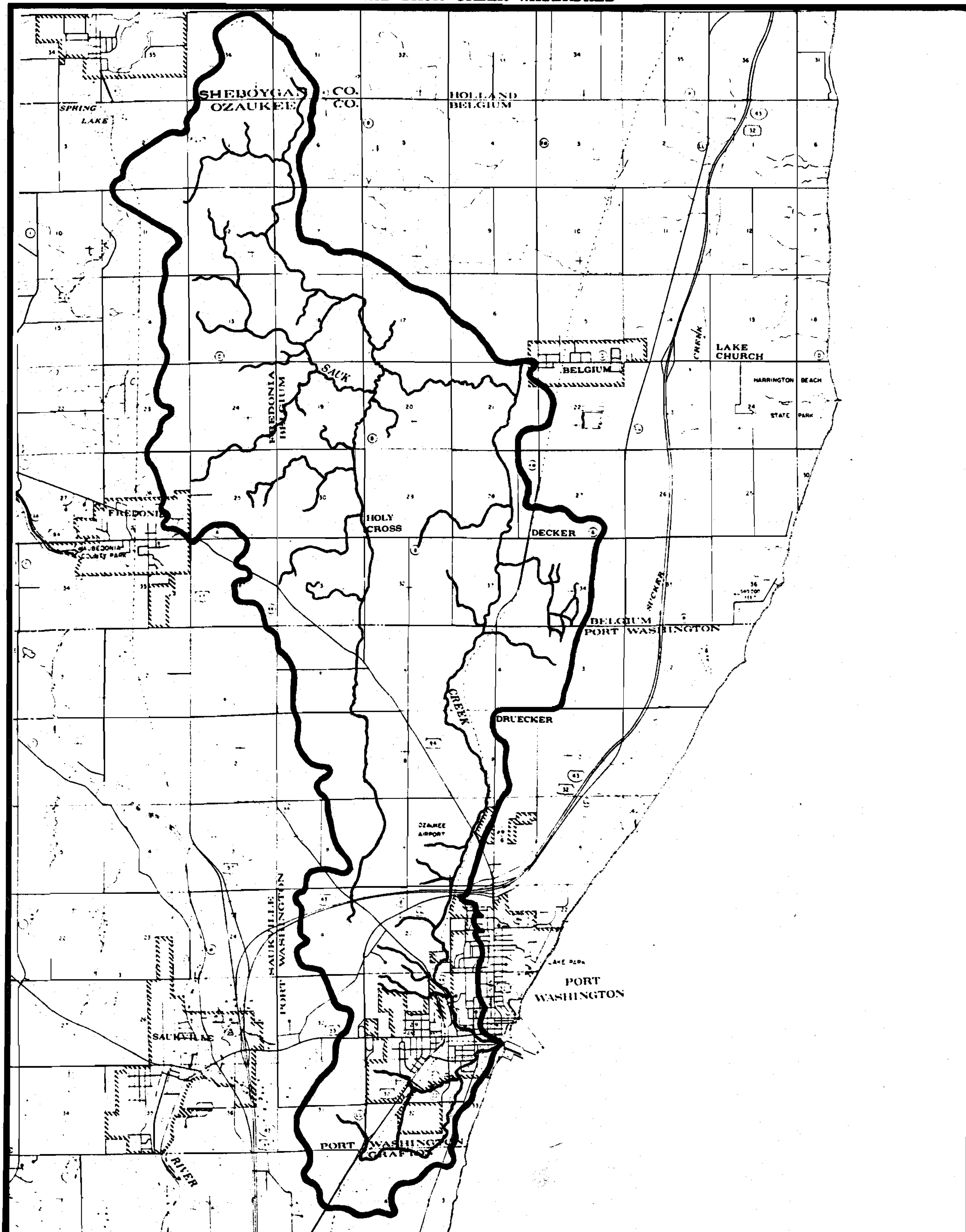

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Table 2

SOIL TYPES FOUND WITHIN THE SAUK CREEK WATERSHED

Soil Type	Susceptibility to Erosion	Percentage of Watershed Covered by Soil Type
Kewaunee silt loam. . .	Slight on 0-2%; moderate on 2-12%; severe on 23-45% slopes	33.0
Kewaunee silty clay loam	Slight on 0-2%; moderate on 2-12% slopes severe on 12-45% slopes	14.0
Manawa silt loam . . .	Slight on 0-2%; moderate on 2-6% slopes	11.0
Poygan silt loam . . .	Slight on 0-2%; moderate on 2-6% slopes	8.0
Casco loam	Slight on 0-2%; moderate on 2-12%; severe on 12-45% slopes	5.0
Lorenzo-rodman loam. .	Slight on 0-2%; moderate on 2-12%; severe on 12-45% slopes	3.0
Juneau silt loam. . . .	Slight on 0-2%; moderate on 2-12% slopes	2.0
Palms mucky peat . . .	Moderate	2.0
Casco silt loam. . . .	Slight on 0-2%; moderate on 2-12%; severe on 12-45% slopes	2.0
Fabius silt loam . . .	Slight on 0-2%; moderate on 2-6% slopes	2.0
Tustin sandy loam. . .	Moderate on 0-6%; severe on 6-12% slopes	2.0
Fabius sandy loam. . .	Slight on 0-2%; moderate on 2-6% slopes	1.0
Houghton muck	Moderate on 0-6%; severe on 6-12% slopes	1.0
Pistakee silt loam . .	Slight on 0-2%; moderate on 2-12% slopes	1.0
Ionia silt loam. . . .	Slight on 0-2%; moderate on 2-12% slopes	1.0
Nenno silt loam. . . .	Slight on 0-2%; moderate on 2-12% slopes	1.0
Ogden muck	Moderate	1.0
Colwood silt loam . . .	Slight on 0-2%; moderate on 2-6% slopes	1.0
Kibbie silt loam. . . .	Slight on 0-2%; moderate on 2-6% slopes	1.0
Fox loam.	Slight on 0-2%; moderate on 2-12%; severe on 12-45% slopes	1.0
Alluvial soils.	Slight on 0-2%; moderate on 2-6% slopes	1.0
Alluvial soils (wet). .	Slight on 0-2%; moderate on 2-6% slopes	1.0
Mussey silt loam. . . .	Slight on 0-2%; moderate on 2-6% slopes	1.0
Fox silt loam	Slight on 0-2%; moderate on 2-12%; severe on 12-45% slopes	1.0

Available data indicate that approximately 118,000 pounds of sediment are deposited in Port Washington Harbor annually.

Limnology of the Harbor

Water quality within the Port Washington Harbor is considered to be very good. A priority pollutant scan was conducted by the Wisconsin Department of Natural Resources (DNR) in 1986 in order to make preliminary determinations regarding the suitability of harbor water for drinking water. Results from the priority pollutant scan indicated that, of the contaminants detected, maximum contaminant levels as set forth by the U.S. Environmental Protection Agency were not exceeded by any individual pollutant (see Table 3).

Four separate taxa of benthic invertebrates were determined to be present during sediment quality analyses. Of the four taxa, the Naididae, a family of small aquatic worms, was most commonly detected during the analyses. Table 4 presents information showing those invertebrate taxa that were determined to be present in Port Washington Harbor sediments in 1982.

The harbor provides quality sheltering and feeding habitat for a host of fish species. Notably, trout, salmon, alewife, smelt, and perch, among others, use the harbor area to find food and cover. Areas shallow enough to provide aquatic macrophyte growth, less than 10 to 12 feet, provide excellent cover for fish and serve as important nursery areas for juvenile perch and alewife. In addition, harbor walls and breakwaters constitute important microhabitat for fish utilizing the harbor area by providing substrates suitable for supporting aquatic prey, and by providing shelter. Finally, bottom elevations in the harbor channel act as a conduit with a gentle gradient that facilitates fish movement into and out of the harbor. Table 5 presents a list of fish species which were present during DNR fish surveys conducted in the harbor during 1984 and 1985. No state or federal endangered, threatened, or rare species were observed during the surveys.

Harbor dredging has the potential to negatively impact the fishery resource within Port Washington Harbor. If fish are spawning within the harbor, the suspension and resettling of sediments during the dredging process may result

Table 3

SELECTED INORGANIC POLLUTANTS DETECTED DURING THE PRIORITY POLLUTANT SCAN OF SURFACE WATER FROM PORT WASHINGTON HARBOR: 1986

Parameter	Sampled Concentration (ug/l)	Allowable Contaminant Level (ug/l)
Arsenic	10	50
Barium	400	1,000
Cadmium	0.2	10
Chloride	10	250
Copper	50	1,000
Lead	3	50
Manganese	40	50
Mercury	0.2	2
Selenium	5	10
Silver	0.5	50
Zinc	20	5,000

Source: Wisconsin Department of Natural Resources

Table 4

BENTHIC INVERTEBRATES DETECTED DURING
SEDIMENT QUALITY ANALYSIS: 1982

Sampling Site	Taxa of Organisms (Class-Family)	Common Name	Number of Organisms
1	Oligochaeta-Naididae	Aquatic earthworms	89
2	Oligochaeta-Naididae	Aquatic earthworms	71
	Hirundinea-Glossiphonidae	Leeches	1
3	Oligochaeta-Naididae	Aquatic earthworms	451
	Crustacea-Assellidae	Aquatic sow bugs	1
4	Oligochaeta-Naididae	Aquatic earthworms	374

Source: U.S. Army Corps of Engineers

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Table 5

SPECIES OF FISH IDENTIFIED DURING
PORT WASHINGTON HARBOR SURVEYS: 1984 AND 1985

Common Name	Scientific Name	Pollution Tolerance[1]	Occurrence[2]
Clupeidae			
Alewife[3]	*Alosa pseudoharengus*	--	O
Gizzard shad	*Dorosoma cepedianum*	--	A
Salmonidae			
Lake whitefish	*Coregonus clupeaformis*	I	O
Coho salmon[3]	*Oncorhyncus kisutch*	I	C
Chinook salmon[3]	*Oncorhynchus tshawytscha*	I	O
Rainbow trout[3]	*Salmo gairdnerii*	I	C
Brown trout[3]	*Salmo trutta*	I	A
Lake trout	*Salvelinus namaycush*	I	O
Osmeridae			
Rainbow smelt	*Osmerus mordax*	T	O
Esocidae			
Northern pike	*Esox lucius*	T	O
Cyprinidae			
Hornyhead chub	*Nocomis biguttatus*	I	O
Spottail shiner	*Notropis hudsonius*	I	O
Bluntnose minnow	*Pimephales notatus*	T	O
Fathead minnow	*Pimephales promelas*	VT	O
Carp[3]	*Cyprinus carpio*	VT	C
Catostomidae			
White sucker	*Catostomus commersoni*	VT	C
Gasterosteidae			
Ninespine stickleback	*Pungitius pungitius*	T	O
Centrarchidae			
Rock bass	*Amblophlites rupestris*	T	C
Pumpkinseed	*Lepomis gibbosus*	T	C
Bluegill	*Lepomis macrochirus*	T	O
Black crappie	*Pomoxis nigromaculatus*	T	O
Percidae			
Johnny darter	*Etheostoma nigrum*	T	O
Yellow perch	*Perca flavescens*	T	A
Cottidae			
Sculpin	*Cottus* sp.	I	O

[1]VT = Very tolerant
T = Tolerant
I = Intolerant

[2]A = Abundant
C = Common
O = Occasional

[3]Fish species is alien, or non-native, to Wisconsin.

Source: Wisconsin Department of Natural Resources

in siltation and sedimentation covering of those spawning beds. In addition, dredging areas which support benthic organisms as well as stands of aquatic macrophytes would remove important nursery habitat, food, and cover for fish utilizing the harbor area. Care should be taken to minimize these and other potential adverse effects during the planning and implementation phases of harbor dredging.

Wetlands

There are no areas of significant emergent wetland within Port Washington Harbor.

Wildlife Habitat

Port Washington Harbor, due to its association with Lake Michigan, provides important habitat for wildlife, especially migratory waterfowl. The harbor area lies adjacent to one of the major migratory corridors for waterfowl using the Mississippi flyway during migration. Bellrose,[2] in his analysis of waterfowl migration corridors east of the Rocky Mountains, lists the western shore of Lake Michigan, which includes Port Washington Harbor, as a major migratory route for diving ducks and Canada geese. Because the harbor provides high quality resting, sheltering, and feeding habitat for several species of waterfowl using the Lake Michigan migratory corridor, the DNR has classified the harbor as a Class I habitat type, the Department's highest wildlife habitat rating. In addition, the harbor also provides important sheltering and resting habitat for a variety of other water-related birds such as gulls and terns, including the common tern, (*Sterna hirundo*), an endangered species in Wisconsin. Table 6 lists those species that have been observed in the harbor area.

Other Natural and Historic Features

There are no designated state scientific or natural areas, or woodlands in or adjacent to the harbor area. However, all of Port Washington Harbor lies within a SEWRPC designated primariy environmental corridor.

The Hoffman House Hotel, which was constructed in 1901, lies adjacent to the primary environmental corridor which encompasses the harbor area and is listed

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[2] Bellrose, Frank C., 1977, *Ducks, Geese, and Swans of North America*; Stackpole Publishing Company, 337 pp.

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Table 6

BIRDS OCCURRING IN THE PORT WASHINGTON HARBOR STUDY AREA

Podicipedidae

Podiceps auritus--Horned grebe

Ardeidae

Ardea herodias--Great blue heron

Anatidae

Anas platyrhynchos--Mallard

Anas rubripes--Black duck

Anas clypeata--Northern shoveler

Aythya americana--Redhead

Aythya collaris--Ring-necked duck

Aythya valisneria--Canvasback

Aythya affinis--Lesser scaup

Aythya marila--Greater scaup

Bucephala clangula--Common goldeneye

Bucephala albeola--Bufflehead

Clangula hyemalis--Oldsquaw

Oidemia nigra--Black scoter

Oxyura jamaicensis--Ruddy duck

Lophodytes cucullatus--Hooded merganser

Mergus merganser--Common merganser

Mergus servator--Red breasted merganser

Rallidae

Fulica americana--American coot

Laridae

Larus argentatus--Herring gull

Larus delawarensis--Ring-billed gull

Larus philadelphia--Bonaparte's gull

Sterna hirundo--Common tern[1]

Hydroprogne caspia--Caspian tern

[1] A Wisconsin Endangered Species

Source: Wisconsin Electric Power Company and SEWRPC.

on the National Register of Historic Places in Wisconsin. No other known historic or archeological sites have been identified in or adjacent to the harbor area.

The Environmental Corridor Concept

One of the most important tasks undertaken by the Commission as part of its regional planning effort was the identification and delineation of those areas of the Region having high concentrations of natural, recreational, historic, aesthetic, and scenic resources and which, therefore, should be preserved and protected in order to maintain the overall quality of the environment. Such areas normally include one or more of the following seven elements of the natural resource base which are essential to the maintenance of both the ecological balance and the natural beauty of the Region: 1) lakes, rivers, and streams and their associated undeveloped shorelands and floodlands; 2) wetlands; 3) woodlands; 4) prairies; 5) wildlife habitat areas; 6) wet, poorly-drained, and organic soils; and 7) rugged terrain and high-relief topography. While these seven elements constitute integral parts of the natural resource base, there are five additional elements which, although not a part of the natural resource base per se, are closely related to or centered on that base and therefore are important considerations in identifying and delineating areas with scenic, recreational, and educational value. These additional elements are: 1) existing outdoor recreation sites; 2) potential outdoor recreation and related open space sites; 3) historic, archaeological, and other cultural sites; 4) significant scenic areas and vistas; and 5) natural and scientific areas.

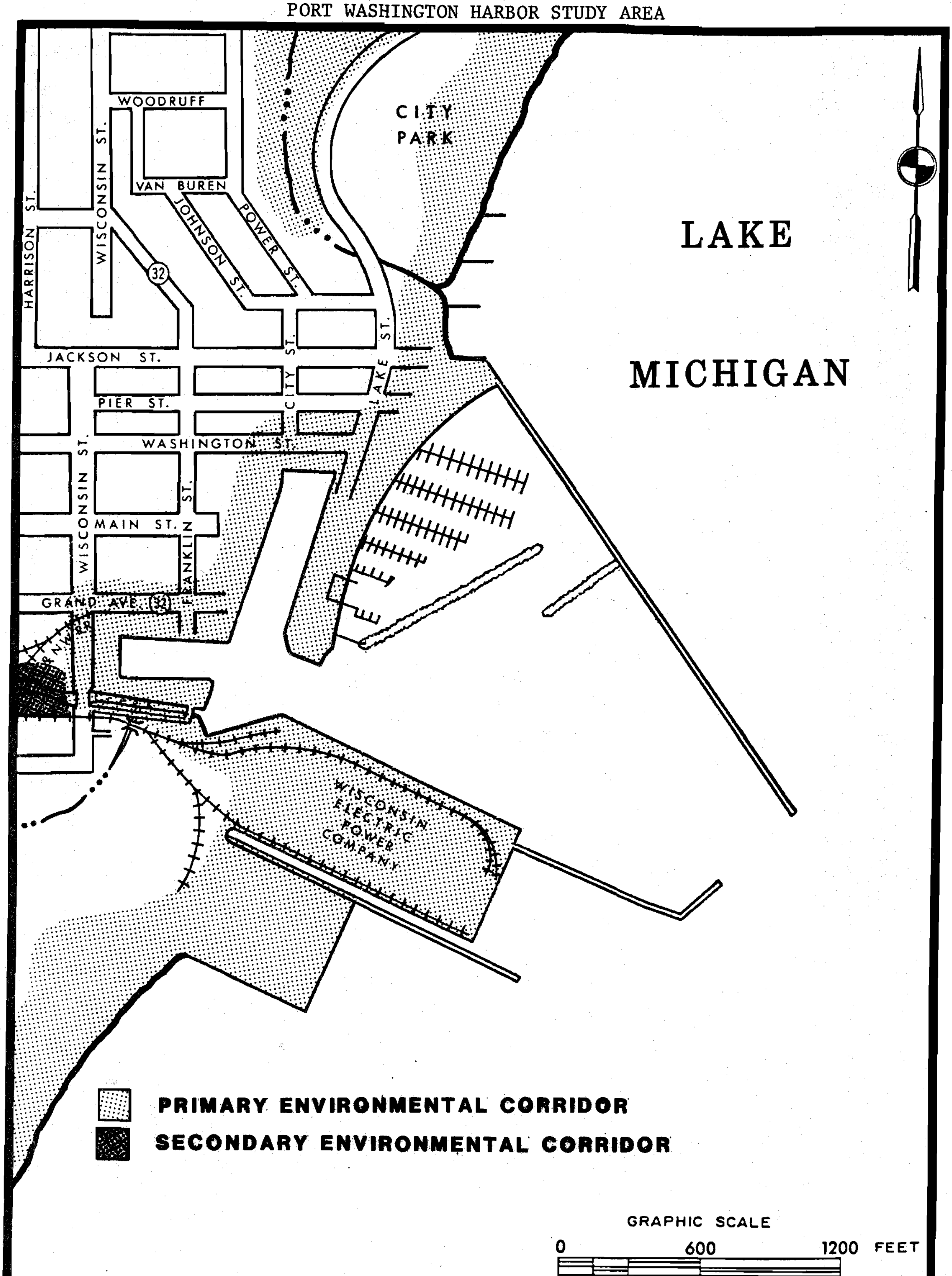
The delineation of these 12 natural resource and resource-related elements on a map results in an essentially linear pattern of relatively narrow, elongated areas which have been termed "environmental corridors" by the Commission.

Primary Environmental Corridors:

Primary environmental corridors include a wide variety of the above-mentioned resource and resource-related elements and are at least 400 acres in size, two miles long, and 200 feet wide. As stated earlier, and as indicated on Map 5, the entire harbor area lies within a primary environmental corridor.

Map 5

ENVIRONMENTAL CORRIDORS IN THE
PORT WASHINGTON HARBOR STUDY AREA



PORT WASHINGTON HARBOR

Secondary Environmental Corridors :

The secondary environmental corridors are generally located along intermittent streams or serve as links between segments of primary environmental corridors. Secondary environmental corridors contain a variety of resource elements, often remnant resources from former primary environmental corridors which have been developed for intensive agricultural purposes or urban land uses. Secondary environmental corridors facilitate surface water drainage, maintain pockets of natural resource features, and provide for the movement of wildlife, as well as for the movement and dispersal of seeds for a variety of plant species. Such corridors should also be preserved in essentially natural, open uses as urban development proceeds, particularly when the opportunity is presented to incorporate the corridors into urban stormwater detention areas, associated drainageways, and neighborhood parks. As indicated on Map 5, Sauk Creek, the main tributary to Port Washington Harbor, lies within a secondary environmental corridor.

TRANSPORTATION FACILITIES

Transportation routes can serve an important function in dredged material disposal. Accordingly, any evaluation of potential upland disposal sites must consider the accessibility of such potential sites as determined by arterial street and highway locations and characteristics.

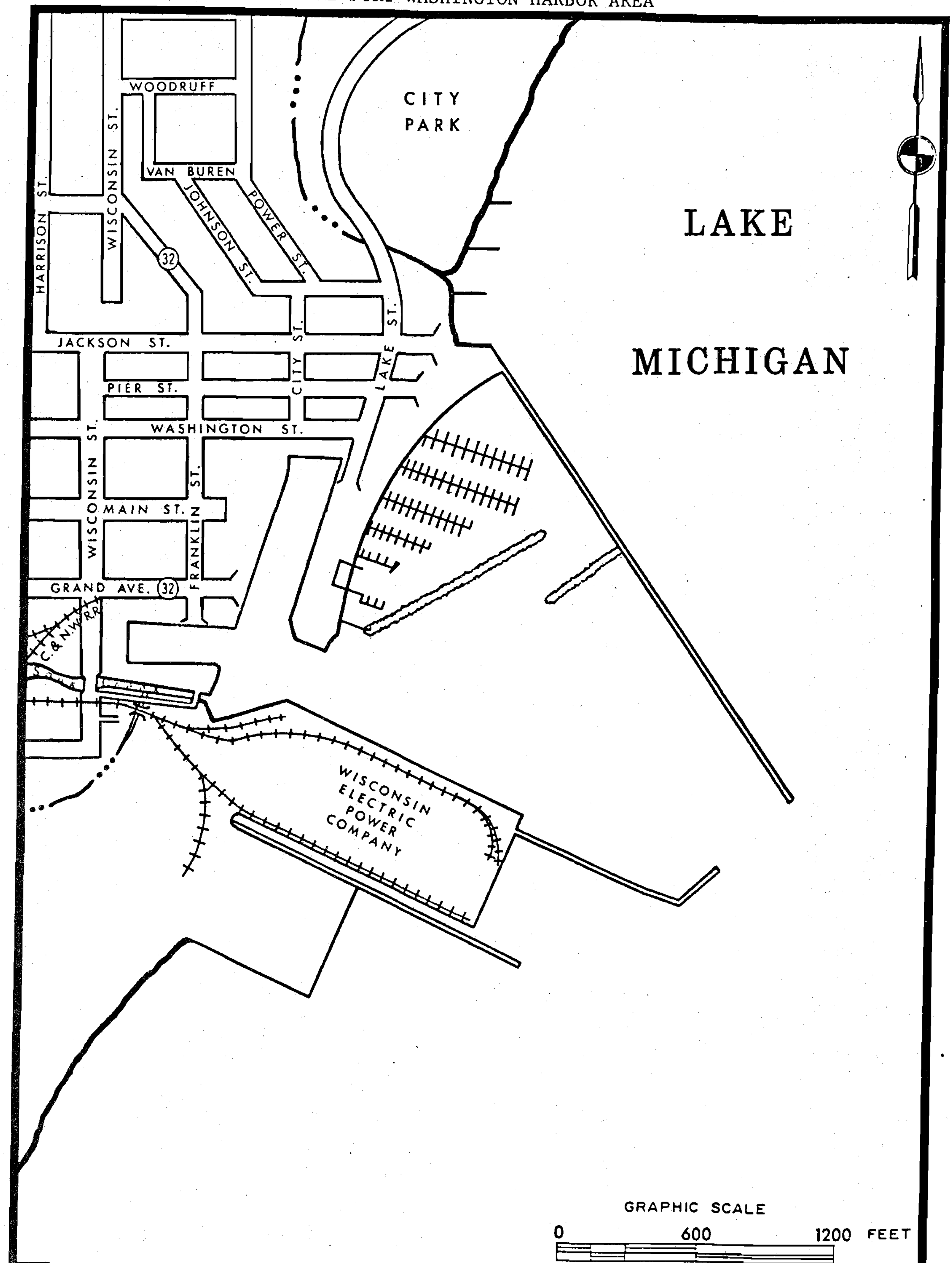
Access to and egress from the Port Washington Harbor area is provided by several local streets and one arterial highway. As shown on Map 6, local street access to the harbor is provided by Jackson Street, Pier Street, and Washington Street, and arterial street access is provided by STH 32, which provides access to STH 33 and IH 43. The existing surface transportation facilities in and around the Port Washington Harbor area, therefore, are adequate to provide for the ready transport of dredged material to upland areas by truck. Map 7 indicates the arterial street and highway network within Ozaukee and Washington Counties.

LAND USE WITHIN THE WATERSHED

About 30 square miles, or 91 percent of the total area of the Sauk Creek watershed, remains in rural land uses, with 27 square miles, or about 82 percent of the rural area, being in agricultural use. An additional three square

Map 6

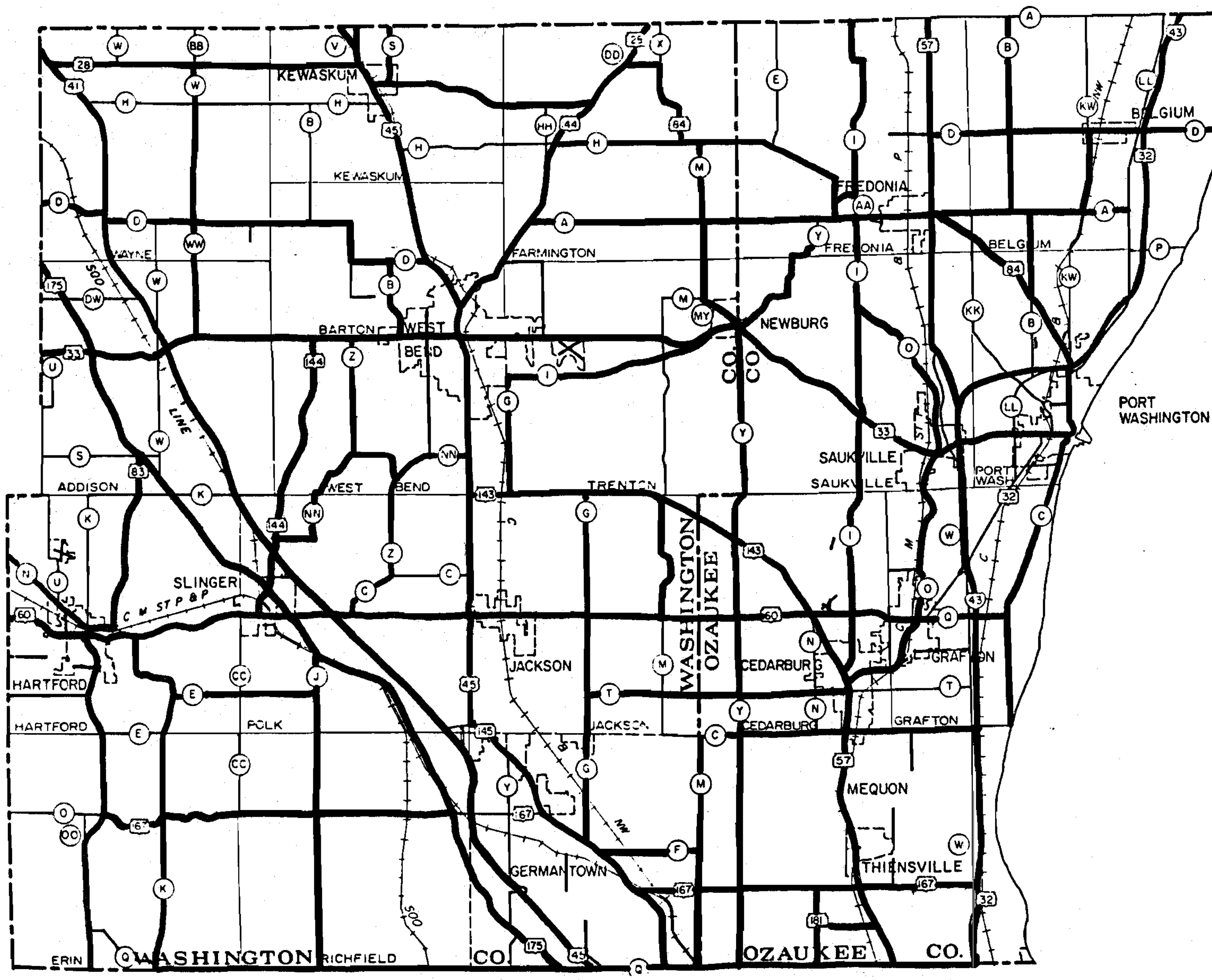
LOCAL STREET ACCESS WITHIN THE PORT WASHINGTON HARBOR AREA



PORT WASHINGTON HARBOR

Map 7

ARTERIAL STREETS AND HIGHWAYS IN
WASHINGTON AND OZAUKEE COUNTIES



Source: SEWRPC

miles consists of urban-related land uses located in and near the City of Port Washington and the Village of Fredonia in the southern and west-central portion of the watershed, respectively. Table 7 sets forth the extent and proportion of the major land use categories within the watershed as they relate to water quality conditions.

GENERAL HARBOR WATER USES

Presently, the harbor provides launching and mooring facilities for small and medium-sized pleasure craft and mooring facilities for commercial and chartered fishing vessels. By providing these facilities, the harbor supports a commercial and private sport fishery which includes significant catches of desirable game species such as coho and chinook salmon, and lake, rainbow, and brown trout.

Large coal barges enter the harbor to deliver coal to the Wisconsin Electric Power Company (WEPCO) electric power generating station which is located south of and immediately adjacent to the harbor area. Coal-laden barges moor inside the harbor in an area adjacent to the south harbor wall while unloading coal. As a byproduct of the electric power generating process, the WEPCO power plant discharges warmwater into the harbor area from an outfall located north of the south harbor wall. In addition, the City of Port Washington discharges treated sanitary sewer effluent to the outer harbor from a sewage treatment plan outfall located just off the south end of the small boat marina.[3]

The Port Washington Harbor is contiguous with Lake Michigan and as such is classified as a coldwater fishery. Accordingly, the coldwater fishery and aquatic life and recreational standards of the Wisconsin Department of Natural Resources should be applied to the harbor. Lake Michigan is also classified as a public water supply, and public water supply water quality standards should also be considered in relation to Port Washington Harbor. However, Sauk Creek, the direct tributary to Port Washington Harbor, is recommended by

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[3]Volume 3 of SEWRPC Planning Report No. 30, A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000, recommends that the City of Port Washington sewage treatment plant sewer outfall be constructed to discharge sewage treatment plant effluent to Lake Michigan beyond the confines of the area enclosed by the harbor breakwater.

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Table 7

AREAL EXTENT OF LAND USE CATEGORIES WITHIN THE SAUK CREEK WATERSHED: 1980

Land Use	Acres	Percent
URBAN		
Residential	685	3.2
Commercial[a]	137	0.6
Industrial[b]	111	0.5
Transportation[c]	968	4.5
Recreation	40	0.1
Subtotal	1,941 (3.0 mi^2)	8.9
RURAL		
Agriculture[d]	17,478	82.0
Wetlands	999	4.7
Woodlands	395	2.0
Surface Water	28	0.1
Other Open Space[e]	489	2.3
Subtotal	19,389 (30.0 mi^2)	91.1
Total	21,330 (33.0 mi^2)	100.0

[a] Includes: retail, communication, utilities, administrative, and institutional land uses.

[b] Includes: manufacturing, landfills and dumps, and extractive operations.

[c] Includes: streets and highways, off-street parking, airfields, railroad yards, and terminals.

[d] Includes: small grains, hay, row crops, specialty crops, sod farms, orchards, and nurseries.

[e] Includes: pasture, unused urban and rural lands.

Source: SEWRPC

the Southeastern Wisconsin Regional Planning Commission to be classified as a warmwater fishery. Therefore, warmwater fishery and aquatic life and recreational standards should be applied to Sauk Creek. Coldwater and warmwater fishery and aquatic life standards are presented in Table 8.

EXISTING WATER QUALITY MANAGEMENT PRACTICES

The Sauk Creek watershed has not been designated as a priority watershed under the Wisconsin Fund Nonpoint Source Pollution Abatement Program because the nonpoint pollution problems have not been determined to be as critical as those found in some neighboring watersheds. Volume Two of SEWRPC Planning Report No. 30, A Regional Water Quality Management Plan For Southeastern Wisconsin--2000, indicated that as of 1975, the Sauk Creek watershed exhibited a moderate potential for urban nonpoint source pollution and a moderate-to-low potential for rural nonpoint source pollution.

The soils within the Sauk Creek watershed are generally silt loams. Most of the soils are relatively fertile and produce high crop yields if managed properly. If not managed properly, runoff from these soils may contribute to high sediment and nutrient levels in stream waters, and ultimately in Port Washington Harbor.

Pollution Loadings

Since 1975, urban sources of pollution have been estimated to contribute about 18,910 pounds, or 4 percent of the nitrogen; 4,720 pounds, or 7 percent of the phosphorus; 156,660 pounds, or 11 percent of the biochemical oxygen demand; $1,514,912 \times 10^8$ counts per year, or 3 percent of the fecal coliform; and 7,075 tons per year, or 13 percent of the sediment levels which occur as water pollutants in the Sauk Creek watershed. Of the urban contribution, the point sources of pollution, which include two flow relief devices and one industrial discharge have been determined to contribute only 370 pounds per year, or 2 percent of the nitrogen; 60 pounds per year, or 1 percent of the phosphorus; 2,010 pounds per year, or 1 percent of the biochemical oxygen demand; $110,000 \times 10^8$ counts per year, or 7 percent of the fecal coliform; and essentially

Table 8

COLDWATER FISHERY AND AQUATIC LIFE STANDARDS AND PUBLIC WATER SUPPLY FOR PORT WASHINGTON HARBOR AND WARMWATER FISHERY AND AQUATIC LIFE STANDARDS FOR SAUK CREEK

Water Quality Parameters	Individual Water Quality Standards		
	Public Water Supply	Warmwater Fish and Aquatic Life	Coldwater Fish and Aquatic Life
Maximum Temperature (°F)	--	89[a,c]	--[a,b,c]
pH Range (S.U.)	6.0-9.0[d]	6.0-9.0[d]	6.0-9.0[d]
Minimum Dissolved Oxygen (mg/l)	--	5.0	6.0[c]
Maximum Fecal Coliform (counts per 100 ml)	200-400[e]	--	--
Maximum Total Residual Chlorine (mg/l)	--	0.01	0.002
Maximum Un-ionized Ammonia-Nitrogen (mg/l)	--	0.04	0.02
Total Ammonia Nitrogen (mg/l)	--	--	--
Maximum Total Dissolved Solids (mg/l)	500-750[f]	--	--
Other	--[g]	--[i]	--[h,i]

[a]There shall be no temperature changes that may adversely affect aquatic life. Natural daily and seasonal temperature fluctuations shall be maintained. The maximum temperature rise at the edge of the mixing zone above the existing natural temperature shall not exceed 5°F for streams and 3°F for lakes.

[b]There shall be no significant artificial increases in temperature where natural trout or stocked salmon reproduction is to be protected.

[c]Dissolved oxygen and temperature standards apply to streams and the epilimnion of stratified lakes and to the unstratified lakes; the dissolved oxygen standard does not apply to the hypolimnion of stratified inlake lakes. Trends in the period of anaerobic conditions in the hypolimnion of deep inland lakes should be considered important to the maintenance of their natural water quality, however. Dissolved oxygen shall not be lowered less than 7.0 mg/l during the trout spawning season.

[d]The pH shall be within the range of 6.0 to 9.0 standard units with no change greater than 0.5 units outside the estimated natural seasonal maximum and minimum.

-continued-

Footnotes (continued)

[e]Shall not exceed a monthly geometric mean of 200 per 100 ml based on not less than five samples per month nor a monthly geometric mean of 400 per 100 ml in more than 10 percent of all samples during any month.

[f]Not to exceed 500 mg/l as a monthly average nor 750 mg/l at any time.

[g]The intake water supply shall be such that by appropriate treatment and adequate safeguards it will meet the established Drinking Water Standards.

[h]Streams classified as trout waters by the DNR (Wisconsin Trout Streams, publication 213-72) shall not be altered from natural background by effluents that influence the stream environment to such an extent that trout populations are adversely affected.

[i]Unauthorized concentrations of substances are not permitted that alone or in combination with other materials present are toxic to fish or other aquatic life. The determination of the toxicity of a substance shall be based upon the available scientific data base. References to be used in determining the toxicity of a substance shall include, but not be limited to, Quality Criteria for Water. EPA-440/9-76-003, U.S. Environmental Protection Agency, Washington, D.C., 1976; Water Quality Criteria 1972. EPA-R3-73-003, National Academy of Sciences, National Academy of Engineering, U.S. Government Printing Office, Washington, D.C., 1974; and the Federal Register, Environmental Protection Agency, Water Quality Criteria Documents; Availability, November 28, 1980. Questions concerning the permissible levels, or changes in the same, of a substance, or combination of substances, or undefined toxicity to fish and other biota shall be resolved in accordance with the methods specified in Water Quality Criteria 1972 and Standard Methods for the Examination of Water and Wastewater, 14th Edition, American Public Health Association, New York, 1975, or other methods approved by the Department of Natural Resources.

Source: Wisconsin Department of Natural Resources and SEWRPC.

none of the sediment levels to the watershed.[4] Nonpoint sources--including the estimated septic tank and construction-related contributions in the drainage area--account for the remaining 18,540 pounds per year, or 98 percent of the nitrogen; 4,660 pounds per year, or 99 percent of the phosphorus; 154,650 pounds per year, or 93 percent biochemical oxygen demand; 1,404,912 x 10^8 counts per year, or 93 percent of the fecal coliform; and 7,075 tons per year, or nearly all of the sediment yields contributed from urban sources.

Of the total pollutant loads, rural pollution sources have been estimated to contribute the remaining 502,700 pounds per year, or 96 percent of the nitrogen; 67,600 pounds per year, or 93 prcent of the phosphorus, 1,297,010 pounds per year, or 89 percent of the biochemical oxygen demand, 58,374,375 x 10^8 counts per year, or 97 percent of the fecal coliform, and 47,865 tons per year, or 87 percent of the sediment levels which occur as water pollutants in the watershed. Of the rural pollution sources, none are point sources, since none of the livestock operations in the watershed are of sufficient size to be considered as a point source. Other livestock feeding operations--inclusive of the disposal of manure on croplands--were estimated to contribute 259,010 pounds per year, or 52 percent of the nitrogen; 60,190 pounds per year, or 89 percent of the phosphorus; 1,014,140 pounds per year, or 78 percent of the biochemical oxygen demand; 58,374,395 x 10^8 counts per year, or all of the fecal coliform; and 3,190 tons per year, or 7 percent of the sediment from rural sources. The remainder of the estimated rural pollution load, 243,690 pounds per year, or 48 percent of the nitrogen; 7,410 pounds per year, or 11 percent of the phosphorus; 282,870 pounds per year, or 22 percent of the biochemical oxygen demand; and 44,675 tons per year, or 93 percent of the sediment, have been determined to be contributed by other rural nonpoint sources, namely stormwater runoff from rural land uses and atmospheric loadings to surface waters.

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[4]In 1981, the City of Port Washington rehabilitated its public sanitary sewer system. Accordingly, all wastewater discharges that previously were discharged through the two flow relief devices and the single industrial discharge outfall now are routed into the City of Port Washington sewage treatment plant for treatment prior to discharge into the Port Washington harbor.

Urban Stormwater Management

There was one known urban stormwater drainage system providing service to the subareas of the Sauk Creek watershed within the Region in 1975. This system is operated by the City of Port Washington. The portion of the system that lies within the Sauk Creek watershed has a tributary drainage area of about 1.4 square miles, or about 4 percent of the total area of the watershed. Of the 15 stormwater outfalls currently in operation, five discharge directly into Port Washington Harbor. The remaining 10 stormwater outfalls discharge directly into Lake Michigan or into direct tributaries which discharge directly to Lake Michigan outside the harbor.

The regional water quality management plan recommended the implementation of low-cost urban nonpoint source pollution control measures such as public education programs; litter and pet waste control; improved timing and efficiency of street sweeping, leaf collection, and catch basin cleaning; proper use of fertilizers and pesticides; industrial and commercial storage facilities and runoff control measures; and critical area protection to provide a sufficient level of urban nonpoint source pollution control in the Sauk Creek watershed. The plan found that construction erosion control practices and proper management of onsite sewage treatment facilities will also be necessary for the abatement of urban nonpoint source pollution.

Minimum rural land management practices recommended by the plan included the proper use of fertilizers and pesticides, critical area protection, chisel tillage, pasture management, and contour plowing. Measures recommended to reduce pollutant loadings from animal operations include animal waste runoff control, surface water diversions, settling basins and holding ponds. In addition, the report further recommended that animal operations located less than 500 feet from a stream and in high or very high pollution areas require manure storage through the winter in a dry stacking system incorporating runoff control, or in a liquid or slurry storage system with no winter spreading of manure, in order to avoid spreading on frozen ground and the attendant high rates of surface runoff.

Urban and rural nonpoint source pollution abatement recommendations, especially those addressing erosion, sediment quality, and subsequent sedimentation problems, are important to proper harbor maintenance. Sedimentation rates, along with lake water levels, directly influence the need for dredging within Port Washington Harbor. While it is not possible to manage the lake water stages at the regional or state levels, the rate of sedimentation within the harbor can be influenced by appropriate land management practices. The recommended agricultural and construction erosion control measures can, if properly implemented and maintained, reduce the frequency for the need to dredge within Port Washington Harbor, and contribute to the improvement and maintenance of nonpolluted sediment quality conditions within the harbor.

QUANTITY AND CHARACTERISTICS OF DREDGED MATERIALS FROM THE PORT WASHINGTON HARBOR

Characteristics of Dredged Materials

The U.S. Army Corps of Engineers performed analyses to determine the composition and pollutant content of the sediments in the Port Washington Harbor. Map 8 shows the location of the sediment sampling stations. Table 9 presents a summary of the pollutant concentrations found during the sediment analyses. Table 9 also presents data regarding the solids content and the particle size of the sediments analyzed.

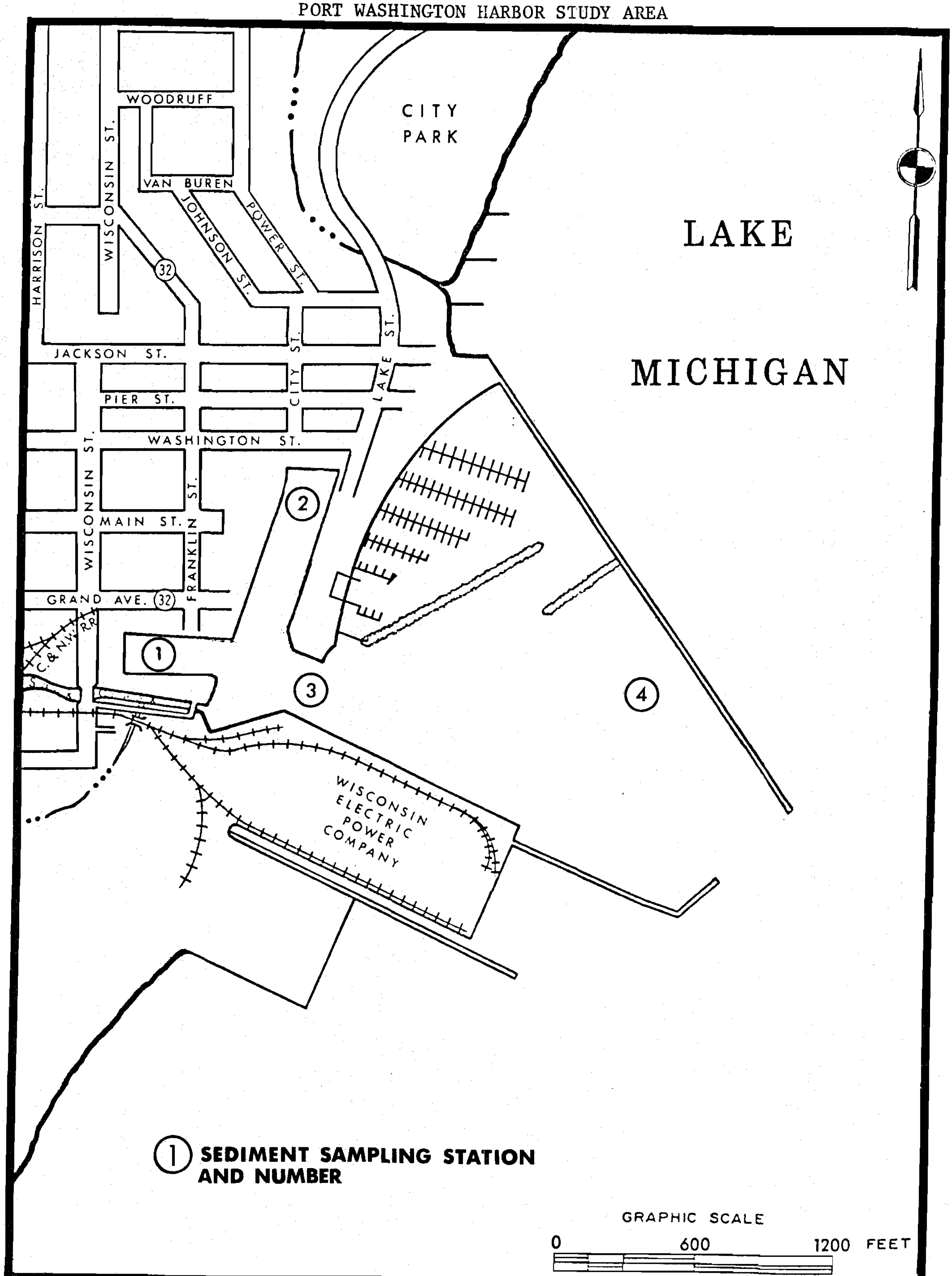
In light of the state-of-the-art knowledge regarding in-water disposal of dredged material, the Wisconsin Department of Natural Resources (DNR) is again considering the possibility of allowing in-water disposal of clean dredged materials. To that end, the DNR, by means of a technical subcommittee on determination of dredge material suitability, has developed guidelines for evaluating disposal options for dredged materials based upon pollutant concentrations. Table 10 presents a summary of the criteria used to classify sediment disposal options. In addition to the criteria for chemical contaminants, the subcommittee also established criteria for in-water disposal. The criteria are as follows:

1) If any pollutant, or group of pollutants, of concern is found in concentrations greater than 125 percent of the criteria for that pollutant, in-water disposal will not be allowed.

2) If three or more pollutants are found in concentrations greater than 110 percent of the criteria for those pollutants, in-water disposal will not be allowed.

Map 8

SEDIMENT SAMPLING STATIONS IN THE
PORT WASHINGTON HARBOR STUDY AREA



PORT WASHINGTON HARBOR

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Table 9

QUALITY OF SEDIMENTS IN THE PORT WASHINGTON HARBOR: 1982

Parameter	Site 1	Site 2	Site 3	Site 4
Percent Solids	70.0	78.6	57.9	88.7
Total Volatile Solids	2.52	2.26	1.80	2.93
Total Organic Carbon	8,200	5,500	7,400	7,100
Biochemical Oxygen Demand	NR	NR	NR	NR
Chemical Oxygen Demand	43,400	27,400	58,500	37,100
Oil and Grease	793	1,980	449	333
Cyanide	0.4	0.3	0.4	0.3
Phenols	0.06	0.13	0.07	0.05
Total Phosphorus	233	375	572	344
Total Kjeldahl Nitrogen	1,210	821	604	685
Copper	33.7	25.2	32.8	27.9
Arsenic	3.7	5.4	8.6	8.0
Lead	50.8	43.4	27.1	25.2
Nickel	5.50	9.61	12.2	6.44
Chromium	28.5	20.3	23.7	21.9
Mercury	0.26	0.09	0.15	0.09
Zinc	65.7	63.4	48.5	54.6
Cadmium	1.52	4.03	4.85	1.0
Iron	6,410	6,930	6,990	6,950
Ammonia	155	60	70	116
Manganese	293	24	247	258
Total PCBs	0.152	0.155	0.092	0.043
Aldrin	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND
Heptachlor Epoxide	ND	ND	ND	ND
Heptachlor	0.01	0.01	0.01	0.01
Lindane	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND
DDT	ND	ND	ND	ND
DDE	0.038	0.044	0.022	0.01
Fecal Coliform (#/g wet)	9	4	9	4
Grain Size (percent)	--	--	--	--
> 2 mm	1.1	16.0	1.0	1.0
0.43-2 mm	2.6	14.5	2.5	1.0
0.17-0.43 mm	4.9	14.6	15.6	8.0
0.074-0.17 mm	12.0	11.4	23.1	19.6
< 0.074 mm	79.4	43.3	57.8	71.8

NOTE: Values are ug/g dry weight except as noted.

ND = Not Detected.

Source: U.S. Army Corps of Engineers

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Table 10

MAXIMUM ALLOWABLE CONCENTRATIONS OF POLLUTANTS
FOR IN-WATER DISPOSAL OPTIONS AND CONCENTRATIONS
OF SPECIFIED SUBSTANCES DETECTED DURING ANALYSIS: JUNE 1982

Parameter	Maximum Allowable Concentration	Detected Concentrations			
		Site 1	Site 2	Site 3	Site 4
Organics					
Polychlorinated Biphenyls (PCBs)	.05	0.152	0.155	0.092	0.043
Total 2,3,7,8 TCDD (Dioxin)	1.0 pg/g	ND	ND	ND	ND
Total 2,3,7,8 TCDF (Furan)	1.0 pg/g	ND	ND	ND	ND
Metals					
Copper	100	33.7	25.2	32.8	27.9
Arsenic	10	3.7	5.4	8.6	8.0
Lead	50	50.8	434.0	27.1	25.2
Nickel	100	5.50	9.61	12.2	6.44
Barium	500	ND	ND	ND	ND
Chromium	100	28.5	20.3	23.7	21.9
Mercury	0.1	0.26	0.09	0.15	0.09
Zinc	100	65.7	63.4	48.5	54.6
Cadmium	1.0	1.52	4.03	4.85	1.0
Selenium	1.0	ND	ND	ND	ND
Pesticides					
Aldrin	.01	ND	ND	ND	ND
Dieldrin	.01	ND	ND	ND	ND
Chlordane	.01	ND	ND	ND	ND
Endrin	.05	ND	ND	ND	ND
Heptachlor	.05	0.01	0.01	0.01	0.01
Lindane	.05	ND	ND	ND	ND
Toxaphene	.05	ND	ND	ND	ND
DDT	.01	ND	ND	ND	ND
Other					
Oil and Grease	1,000	793	1,980	449	333

NOTE: All values are in ug/g dry weight unless noted.

ND = Not Detected

Source: Wisconsin Department of Natural Resources

3) If one or two pollutants are found in concentrations within the range of 110 to 125 percent of the criteria for those same pollutants, in-water disposal will be determined on a case-by-case basis.

4) If all pollutants are found at concentrations of 110 percent or less than the criteria for those same pollutants, in-water disposal may be allowed.

5) For on-the-beach disposal the particle size of the dredged material must meet the following criteria: the average percent of dredged material finer than 0.074 millimeters (mm) must be within 10-15 percentage points of average disposal site material finer than 0.074 mm.

According to the sediment analyses conducted, sediments from the inner harbor (see Map 2) exceed in-water disposal pollutant criteria individually for oil and grease, cadmium, lead, mercury, and PCBs. In addition, sediments from the inner harbor also exceed 125 percent of the concentrations of established criteria for lead, cadmium, and mercury. Due to these pollutant concentrations, sediments from the inner harbor would not be suitable for in-water disposal, or beach nourishment, and, as such, must be disposed of at suitable upland sites or in confined disposal facilities. Sediments from the outer harbor (see Map 2) are considered "clean" according to the Wisconsin Department of Natural Resources sediment quality criteria and therefore may be considered for approved in-water disposal and beach nourishment methods.

<u>Estimated Quantity of Dredged Materials</u>

As already noted, maintenance dredging in the Port Washington Harbor is divided into two different areas of responsibility: the federal government and the City of Port Washington. The federal government, through the U.S. Army Corps of Engineers, maintains channels conducive to navigation in the "Federal project waters," as shown on Map 3. The City of Port Washington, through the Port Washington Harbor Commission, conducts maintenance dredging outside the federal project water limits.

Quantities of materials dredged for both maintenance and new work projects since 1960 are listed in Table 6. Since that time, approximately 194,940 total cubic yards, or about 7,500 cubic yards per year of dredged material, has been removed from the harbor. Of this total, 120,300 cubic yards, or 62 percent, was dredged for maintenance, while 74,640 cubic yards, or 38 percent, was new work dredging--that is, work beyond normal maintenance activities.

As recently noted, sediments from the inner harbor portion are classified as polluted with respect to oil and grease, cadmium, lead, mercury, and PCBs. The object of this study, however, is directed at the analysis of upland or nearshore disposal methods of unpolluted dredged materials. Therefore, only materials removed from the outer harbor portion, which are considered "clean" by the Wisconsin Department of Natural Resources, are considered for disposal in this report.

As already noted, approximately 120,300 cubic yards of dredged material was removed from the Port Washington Harbor for maintenance activities since 1960. Therefore, based upon this 26-year interval, approximately 4,600 cubic yards of dredged material has been removed annually. However, only the outer harbor portion, which comprises nearly 86 percent of the entire harbor area, is considered suitable for unpolluted dredged material removal. It is estimated, then, that maintenance dredging will result in the removal of approximately 4,000 cubic yards of dredged material per year, which can then be considered for disposal or reuse at nearshore or upland sites.

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Chapter III

UNPOLLUTED DREDGED MATERIAL DISPOSAL OPTIONS

This section evaluates alternatives for disposing of unpolluted dredged materials. The first section of this chapter addresses upland alternatives. Specifically, the following four alternatives are examined: the disposal of dredged material into a special-purpose landfill or lagoon; the disposal of dredged material into a general refuse sanitary landfill; the surface spreading of dredged material on to agricultural lands; and the use of dredged materials as fill material. In the following section, nearshore disposal alternatives, including open water disposal and the disposal of polluted dredged materials into a confined disposal facility, is discussed.

As previously noted, the materials required to be dredged from the inner harbor portion of Port Washington Harbor at the present time are classified as polluted with respect to oil and grease, cadmium, lead, mercury, and PCBs, a fact which limits their current potential for productive upland uses. However, sediments located in the outer portion of the harbor are considered to be clean or unpolluted and, therefore, may be suitable for productive upland uses. Information has been provided herein on upland disposal methods which may be suitable for unpolluted dredged materials from the outer harbor portion of Port Washington Harbor.

UPLAND DISPOSAL ALTERNATIVES

Use of a Landfill or Lagoon Designed Exclusively for Dredged Material Disposal

The alternative calling for the disposal of dredged materials in a secure landfill or lagoon designed to meet environmental protection needs offers particular advantages for dealing with dredged materials whether polluted or unpolluted. Two options can be considered: a sanitary landfill and a lagoon system.

Construction of a sanitary landfill is an engineered method of disposing of solid wastes on land in a manner that minimizes environmental hazards and nuisances. Various engineering modifications may be applied in the development of an environmentally safe sanitary landfill for the disposal of materials which are considered to present potential environmental problems. Limiting the types of materials to be landfilled can have advantages, including the enhanced ability to predict leachate generation rates and character; the ability to specifically design the landfill for a well-defined and relatively uniform material; and the ability to operate equipment and to follow procedures which are specially designed to handle the specific type of material.

Landfills are usually constructed as being one of four types: 1) a natural attenuation landfill, 2) a zone of saturation landfill, 3) a clay-lined landfill, and 4) a shallow lift landfill. The type of construction will depend upon the site details and the quantity and quality of the dredged material. Illustrations of these four landfill types are provided in Figure 1.

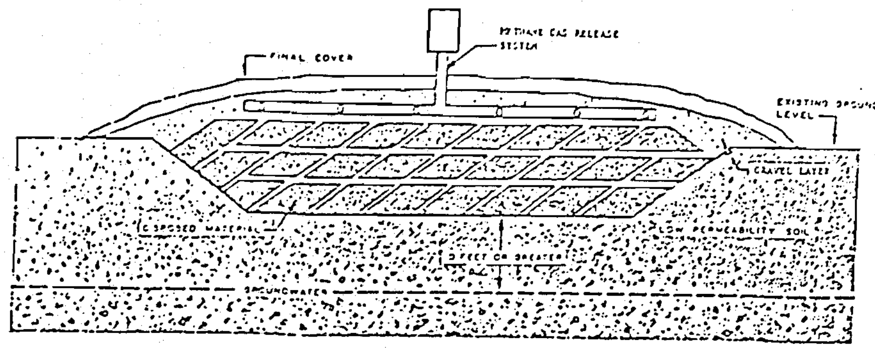
The natural attenuation landfill is constructed over the natural, in-place soils in such a way that a very limited amount of leachate is generated; upon leaving the landfill structure, the leachate is treated and purified as it passes through the underlying soils. Adequate amounts of underlying heavy soils such as clays and silts are necessary for this type of landfill, as is a minimum depth of about 20 feet to groundwater or to bedrock.

A zone of saturation landfill is one constructed in an area where suitable soils exist but the groundwater table is relatively high. The landfill is developed by the excavation into clay soils below the groundwater table. The soils on the site should generally be composed of clay materials, such that the rate of infiltration to the landfill does not exceed the surface evaporation rates. Natural sand and silt seams should be isolated from the waste mass to avoid locally high rates of infiltration. A leachate collection system is needed to remove leachate for treatment. During and after the filling operations, groundwater will infiltrate the landfill, diluting somewhat the leachate normally generated. The direction of groundwater flow is by design into the landfill since the groundwater elevation is higher than the elevation of the leachate in the landfill. This is different from a natural attenuation-type landfill, in which the leachate is discharged into the groundwater reservoir following filtration through a liner. This landfill type also generally affords potential for monitoring of the groundwater quality impacts.

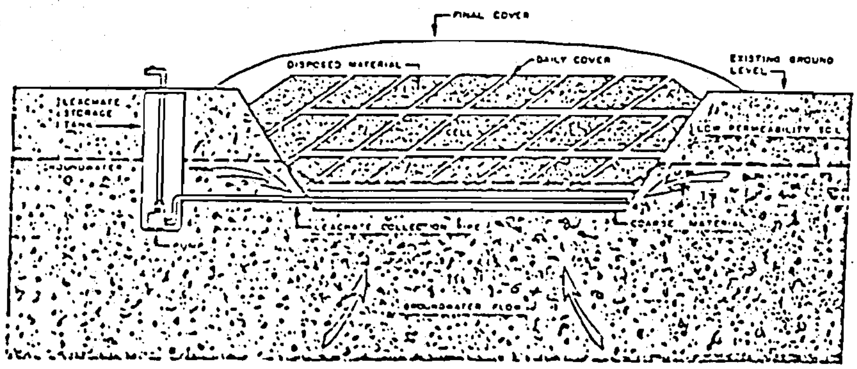
FIGURE 1

TYPES OF LANDFILLS UTILIZED IN THE STATE OF WISCONSIN

NATURAL ATTENUATION LANDFILL

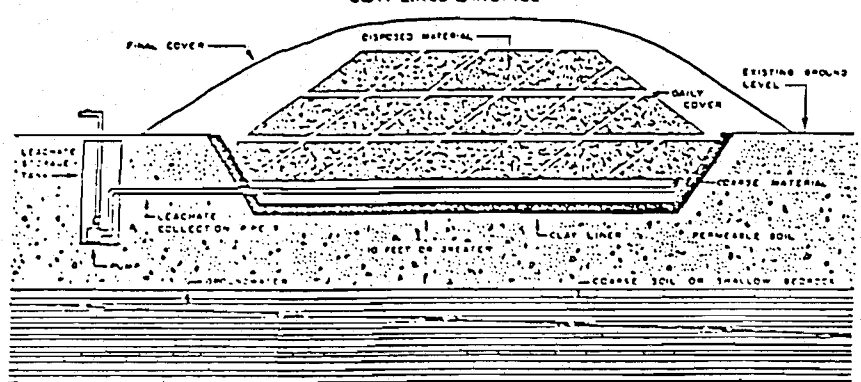


ZONE OF SATURATION LANDFILL



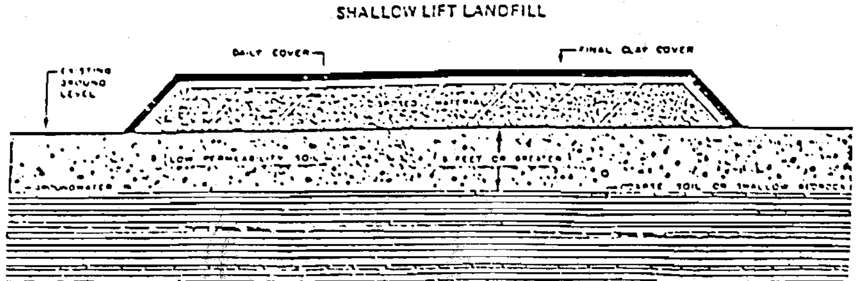
Note: This type of facility may also be equipped with a liner or double liner of clay and/or synthetic materials.
A methane gas release system may also be used as noted above for the natural attenuation landfill.

CLAY-LINED LANDFILL



Note: This type of landfill may require a double liner and leachate collection system in some instances. Synthetic lining material may also be used.
A methane gas release system may also be used as noted above for the natural attenuation landfill.

SHALLOW LIFT LANDFILL



SOURCE: SEWRPC

If in-place soils are not adequate for construction of a natural attenuation landfill due to high permeability, a clay-lined landfill can then be constructed to minimize the migration of leachate from the landfill. Leachate is then collected from the landfill and treated prior to disposal.

A landfill similar to the natural attenuation landfill is the shallow lift landfill. This type of landfill provides for the placement of a layer of waste on the land surface, above grade, over a natural clay type of soil generally with a low permeability. The depth of the clay is generally at least 10 feet. The material landfilled is then covered with a final layer of relatively impermeable soil.

With the various engineering options available, it appears that a sanitary landfill could represent an environmentally safe disposal alternative for polluted dredged materials from Port Washington Harbor. The landfill has advantages in that it can be operated year-round rather than being dependent upon the availability of agricultural land or construction fill needs.

Another option for disposal is a lagoon constructed in a manner similar to an engineered landfill. The lagoon could have a clay liner, a leachate collection system, and a system for supernatant drawoff. When sediments have become dewatered in the lagoon over time, and have consolidated, the sites can be covered with topsoil or other material suitable for planting, and put to other uses. Figure 2 indicates one type of lagoon construction.

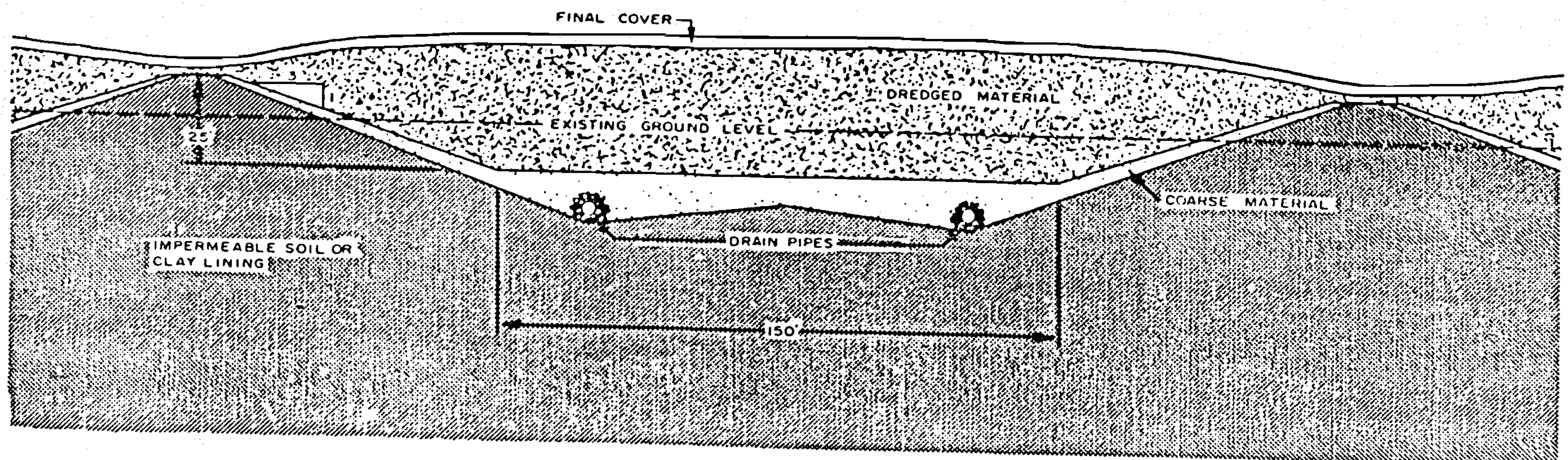
Potentially suitable areas which may be considered for the construction of a sanitary landfill for dredged materials within 25 miles of Port Washington Harbor are shown on Map 9.

Disposal of Dredged Material in General Refuse Sanitary Landfills

General refuse sanitary landfills may provide suitable disposal facilities for clean dredged materials from the Port Washington Harbor area. Moreover, the dredged materials may have several potential, cost-effective applications in solid waste management, since such materials are essentially a soil mixture with a high water content that can be reduced. The substitution of dewatered dredged materials for soil may therefore be feasible for daily cover material,

Figure 2

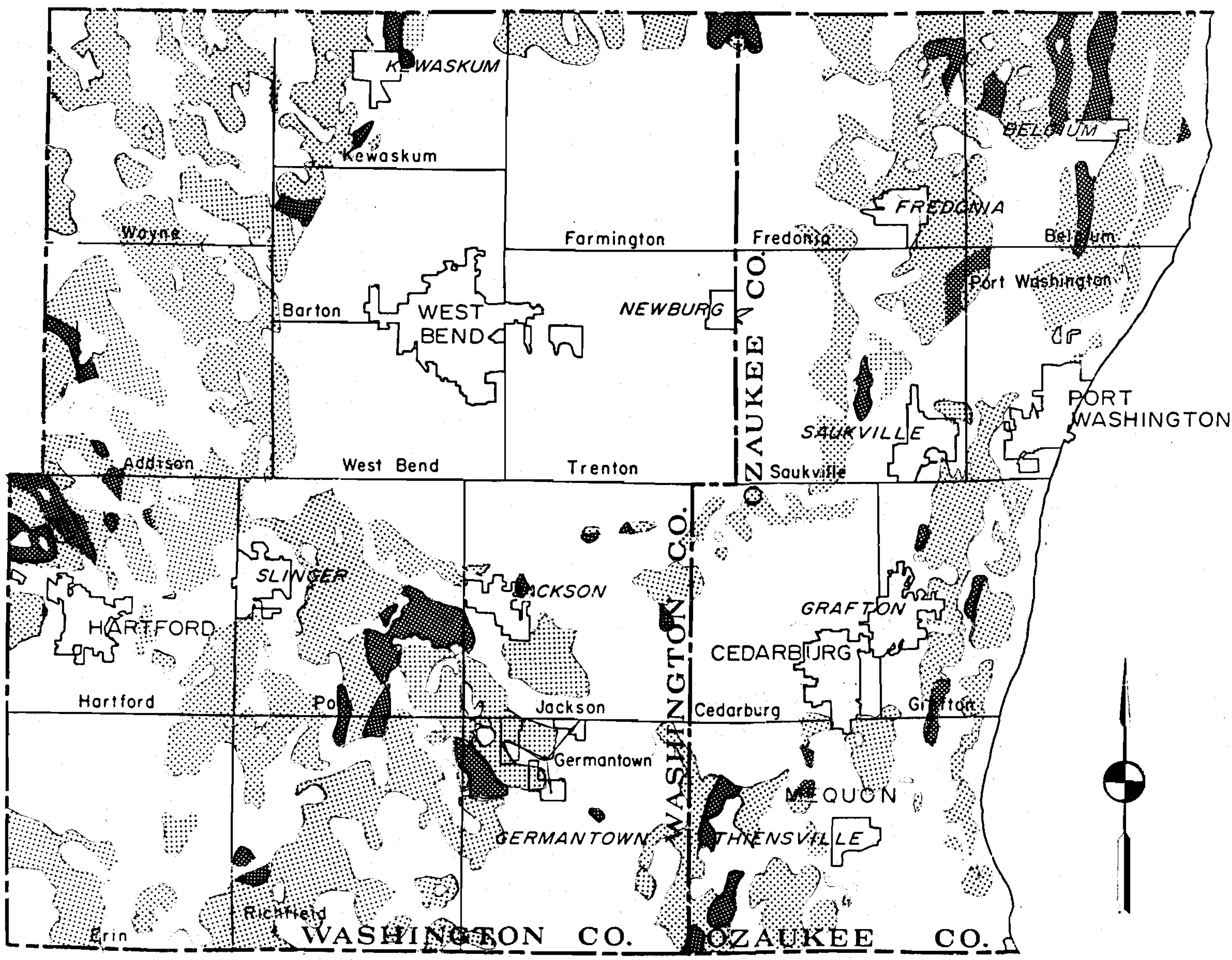
EXAMPLE OF A LAGOON POTENTIALLY SUITABLE FOR DREDGED MATERIALS DISPOSAL



Source: SEWRPC.

Map 9

GENERALIZED SUITABILITY RATINGS FOR SPECIAL-PURPOSE LANDFILL SITING FOR UNPOLLUTED DREDGED MATERIAL DISPOSAL[1]



Legend

Areas With a High Potential for Siting a Landfill for Unpolluted Dredged Material Disposal

Areas with a Limited Potential for Siting a Landfill for Unpolluted Dredged Material Disposal

Areas with no Potential for Siting a Landfill for Unpolluted Dredged Material Disposal

[1]Criteria utilized to determine suitability ratings are generally based upon the requirements set forth in Chapter NR 180 of the Wisconsin Administrative Code.

Source: SEWRPC

gas and leachate barriers, liners, and final cover materials. This is particularly true in areas considered marginal for sanitary landfill development because of the lack of soil materials with suitable properties for the aforementioned uses. The locations of existing sanitary landfills which could be considered for such application of dredged materials are shown on Map 10.

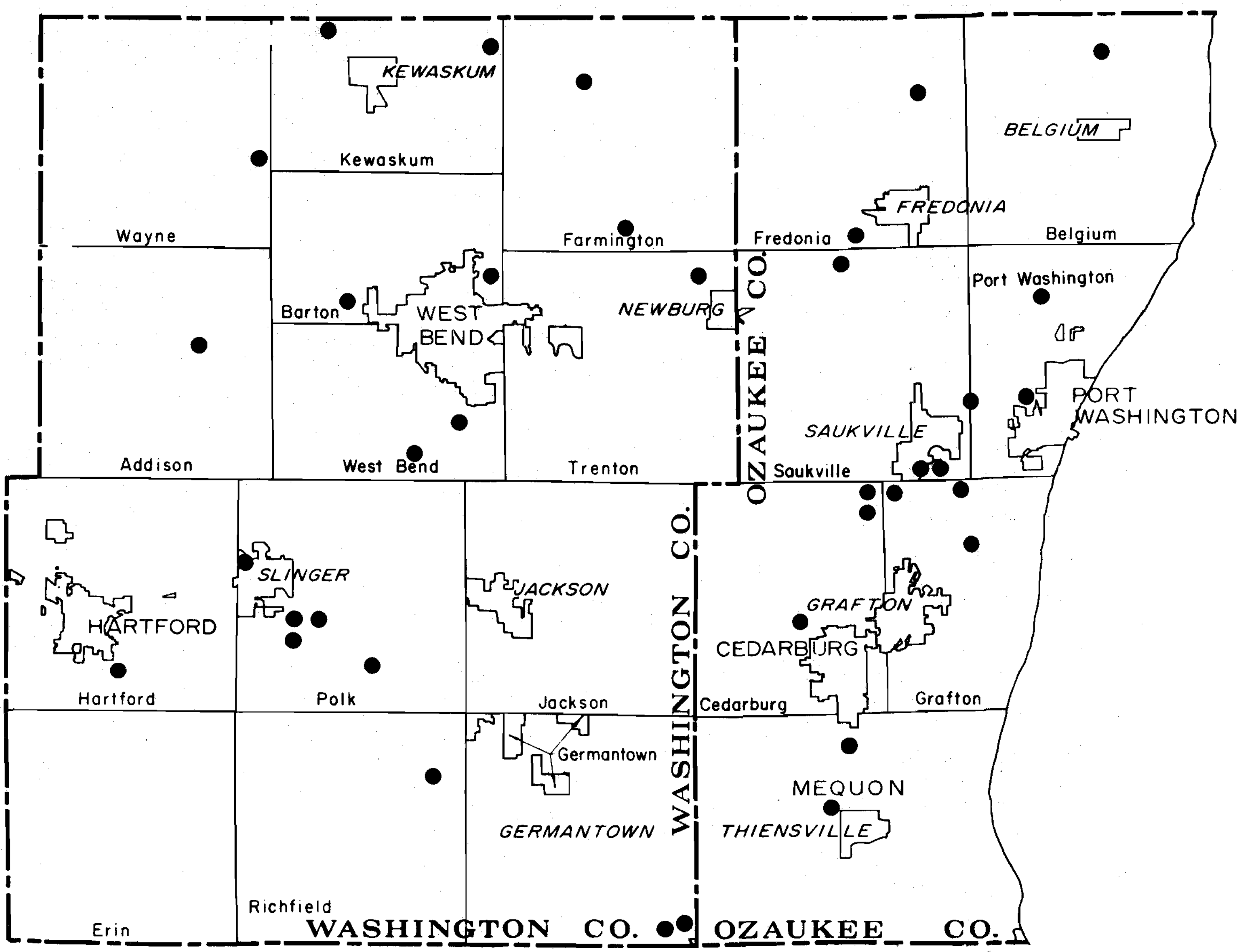
Daily Soil Cover: As a daily cover material, dewatered dredged materials could serve to prevent fly and other insect emergence from, and rodent burrowing in, the solid wastes; to act as a control of surface water infiltration; to prevent internal solid waste fires; and to enhance the aesthetics of the landfill operation. The suitability of dredged materials from Port Washington Harbor for use as a cover material depends on: 1) the amount of dredged material needed for such a purpose; 2) the amount of material to be dredged from the harbor; and 3) the distribution of the various-sized soil particles after dewatering. The characteristics of a desirable cover material are easy workability, moderate cohesion, and significant strength. A mixture of sand, silt, and clay has been used as a suitable cover material. When compacted, the granular, coarse particles are held together by the binding action of the silt and the cohesion of the clay. The fines--smallest soil particles--also serve to reduce the permeability of the cover material. Soils which are not suitable for use as cover are highly organic soils and peat.

The use of dewatered, clean dredged material is feasible at general refuse landfills because such materials can be easily hauled, spread, and compacted by conventional earth-moving equipment. The use of dredged materials as a slurry or as a semisolid for cover, however, is not feasible, because of onsite handling and storage problems. Neither slurry nor semisolid dredged materials will remain on the slope of the working face of a landfill, and drying the material in place would involve periods of time during which the surface would be unworkable. Increased rates of leachate generation would also occur, unless special measures were applied to control the water released from the dredged materials into the solid waste.

Gas and Leachate Barriers: As solid waste decomposes under anaerobic conditions, dangerous or toxic gases such as methane and hydrogen sulfide are produced. To prevent the development of health and safety hazards near sanitary

Map 10

KNOWN EXISTING SOLID WASTE LANDFILLS IN
WASHINGTON AND OZAUKEE COUNTIES: 1980



Source: SEWRPC

landfills, these decomposition gases must be confined laterally to the boundaries of the landfill. Also, water seeping through solid waste may become contaminated. The contamination of surface and groundwater by solid waste leachate must be averted by either collection and treatment or prevention of its production. Depending on their permeability, dredged materials may be used as suitable gas and leachate barriers in sanitary landfills.

In order to control the lateral migration of decomposition gases from within a sanitary landfill, a vertical barrier is constructed by excavating a relatively narrow--typically one- to four-foot-wide--trench around the landfill to a depth below the lowest solid waste. The trench is backfilled with impervious soil, compacted, and saturated with water.

Landfill Liner or Final Cover Material: In order to prevent leachate production by groundwater or by infiltrating surface water, an impervious liner extending from beneath the solid waste to the surface is constructed around a sanitary landfill. One commonly used liner material is clay soil, compacted to form a membrane about five feet thick, completely sealing the bottom and sides of the sanitary landfill. In addition, following completion of the filling operation, the landfill is typically capped with about 12 inches of coarse sand and gravel, about 12 inches of relatively impermeable clay, and about 6 inches of topsoil. For use as a liner or for use as the impermeable portions of the final cover material in a sanitary landfill, the dredged material would have to be fairly well segregated into fractions of mostly silt- and clay-sized particles, and would have to have a moderate to slow permeability: i.e., less than 0.002 inch per hour.

The flow of water through soil is highly dependent on the size, shape, arrangement, and gradation of particles. Fine-grain, compacted, dredged material samples have been shown to be highly impervious to water. The use of fine-grained dredged material would require that the material be dewatered to near optimum moisture content and then carefully compacted.

In summary, dredged material that has been partially dewatered to the point that it has a water content comparable to that of similar natural soil generally has the physical and engineering properties required to be suitable for several uses in a sanitary landfill operation. Construction of cover, liners, and gas and leachate barriers is technically feasible based on a comparison of the properties of suitable natural soils with the properties of dried dredged material.

Land Application

A third alternative for the upland disposal of dredged materials is to use these materials to beneficially amend marginal lands for agricultural purposes or to improve the productivity of existing agricultural lands. The physical and chemical characteristics of soils can be altered through the addition of dredged materials, to render the water and nutrient levels more favorable for crop production. The potential benefits associated with adding dredged materials to marginal soils include increased water-holding capacity, increased organic (humus) and nutrient content, enhanced tilth, and increased hydraulic conductivity to improve drainage.

Many of the natural soils in the Southeastern Wisconsin Region are comprised of fine-textured clay particles. Those bottom sediments having a high sand content would be the type of dredged material most beneficial to conditioning such clay soils. As shown in Table 9 of this report, sediment analyses at selected locations in the Port Washington Harbor indicated that sand, which includes sediments containing grain sizes in the 0.074 to 2.0 mm range, comprised 21 percent to 57 percent of the bottom materials. Based on that data, clean dredged materials from Port Washington Harbor may be considered for use as a soil conditioner.

Existing agricultural lands which may be considered for the application of clean dredged materials are shown on Map 11.

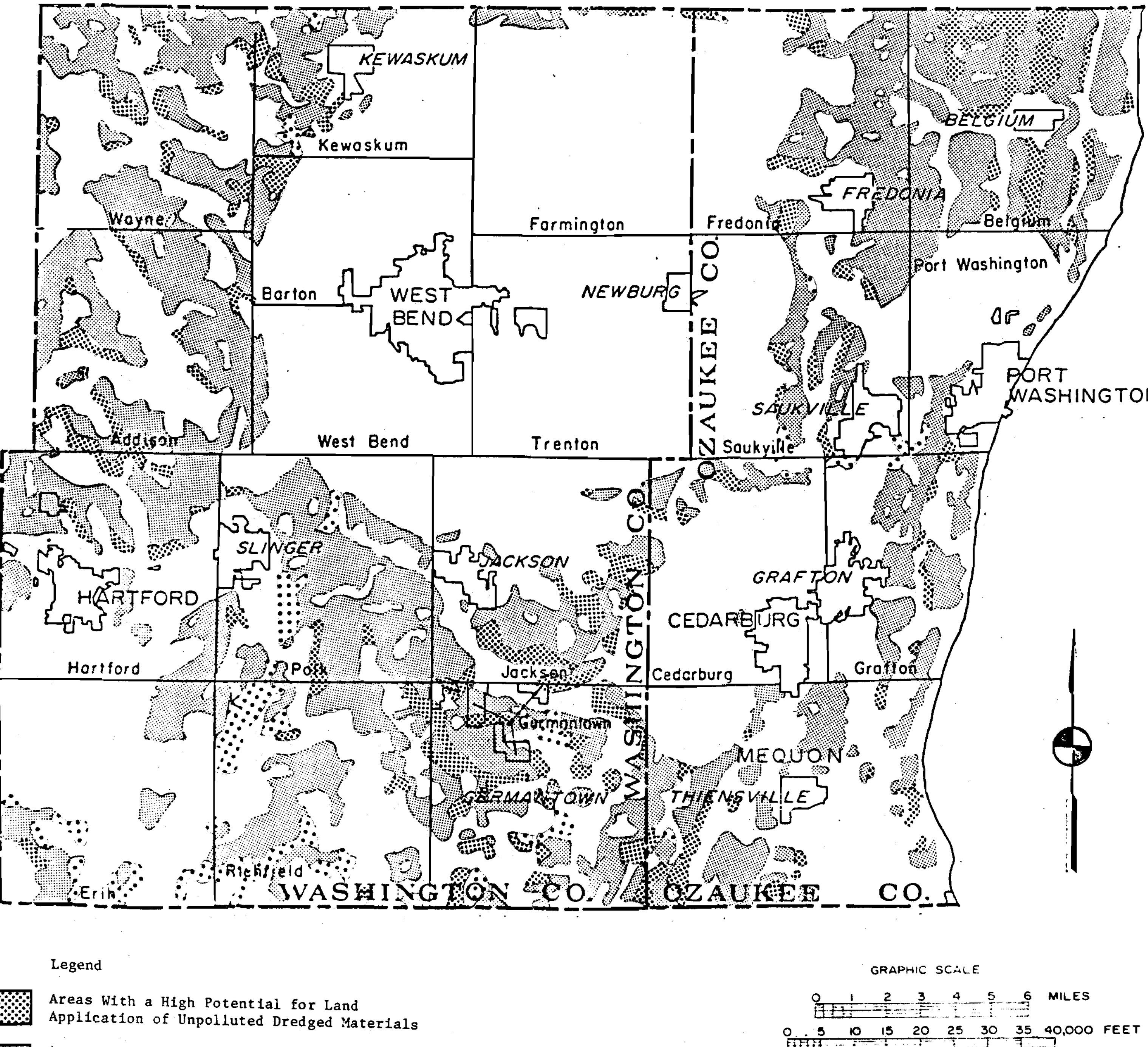
Use of Dredged Material As Fill

Dredged materials are comprised of a varying mixture of sand, silt, and clay particles. Such materials have been successfully applied in various construction projects across the country. Such uses for dredged materials have included wildlife habitat development, the reclamation or rehabilitation of sand and gravel pits, and fill for the construction of roadways and airport runways.[5]

[5] Any proposed wetland filling is subject to federal, state, and local wetland regulations.

Map 11

GENERAL SITING ANALYSIS RESULTS FOR USE OF DREDGED MATERIAL ON AGRICULTURAL LAND[1]



Legend

- Areas With a High Potential for Land Application of Unpolluted Dredged Materials
- Areas with a Moderate Potential for Land Application of Unpolluted Dredged Materials
- Areas with a Low Potential for Land Application of Unpolluted Dredged Materials
- Areas with No Potential for Land Application of Unpolluted Dredged Materials

Source: SEWRPC

[1] Criteria utilized to determine suitability ratings are generally based upon the requirements set forth in SEWRPC Community Assistance Planning Report No. 68, Upland Disposal Area Siting Study for Dredged Materials from the Port of Milwaukee.

The productive use of dredged material as fill is dependent upon the composition and quality of the material. Dredged materials have been used for creating or enhancing recreational facilities such as golf courses, tennis courts, and baseball fields. An example of such application of dredged material is the East Potomac Park in Washington, D. C. which was created by dredged material deposition. Dredged material was also used in the construction of Grant Park in Chicago, Illinois. Pelican Island in Galveston, Texas, is a dredged material disposal site which contains not only recreational land uses, but also port terminals, manufacturing land uses, commercial offices, a shipyard, and a college.

Dredged materials have also been used as common fill material for highway construction in California, Georgia, Pennsylvania, and Texas. Fill is used chiefly for highway construction, since standard arterial facilities normally conform to the existing grade of the natural terrain, and therefore include only limited use of cut-and-fill techniques. The principal use of fill in normal highway construction in southeastern Wisconsin would be in the construction of state and county trunk highways.

The use of dredged materials from the Port Washington Harbor area as a construction material may be a potentially viable, partial long-term solution to the disposal of a portion of some of the dredged materials from the Port Washington Harbor. Indeed, some material dredged from Port Washington Harbor in 1981 is presently stockpiled by the City of Port Washington for future use as sewer trench backfill. However, it is not expected that this would be a total solution, owing to the intermittent need for such materials and the fact that some of the dredged material may be considered to be unsuitable for use in construction. Moreover, the glacial geology of the Region affords an abundant supply of sand and gravel from existing mineral extraction operations located across the entire Region.

In numerous situations, the application of dredged material has provided for the development or enhancement of terrestrial and aquatic wildlife habitat.[6]

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[6] Any proposed wetland filing is subject to federal, state, and local wetland regulations.

Often, dredged material disposal sites are chosen for ease of transport, or other circumstances that make them economically and technically desirable for dredged material disposal. However, some disposal areas have been designed to improve existing habitat or create additional productive areas for wildlife. As previously discussed, economic and environmental considerations make use of selection criteria an important aspect in choosing future disposal areas and the type of material which can be used at such sites. Potential disposal areas located next to existing wildlife habitat may supply a needed habitat component, such as additional nesting cover or feeding areas, which could be lacking in the adjacent existing area. The indigenous plants and animals on and adjacent to a proposed disposal site should also be evaluated as part of the disposal site selection criteria. Knowledge of existing plant species on or adjacent to the potential disposal site will facilitate the selection of plant species to be established on the site and the species of wildlife for which the potential habitat improvement is designed.

In summary, it appears that the use of dredged materials as fill for various types of projects in upland areas, such as recreation land enhancement, wildlife habitat, or light industry development, has the potential to be a viable alternative for dredged material disposal. However, the potential uses and site conditions are so varied that each use would need to be evaluated with respect to feasibility on a case-by-case basis.

NEARSHORE DISPOSAL ALTERNATIVES

Beach Nourishment

Beach nourishment methods can aid in the maintenance of the natural longshore transport of sediment by currents (littoral drift). Also known as "sand by passing," this method of nearshore disposal is commonly used to mitigate against shoreline erosion related to the existence of breakwaters and similar structures which interfere with littoral drift patterns. Depositing dredged materials downstream from such structures would help to maintain important natural processes while reducing localized erosion problems.

Dredged material partical size is the primary factor of importance when considering beach nourishment options because particle size directly influences net nourishment. This use of dredged material requires no permit if the dredged material is placed above the ordinary high water mark or behind an approved bulkhead line.[7]

Beach Restoration

Beach restoration methods involve designing and constructing a beach which has been severely degraded or destroyed due to erosive forces. Restoration techniques are often used in conjunction with coastal structures such as breakwaters and groins. Beach restoration differs from beach nourishment in that the former involves extensive engineering and construction practices while the latter relies primarily on natural process which are induced to produce a desired result.

Dune Construction and Management

Dune construction and management techniques are used primarily for erosion control and storm protection. Dredged materials are used to reconstruct dunes or maintain dune profiles after major storms. Dune restoration techniques can also be used to enhance the quality of recreational and natural areas by providing dune-like habitat.

Wetland Mitigation and Protection

Nutrient-rich dredged material has been used to create or restore wetland areas. Generally, the process involves placing dredge materials in water at a suitable location to raise the bottom elevation to provide water depths which are conducive to the establishment and growth of aquatic vegetation. In addition, dredged materials are also used to construct barrier reefs or barrier islands to reduce damage to existing coastal wetland complexes.

Shoal Construction

This practice involves placing suitable dredged material in deep water areas to create shoals which would hopefully be used as breeding habitat for fish. A traditional open water dumping area off Menominee, Michigan is currently used as a whitefish spawning area. However, the Wisconsin Department of Natural Resources presently prohibits the open water disposal of dredged

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[7] Wisconsin Department of Natural Resources and Wisconsin Coastal Management Program, "Great Lakes Dredging", 1986.

materials and NR 341 only allows the deposition of dredged materials in the nearshore area. Therefore, shoal construction can only be considered in the nearshore area.

Disposal in a Confined Disposal Facility

A confined disposal facility is a diked area in which both polluted and unpolluted dredged materials are placed and detained and from which only unpolluted materials, mostly water, are allowed to pass. Polluted material dredged from Port Washington Harbor was placed in a confined disposal facility in the Milwaukee Harbor in 1977 and 1981.

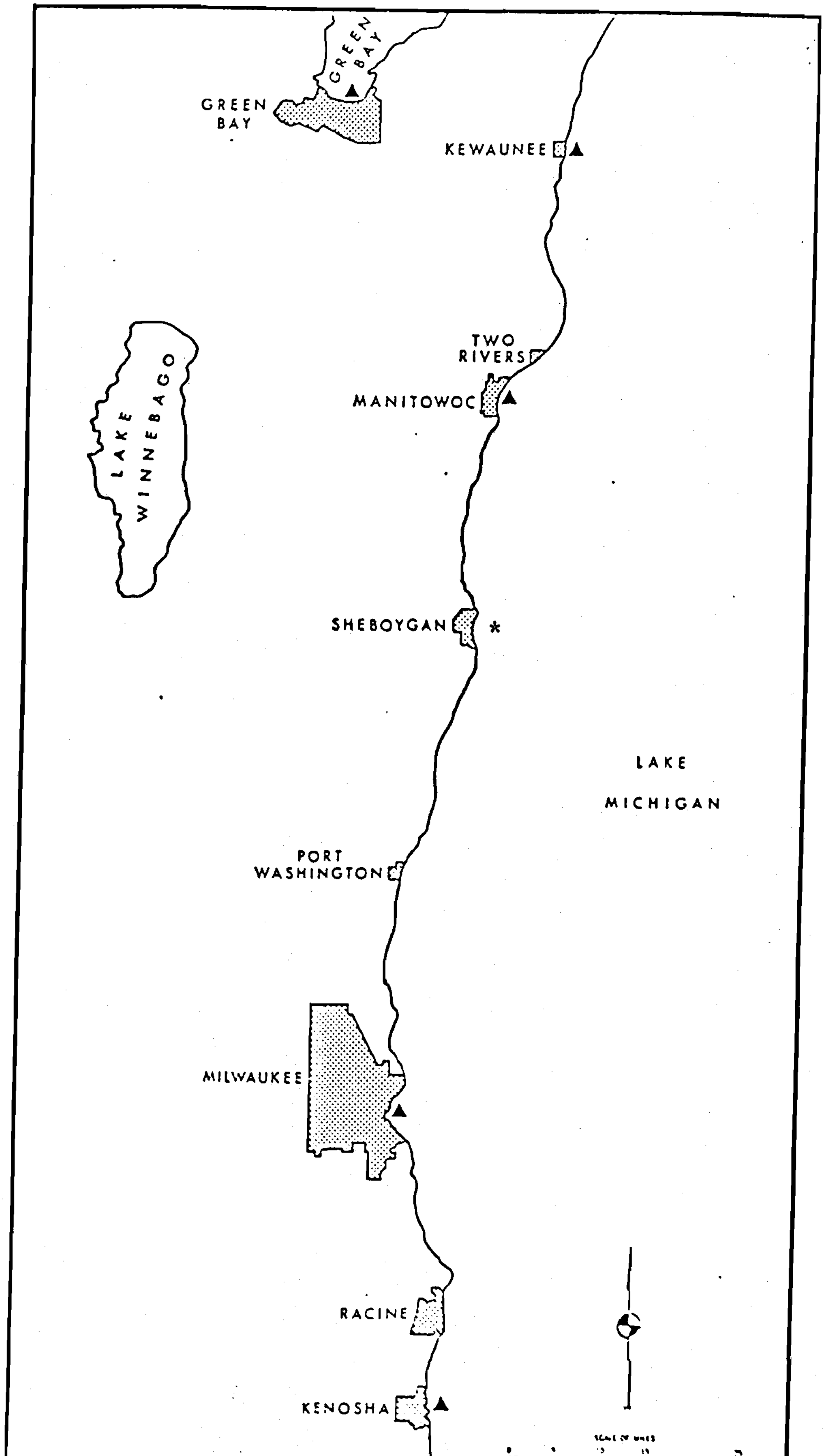
Disposal of dredged materials in a confined disposal facility is an option that should be considered during the dredged material disposal method selection process. To that end, cost estimates for this disposal method are presented in the Economic Impacts section of this report. Map 12 shows the location of existing confined disposal facilities along the western shore of Lake Michigan.

Conclusion

Based upon the foregoing, it appears that all of the options considered have potential as a disposal method for at least a portion of the dredged material from Port Washington Harbor. The economic and environmental costs of these alternatives are further evaluated in a following section of this report.

Map 12

EXISTING CONFINED DISPOSAL FACILITIES



Source: SEWRPC

▲ - Confined Disposal Facility

* The City of Sheboygan has a lakebed grant authorizing the future construction of a confined disposal facility.

Chapter IV

SITING ANALYSIS FOR DISPOSAL OF UNPOLLUTED DREDGED MATERIAL

INTRODUCTION

Potentially feasible methods for the disposal of materials from the Port Washington Harbor include:

1. Disposal in a new landfill or lagoon specially designed and exclusively used for dredged materials.

2. Disposal in an existing or new general refuse sanitary landfill, jointly with other solid wastes. This alternative includes the potential for use of the dredged material for daily cover and other beneficial uses in landfills.

3. Surface application on land as an agricultural soil conditioner.

4. Use as a fill material for highways, light industrial or commercial complexes, recreation land, and wildlife habitat areas.

5. Nearshore disposal, including beach nourishment, beach restoration, dune construction and management, wetland mitigation and protection, and shoal construction.

6. Deposition in a confined disposal facility.

The ultimate selection of a specific site for the application of any of these techniques, with the exception of dredged material deposition in a confined disposal facility, will require that detailed, site-specific studies be conducted to evaluate the economic, social, environmental, and technological considerations on a site-by-site basis. The conduct of these site-specific studies is time-consuming and expensive. However, considerable information on the applicability of alternative disposal methods can be obtained by proceeding through a generalized site selection process prior to site-specific analyses. In this way the entire process of selecting a specific site is logically divided into two phases. The first phase, or general area phase, which is the subject of this report, is used to select portions of the study area with a high potential for the location of disposal sites. The second, or site-specific, phase considers the possibility of actual sites at a more detailed level of analysis.

This section of the report is directed at providing the City of Port Washington with a general indication of where upland and nearshore disposal sites could best be located within Washington and Ozaukee Counties. The analysis is also directed at the selection of a representative sample of general upland and nearshore areas for disposal sites for use in the preparation of cost estimates for the alternatives.

The identification of potential upland sites for the disposal or reuse of dredged material requires the establishment and application of specific criteria to be used in evaluating potential sites. The criteria selected for use in this siting analysis are based upon data which are readily available from existing sources. The criteria to be considered for each feasible disposal alternative selected for use in the study are listed below. Following discussion of criteria, the methodology used in applying the criteria is described.

The criteria utilized have their foundation in an understanding of the man-made and natural resource features of the study area, as those features are characterized in quantitative data in the SEWRPC files. This report includes a brief description of these features, with emphasis on those features most directly related to the location of dredged material disposal areas.

NEW LANDFILL OR LAGOON SITING ANALYSIS

The siting of a new landfill or lagoon for the exclusive disposal of dredged materials or a new landfill for the disposal of dredged material in conjunction with other solid wastes relies upon data available on geology, groundwater, soils, topography, surface water resources, environmentally significant areas, existing and planned urban development, and transportation systems.

The size of a dredged material disposal site would vary depending upon the proposed dredging effort and site life, the site topography, the type of landfill method, and the depth of fill. The following assumptions have been made in order to estimate the area needed for a landfill or lagoon:

- The total amount of dredged material to be deposited at the site is 40,000 cubic yards, equivalent to the estimated amount of approximately 4,000 cubic yards to be generated annually over 10 years--1986 to 1996--of maintenance dredging.

- The average depth of the fill is 30 feet, exclusive of the final cover.

- The ratio of dredged material to other covering soils or other material is five to one.

Although the primary concern of this chapter is the siting analysis of unpolluted dredged material disposal alternatives during a 10-year period, it appears most practical and cost effective, however, that the construction of a special purpose landfill be engineered to accommodate unpolluted dredged material over a 20-year period. Therefore, assuming these conditions and a buffer zone around the landfill of 300 feet, a site of about 20 acres would be required.

Criteria for Special Purpose Landfill Disposal Area Siting

The criteria utilized in the analyses are generally based upon requirements set forth in Chapter NR 180 of the Wisconsin Administrative Code and upon other pertinent engineering requirements for landfill or lagoon sites. The discussions in the following sections are directed toward dividing Ozaukee and Washington Counties into areas with no potential for the location of a dredged material landfill or lagoon; areas with limited potential for such location; and areas with a high potential for such location.

Geology: The following are the main geologic considerations for landfill or lagoon siting:

- Bedrock Depth--A depth to bedrock of greater than 50 feet would be ideal, while greater than 20 feet is generally considered the practical minimum distance in southeastern Wisconsin in order to reduce the potential for groundwater contamination. Areas with depths of less than 20 feet to bedrock are considered to have no potential for the location of a new dredged material landfill or lagoon.

- Bedrock Type--The Maquoketa shale functions as an aquiclude or vertical flow barrier and is present in most of the Region, including Ozaukee and Washington Counties. The areas in the western portion of the Region where the Maquoketa shale is not present are important groundwater recharge areas where water percolates downward through glacial deposits into the sandstone aquifer--the major source of groundwater supply in the Region. Because of the importance of this sandstone aquifer recharge area to the groundwater supplies of southeastern Wisconsin and northeastern Illinois, the recharge area is considered to have a limited potential for the location of a new dredged material landfill.

- Glacial Deposit Type--The types of glacial deposits present in an area are an indication of its suitability for landfill construction. Generally, glacial ground moraine and end moraines are most likely to contain materials best suited for landfill construction. However, this consideration is too variable for general screening purposes and must be evaluated on a site-by-site basis. Thus, this factor is not used in the general area phase analysis.

Groundwater: Groundwater considerations in landfill or lagoon siting include the following:

- Groundwater Depth--Areas with a depth of less than 10 feet to groundwater are considered to have a limited potential for landfill or lagoon siting because of engineering and construction requirements needed to provide for groundwater protection.

- Well Locations--Chapter NR 180 of the Wisconsin Administrative Code requires that landfills be located at a horizontal distance of more than 1,200 feet of any public or private water supply well unless special conditions exist which indicate that contamination will not occur. This factor is discussed further in a later section on existing urban development in landfill siting.

- Flow Direction--Generalized mapping of the groundwater flow patterns is available. However, local variation in the regional flow patterns is often significant, and this aspect of landfill siting must be developed on a more site-specific basis.

Soils: In selecting areas for landfill sites, data from the detailed soil surveys are an important consideration, since they may be indicative of the subsurface conditions--below the five- to six-foot depth of the soil samples--and since the soil type indicates the surface material necessary for construction at the sites. Specific soil types were considered during the upland disposal site selection process for this report.

Surface Water: With regard to the surface waters of the two-county area, the locational criteria for the siting of a solid waste land disposal site are set forth in Chapter NR 180 of the Wisconsin Administrative Code, which does not permit a landfill within the following areas:

- Within 1,000 feet of any navigable lake, pond, or flowage.

- Within 300 feet of a navigable river or stream.

- Within a floodplain.

- Within wetlands.

- Within an area where, according to the findings of the Department of Natural Resources, there is a reasonable probability that disposal of solid waste will have a detrimental effect on surface water.

The areas covered by the first four of the above-noted limitations were categorized in the general area phase siting study as having no potential for a landfill or lagoon. The fifth factor noted above can be properly considered only in site-specific studies.

Environmentally Significant Areas: The siting of a solid waste management facility requires consideration of environmentally significant areas. Environmentally significant areas which would have no potential for a dredged material landfill or lagoon include primary environmental corridors, woodlands, wetlands, floodlands, groundwater discharge and recharge areas, and specially designated natural areas and selected types of wildlife habitat. However, woodlands are often used effectively as buffer zones for landfills.

Urban Areas: The following two considerations relate landfill or lagoon siting to existing urban development:

- Chapter NR 180 of the Wisconsin Administrative Code requires a separation of at least 1,200 feet between a landfill and any public or private water supply source. This limit may be increased or decreased if justified by site-specific groundwater studies. For purposes of landfill or lagoon site selection, a distance of about one-quarter mile, or 1,320 feet, from existing residential and commercial urban development and industrial areas--where groundwater wells would be found--was considered an approximate limit for general siting analyses. Areas located within this distance of residential and commercial urban development were considered to have no potential for a new landfill or lagoon location.

- The Wisconsin Administrative Code states that solid waste land disposal sites may not be established within 1,000 feet of the nearest edge of the right-of-way of any state trunk highway or interstate or federal aid primary highway, or of the boundary of any public park, unless the site is screened by natural objects, plantings, fences, or other appropriate means so as not to be visible from the highway or park. Tree plantings, berms, and other site modifications are relatively simple engineering modifications that provide adequate screening from roads and parks. Therefore, this consideration was not used to eliminate areas as potential landfill sites.

Historical and Archaeological Sites: The Wisconsin State Historical Society reports that 186 historic and archaeological sites within southeastern Wisconsin have been either listed or deemed eligible for inclusion on the National Register of Historic Places. Thousands of other sites of historic or archaeologic importance have been identified in the Region, including Ozaukee and Washington Counties, and the potential exists for the discovery or designation of additional areas. Regulations require that detailed analyses be conducted by the State Historic Preservation Officer, should a project have the potential to adversely affect a historically or archaeologically important site or area. As such, siting of a landfill or lagoon facility for dredged material disposal may require such a site-specific analysis. Such an analysis can best be done as specific sites are investigated rather than on a large, general area basis. These analyses should be conducted prior to detailed site selection because of the time involved in the historic and archaeologic inventory and analysis.

Methodology of General Area Selection Process For a New Landfill or Lagoon

Two important studies have been conducted in southeastern Wisconsin which are directly related to landfill siting. These studies have generally involved a first phase or general area phase landfill siting study, and have incorporated all or portions of the above-cited criteria. A brief discussion of these studies follows.

Milwaukee Metropolitan Sewerage District (MMSD) Site-Specific Analysis: As part of the Milwaukee pollution abatement program facility planning studies, an analysis of sites available for landfills and for land application was conducted. In that study, areas in southeastern Wisconsin which had no potential for landfill or land application sites were delineated. The screening of areas with low potential for landfill or land application sites was based on excluding from the potential areas all of the following:

- o Wetlands;
- o 100-year recurrence interval floodlands;
- o Recreational areas;

- o Wastewater sludge land application areas specifically recommended by SEWRPC to be used by sewage treatment plants located outside Milwaukee County; and
- o Urban areas.

Copies of the mapping results of that categorization are available in MMSD and SEWRPC files.

County Solid Waste Management Studies: Ozaukee and Washington Counties have completed county solid waste management plans which include a general area landfill site selection process utilizing basically the same criteria discussed above. Copies of the mapped results of these county landfill siting studies are available in the SEWRPC files.

A two-step screening process was used to categorize areas of Washington and Ozaukee Counties with regard to their potential for use as a dredged material landfill. This process first identified certain areas within the two counties which were considered unsuitable for a landfill because of existing or planned land uses or special conditions. As previously discussed, these areas include existing urban areas, wetlands, 100-year recurrence interval floodlands, areas with depths of less than 20 feet to bedrock, environmental corridors, and areas specifically identified in the regional sludge management plan for use for sludge application by sewage treatment plants located outside Milwaukee County. As shown on Map 9, this analysis resulted in the identification of about 476 square miles, or 71 percent of the two-county area, as having no potential for the siting of a dredged material landfill. The second step in the process of identifying those areas with the best potential for a landfill was the consideration of known subsurface conditions.

As already noted, depth to groundwater is an important consideration in the evaluation of the potential suitability of areas for landfill siting. Areas with a depth to seasonal high groundwater of less than 10 feet were considered to have limited potential for landfill siting because of the increased cost of construction and operation of a landfill in these areas. As a result of this second phase screening, an additional 25 square miles, or about 4 percent of the two-county area, was classified as having limited potential for landfill siting. These areas are also shown on Map 9. The remaining 170 square miles, or 25 percent of the two-county area, was determined to have a high potential for landfill siting for dredged material disposal. It should be noted that while this analysis is based upon generalized regional data, the actual siting of a landfill requires more detailed, site-specific analysis. Localized conditions may result in the identification of small areas within each category noted as being more or less suitable for a landfill than indicated in the above analysis.

Existing Landfill Locational Considerations

As previously noted, the potential uses of dredged material in landfills include cover material, gas barrier and vent material, impervious lining material, leachate collection liners, and leachate collection underdrains. The suitability of dredged material for each of these uses was evaluated by comparing the makeup of the dredged material with the properties of soil known to be suitable for use in sanitary landfills. The basic findings are that most dredged material can be considered for many productive uses at a solid waste sanitary landfill. Coarse-grained dredged material can be used for gas vents, leachate drains, and portions of the cover material, while fine-grained materials can be used for gas barriers, impervious liners, and covers. Another possibility is the use of landfills for disposal by placement of the dredged material in the landfill along with other solid wastes without consideration of its beneficial uses.

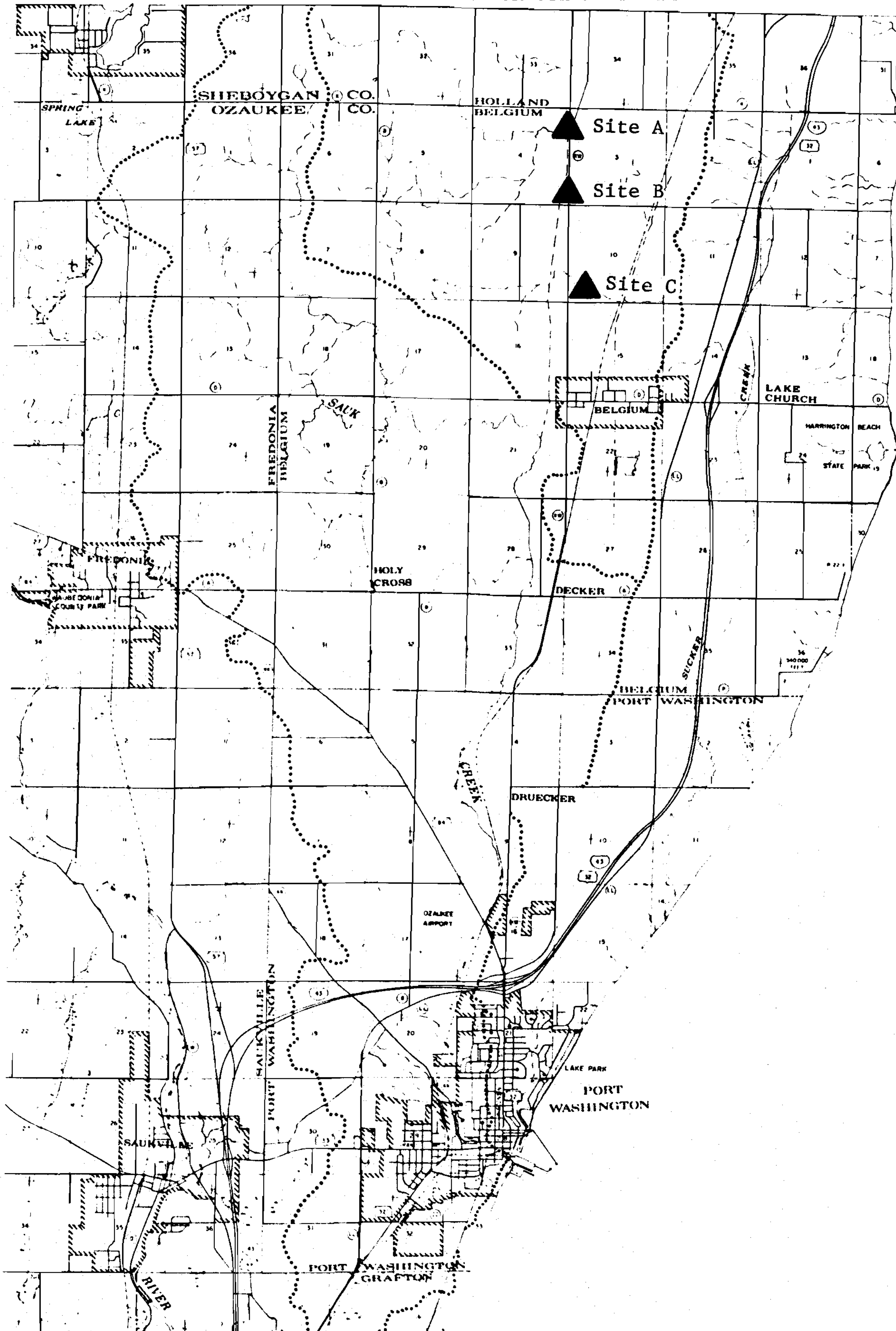
In southeastern Wisconsin, this material can potentially be located at existing landfills or new landfills. Siting for a new landfill was considered in the previous section. The locations of the existing, active landfills in the Region are shown on Map 10 and are recorded as Memorandum No. DSA-1 in the SEWRPC files. The Waste Management landfill in the Village of Germantown, Washington County, has been assumed to be the location for existing landfill disposal.

Site Selections-Special Purpose Landfill

Three sites have been selected as having potential for upland disposal of unpolluted dredged spoil material in a special purpose landfill (see Map 13).

Map 13

PROPOSED SITE SELECTIONS FOR UNPOLLUTED DREDGED MATERIAL DISPOSAL IN A SPECIAL PURPOSE LANDFILL



Source: SEWRPC

All three sites are located within five miles of Port Washington Harbor and are located along established county trunk roads in order to facilitate transport.

Site A: Site A is an approximately 20-acre site located in the northwest one-quarter and northeast one-quarter of U.S. Public Land Survey Sections 3 and 4, respectively, Township 11 North, Range 22 East, in the Town of Port Washington.

Site B: Site B is an approximately 20-acre site located in the southwest one-quarter and southeast one-quarter of U.S. Public Land Survey Sections 3 and 4, respectively, Township 11 North, Range 22 East, in the Town of Port Washington.

Site C: Site C is an approximately 20-acre site located in the northwest one-quarter of U.S. Public Land Survey Section 10, Township 11 North, Range 22 East, in the Town of Port Washington.

Drainage Basin Size, Topography, and Soils

Site A: Site A is located within a 1,516-acre drainage basin that drains into an unnamed intermittent stream which is tributary to Sauk Creek. The site is characterized by a nearly level topography which is underlain by Manawa and Poygan silt loams and Kewaunee loams. The degree of soil erosion which has occurred on this site is slight--none to one quarter of the original soil surface has been removed.

Site B: Site B is located within a 1,516-acre drainage basin that drains into an unnamed intermittent stream which is tributary to Sauk Creek. The site is characterized by a nearly level topography which is underlain by Kewaunee loams and Kewaunee and Manawa silt loams. The degree of erosion which has occurred on this site is slight--none to one quarter of the original soil surface has been removed.

Site C: Site C is located within a 753-acre drainage basin that drains into an unnamed intermittent stream tributary to Sucker Creek. The site's topography ranges from nearly level to gently rolling slopes, which is underlain by Manawa and Kewaunee silt loams. The degree of erosion which has occurred on this site is slight--none to one quarter of the original soil surface has been removed.

Woodlands, Wetlands, Wildlife Habitat, and Historical Features

No woodlands, wetlands, regionally significant wildife habitat, or primary environmental corridors are located within or immediately adjacent to proposed Sites A, B, and C. In addition, no federal or state rare, threatened, or endangered species are known to be inhabiting or using any of the three proposed sites. Further, no sites of historic significance are located within or immediately adjacent to any of the three proposed project sites.

Land Uses

All three sites are located on lands which are presently being used for production of row and small grain crops. In addition, these agricultural lands have been designated as prime agricultural land in SEWRPC Community Assistance Planning Report No. 87. The construction and operation of a special purpose landfill for the deposition of unpolluted dredged material would result in the permanent loss of approximately 15 acres of prime agricultural land at each of the three sites.

Other Uses

No other land uses are known to occur within the proposed project boundaries for any of the three upland disposal sites.

LAND APPLICATION SITING CONSIDERATIONS

A potential alternative for the productive use of dredged material is the surface application of dredged materials to amend marginal agricultural land or farmland where productivity can be improved through use of soil-conditioning measures. Generally, agricultural lands having the most potential for this alternative are characterized by poor drainage and low fertility, and may be severely eroded. The addition of dredged material to these areas may alter the characteristics of the soil in such a way that water and nutrients become more available for plant growth and, in some cases, soil drainage characteristics may be improved.

The use of specific site-selection criteria is necessary to ensure that appropriate areas are chosen for use of dredged materials to enhance the quality and productivity of agricultural land. As with other forms of dredged material disposal, it is generally required that the physical and chemical characteristics of the dredged material and the soil characteristics of the agricultural land disposal site be singly and jointly evaluated.

Chemical analysis of the dredged material and the soil at a proposed agricultural site will determine the amount of dredged material required at the site to increase fertility and/or improve drainage. Even though this type of site-specific analysis is needed to match the character of the dredged material to the specific location for land application, some insight can be gained into the practicality of this method of disposal by a more general review of potential disposal sites.

Other Criteria and Land Application Area Siting Considerations

Many of the criteria discussed above for potential landfill site location are applicable to land spreading sites. These include criteria which would categorize the following areas as having no potential for land application sites:

- Primary environmental corridors;
- Environmentally significant areas;
- 100-year recurrence interval floodlands;
- Areas designated by the regional wastewater sludge management plan for land application of sewage sludge from specific sewage treatment plants located outside Milwaukee County; and
- Urban areas.

Further criteria have been established for the application of wastewater sludge to agricultural lands. Such criteria, as presented in Wisconsin Department of Natural Resources Technical Bulletin No. 88[8] (revision of 1981), may also be applicable to the use of nonpolluted or moderately polluted dredged

[8] D.R. Keeney, K.W. Lee, and L.M. Walsh, Guidelines for the Application of Wastewater Sludge to Agricultural Land in Wisconsin, Wisconsin Department of Natural Resources Technical Bulletin No. 88, 1975 (Revised 1981).

material to amend soils of agricultural lands. Further, site-specific analyses and dredged material testing, in addition to those discussed below, would be required under this alternative. Such analyses are also discussed in Technical Bulletin No. 88. Detailed analyses of the dredged material is needed because certain crops are sensitive to the quality characteristics of sludges and because certain crops will be consumed by animals and human beings. The nutrient and metal content of the dredged materials will affect the amount of material which can be applied and the type of crops which can be grown. Soil properties and crop types are significant factors to be considered in the evaluation of potential sites for land application of dredged material.

Methodology for General Agricultural Site Selection Process

As previously discussed, the first step in the process of identifying those areas with the best potential for land application of dredged material was to locate and delineate certain areas considered unsuitable for land application because of existing land uses or special conditions. These areas include urban areas, wetlands, 100-year recurrence interval floodlands, environmental corridors, and areas specifically identified in the regional sludge management plan as sites for the application of sludge from sewage treatment plants located outside Milwaukee County. As shown on Map 11, this analysis resulted in the identification of about 441 square miles, or 66 percent of the area of the two-county area, as having no potential for land application of dredged material. The second step in the process of identifying those areas with the best potential for land application of dredged material was the consideration of the characteristics of the dredged material and of the in-place soils.

As previously discussed, the sand content of dredged materials from the Port Washington Harbor ranged from 20 percent to 57 percent. Therefore, based on this data, the clean dredged material from the Port Washington Harbor is well suited for the application as a soil conditioner to improve drainage, texture, and permeability. With these considerations in mind, the characteristics of the soil covering Washington and Ozaukee Counties remaining after the first screening were reviewed. Based upon very broad suitability associations, the soils in this area were then classified as having a high, moderate, or low potential for disposal of dredged material on agricultural land. The suitability classifications are shown on Map 11. Areas remaining after the first screening which have soils that are generally poorly drained, have a high

..ater table, and are interspersed with peat and muck are not well suited for some agricultural uses, and cover about 164 square miles, or 24 percent of both counties. Such areas were determined to have a high potential for land application of dredged materials since the drainage characteristics of these soils could potentially be improved by the addition of dredged materials. It should be noted that many of the areas containing these types of soils are characteristic of wetlands and floodlands, and consequently were eliminated from further consideration during the first stage of the screening process. Areas remaining after the first screening which have soils that are generally well drained and are productive as cropland are considered well suited for agricultural use. These areas cover about 46 square miles, or 7 percent of Washington and Ozaukee Counties, and were determined to have a moderate potential for land application of dredged materials. Steeply sloped areas which have bedrock close to the surface and thin, moderately fertile soils are generally not well suited for many agricultural uses. Such areas remaining after the first screening cover about 20 square miles, or 3 percent of both counties, and were determined to generally have a low potential for land application of dredged materials.

It should be noted that the actual selection of an area suitable for land application of dredged material would require more detailed, site-specific analyses. Localized conditions may result in the identification of small areas within each category which have characteristics which make a site more or less suitable for land application of the dredged material than indicated in the above analysis.

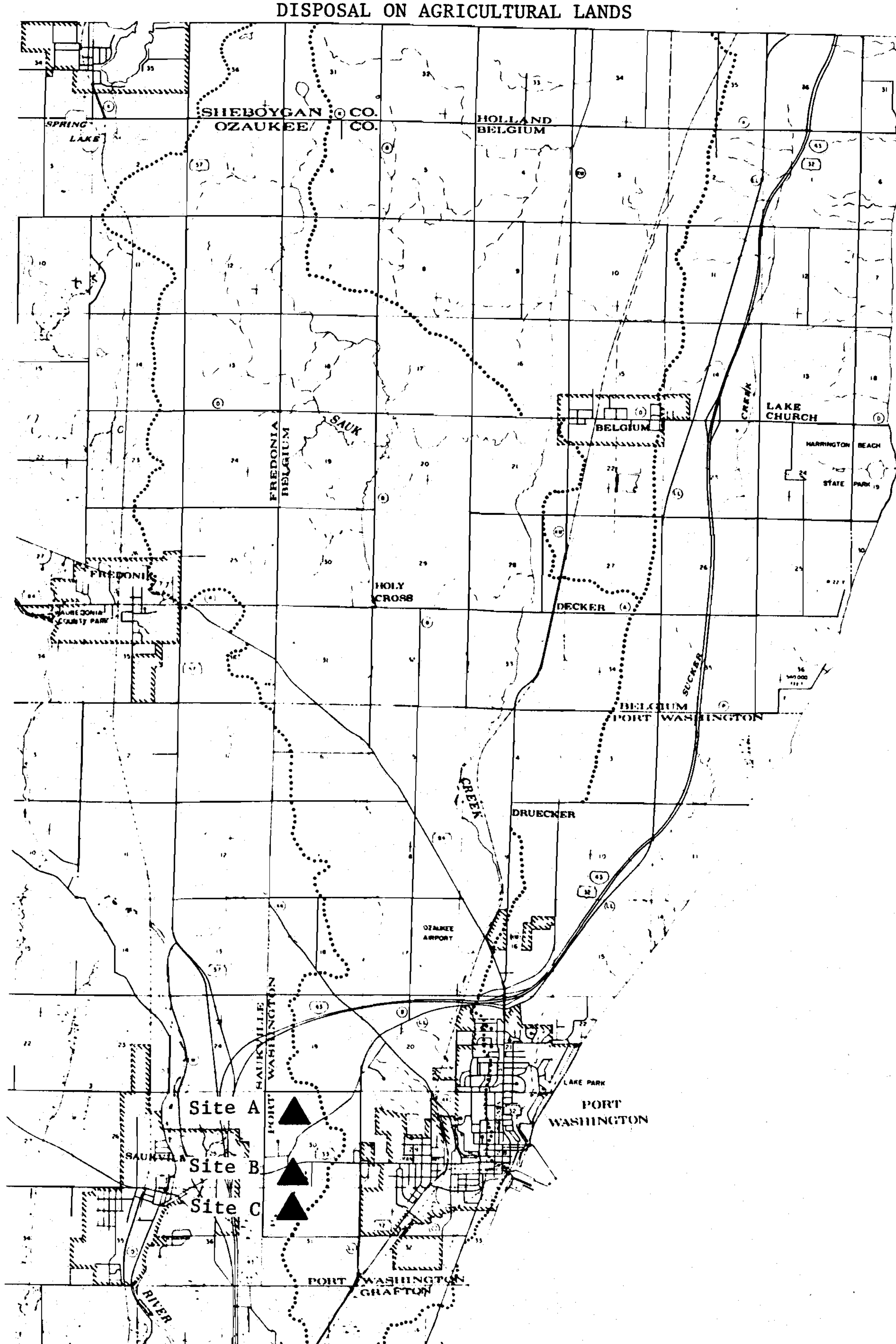
Site Selections-Agricultural Land Enhancement

Three sites have been identified within the two-county area as having potential for upland disposal of unpolluted dredged material and incorporation into agricultural soils (see Map 14). All three sites are located within 3.5 miles of the Port Washington Harbor along arterial highways in order to facilitate transport.

Site A: Site A is approximately 24 acres in size and is located in the northeast one-quarter of U.S. Public Land Survey Section 30, Township 11 North, Range 22 East, in the Town of Port Washington.

Map 14

PROPOSED SITE SELECTIONS FOR UNPOLLUTED DREDGED MATERIAL DISPOSAL ON AGRICULTURAL LANDS



Source: SEWRPC

Site B: Site B is approximately 18 acres in size and is located in the southeast one-quarter of U.S. Public Land Survey Section 30, Township 11 North, Range 22 East, in the Town of Port Washington.

Site C: Site C is approximately 24 acres in size and is located in the northeast one-quarter of U.S. Public Land Survey Section 31, Township 11 North, Range 22 East, in the Town of Port Washington.

Drainage Basin Size, Topography, and Soils

Site A: Site A is located within a 652-acre drainage basin that drains into an unnamed intermittent stream tributary to Sauk Creek. The site exhibits flat to gently rolling topography--the slope varies from 0 to 6 percent--and is underlain by Kewaunee silt loams and Manawa silt loams. The degree of soil erosion which has occurred on this site varies from slight--none to one quarter of the original soil surface has been removed by erosion--to moderate --one-fourth to three-quarters of the original soil surface has been removed by erosion.

Site B: Site B is located within an approximately 951-acre drainage basin which drains into an unnamed perennial stream directly tributary to the Milwaukee River. The site exhibits flat to gently rolling topography--slope varies from 0 to 6 percent--and is underlain predominantly by Kewaunee and Manawa silt loams. Approximately 1.25 acres of the site is underlain by palms muck. The degree of soil erosion which has occurred to this area varies from none to slight.

Site C: Site C is located within an approximately 469-acre drainage basin which drains into an unnamed intermittent stream which is tributary to Sauk Creek. The site exhibits flat to gently rolling topography--slope varies from 0 to 6 percent--and is underlain by Kewaunee soils, Kewaunee silt loams, and Manawa silt loams. The degree of soil erosion which has occurred on this site is slight--none to one quarter of the original soil surface has been removed.

Woodlands, Wetlands, Wildlife Habitat, and Historical Features

No woodlands, wetlands, regionally significant wildlife habitat, or primary environmental corridors are located within or immediately adjacent to the proposed Sites A, B, and C. In addition, no federal or state rare, threatened, or endangered species are known to be inhabitating or using any of the three proposed disposal sites. Further, no sites of historic significance are located within any of the three proposed project boundaries.

Land Uses

All three sites are located on lands which are currently being used for production of row and small grain crops. In addition, these agricultural lands have been designated as prime agricultural land in SEWRPC Community Assistance Planning Report No. 87, A Farmland Preservation Plan for Ozaukee County. Dredged material disposal will not result in a loss of prime agricultural land, rather, it would serve to enhance the existing agricultural qualities of those lands which would received the clean dredged material.

Other Uses

No other land uses occur within the proposed project boundaries for any of the three proposed agricultural disposal sites.

USE OF DREDGED MATERIAL AS FILL CONSIDERATIONS

Historically, the use of dredged material to supplement or replace conventional fill materials used during general construction activities, establish or enhance park and recreation areas, or develop wildlife habitat was dictated by the proximity of the dredging work to these sites. However, the lack of applicable land areas near dredging activities and increased environmental concerns about dredge material disposal have dictated that a broader range of upland disposal sites be considered, and that criteria for selection of such sites be developed. The U. S. Army Corps of Engineers has conducted a dredged material research program to develop economically feasible dredging and disposal alternatives, including consideration of dredged material as a manageable, usable resource. As part of that study, procedures for site selection and for the evaluation of various uses as a fill material were developed.

An analysis of the physical and chemical characteristics of the dredged material to be used to supplement or replace conventional fill material is a necessary first step in determining whether the material is conducive to such use. The soil composition and structural characteristics of the dredged material will determine to a large extent its potential use. These characteristics include the general makeup of the material by soil type components such as sand, silt, clay, gravel, and organic material. Further, other physical soil characteristics associated with drainage, moisture content, compactability, and stability of the soil aggregates would also need to be determined. The time required to dewater the material and the density of the material will also have to be evaluated before it can be used. In most cases, material will need to be partially dried before it can be utilized. In addition, environmental considerations dictate that the chemical characteristics of the dredged material be analyzed. As previously discussed, dredged materials from the Port Washington Harbor contain varying concentrations of pollutants which would restrict their potential for productive uses.

The criteria that are utilized to predetermine the suitability of a site for the disposal of dredged material are important to ultimate site selection and to an understanding of the major planning considerations that affect the productive use of dredged material. General engineering criteria associated with construction work, such as the structural foundation and integrity of the underlying soil layers, will need to be assessed. Further, the depth to the water table, slope, and surface drainage characteristics at the site will need to be determined. Future use of the area will also be an important criterion in determining site selection, since light industry, open space, and/or recreation areas have less stringent fill requirements. Institutional constraints and environmental regulations would also need to be considered during site selection.

In order for use of the dredged material to be economically feasible, it is likely that the usable fraction, or sand and gravel portion, of the material will need to be separated from the unusable, organic components. This could probably best be accomplished as the dredging proceeds, with the material which is best suited for future use being segregated and transported to the site where it will be utilized, and the remaining portions disposed of in suitable landfills.

Because of the varied types of use, and varied locations for use, of fill material, specific, site selection criteria have not been presented. These would have to be developed on a site-specific basis.

NEARSHORE DISPOSAL CONSIDERATIONS

The following section provides an overview of the physical, chemical, and biological impacts which are typically associated with open water dredge material disposal methods.

Environmental Impacts in the Water Column

Contaminants: Although the vast majority of heavy metals, nutrients, and petroleum and chlorinated hydrocarbons are usually associated with the fine-grained and organic components of the sediment, there is no biologically significant release of these chemical constituents from typical dredged material to the water column during or after dredging or disposal operations.[9] Levels of manganese, iron, ammonium nitrogen, orthophosphate, and reactive silica in the water column may be increased somewhat for a matter of minutes over background conditions during open-water disposal operations; however, there are no persistent well-defined plumes of dissolved metals or nutrients at levels significantly greater than background concentrations.

Turbidity: Research into the effect of turbidity on water quality degradation resulting from the resuspension of dredged material during dredging and disposal operations are for the most part minimal.[10] The possible impact of depressed levels of dissolved oxygen has been of particular concern, due to the very high oxygen demand associated with fine-grained dredged material slurry. However, even at open water pipeline disposal operations where the dissolved oxygen decrease should theoretically be greatest, near-surface dissolved oxygen levels of 8 to 9 parts per million (ppm) will be depressed during the operation by only 2 to 3 ppm at distances of 75 to 150 feet from the discharge point. The degree of oxygen depletion generally increases with depth and increasing concentration of total suspended solids; nearbottom levels may be less than 2 ppm. Therefore, open water site selection should avoid those areas where fish with a need for high levels of dissolved oxygen, such as trout, are frequently found. However, dissolved oxygen levels usually

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[9] Dredging and Dredged Material Disposal, 1983, U.S. Army Corps of Engineers, Engineer Manual EM 1110-2-5025.

[10] Ibid.

increase with increasing distance from the discharge point, due to dilution and settling of the suspended material.

It has been demonstrated that elevated suspended solids concentrations are generally confined to the immediate vicinity of the dredge or discharge point and dissipate rapidly at the completion of the operation. If turbidity is used as a basis for evaluating the environmental impact of a dredging or disposal operation, it is essential that the predicted turbidity levels are evaluated in light of background conditions. Average turbidity levels, as well as the occasional relatively high levels that are often associated with naturally occurring storms, high wave conditions, and floods, should be considered.

Environmental Impacts on the Benthos

Physical: Whereas the impact associated with water column turbidity around dredging and disposal operations is for the most part insignificant, the dispersal of fluid mud dredged material appears to have a relatively significant short-term impact on the benthic organisms within open-water disposal areas. Open-water pipeline disposal of fine-grained dredged material slurry may result in a substantial reduction in the average abundance of organisms and a decrease in the community diversity in the area covered by fluid mud. Despite this immediate impact, recovery of the community apparently begins soon after the disposal operation ceases.[11]

Disposal operations will blanket established bottom communities at the site with dredged material which may or may not resemble bottom sediments at the disposal site. Recolonization of animals on the new substrate and the vertical migration of benthic organisms in newly deposited sediments can be important recovery mechanisms. The first organisms to recolonize dredged material usually are not the same as those which had originally occupied the site; they consist of opportunistic species whose environmental requirements are flexible enough to allow them to occupy the disturbed areas. Trends toward reestablishment of the original community are often noted within several months of disturbance, and complete recovery approached with a year or two. The general

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[11]Ibid.

recolonization pattern is often dependent upon the nature of the adjacent undisturbed community, which provides a pool of replacement organisms capable of recolonizing the site by adult migration or larval recruitment.

Organisms have various capabilities for moving upward through newly deposited sediments, such as dredged material, to reoccupy positions relative to the sediment-water interface similar to those maintained prior to burial by the disposal activity. Vertical migration ability is greatest in dredged material similar to that in which the animals normally occur and is minimal in sediments of dissimilar particle-size distribution. Bottom-dwelling organisms having morphological and physiological adaptations for crawling through sediments are able to migrate vertically through several inches of overlying sediment. However, physiological status and environmental variables are of great importance to vertical migration ability. Organisms of similar life-style and morphology react similarly when covered with an overburden. For example, most surface-dwelling forms are generally killed if trapped under dredged material overburdens, while subsurface dwellers migrate to varying degrees. Laboratory studies suggest vertical migration may very well occur at disposal sites, although field evidence is not available. Available information indicates the vertical migration phenomenon is highly variable among species.

Dredging and disposal operations have immediate localized effcts on the bottom life. The recovery of the affected sites occurs over periods of weeks, months, or years, depending on the type of environment and the biology of the animals and plants affected. The more naturally variable the physical environment, especially in relation to shifting substrate due to waves and currents, the less effect dredging and disposal will have. Animals and plants common to such areas of unstable sediments are adapted to physically stressful conditions and have life cycles which allow them to withstand the stresses imposed by dredging and disposal. Exotic sediments (those in or on which the species in question does not normally live) are likely to have more severe effects when organisms are buried than sediments similar to those of the disposal site. Generally, physical impacts are minimized when sand is placed on a sandy bottom and are maximized when mud is deposited over a sand bottom. When disposed sediments are dissimilar to bottom sediments at the sites, recolonization of the dredged material will probably be slow and carried out by organisms whose life habits are adapted to the new sediment. The new community may be different from that originally occurring at the site.

Dredged material discharged at disposal sites which have a naturally unstable or shifting substrate due to wave or current action is rather quickly dispersed and does not cover the area to substantial depths. This natural dispersion, which usually occurs most rapidly and effectively during the storm winter season, can be assisted by conducting the disposal operation so as to maximize the spread of dredged material, producing the thinnest possible overburden. The thinner the layer of overburden, the easier it is for mobile organisms to survive burial by vertical migration through dredged material. The desirability of minimizing physical impacts by dispersion can be overridden by other considerations, however. For example, dredged material shown by biological or chemical testing to have a potential for adverse environmental impacts might best be placed in an area of retention, rather than dispersion. This would maximize habitat disruption in a restricted area, but would confine potentially more important chemical impacts to the same small area.

Since larval recruitment and migration of adults are primary mechanisms of recolonization, recovery from physical impacts will generally be most rapid if disposal operations are completed shortly before the seasonal increase in biological activity and larval abundance in the area. The possibility of impacts can also be reduced by locating disposal sites in the least sensitive or critical habitats. This can sometimes be done on a seasonal basis. Known fish migratory routes and spawning beds should be avoided just before and during use, but might be acceptable for disposal during other periods of the year. However, care must be taken to ensure that the area returns to an acceptable condition before the next intensive use by the fish. Municipal or industrial water intakes and highly productive backwater areas should be avoided when selecting disposal sites.

All the above factors should be evaluated in selecting a disposal site, method, and season in order to minimize the habitat disruption of disposal operations. All require evaluations on a case-by-case basis by persons familiar with the ecological principles involved, as well as the characteristics of the proposed disposal operations and the local environment.

<u>Contaminants</u>: Dredging and disposal do not introduce new contaminants to the aquatic environment, but simply redistribute the sediments which are the natural depository of contaminants introduced from other sources. The potential for accumulation of a metal in the tissues of an organism (bioaccumulation) may be affected by several factors such as duration of exposure, salinity, water hardness, exposure concentration, temperature, the chemical form of the metal, and the particular organism under study. The relative importance of these factors varies from metal to metal, but there is a trend toward greater intake at lower salinities. Elevated concentrations of heavy metals in tissues of benthic invertebrates are not always indicative of high levels of metals in the ambient medium or associated sediments. Although a few instances of uptake of possible ecological significance have been shown, the diversity of results among species, different metals, types of exposure, and salinity regimes strongly argues that bulk analysis of sediments for metal content cannot be used as a reliable index of metal availability and potential ecological impact of dredged material, but only as an indicator of total metal context. Bioaccuulation of most metals from sediments is generally minor. Levels often vary from one sample period to another and are quantitatively marginal, usually being less than one order of magnitude greater than levels in the control organisms, even after one month of exposure. Animals in undisturbed environments may naturally have high and fluctuating metal levels. Therefore, in order to evaluate bioaccumulation, comparisons should be made between control and experimental organisms at the same point in time.

Organochlorine compounds such as DDT, dieldrin, and polychlorinated biphenyls (PCBs) are environmental contaminants of worldwide significance which are manmade and, therefore, do not exist naturally in the earth's crust. Organochlorine compounds are generally not soluble in surface waters at concentrations higher than approximately 20 parts per billion (ppb), and most of the amount present in waterways is associated with either biological organisms or suspended solids. Organochlorine compounds are released from sediment until some equilibrium concentration is achieved between the aqueous and the solid phases and then readsorbed by other suspended solids or biological organisms in the water column. The concentration of organochlorines in the water column is reduced to background levels within a matter of hours as the organochlorine compounds not taken up by aquatic organisms eventually settle with the particulate matter and become incorporated into the bottom deposits in aquatic ecosystems. Most of these compounds are stable and may accumulate to relatively high concentrations in the sediments. The manufacture and/or disposal of most of these compounds is now severely limited; however, sediments that have already been contaminated with organochlorine compounds will probably continue to have elevated levels of these compounds for several decades. The low concentrations of chlorinated hydrocarbons in sediment interstitial water indicate that during dredging operations, the release of the interstitial water and contaminants to the surrounding environment would not create environmental problems. Bioaccumulation of chlorinated hydrocarbons from deposited sediments does occur. However, the sediments greatly reduce the bioavailability of these contaminants, and tissue concentrations may range from less than one to several times the sediment concentration. Unreasonable degradation of the aquatic environment due to the routine maintenance dredging and disposal of sediment contaminated with chlorinated hydrocarbons has never been demonstrated.

The term "oil and grease" is used collectively to describe all components of sediments of natural and contaminant origin which are primarily fat soluble. There is a broad variety of possible oil and grease components in sediment, the analytical quantification of which is dependent on the type of solvent and method used to extract these residues. Trace contaminants, such as PCBs and chlorinated hydrocarbons, often occur in the oil and grease. Large amounts of contaminant oil and grease find their way into the sediments of the Nation's waterways either by spillage of as chronic inputs in municipal and industrial effluents, particularly near urban areas with major waste outfalls. The literature suggests long-term retention of oil and grease residues in sediments, with minor biodegradation occurring. Where oily residues of known toxicity became associated with sediments, these sediments retained toxic properties over periods of years, affecting local biota. Spilled oils are known to readily become adsorbed to naturally occurring suspended particulates, and oil residues in municipal and industrial effluents are commonly found adsorbed to particles. These particulates are deposited in sediments and are subject to suspension during disposal. Even so, there is only slight desorption, and the amount of oil released during the elutriate test is less than 0.01 percent of the sediment-associated hydrocarbons under worst-case conditions. Selected estuarine and freshwater organisms exposed for periods up to 30 days to dredged material that is contaminated with thousands of parts per million of oil and grease experience minor mortality. Uptake of hydrocarbons from heavily contaminated sediments appears minor when compared with the hydrocarbon content of the test sediments.

Ammonia is one of the potentially toxic materials known to be released from sediments during disposal; it is routinely found in evaluations of sediments using the elutriate test and in the water near a disposal area where concentrations rapidly return to baseline levels. Similar temporary increases in ammonia at marine, estuarine, and freshwater disposal sites have been documented in several Corps of Engineers dredged material research projects, but concentrations and durations are usually well below levels causing concern.

The potential environmental impact of contaminants associated with sediments must be evaluated in light of chemical and biological data describing the availability of contaminants to organisms. Information must then be gained as to the effects of specific substances on organism survival and function. Many contaminants are not readily released from sediment attachment and are thus less toxic than contaminants in the free or soluble state on which most toxicity data are based.

There are now cogent reasons for rejecting many of the conceptualized impacts of disposed dredged material based on classical bulk analysis determinations. It is invalid to use total sediment concentration to estimate contaminant levels in organisms since only a variable and undetermined amount of sediment-associated contaminant is biologically available. Although a few instances of toxicity and bioaccumulation of possible ecological consequence have been seen, the fact that the degree of effect depends on species, contaminants, salinity, sediment type, etc., argues strongly that bulk analysis does not provide a reliable index of contaminant availability and potential ecological impact of dredged material.

Methodology for General Open Water Disposal Site Selection Process

The following guidelines for selecting an open water disposal site should be used, bearing in mind the site-specific conditions, types, and quantities of dredged materials and methods of transportation used. Some of the guidelines may seem to be contradictory at times when applied simultaneously and with equal weight to certain locations. The weight assigned to various factors in such situations will depend on site-specific conditions.

Open Water Disposal Sites Should Be Located so As To Avoid Adverse Impacts On:

1. Commerce and transportation, including commercial shipping, commercial fishing, pipeline and cable crossings, and mineral and aggregate extraction.

2. Water intakes and outfalls.

3. Recreational uses and aesthetic values of the area.

4. Bottom topography so as not to adversely impact water circulation, current patterns, water level fluctuations, temperature regime, erosion and accretion patterns, and wave climate.

5. Sites of natural, cultural, archaeological, historical, and research significance.

6. Sanctuaries and refuges, breeding, spawning, nursery and feeding habitats, and passage areas for biota.

7. Species of special interest such as threatened and endangered species.

In addition, open water disposal sites should:

1. Be compatible with physical and chemical characteristics of the dredged material to the extent practicable;

2. Utilize the smallest practicable disposal area;

3. Use current and past dredged material disposal sites, if these sites meet the proposed guidelines; and

4. Be selected to minimize the dispersal, erosion, and slumping of the material to affect the smallest practical part of the waterbody.

In applying the above-mentioned guidelines, the following considerations need to be addressed.

Commercial Activities: The use of open water areas for the disposal of dredged material should not conflict with other high priority uses. The sites selected should not interfere with navigation, commercial fishing, submerged pipelines or cables, and sand, gravel, or mineral extractions.

Information regarding the navigation channels in the Great Lakes is available from the nautical charts issued by the U.S. National Oceanic and Atmospheric Administration (NOAA). Except for long, buoyed navigation channels extending several kilometers from shore, open water disposal sites have typically been located one to three kilometers away from navigation channels. It is believed that this distance is sufficient to prevent potential adverse impacts to the navigation channels. At locations where open water disposal sites may be near commercial navigation sailing courses, minimum depths at Low Water Datum should be maintained, where feasible, in order to avoid grounding of vessels. The minimum depth needed at any specific area should be at least equal to the greatest project depth which is charted at nearby navigation channels and harbors. The locations of other installations in the lake bottom such as cables, pipelines, well-heads, and commercial fishing net stakes are identified on the nautical charts. The NOAA Coast Pilot Number 6 for the Great Lakes should be consulted for detailed descriptions of available navigation depths in the vicinity of potential disposal sites. In those cases where it may not be possible to maintain a minimum depth, open lake disposal areas should be identified on new charts so navigators can avoid them.

Published information is not generally available regarding the locations of sand, gravel, or mineral resources and extraction activities in many areas of the Great Lakes. The current national and local permitting processes for disposal activities consider potential conflicts between open water dredged material disposal and sand, gravel, or mineral extraction.

Water Intakes and Outfalls--Use of open water disposal site should not interfere with municipal, industrial, or other types of water intakes and outfalls.

Deposition of dredged material close to a water intake may increase the suspended solids load to a water treatment facility resulting in additional filtration requirements and costs. In some cases material deposited in the vicinity of a water intake may not have an immediate effect, since most dumping occurs during calm periods. Such material, however, can be resuspended during storms and affect the quality of water entering the intake. Mounds of material adjacent to an intake may also affect the proper functioning of the intake port as a result of physical obstruction to the port. Such mounds of materials often serve as an attractant to certain species of fish which could be drawn into an intake.

Disposal of dredged material close to an effluent outfall may reduce the dispersion of the effluent. Thermal, sewage, and stormwater effluents require adequate mixing and transport via currents to prevent local water quality degradation. Mounds of dredged material could impede water movement in the vicinity of outfalls. Deposition of material resulting in blockage of a diffuser port on multiport outfalls may result in hydraulic overloading in the outfall. This would result in the diffuser caps being lifted off causing pressure drops at the remaining ports. Disposal in the vicinity of an outfall must be well outside of a safe zone designated by appropriate regulatory agencies and the agency and operator responsible for the outfall.

Recreational Uses and Aesthetic Values of the Area--An open water disposal site should be removed from areas of recognized recreational value such as beaches, and wildlife areas. Disposal procedures should be designed so as to prevent or minimize any potential damage to the aesthetically pleasing features of the open water site, especially in regards to water quality. Disposal operations should be timed so as not to interfere with the peak recreational period.

Bottom Topography--Bottom topography influences the current patterns and water circulation and, therefore, plays a critical role in the ecology of lakes. Current patterns and water circulation, i.e., physical movement of water in the aquatic system, act to transport sediment and dilute dissolved and suspended chemical constituents. They also transport food and nutrients for aquatic communities, provide directional orientation to migrating species, and moderate extremes in temperature variations. Normal water fluctuations in a body of water affect water depth, water quality, and are critical during spawning and feeding season. Prevalent accretion and erosion patterns in an area determine the bottom movement of material. Similarly, alterations in the wave climate can severely affect or destroy populations of aquatic animals and vegetation, modify habitats, reduce food supplies, and change accretion and erosion patterns.

The dredge material should be deposited in a layer of suitable thickness at the disposal site to maintain natural bottom contours and elevation. In locations where mounding is an acceptable and ecologically desirable alternative, the shape and orientation of the mounds should be such that they will have a minimal impact on the prevailing current pattern and water circulation. The height and shape of mounds should be such as not to change existing depths and available fetches to adversely alter the wave climate of the area. The disposal of the dredged material should not result in enclosed areas of stagnant water, especially during low water cycles.

Sites of Historical Signficance--Open lake dredged material disposal sites should be located away from areas of historical significance. Areas which are designated for their natural, cultural, archaeological, historical or scientific significance should be preserved in their existing state and managed so as to ensure continued access.

Natural areas include important examples of natural history in the form of plant and animal communities, landforms or geological features. Natural areas are tracts of land so little modified by man's activity or sufficiently recovered that they contain native plant and animal communities believed to be representative of the presettlement landscape.

Historic and cultural resources include sites, areas, structures and objects of significance in history, architecture, archaeology or culture, e.g., sunken ships at the bottom of the Great Lakes. Such sites may be valuable because in their natural and undisturbed state, they contain useful scientific information. In many areas known historical sites are catalogued. Where such information does not exist, it is advisable to carry out a scuba diving or alternative survey to ensure that the potential disposal is not of historical significance.

Sanctuaries and Refuges, Breeding, Spawning, Nursery and Feeding Habitats, and Passage Areas of Biota--The disposal of dredged material should not damage or destroy wetlands, sanctuaries, refuges or other areas designated and managed for the preservation of fish and wildlife. Improper disposal can reduce suitable habitats for many species of fish, wildlife, and other biota, and interfere with spawning, migration, or other life stage activities. Habitats can also be damaged by changes in water levels or circulation and by smothering. Appropriate surveys of the area should be conducted prior to dredged material disposal in such areas.

Possible Impacts on Species of Special Interest--Applicable State and Federal listings of species whose continued existence is considered to be in jeopardy (i.e., those species designated as "rare and protected", "threatened", "endangered") must be considered when selecting a disposal site. The disposal site must not adversely impact on or interfere with the continued survival, reproduction, or movement of such species, or with management efforts to protect and rehabilitate such species. In addition, the disposal site must not adversely impact on or interfere with management plans or efforts for other species of special interest such as those designated for intensive management or for introduction into the Great Lakes. Included in these considerations is protection of the forage base upon which these species are dependent.

Sediment Compatibility with Substrate at Disposal Site--Compatibility of the dredged material with the substrate at the disposal site is desirable in order to maintain the physical, chemical, and biological state of the site. Some allowance for temporary changes in the substrate immediately following disposal can be made but the major objective should be either an improvement or a quick return to predisposal substrate at the disposal site.

"Sediment matching" has been used to minimize the impact of dredged material disposal on biota. This involves finding an area having substrate similar to that at the site to be dredged and disposing of the dredged material at that location. Sediment matching accomplishes two things:

1. It reduces the time required for recolonization by biota because organisms from nearby areas should be adapted to conditions found in the dredged material; and

2. It minimizes the time required for the establishment of a "stable" biological community. The more similar the dredged material are to the surrounding area, the less time will be required to reach equilibrium with respect to both chemical and physical characteristics.

For the above two reasons, sediment matching should be employed if at all possible. However, there are circumstances that preclude the use of sediment matching. These include the absence of substrate similar to the substrate to be dredged, economics, and need or desire on the part of resource managers to create a new habitat type in an area.

If sediment matching is not practical, then consideration must be given to the type of sediment to be dredged and its compatibility with substrate at the disposal site. From a biological (habitat) perspective, sediment can be conveniently divided into three types: coarse--gravel, cobbles, boulders (with some fines); medium--sand with some fines; fine--silt and clay. Each of these has characteristics that make it more or less valuable to different components of the biological community.

Coarse grained sediments provide valuable habitat for many species of invertebrates, including those that are considered to be valuable as fish food, and generally provide good habitat for fish spawning, rearing and feeding.

Medium grained sediments provide poor substrate for invertebrates, except for the few species that are capable of living in and on this unstable, nutrient poor medium. Sand should not be deposited on another substrate type unless absolutely necessary. In cases where sand is deposited in deep water over fine sediment, there may be a long period of time over which the substrate will be altered unless sand passes completely through the softer material.

Fine grained sediments provide good substrate for benthic invertebrates but are generally poor for fish spawning. If macrophyte growth occurs, then excellent habitat for spawning, rearing, and foraging is provided for some species. Fine sediments, however, are usually nutrient rich and can cause or aggravate enrichment problems.

Minimizing the Size of Disposal Area--Use of a site for dredged material disposal will have at least some short-term impacts. In order to minimize the area affected, the size of the disposal area used should be kept to a minimum. The disposal area must be easy to locate by the ship or barge operator so the material can be placed inside the designated site. To facilitate this, the disposal area should be clearly marked. Accurate site location is particularly important if the deposited material is to be capped with other materials (to better match substrate, enhance habitat or help seal off pollutants). The capping material must be accurately placed over the previously deposited material.

Use of Current and Past Disposal Sites--Current and past open water disposal sites were chosen after consideration of factors such as distance from dredging site, proximity to navigation channels, etc. They may already be in compliance with the guidelines. The use of existing sites is preferred for localizing impacts of disposal. If there are some unavoidable adverse impacts from disposal, it would be preferable to continue to use existing sites where degradation has already occurred rather than affecting other areas. Since these sites have been used in the past, surveys can be done to determine actual impacts from their use by comparison with surrounding lake bottom outside the disposal area.

Minimizing Dispersal, Erosion and Slumping of Dredged Material at the Disposal Site--Retention of dredged materials at disposal sites can be fostered by proper site selection, disposal methods, and dredged material stabilization.

Disposal sites should, therefore, have the following characteristics: 1) particle sizes as fine as or finer than the dredged materials, 2) bottom slopes should not be steep, 3) sites should not be adjacent to channels. Use disposal sites which have shown minimum dispersal, slumping, or erosion of dredged materials in the past.

Disposal methods which would aid in dredged material retention are: 1) accurate placement of dredged materials, 2) timing of disposal so that water levels and currents would permit maximum settling and compaction, and 3) minimization of substrate elevations.

Retention of dredged materials onsite can be fostered by: 1) capping or surrounding materials of small particle sizes with coarser materials, and 2) establishing aquatic or semi-aquatic vegetation as soon as possible.

Site Selections-Beach Nourishment

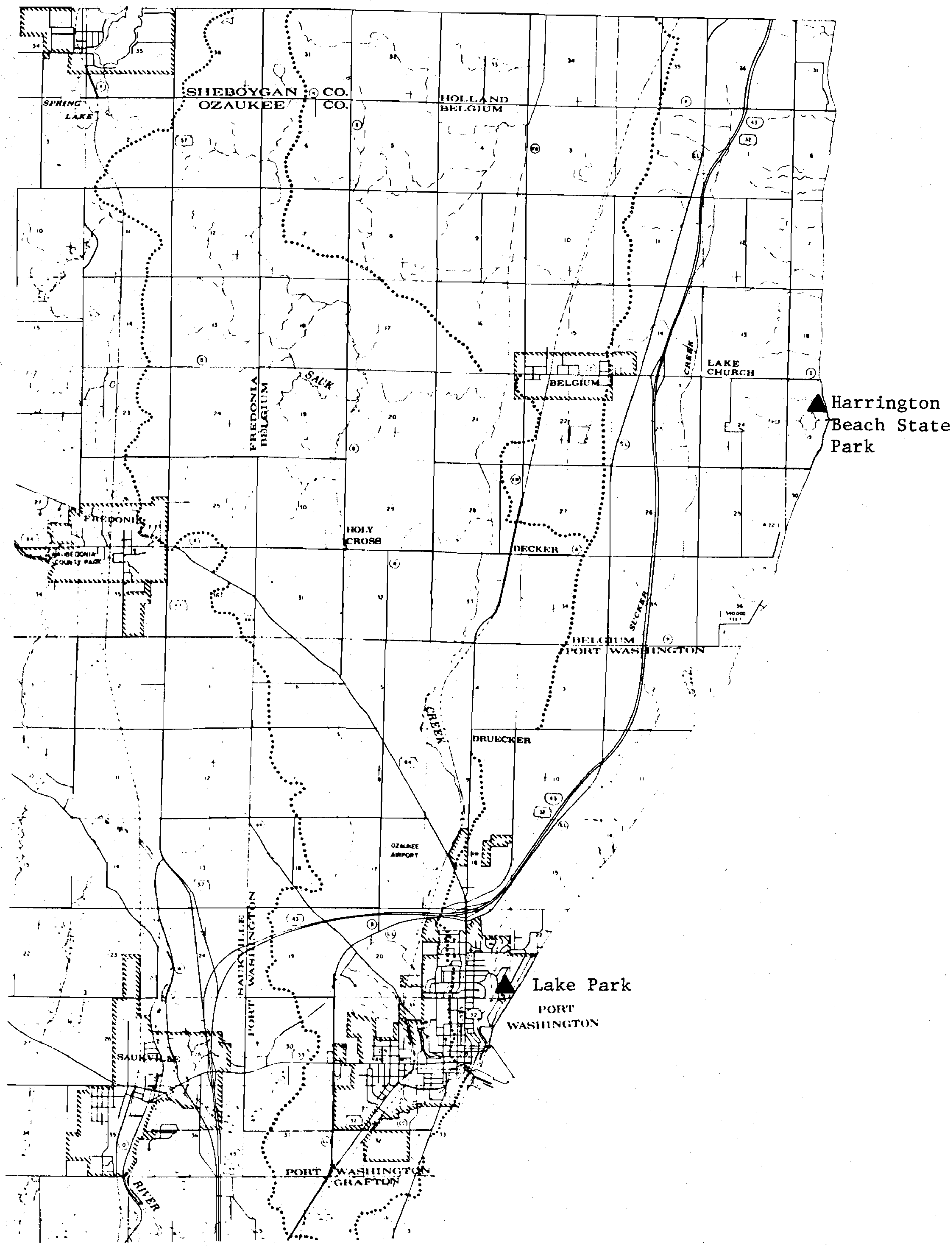
Two sites have been selected as having a potential for unpolluted dredged material disposal in the form of beach nourishment (see Map 15). Shoreline erosion problems at Harrington Beach State Park and at the City of Port Washington's Lake Park are of sufficient magnitude to warrant remedial action to help mitigate against the destructive effects that are resulting from excessive shoreline erosion.

1) Harrington Beach State Park: Harrington Beach State Park is a 636-acre park, located approximately seven miles north of the City of Port Washington. The park has approximately 1.1 miles of shoreline, all of which is experiencing significant shoreline erosion.

Limnology--Fish species which are typically found in Lake Michigan--including salmon, trout, perch, smelt, and alewive--may be expected to occur in the Harrington Beach nearshore area. Information concerning the location of spawning beds in the Harrington Beach area is not presently available. However, provided unknown spawning beds are not silted in from dredged material

Map 15

POTENTIAL BEACH NOURISHMENT SITES



Source: SEWRPC

deposition in the nearshore area, beach nourishment is not expected to result in a long-term adverse impact to local benthic and fish communities located in the proposed project area.

Wetlands and Wildlife Habitat--There are no emergent wetlands located in Lake Michigan adjacent to the beach area. Further, no regionally significant wildlife habitat has been identified in the beach area, although the beach itself does provide important feeding and resting habitat for migratory shorebirds such as semipalmated plovers and ruddy turnstones, due to its location in a major migratory corridor along the western shore of Lake Michigan. Also, common and Forester's terns and piping plovers, all endangered species in the State of Wisconsin may potentially use the project area at Harrington Beach State Park for resting and feeding. In addition, the nearshore area provides resting and feeding habitat for a variety of migratory waterfowl such as old squaw and bufflehead and for common and red-throated loons as well. Beach nourishment in this area has the potential to create additional "beach" habitat which may be used by migratory shore bird species as a resting and feeding habitat, and would not be expected to result in an adverse impact to migratory waterfowl using the nearshore area for feeding and resting during the spring and fall migrations.

Water Uses--Presently the beach at Harrington Beach State Park serves as a swimming beach for visitors using the park facilities. Beach nourishment would help to maintain and provide additional beach acreage for recreational purposes while offsetting shoreline losses to erosion. Beach nourishment using unpolluted dredged materials can be implemented in such a manner so as not to negatively impact recreational uses at Harrington Beach.

Water Quality--Aside from some short-term turbidity associated with the deposition of the unpolluted dredged material, no measurable adverse impacts to the water quality are expected to result from beach nourishment in this area. Particle size dredged material will influence the net accretion of dredged material since silts and clays remain suspended in the water column and are eventually moved into deeper waters by wave action. Only the heavier particles will accumulate in the nearshore area. Any contaminants attached to the fine particles of dredged material have the potential to be reintroduced into the water column upon deposition in the nearshore area. However, with the maintenance of clean sediment conditions within the Port Washington Harbor, the levels of these contaminants, if extant, are probably low enough to preclude any significant adverse impact to water quality conditions with or downdrift from the project area.

2) Port Washington Lake Park: Lake Park is a 66-acre park owned by the City of Port Washington and located immediately north of Port Washington Harbor. Situated on top of an approximately 100-foot bluff, Lake Park is experiencing significant erosion at the toe of the bluff along its entire 3,000 foot shoreline. Undercutting is contributing to destabilization, resulting in the loss of parkland area as unstable portions of the bluff slump into Lake Michigan.

Limnology--Fish species which are typically found in Lake Michigan--including salmon, trout, perch, smelt, and alewife--may be expected to occur in the Lake Park nearshore area. Information regarding the specific location of spawning beds in the Lake Park area is not presently available. However, provided that unknown spawning beds are not silted in from dredged material deposition in the nearshore area, beach nourishment is not expected to result in a long-term adverse impact to local benthic and fish communities located in the proposed project area.

Wetlands and Wildlife Habitat--There are no emergent wetlands located in the nearshore area adjacent to Lake Park. Further, no regionally significant wildlife habitat has been identified in the Lake Park nearshore area. However, as with Harrington Beach, the Lake Park coastal zone provides resting and feeding habitat for a variety of migratory waterfowl such as goldeneye and mergansers, and for shorebirds such as common and forester's terns, both designated as endangered species in Wisconsin. Beach nourishment in this area is not expected to adversely impact waterfowl or shorebird use of the shallow nearshore waters adjacent to Lake Park.

Water Uses--Recreational activities within Lake Park are essentially restricted to those portions of the park located on top of the bluff, and do not include any of Lake Park's shoreline. Therefore, beach nourishment is not expected to impact recreational activities occurring within Lake Park.

<u>Water Quality</u>--As is the case for Harrington Beach State Park, no measurable adverse effects to the local water quality, with the exception of some short-term increased turbidity around the disposal site, are expected to result from beach nourishment in the Lake Park project area. Particle size dredged material will influence the net accretion of dredged material since silts and clays remain suspended in the water column and are eventually moved into deeper waters by wave action. Only the heavier particles will accumulate in the nearshore area. Any contaminants attached to the fine particles of dredged materials have the potential to be reintroduced into the water column upon deposition into the nearshore area. However, with the maintenance of clean sediment conditions within the Port Washington Harbor the levels of these contaminants, if extant, are probably low enough to preclude any significant adverse impact to water quality conditions with or downdrift from the project area.

LAND USE CONSIDERATIONS

The potential disposal of dredged materials from the Port Washington Harbor in upland and nearshore areas may be expected to impact upon, and be impacted by existing land use patterns in Ozaukee and Washington Counties, where the upland and nearshore disposal of dredged materials will most likely occur. Accordingly, an understanding of existing land use patterns, and of the trends in such patterns, is important to the sound evaluation of potential upland and nearshore disposal sites. For instance, areas which include wetlands--primarily environmental corridors and residential developments, among others--are not suitable for landfill siting. Pertinent criteria relating to specific land use concerns are found in the environmental considerations section of the upland disposal section of this report.

Existing 1980 land uses for Ozaukee and Washington Counties are summarized in Table 11. Table 11 shows that approximately 41 square miles, or 18 percent of Ozaukee County; and approximately 51 square miles, or 12 percent of Washington County, are devoted to urban-type land uses. The largest land use category within the two-county area is still agriculture, which occupies approximately 412 square miles, or 71 percent of the total rural area and about 61 percent of the total two-county area. The next largest land use category is open lands, including water, wetlands, and woodlands, which occupy about 162 square

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Table 11

GENERALIZED LAND USE IN OZAUKEE AND WASHINGTON COUNTIES: 1980

	Urban Land Uses (acres)									Rural Land Uses (acres)			
County	Residential	Commercial	Industrial	Transportation[a]	Communications and Utilities	Government and Institution	Recreation[b]	Unused[c]	Urban Subtotal	Agriculture	Other Open[d]	Rural Subtotal	County Total
Ozaukee	13,209	428	534	8,357	190	1,003	1,746	1,073	26,540	93,832	30,082	123,914	150,454
Washington	15,508	508	641	12,082	191	1,074	1,767	562	32,333	169,574	76,926	246,500	278,833
Two-County Total	28,717	936	1,175	20,439	381	2,077	3,513	1,635	58,873	263,406	107,008	370,414	429,287

[a]Includes off-street parking.

[b]Consists of intensively used outdoor recreation facilities.

[c]Consists of vacant land surrounded by urban land uses.

[d]Includes surface water, wetlands, woodlands, extractive uses, landfills, and unused rural lands.

Source: SEWRPC

miles, or 29 percent of the rural area of the two-county region and about 25 percent of the total two-county area. Approximately 86 percent of the two-county area, therefore, is devoted to rural land uses, including agriculture, woodlands, wetlands, other open lands, and surface waters. Of the two-county area devoted to urban uses, residential land occupies the greatest proportion, about 45 square miles, or 49 percent of the total urban area of the two-county region and about 7 percent of the total area.

Chapter V

COMPARATIVE EVALUATION OF UNPOLLUTED DREDGED MATERIAL DISPOSAL ALTERNATIVES AND RECOMMENDED PLAN

The preceding chapters of this report presented information on the need, and alternative means, for the disposal or reuse of unpolluted dredged material from the Port Washington Harbor. The information was intended to provide a basis for the comparitive evaluation of the disposal alternatives. As noted in Chapter II, it is estimated that about 4,000 cubic yards per year of unpolluted material would be dredged from the outer harbor. In addition, it is anticipated that about 600 cubic yards per year of polluted material would be dredged from the inner harbor. This study addresses only the disposal of the unpolluted dredged material. The following sections provide a brief description of each disposal alternative considered. Table 12 presents data on the costs of each of the dredged material disposal alternatives.

Alternative One: Disposal of Unpolluted Dredged Material in a Landfill Designed Exclusively for Dredged Material Disposal

This alternative requires the construction of a landfill specifically designed for the disposal of unpolluted dredged materials. Although the primary concern of this report is the evaluation of dredged material disposal alternatives over a 10-year period, for practical as well as cost effective reasons, the construction of a special purpose landfill should be engineered to accommodate unpolluted dredged material over a 20-year design period. Therefore, it is estimated that a 20-acre site would be required for the disposal of about 4,000 cubic yards of dredged material per year over the 20-year design period. Potential site locations are shown on Map 13. The cost of disposal utilizing this alternative is estimated to be approximately \$18.32 per cubic yard of dredged material measured in place, resulting in an expenditure of approximately \$73,300 per year over the 10-year project period from 1987 through 1996.

The major advantage of this alternative is that it would provide a flexible and environmentally safe method of disposal which can be used at all times of the year, whenever dredging occurs. In addition, the landfill can be specifically designed to accommodate the disposal of the dredged material.

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Table 12

SUMMARY OF COST ANALYSIS OF ALTERNATIVE DREDGE MATERIAL DISPOSAL MEASURES: 1986-1996

Alternative[a]	Capital	Annual Operation and Maintenance	Total Annual Cost	Cost per Cubic Yard of Dredged Materials[b]
Upland Disposal:				
New Landfill	\$308,000[c]	\$42,500	\$73,300	\$18.32
Existing Landfill	224,000	42,500	64,900	16.22
Agricultural Soil Conditioner	55,000	67,200	72,700	18.18
Fill	84,000	38,600	47,000	11.75
Nearshore Disposal:				
Beach Nourishment[d]	5,000	28,500	29,000	7.26
Existing Confined Disposal Facility	144,000	25,800	40,200	10.06

[a]All alternatives include dredging with mechanical dredging equipment.

[b]The unit costs are provided per cubic yard of dredged materials at an assumed solids content of 50 percent total solids.

[c]This amount reflects 50 percent of the cost of the recommended 20-year landfill site.

[d]Open water disposal is currently prohibited by Section 30.12 of the Wisconsin State Statutes.

Source: SEWRPC

The major disadvantage of this alternative is the potential problem entailed in obtaining local public support for the location of a specific landfill site for the deposition of dredged material. Public concern, including concern over a perceived potential for groundwater contamination--however ill-founded --could pose a problem in the implementation of this alternative. In addition, significant engineering and legal efforts would be necessary to obtain the required approvals of a site for the construction of a landfill for dredged materials.

Alternative Two: Disposal of Unpolluted Dredged Material in an Existing Landfill Along with Other Solid Wastes

This alternative requires the transport of unpolluted dredged material to an existing sanitary landfill site for disposal with other solid wastes. Known existing solid waste landfills in Washington and Ozaukee Counties, which may serve as potential disposal sites, are shown on Map 10. The cost of disposal utilizing this alternative is estimated to be approximately $16.22 per cubic yard of dredged material measured in place, resulting in an annual cost of $64,900 over the 10-year project period from 1987 through 1996.

The major advantage of this alternative is that it would provide a flexible and environmentally-safe method of disposal which can be used at all times of the year, whenever dredging occurs. Furthermore, the costs associated with landfill siting, design, and construction would be transferred to the landfill owner and operator. The major disadvantage of this alternative is the decrease which would occur in the available capacity of the landfill to accept other types of solid waste.

Alternative Three: Application of Unpolluted Dredged Material as an Agricultural Soil Conditioner

Alternative three provides for the use of unpolluted dredged material to condition agricultural land where productivity can be improved through the addition of the dredged materials. It is estimated that approximately 10 acres of agricultural land per year would be required for the disposal of about 4,000 cubic yards of dredged material per year. Potential land application sites are shown on Map 11. This cost of disposal utilizing this alternative is estimated to be approximately $18.18 per cubic yard of dredged material measured in place, resulting in an annual cost of $72,700 over the 10-year project period from 1987 through 1996.

An analysis of the specific soil characteristics of the proposed agricultural disposal sites would be necessary to determine which areas would benefit from the addition of dredged materials. The physical and chemical composition of dredged materials would also need to be determined in order to assess the suitability of such materials for soil incorporation.

A major advantage of this alternative is that the dredged material is used for a beneficial purpose rather than merely being disposed of; the dredged material providing increased fertility and improved drainage to the agricultural lands involved.

The major disadvantage of this alternative is that public concern, particularly relating to the perceived potential for soil and groundwater contamination, could present a problem in obtaining local public support for the incorporation of unpolluted dredged material into agricultural soils. Also, detailed site selection criteria would need to be developed and applied in order to assure the proper application of the material as a soil conditioner.

Alternative Four: Use of Unpolluted Dredged Material as Fill

This alternative requires the use of dredged materials to replace, or supplement, conventional fill materials. The alternative assumes that the characteristics of the dredged material would render the material suitable for such a use. The potential site conditions that could be encountered in the use of dredged material as fill area so varied that each site would need to be evaluated with respect to feasibility on a case-by-case basis. The alternative consists of three main components: a storage and partial dewatering system, a transportation system, and a filling operation. The cost of disposal utilizing this alternative is estimated to be approximately $11.75 per cubic yard of dredged material measured in place, resulting in an annual expenditure of $47,000 over the 10-year project period from 1987 through 1996.

A major advantage to this method of disposal is that it would substitute dredged material for conventional, more expensive sources of fill, while at the same time providing a convenient and inexpensive means of disposal.

The major disadvantage of this alternative is the need to do extensive sampling of bottom sediments prior to dredging and to segregate the material during the dredging process. Although no land would need to be committed other than for temporary storage, for disposal under this alternative, construction sites requiring fill would generally need to be located in proximity to the harbor. Further, the fill sites would be required to have subsoil, groundwater, slope, and surface drainage characteristics that would permit the use of the dredged material as fill. Finally, it is likely that only a portion of the unpolluted dredged material could be used to implement this alternative because of the limited demand for such fill materials in the study area.

Alternative Five: The Use of Unpolluted Dredged Material for Beach Nourishment

This alternative provides for the use of unpolluted dredged materials for beach nourishment with the intent of mitigating excessive shoreline erosion. The cost of disposal utilizing this alternative is estimated to be approximately \$7.26 per cubic yard of dredged material measured in place, resulting in an annual cost of \$29,000 over the 10-year project period from 1987 through 1996.

A major advantage of this alternative is cost--beach nourishment being the least costly of all the disposal options considered. In addition, any beach nourishment which occurs at the sites proposed in this report, namely, Harrington Beach State Park and Port Washington Lake Park, respectively, would result in substantial public benefit, as both sites are intended to serve as swimming beaches for visitors using the park facilities. Beach nourishment, then, would help maintain suitable beach acreage for this recreational purpose while, at the same time, offsetting the effect of public shoreline losses due to erosion.

Another advantage to using beach nourishment as a dredged material disposal method is the temporary nature of the benefit to be derived. That is, since beach nourishment projects typically occur in areas experiencing significant shoreline erosion, it may be expected that the same erosive forces that normally occur at the proposed site will continue to occur and therefore will act upon any dredged material disposited in the project area. Therefore, there can be expected to be a continuing need for beach nourishment to maintain the benefits provided.

Two disadvantages are attendant to this alternative. The feasibility of potential beach nourishment projects is dictated, in part, by the particle size of the dredged material, as particle size matching is critical to the success of any beach nourishment project. Consequently, the dredged materials will have to be analyzed to assure a proper partical size match for the proposed nourishment use. It is important to note that at this time open-water disposal of dredged material, including beach nourishment, is unfortunately prohibited by Wisconsin State law. However, the Wisconsin Department of Natural Resources is presently in the process of revising NR 347 to provide for the deposition of unpolluted dredged material in the nearshore area for beneficial uses, including beach nourishment.

Alternative Six: Disposal of Dredged Material in a Confined Disposal Facility

Currently, it is the policy of the U.S. Army Corps of Engineers to use existing confined disposal facilities exclusively for the disposal of polluted dredged materials. Moreover, other Great Lakes states, with the exception of Wisconsin, allow the open water disposal of clean dredged materials. However, Wisconsin, unlike the other Great Lakes states, considers dredge materials to be a solid waste. Therefore, the open water disposal of dredged materials in Wisconsin is presently prohibited. Consequently, both polluted and clean dredged materials are often disposed of in existing confined disposal facilities.

Chemical analyses of samples of the existing bottom sediments taken from the inner harbor portion of the Port Washington Harbor are classified as polluted with respect to oil and grease, cadmium, lead, mercury, and PCBs, a fact which limits, or prohibits, the potential use of these materials for beach nourishment. Therefore, these and the clean dredged materials from the outer harbor portion may be deposited in existing confined disposal facilities. The location of existing confined disposal facilities within the Southeastern Wisconsin Region are shown on Map 12. As previously noted, the disposal of the polluted dredged materials was not considered in this study. However, the costs for disposal using this alternative are reported herein. The cost of disposal utilizing this alternative is estimated to be approximately \$10.06 per cubic yard of dredged material measured in place, resulting in an annual cost of \$40,200 over the 10-year project period from 1987 through 1996.

RECOMMENDED PLAN FOR THE DISPOSAL OF UNPOLLUTED DREDGED MATERIAL FROM PORT WASHINGTON HARBOR

The objective of this study, undertaken at the request of the Wisconsin Coastal Council and the City of Port Washington, was to evaluate alternative disposal methods for the deposition of unpolluted dredged materials from the outer harbor portions of the Port Washington Harbor. Upland or nearshore disposal methods and beneficial uses, as described in this report, provide alternatives to the historically more prevalent methods of disposing of dredged materials in confined disposal sites. The purpose of this section is to identify the most practical and cost-effective alternative for the disposal of unpolluted dredged material from the Port Washington Harbor.

A comparative evaluation of the six alternative methods considered for the disposal and beneficial uses of unpolluted dredged materials from the Port Washington Harbor, indicates that the cost of the dredged material disposal may be expected to range from $7.26 per cubic yard of dredged material measured in place for the beach nourishment alternative; to $18.32 per cubic yard for the construction of a new landfill. Each of the six alternatives considered, was also evaluated in terms of its practicality of implementation. In addition, a seventh alternative, which envisions the combined use of several alternative methods of beneficial use and disposal of the dredged materials, was evaluated.

Based upon the results of the comparitive evaluation and the inherent heterogeneity in the physical composition of the bottom sediments to be dredged, the use of a combination of disposal alternatives may provide the most practical method of disposal of unpolluted dredged materials. The use of several dredged material disposal methods, however, will require some efforts to overcome or minimize the disadvantages attendant to each.

It is recommended, therefore, that a combination of alternative dredged material disposal methods be utilized for the disposal of unpolluted dredged materials from the Port Washington Harbor. Specifically, these recommended alternatives include the disposal of the dredged material primarily through beach nourishment and, where appropriate, the stockpiling of the coarse dredged materials for future uses as fill material. In addition, disposal of material in an existing confined disposal facility should be continued as an alternative back-up method for dredged materials not disposed of by the recommended methods.

The major advantage of utilizing these recommended alternatives for the disposal of unpolluted dredged materials is that they would provide a flexible and environmentally safe method of disposal for the wide variety of materials that may be encountered in dredging the Port Washington Harbor. Furthermore, the beneficial disposal methods can be utilized at all times of the year. The major disadvantage of this combination of alternatives, however, is the need for sampling of the bottom sediments prior to dredging. In addition, upon the commencement of the dredging process, the segregation of the coarse dredged materials from the finer sediments must be properly performed to ensure that the reusable fill and beach nourishment fractions are identified and separated for proper use in the respective disposals.

Two sites have been selected as having a potential for unpolluted dredged material disposal in the form of beach nourishment. Shoreline erosion problems at both Harrington Beach State Park and at the City of Port Washington's Lake Park are of sufficient magnitude to warrant remedial action to help mitigate the destructive effects of excessive shoreline erosion. Consideration of the present littoral currents and recession rates in the vicinity of the Port Washington Lake Park beach, as well as the proximity of the park to the Port Washington Harbor, indicates that any beach nourishment effort at the Lake Park beach may be expected to result in the immediate erosion of the nourished areas and the subsequent deposition of the materials at or near the mouth of the Port Washington Harbor. The Harrington Beach Park site, located to the north of the Port Washington Harbor, may be expected to be a better site for beach nourishment. Although the same littoral current and recession activities are occurring at Harrington Beach as at Lake Park, the rate of recession is not as great as at Lake Park and the distance involved may be expected to reduce the time and amount of unpolluted dredged material redeposited at, or near, the Port Washington Harbor. It is therefore recommended that the beach nourishment alternative, which involves the deposition of up to 4,000 cubic yards of unpolluted dredged material per year, be considered for application at the Harrington Beach site.

As already noted, open-water disposal of dredged material, including beach nourishment, is presently prohibited under Wisconsin State Law. However, the Wisconsin Department of Natural Resources is presently in the process of revising NR 347 of the Wisconsin Administrative Code to allow the deposition of unpolluted dredged material in the nearshore area for specified public beneficial uses, including beach nourishment. Presently, the beach at Harrington Beach State Park serves as a swimming beach for visitors using the park facilities. Beach nourishment, then, would help maintain suitable beach acreage for this recreational purpose while at the same time offsetting the effect of public shoreline losses due to erosion.

Also, as already noted, sediments from the inner harbor portion of the Port Washington Harbor are classified as polluted with respect to oil and grease, cadmium, lead, mercury, and PCBs, and are not suitable for in-water disposal options such as beach nourishment. However, sediments located in the outer harbor, based on the limited sampling results available may be expected to be "clean" and, as such, should be suitable for use in approved beach nourishment projects. It is suggested, however, that prior to implementation of the recommended disposal plan, a chemical analysis of the sediments concerned be performed. Sediment samples should be taken from, and the pollutant concentrations determined for, the sediments from various locations within the outer harbor. The results should be carefully documented and compared to established criteria for in-water disposal prior to the commencement of the beach nourishment project.

As described in the characteristics of dredged material section of this report, nearshore disposal projects must meet the following criterion: the average proportion of the dredged materials finer than 0.074 millimeters (mm) must be within 10 to 15 percentage points of the average proportion of the materials at the disposal site finer than 0.074 mm. If, during the sediment sampling phase of implementation of the recommended disposal plan, it is determined that the dredged materials do not meet this criterion, then it is recommended that the dredged materials be used for fill or placed in an existing confined disposal facility. The location of existing confined disposal facilities which could be considered for deposition of dredged materials are shown on Map 12.

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APPENDICES

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Appendix A

EXCEPTS OF A MEMORANDUM DATED JANUARY 15, 1987, TO WILLIAM J. BRAH, MANAGER, OFFICE OF COASTAL MANAGEMENT, WISCONSIN DEPARTMENT OF ADMINISTRATION, FROM P. SCOTT HAUSMAN, CHIEF, WATER REGULATION SECTION, WISCONSIN DEPARTMENT OF NATURAL RESOURCES, CONCERNING THE PORT WASHINGTON UNPOLLUTED DREDGED MATERIAL DISPOSAL STUDY

Port Washington Harbor Dredging Study by Southeastern Wisconsin Regional Planning Commission

The preliminary draft harbor maintenance report for the City of Port Washington prepared by the Southeastern Regional Planning Commission (SEWPRC) was reviewed on Tuesday, September 9, 1986, with staff from SEWRPC and the Department of Natural Resources. The report closely followed the suggested planning outline prepared by a working group of Department of Natural Resources staff and the RPC's. The report also closely follows the guidelines in the proposed legislation. A number of suggestions were made by participants during the review to clarify and make the report more comprehensive. Staff from the SEWRCP and DNR have been in close contact since the review. A January 8, 1987 meeting was held at SEWRPC office to review addendums to the draft plan. We feel the report, with addendums, would be an acceptable Community Harbor Maintenance Plan for the City of Port Washington. One addendum would be appropriate sediment tests and evaluation from locations that are clearly located and identified within the area to be dredged. It is our understanding that there has been community contact with local officials. We believe that upon favorable action on the proposed legislation and the completion of a dredging maintenance application containing the required dredge material analysis, a ten year maintenance permit could be issued.

Again the reviewers compliment the staff from the Southeastern Regional Planning Commission for their fine cooperation and the excellent preparation of the report. The willingness and excellent open relationship by agency staff working together certainly added to the quality of this report.

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Appendix B

city of

Port Washington

100 W. Grand Avenue
Port Washington, WI 53074

Administrative Office (414) 284-5585
Public Works (414) 284-2600

March 19, 1987

RECEIVED
MAR 24 1987
SEWRPC

Mr. Donald M. Reed
SEWRPC
916 North East Avenue
P. O. Box 769
Waukesha, WI 53187-1607

Dear Mr. Reed:

The City of Port Washington Harbor Commission has reviewed the final draft of the "Unpolluted Dredge Materials Disposal Plan For The Port Washington Harbor" prepared by the Southeastern Wisconsin Regional Planning Commission. Upon their review, the Harbor Commission accepted the plan and had no further additional comments to make. When the City makes the decision to expand their Marina, SEWRPC and the DNR will be contacted to discuss the appropriate plan to be utilized when dredging is done in the harbor.

If you have any questions, please feel free to give me a call.

Sincerely,

Mark E. Grams

Mark E. Grams
City Administrator

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Special acknowledgement is due Mr. Donald M. Reed, SEWRPC Principal Biologist, Mr. James F. Drought, SEWRPC Research Analyst, and Mr. Craig D. Thompson, former SEWRPC Research Analyst, for their contribution to the preparation of this report.