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CHOPTANK RIVER DREDGED MATERIAL PLACEMENT STUDY

TECHNICAL APPENDICES
VOLUME II

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PREPARED BY

lbot County Department of Public Works

for

ryland Department of Natural Resources

Tidewater Administration

1981

CHOPTANK RIVER DREDGED MATERIAL PLACEMENT STUDY

TECHNICAL APPENDICES

VOLUME II

by

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APPENDIX A: ASSESSMENT OF DREDGING NEEDS FOR THE PERIOD 1980-90

The primary objective of the dredging needs assessment was to compile an inventory of existing and planned dredging projects within the study area and to assess the need for the development of a comprehensive dredged material placement (DMP) plan for the ten-year period 1980-1990. The general criteria for inclusion of a particular dredging project in any such plan were (1) that the project was expected to be accomplished between 1980 and 1990 and (2) that the project did not at this time have associated therewith an approved or potentially suitable DMP site.

The dredging projects examined by this Study can be classified on the basis of the source of project funding to include: Federal, non-Federal (i.e., State/County/local), and private. Within each of these classifications are two types of dredging operations which are differentiated on the basis of whether the operation involves construction of a new project or maintenance of an existing one. It is the latter distinction which is of primary, but not singular, importance with regard to assessing the future dredging needs and, hence, the need for DMP sites. It can generally be assumed that the formulation of plans for new work dredging projects will also include plans for dealing with the dredged material expected to be generated by the proposed project. Consequently, the primary emphasis is placed on dredging activities associated with the maintenance of previously constructed projects.

While maintenance of a navigation project is generally conducted as the need arises, the justification thereof is generally based on economic considerations, irrespective of the source of project funding. As only maintenance of Federally authorized projects is legislatively mandated, it can generally be expected that funds for such work will be more readily available than for non-Federal and private maintenance operations. Although projects within the non-Federal and private sectors may outnumber Federal projects, the magnitude of the latter are usually significantly greater in terms of the total volume of material deriving therefrom. The maintenance operations associated with Federal projects, then, are considered to dominate the dredging activities within the geographical area covered by this Study. The following order of priority was established for the purpose of assessing the expected dredging needs within the study area for the period 1980-1990: (1) Federal, (2) State/County/local, and (3) private projects.

The approach utilized to accomplish the dredging needs assessment and determination of the need for a comprehensive DMP plan consisted of two phases. The first phase involved: (1) the identification of the various projects within the study area and (2) the compilation of a history of the dredging operations associated with each project so identified. The second phase utilized the historical data thus obtained to determine (1) which projects were expected to undergo dredging operations between 1980 and 1990 and (2) had associated therewith an approved or potentially suitable DMP site. The following outline summarizes the general procedure and the data/information requirements for compiling project histories:

1. Identify dredging projects within the study area
2. Secure all available information pertaining to past or expected dredging activities associated with each project including:
   a) date and type of each dredging activity
   b) volume and composition of material dredged
   c) location and type of DMP activity
3. Secure any additional information pertinent to the project including:
   a) DMP sites -
      i. agency or party responsible for securing sites
      ii. funding responsibilities for site and/or facility
      iii. planned or existing use of site(s)
   b) Costs associated with dredging and with DMP sites and facilities

Information and data pertaining to Federal and non-Federal projects was obtained by a search of records and by interviews with key personnel of the respective governmental agencies. These same agencies issue a variety of dredging and dredging-related permits and thus also served as a means of identifying dredging projects in the private sector. As professional engineering firms were usually retained to design, engineer, and administer dredging contracts for private projects, detailed information was obtained by consultation with the appropriate firm.

The average maintenance interval and average annual shoaling volume was computed for those projects which were not specifically scheduled to undergo maintenance dredging operations. The latter data was utilized to arrive at an estimate of the volume of dredged material expected to be generated by a maintenance operation at some future date. This information was required in order to (1) evaluate the suitability of existing DMP sites with respect to currently available and required capacities and (2) to determine the site and facility requirements for the purpose of identifying additional DMP sites if required. The maintenance interval was taken as the average of the time intervals between successive maintenance operations and applied to the date of the most recent operation to provide a projected date for future maintenance. The average annual shoaling volume was computed as the total volume of shoal material removed for all maintenance operations averaged over the total time interval between project construction and the most recent operation.

A relatively large degree of uncertainty can be associated with the maintenance intervals and average annual shoaling volumes computed in this manner. For example, the time interval between successive maintenance operatons is dependent upon both the need (i.e., extent of shoaling as indicated by channel centerline controlling depths relative to the authorized project depth) and the availability of funds. For periods when funding is not a problem, maintenance dredging can be expected to occur more frequently than when funds are limited even though the need may not be at a critical stage (i.e., controlling depths are at or only slightly greater than project depths). Moreover, the practice of overdepth dredging (i.e., removal of shoal material to depths greater than the authorized project depth) is usually employed more frequently and to depths greater than the accepted 1- to 2-ft overdepth. Finally, maintenance dredging of the entire project may be expected to occur even though shoaling may be confined to a relatively small portion of the project. The combination of these practices can ultimately give rise to smaller maintenance interval values and larger annual shoaling volumes than would actually exist were maintenance operations conducted only when clearly required.

Additional uncertainties can be introduced in the annual shoaling volumes when the data from which they are computed consists solely of values for the total volume of material removed for each operation. The dredged material volume reported for one maintenance operation may, for example, represent dredging of only a portion of the total project at a 1-ft overdepth while that for a subsequent operation derives from dredging of the total project at a 2-ft overdepth. The failure to take into account the differences in overdepth dredging (i.e., 1-ft versus 2-ft) and the proportion of the project which was maintained (i.e., total project versus segment of the project) when determining annual shoaling volumes and maintenance intervals can lead to erroneous conclusions regarding these parameters. Thus, it is advisable whenever possible to obtain information regarding not only the date and the volume of material removed but also what portion of the project was maintained, the general overall condition and the controlling depth of the project at the time of maintenance, and the extent of overdepth dredging. This information can most readily be obtained by examination of pre- and post-dredging surveys.

Under current policies and practices, requests for maintenance of a Federal or State funded project originate with the local (i.e., County) project sponsor. Upon receiving such a request, a survey of the project is conducted by the funding agency and an evaluation is made as to the actual need for maintenance dredging. It is not uncommon for a one to two year period to lapse between the time that the need for maintenance is established and the work is accomplished. Overall, this approach tends to minimize unnecessary dredging as maintenance is conducted as the need arises rather than on an established schedule. If it is determined that dredging is not warranted at that time, detailed information is thus available for future planning purposes. Quantification of maintenance intervals and annual shoaling volumes for general planning purposes is probably not justified in view of the time lag between establishment of the need for maintenance and the accomplishment thereof and the fact that projects with high annual shoaling volumes are maintained on a fairly regular basis. However, even general planning cannot be reliably accomplished for projects which have neither been maintenance dredged nor surveyed and for which a period of 10 or more years has lapsed since construction. In spite of the aforementioned uncertainties associated with the maintenance interval and the annual shoaling volumes, these parameters were judged to be adequate for the level of planning intended for accomplishment by this Study.

The responsibility for securing DMP sites generally resides with the party or agency designated as the local project sponsor. Consequently, the project sponsor served as the primary source of information regarding the availability of DMP sites for projects which, on the basis of the historical data, were judged to have a high probability of undergoing construction and maintenance dredging operations. The information thus obtained basically consisted of an indication of the availability of either an approved or potentially suitable site which could be utilized for DMP activities. In general only projects for which DMP sites were currently judged not available or questionable were included in those for which a DMP plan was to be developed.

Records regarding the construction, operation, and maintenance activities of Federally authorized projects were by far the most complete and provided the greatest detailed information regarding these activities. Thus, only the histories of Federal projects were tabulated and presented in detail in this Report (Tables A-1 thru A-20). In spite of the relatively detailed records maintainted by the COE, certain information which would greatly aid in planning for future work is either not available or requires exceedingly time-consuming searches. Most, if not all, of the additional information either currently is or could be obtained in the course of the planning and execution of the dredging operation. Although quantitative data and information would be of greatest value, data of a qualitative nature would be the most economical to obtain and would generally be adequate for planning purposes. The data and information or primary interest and greatest utility include:

1. Dredged Material Data
   a. Volume and composition (particle size distribution)

2. Containment Facility Data
   a. Location
   b. Design (area, shape, internal configuration, dike height)
   c. Performance or efficiency (results of suspended solids monitoring)

3. Dredging Data
   a. Dredge plant characteristics (size, production rate, pipeline length)
   b. Operation (daily operation including estimates of the volume and composition of material dredged and location within project, total time to complete job noting unusual circumstances)

That of the aforementioned data which is at present not routinely obtained should be forthcoming as a result of the increased involvement of the Baltimore District COE in the planning and execution of dredging/DMP operations, particularly with regard to the latter operation. Within the past year, the COE has begun to secure at least semi-quantitative data regarding channel sediment compositions. Project condition surveys provide estimates of the expected dredged material volume and, together with the sediment composition data, permit more accurate determinations of containment facility design requirements (see Appendix C) as well as an opportunity to more seriously consider alternative methods of dredged material placement (i.e., placement of dredged sediments in aquatic areas for the purposes of shore erosion abatement and/or habitat creation). The COE has also begun to take a more active role regarding various engineering and design aspects of land-based DMP facilities. This is in marked contrast to past practices whereby the dredging contractor was given considerable latitude in such matters. Thus it should be expected that future DMP operations will be accomplished in a much more efficient manner from environmental and economic standpoints.

Data and information pertaining to the construction, operation, and maintenance activities of Federally authorized projects is presented in Tables A-1 thru A-20. For the majority of projects, the estimated volume of dredged material expected to be removed at the projected date of future maintenance can be obtained as the product of the average annual shoaling volume and the respective maintenance interval. These volumes and the projected dates of future maintenance were developed based on the data from previous maintenance operations and also taking into account the potential savings in terms of dredging mobilization/demobilization costs, DMP facility construction costs, and man hours associated with coordinating the activity with the requisite regulatory and funding agencies if dredging operations for two or more projects could be coordinated and conducted sequentially. Clearly, the adherence to any projected schedule may not be possible as the actual date of future maintenance and the volume of material dredged at that time will be further influenced by changes in shoaling rates as well as the availability of DMP sites and of funds necessary to accomplish the operation. Consequently, the use of the data for definitive planning purposes is cautioned. The data and schedules are of general utility and necessary for planning intended for accomplishment by this Study. The information also provides the Federal and local project sponsors an opportunity to anticipate future dredging/DMP needs and thereby assure that a future maintenance operation can be accomplished in the most economically and environmentally sound manner.

The major sources of data and information whereby dredging project histories were compiled are given below:

U.S. Army Corps of Engineers, Baltimore District, P.O. Box 1715, Baltimore, Maryland 21203
- Annual Report of the Chief of Engineers (Baltimore District Extract)

- Hydrographic surveys (pre- and post-dredging and project conditions) on file in Operations Branch
- Authorizing documents on file in Operations Branch
- Dredging permit requests on file in Permits Branch

Dredging Division, Maryland Department of Natural Resources, 69 Prince George Street, Annapolis, Maryland 21401
- Consultation with Benjamin Linthicum, Chief, State Dredging Division
- Project files

Dorchester County Highway Department, RFD 1, Box 187, Cambridge, Maryland 21613
- Consultation with L. Eldridge Lloyd, Dredging Project Planner
- Project files

Talbot County Department of Public Works, Court House, Easton, Maryland 21601
- Consultation with Robert Rauch, County Engineer
- Project files

Caroline County Department of Planning, P.O. Box 207, Denton, Maryland 21629
- Consultation with Alan Visintainer, County Planner
- Project files

Table A-1

Data Sheet for the Federal Navigation Project in Cambridge Harbor

Location: Longitude, 76° 04'; Latitude, 38° 35'. Off Choptank River near Cambridge, Dorchester County, Maryland.

Project Authorization: River and Harbor Act of 3 March 1871 and modified by River and Harbor Acts of 11 August 1888 (H. Doc. 105, 49th Cong., 2d sess.), 13 June 1902 (H. Doc. 119, 54th Cong., 2d sess.), 3 March 1925 (H. Doc. 210, 68th Cong., 1st sess.), 26 August 1937 (Rivers and Harbors Committee Doc. 7, 75th Cong., 1st sess.), 30 June 1948 (H. Doc. 381, 80th Cong., 1st sess.), and 16 June 1978 (H. Doc. 355, 95th Cong., 2d sess.). Local interests required to provide dredged material placement sites for future maintenance. Project completed 1978. The 1948 authorization is considered inactive.

Dredging Operation:

1871 - 1912	Construction[1]	--- No Data ---	
1929	Construction[2]	--- No Data ---	
1958	Construction[3]	101,957 cy	(upland)
1964	Construction[4]	569,214	(confined overboard)
1979	Maintenance[5]	90,000	(confined upland)

1. per 1902 Modification; 2. per 1925 Modification; 3. per 1937 Modification; 4. State project; 5. per 1978 Modification.

Latest Available Survey: Cambridge Creek Condition Survey, July 1974 (File 32, map 55); Cambridge Harbor Post-dredging Survey, May 1979 (File 32, map 61).

Latest Full Report: Annual Report of the Chief of Engineers (Baltimore District Extract), 1979, p. 4-4.

Project Costs (Total as of year indicated):

	1912	1929	1959	1965	1979
Const.	$61,321	81,598	195,974	195,974	195,974
O & M****	6,987	6,987	9,171	11,109	648,358

Average Annual O & M Costs (to 30 Sept 1979): $9,677

Maintenance Interval: Cambridge Harbor - 8 years*
Cambridge Creek - > 22 years**

Projected Maintenance: Cambridge Harbor - 1987*
Cambridge Creek - Uncertain***

Average Annual Shoaling Volume: Cambridge Harbor - 9,000 cy*
Cambridge Creek - Uncertain***

* Estimate given in Environmental Impact Statement prepared for 1979 maintenance dredging of Cambridge Harbor.
** No maintenance required since construction in 1958.
*** Insufficient data to determine.
**** Operations and Maintenance.

Table A-2

Data Sheet for the Federal Navigation Project at:
Duck Point Cove

Location: Longitude, 76°15'; Latitude, 38° 17'. Off Honga River, Dorchester County, near the town of Wingate in Dorchester County, MD.

Project authorization: River and Harbor Act of 2 March 1945 (H. Doc. 241, 76th Cong., 1st sess). Local interests must provide dredged material placement sites for future maintenance. Project completed October 1950.

Dredging Operations:

1950	Construction	54,172 cy	(wetland)
1966	Maintenance	19,300	(wetland)

Latest Available Survey: Condition Survey, Nov. 1979 (File 71, map 124).

Latest Full Report: Annual Report of the Chief of Engineers, 1966, p. 264.

Project Costs (Total as of year indicated):

	1951	1966	1979
Const.	$25,289	25,289	25,289
O & M	$------	18,890	24,058

Average Annual O & M Costs (to 30 Sept 1979): $849

Maintenance Interval: 16 years

Projected Maintenance: 1982

Average Annual Shoaling Volume: 1,200 cy* (1,800; 2,800 cy)**

* Based on 1966 maintenance dredging at which time only a portion of the project was dredged.

** Volumes corresponding to dredging to 1-ft and 2-ft overdepths, respectively, based on 1979 Condition Survey.

Table A-3

Data Sheet for the Federal Navigation Project in Fishing Bay (Farm, Goose, and McCready Creeks)

Location: Longitude, 76° 02'; Latitude, 38° 17'; off Fishing Bay, Dorchester County, Maryland.

Project Authorization: Adopted by the River and Harbor Act of 26 August 1937 (H. Doc. No. 186, 75th Cong., 1st sess.); project completed 1939; no local cooperation required.

Dredging Operations:

1939	Construction	114,300 cy	(overboard, wetland)
1949	Maintenance	81,935	(overboard, wetland)
1956	Maintenance*	44,700	(overboard, wetland)
1963	Maintenance	68,400	(overboard, wetland)
1978	Maintenance	94,500	(confined upland)

* Farm and Goose Creeks only.

Latest Available Survey: Post-dredging Survey, Jan. 1979 (File 71, maps 120-3).

Latest Full Report: Annual Report of the Chief of Engineers (Baltimore District Extract), 1979, p. 4-6.

Project Costs (Total as of year indiated)

	1940	1949	1956	1963	1979
Const.	$23,874	33,874	33,874	33,874	33,874
O & M	$------	46,529	74,414	132,414	649,346

Average Annual O & M Costs (to 30 Sept 1979): $16,234

Maintenance Interval: 10 years

Projected Maintenance: 1988

Average Annual Shoaling Volume: 7,500 cy

Table A-4

Data Sheet for the Federal Navigation Project in Tar Bay and Honga River

Location: Longitude, 76° 15'; Latitude 38° 21'. Waterway connecting the Honga River, Fishing Creek, and Tar Bay, near Hooper Island, Dorchester County, MD.

Project authorization: Emergency Relief Appropriations Act of 1935 and the River and Harbor Act of 30 August 1935 (Rivers and Harbors Committee Doc. 35, 74th Cong., 1st sess). Project modified by the River and Harbor Act of 30 June 1948 (H. Doc. 580, 80th Cong., 2d sess) to include channel in Back Creek. Local interests must furnish dredged material placement sites for maintenance. Project completed 13 November 1935 as per the original authorization and work per the 1948 modification was completed 23 April 1956.

Dredging Operations:

1935	Construction	171,363 cy	(overboard)
1939	Maintenance	68,486	(overboard)
1948	Maintenance	86,600	(overboard)
1955	Maintenance	109,300	(overboard)
1956	Construction*	80,000	(overboard, wetland)
1961	Maintenance	123,300	(overboard)
1966	Maintenance	86,400	(overboard, wetland)
1969	Maintenance	17,765	(overboard)
1974	Maintenance	107,279	(overboard, upland)
1977	Maintenance	71,220	(upland)

* New work as per the 1948 modification.

Latest Available Survey: Condition Survey, Feb. 1980 (File 45, map 304 & 306)

Latest Full Report: Annual Report of the Chief of Engineers (Baltimore District Extract) 1978, p. 408.

Project Costs (Total as of year indicated):

	1935	1939	1948	1956	1961
Constr.	$27,668	27,668	27,668	66,119	66,119
O & M	$------	14,170	51,448	95,655	168,109

1966	1977	1974	1977	1979
66,119	66,119	66,119	66,119	66,119
224,672	251,499	520,499	605,182	894,434

Average Annual O & M Costs (to 30 Sept 1979): $20,800

Maintenance Interval:

	1935-66	1966-77	1935-77
Honga River	6 yrs.	11 yrs.	3 yrs.
Tar Bay	6	8	5
Barren Island Gap	6	3	5
Back Creek > 24 yrs.*			

Projected Maintenance:

	1981	1985	1989	1993
Honga River	X			X
Tar Bay	X		X	
Barren Island Gap	X	X	X	X
Back Creek **		X		

Tar Bay and Honga River (cont.)

Average Annual Shoaling Volume:

Honga River	8,000 cy
Tar Bay	12,000
Barren Island Gap	14,000
Back Creek **	2,000

* No maintenance dredging required since construction in 1956.

** Estimate based on results of 1980 condition survey. Shoaling volume assumes dredging to 2-ft overdepth.

Table A-5

Data Sheet for the Federal Navigation Project in Madison Bay

Location: Longitude, 76° 13'; Latitude, 38° 31'. Off the Little Choptank River in Madison Bay near the town of Madison in Dorchester County, Maryland.

Project Authorization: Adopted 8 December 1976 under general authority of Section 107 of the Rivers and Harbors Act of 1960. Local interests must furnish dredged material placement sites (including retaining dikes when required) for future maintenance. Project completed 11 January 1977.

Dredging Operations:

1977	Construction	114,060 cy	(upland, confined)

Latest Available Survey: Post-dredging Survey, Feb. 1977 (File 30, map 50).

Latest Full Report: Annual Report of the Chief of Engineers (Baltimore District Extract) 1977, p. 4-9.

Project Costs (Total as of year indicated):

	1979
Const.	$125,550
O & M	$-------

Average Annual O & M Costs (to 30 Sept. 1979): $ ---

Maintenance Interval: > 3 years*

Projected Maintenance: Uncertain**

Average Annual Shoaling Volume: Uncertain**

* No maintenance dredging required since construction in 1977.
** Insufficient data to determine.

Table A-6

Data Sheet for the Federal Navigation Project in Muddy Hook and Tyler Coves

Location: Muddy Hook Cove - Longitude, 76° 10'; Latitude, 38° 15'; off Honga River near Hoopersville; Tyler Cove - Longitude 76° 14', Latitude, 38° 21', off Fishing Creek, Upper Hooper Island, Dorchester County, MD

Project authorization: Section 107, River and Harbor Act of 1960 and formally adopted in 1964. Local interests must provide dredged material placement sites (including retaining dikes if required) for future maintenance. Project completed 19 April 1966.

Dredging Operations:

1966 Construction 96,020 cy (wetland)

Latest Available Survey: Muddy Hook Cove Condition Survey, Jan 1980 (File 45, map 349); Tyler Cove Condition Survey, Feb 1980 (File 45, map 351A).

Latest Full Report: Annual Report of the Chief of Engineers, 1966, p. 268.

Project Costs (Total as of year indicated):

	1966	1972	1979
Constr.	$64,001	64,001	64,001
O & M	$------	1,020	3,277

Average Annual O & M Costs (to 30 Sept 1979): $273

Maintenance Interval: Muddy Hook Cove - > 14 years*
Tyler Cove - > 14 years*

Projected Maintenance: Muddy Hook Cove - 1985**
Tyler Cove - 1981**

Average Annual Shoaling Volume: Muddy Hook Cove - 1,500 cy***
Tyler Cove - 1,000 cy***

* No maintenance dredging required since construction in 1966.

** Estimate based on the results of 1980 Condition Surveys.

*** Estimate based on results of 1980 Condition Surveys. Volumes correspond to dredging to 2-ft overdepth. Both projects were dredged to 2-ft overdepth when originally constructed.

Table A-7

Data Sheet for the Federal Navigation Project in Slaughter Creek

Location: Longitude, 76° 16'; Latitude, 38°, 30'. Entrance to Slaughter Creek off Little Choptank River near Taylors Is., Dorchester County, MD

Project authorization: River and Harbor Act of 25 July 1912 (H. Doc. 87, 62d Cong., 1st sess). No local cooperation required. Project completed in 1913.

Dredging Operations:

1913	Construction	16,861 cy	
1974	Maintenance	37,200	(overboard, marsh creation)

Latest Available Survey: Condition Survey March 1980 (File 38, map 16).

Latest Full Report: Annual Report of the Chief of Engineers Baltimore District Extract), 1976, p. 4-8.

Project Costs (Total as of year indicated):

	1913	1965	1975	1979
Constr.	$4,140	4,140	4,140	4,140
O & M	$-----	1,853	101,946	111,685

Maintenance Interval: 62 years* (7 years)**

Projected Maintenance: 2035* (1981)**

Average Annual Shoaling Volume: 600 cy* (5,000 cy)**

Average Annual O & M Costs (to 30 Sept 1979): $1,692

* Based on 1974 maintenance operations.
** Based on 1980 Condition Survey; shoaling volume assumes dredging to 2-ft overdepth.

Table A-8

Data Sheet for the Federal Navigation Project in the Warwick River

Location: Longitude, 75° 58'; Latitude, 38° 37'; Off the Choptank River, near the town of Secretary, Dorchester County, Maryland.

Project Authorization: River and Harbor Act of 13 July 1892 (Annual Report of the Chief of Engineers for 1891, p. 1219). No local cooperation required. Project completed in 1904.

Dredging Operations:

1892-1904	Construction	---No Data---	
1906-1916	Maintenance	126,193 cy	(overboard)
1947	Maintenance	113,690	(upland)

Latest Available Survey: Condition Survey, 1972 (File 40, map 27).

Latest Full Report: Annual Report of the Chief of Engineers (Baltimore District Extract) 1973, p. 4-12.

Project costs (Total as of year indicated):

	1904	1918	1947	1979
Const.	$22,041	22,041	22,041	22,041
O & M	$ -----	24,041	69,794	84,128

Average Annual O & M Costs (to 30 Sept 1979): $1,137

Maintenance Interval: 31 years

Projected Maintenance: 1978

Average Annual Shoaling Volume: 5,600 cy

Table A-9

Data Sheet for the Federal Navigation Project at: Black Walnut Harbor

Location: Longitude, 76° 20'; Latitude, 38° 41'. Off Harris Creek, near the village of Fairbank, Talbot County, Maryland.

Project authorization: Adopted by the River and Harbor Act of 2 March 1945 (H. Doc. No. 217, 76th Cong., 1st sess.). Local interests required to furnish dredged material placement sites for future maintenance. Project completed 23 August 1949.

Dredging Operations:

1949	Construction	77,290 cy	(upland)
1957	Maintenance	59,300	(upland, overboard)
1966	Maintenance*	14,300	(upland, overboard)

* Included construction of County channel.

Latest Available Survey: Condition Survey, 23 Sept. 1977 (File 71, map 111).

Latest Full Report: Annual Report of the Chief of Engineers, 1966, p. 261.

Project Costs (Total as of year indicated):

	1950	1957	1966	1977	1979
Const.	$32,631	32,631	32,631	32,631	32,631
O & M	$------	33,059	50,968	56,142	69,529

Average Annual O & M Costs (to 30 Sept. 1979): $2,398

Maintenance Interval: 9 years

Projected Maintenance: 1981*

Average Annual Shoaling Volume: 4,300 cy

* Corps of Engineers indicated need for maintenance in letter to County dated 14 Nov. 1977.

Table A-10

Data Sheet for the Federal Navigation Project in Claiborne Harbor

Location: Longitude, 76° 17'; Latitude, 38° 50'. Off Eastern Bay near the town of Claiborne in Talbot County, Maryland.

Project Authorization: Adopted by the River and Harbor Act of 13 June 1902 (H. Doc. No. 81, 86th Cong., 1st sess.) and modified by the River and Harbor Act of 3 July 1930 (S. Doc. 157, 71st Cong., 2d sess.). No local cooperation required. Project completed per 1930 modification on 28 April 1931.

Dredging Operations:

1903-1911	Constr. & Maint.	223,522 cy	(overboard)
1912-1929	Maintenance	50,000	(overboard)
1931	Construction	- no data -	
1976	Construction[1]	14,000	(upland)

[1] State funded project consisting of the construction of a channel to and turning basin at the Claiborne public landing. Project cost: $56,195.

Latest Available Survey: Condition Survey, April 1977 (File 33, map 63).

Latest Full Report: Annual Report of the Chief of Engineers (Baltimore District Extract) 1978, p. 4-6.

Project Costs (Total as of year indicated):

	1911	1930	1931	1975	1979
Const.	$27,374	27,374	40,426	42,974	42,974
O & M	$ -----	46,222	46,422	48,629	86,857

Average Annual O & M Costs (to 30 Sept. 1979): $1,296

Maintenance Interval: > 49 years*

Projected Maintenance: Uncertain**

Average Annual Shoaling Volume: Uncertain **

* No maintenance dredging required since construction per 1930 modification.

** Insufficient data to determine.

Note: Federal project currently under review for possible modification. Status report and recommendations were submitted to NAD 10 Oct 1978 for review. Study returned to Baltimore District for revision.

Table A-11

Data Sheet for Federal Navigation Project in Island Creek

Location: Longitude, 76° 09'; Latitude, 38° 40'. Off the Choptank River in Island Creek, Talbot County, Maryland.

Project Authorization: Adopted by the River and Harbor Act of 26 August 1937 (H. Doc. No. 75, 75th Cong., 1st sess.). Local interests must furnish dredged material placement sites for maintenance. Project was completed in 1939.

Dredging Operations:

1939	Construction	19,939 cy	(overboard)

Latest Available Survey: Post-dredging Survey, Sept. 1946 (File 22, map 41)

Latest Full Report: Annual Report of the Chief of Engineers, 1948, p. 460.

Project Costs (Total as of year indicated):

	1939	1948	1965	1979
Const.	$6,230	6,230	6,230	6,230
O & M	$-----	1,068	1,912	5,608

Average Annual O & M Costs (to 30 Sept. 1979): $144

Maintenance Interval: > 41 years*

Projected Maintenance: Uncertain**

Average Annual Shoaling Volume: Uncertain**

* No maintenance dredging required since construction in 1939.
** Insufficient data to determine.

Table A-12

Data Sheet for the Federal Navigation Project at Knapps Narrows

Location: Longitude, 76° 20'; Latitude, 38° 43'. Waterway connecting Harris Creek and Chesapeake Bay, near the town of Tilghman, Talbot County, MD.

Project authorization: 16 September 1933 by the Public Works Administration and adopted by the River and Harbor Act of 20 August 1935 (H. Doc. 308, 72d Cong., 1st sess). Local interests are required to furnish dredged material placement sites for maintenance. Project completed in 1935.

Dredging Operations:

1935	Construction	257,977 cy	(overboard)
1945	Maintenance	81,414	(overboard)
1950	Maintenance	31,015	(overboard, wetland)
1956	Maintenance	90,300	(overboard, wetland)
1962	Maintenance	76,500	(overboard, wetland)
1966	Maintenance**	27,000	(overboard)
1968	Maintenance*	27,400	(overboard)
1975	Maintenance**	85,500	(overboard, upland)
1977	Maintenance*	43,550	(upland)
1980	Maintenance**	64,800	(overboard, upland)

* Harris Creek Channel (West) portion only.
** Bay Channel (East) portion only.

Latest Available Survey: Harris Creek Channel - Condition Survey, Sept. 1979 (File 45, map 347); Bay Channel - Post-dredging Survey, April 1980 (File 45, map 355).

Latest Full Report: Annual Report of the Chief of Engineers (Baltimore District Extract), 1978, p. 4-8.

Project costs (Total as of year indicated):

	1935	1946	1950	1956	1962
Const.	$45,872	46,121	46,121	46,121	46,121
O & M	$------	30,976	45,403	85,094	119,378

1967	1968	1975	1977	1979
46,121	46,121	46,121	46,121	46,121
145,992	173,092	340,701	553,348	578,624

Average O & M Cost (to 30 Sept 1979): $13,456

Maintenance Interval: Approximately 5 years for total project. Bay Channel requires more frequent maintenance than Harris Creek Channel.

Projected Maintenance: 1982, 1987

Average Annual Shoaling Volume: Bay Channel - 9,000 cy
Harris Creek Channel - 5,000 cy

Table A-13

Data Sheet for the Federal Navigation Project at La Trappe River

Location: Longitude, 76° 07'; Latitude, 38° 38'. Off the Choptank River in Talbot County near Trappe, Maryland.

Project Authorization: River and Harbor Act of 13 July 1892 (Annual Report of the Chief of Engineers, 1891, p. 1216). No local cooperation required. Project completed in 1908.

Dredging Operations:

1893-1900	Construction	--- No Data ---	(overboard)
1906	Const. & Maint.	13,686 cy	(overboard)
1908	Maintenance	10,068	(overboard)
1910-1916	Maintenance	61,969	(overboard)

Latest Available Survey: Condition Survey, Jan., 1980 (File 6, map 16, 17).

Latest Full Report: Annual Report of the Chief of Engineers, 1948, p. 461.

Project Costs (Total as of year indicated):

	1908	1918	1948	1979
Const.	$8,064	8,064	8,064	8,064
O & M	$ ----	15,368	16,000	18,153

Average Annual O & M Costs (to 30 Sept. 1979): $259

Maintenance Interval: > 64 years*

Projected Maintenance: Uncertain**

Average Annual Shoaling Volume: 1,400 cy***

* No maintenance required since that accomplished in 1916.
** Project currently under restudy for possible modification.
*** Estimate based on results of 1980 Condition Survey and assumes dredging to 2-ft overdepth.

Table A-14

Data Sheet for the Federal Navigation Project at Lowe's Wharf

Location: Longitude, 76° 20'; Latitude, 38° 46'. In Ferry Cove, near the village of Sherwood, Talbot County, MD

Project authorization: River and Harbor Act of 3 Sept 1954 (H. Doc. 90, 82d Cong., 1st sess). Local interests to furnish dredged material placement sites for maintenance. Project completed 2 July 1957.

Dredging Operations:

1957	Construction	28,781 cy	(wetland)
1971	Maintenance	15,013	(wetland)

Latest Available Survey: Condition Survey, June 1978 (File 33, map 64).

Latest Full Report: Annual Report of the Chief of Engineers (Baltimore District Extract), 1971, p. 4-7.

Project Costs (Total as of year indicated):

	1958	1971	1979
Constr.	$21,000	21,000	21,000
O & M	$------	34,123	39,122

Average Annual O & M Costs (to 30 Sept 1979): $1,863

Maintenance Interval: 14 years

Projected Maintenance: 1985

Average Annual Sholaing Volume: 1,100 cy

Table A-15

Data Sheet for the Federal Navigation Project in Neavitt Harbor

Location: Longitude, 76° 17'; Latitude, 38° 44'. Off Balls Creek near the town of Neavitt in Talbot County, Maryland.

Project Authorization: Adopted 10 August 1966 under general authority provided by Section 107 of the River and Harbor Act of 1960. Local interests must provide dredged material placement sites (including retaining dikes when required) for future maintenance work. Project completed 4 June 1968.

Dredging Operations:

1968	Construction	34,150 cy	(upland)

Latest Available Survey: Project Condition Survey, Jan 78, (File 101, map 4).

Latest Full Report: Annual Report of the Chief of Engineers (Baltimore District Extract), 1968, p. 193.

Project Costs (Total as of year indicated):

	1968	1973	1979
Const.	$36,500	36,500	36,500
O & M	$ ----	3,215	3,215

Average Annual O & M Costs (to 30 Sept. 1979): $322

Maintenance Interval: > 12 years*

Projected Maintenance: Uncertain**

Average Annual Shoaling Volume: Uncertain**

* No maintenance dredging required since construction in 1968.
** Insufficient data to determine.

Table A-16

Data Sheet for the Federal Navigation Project in St. Michaels Harbor

Location: Longitude, 76^{o} 13'; Latitude, 38^{o} 48'. Off the Miles River at the town of St. Michaels in Talbot County, Maryland.

Project Authorization: Approved for accomplishment under general authority provided by section 107 of the River and Harbor Act of 1960. Local interests are to provide dredged material placement sites (including retaining dikes if necessary) for future maintenance work. Project completed May 1964.

Dredging Operations:

1964	Construction	8,271 cy	(upland)

Latest Available Survey: Condition Survey Nov. 1979 (File 33, map 65).

Latest Full Report: Annual Report of the Chief of Engineers, 1964, p. 263.

Project Costs (Total as of year indicated):

	1964	1967	1979
Const.	$16,723	16,723	16,723
O & M	$ ----	70	70

Average Annual O & M Costs (to 30 Sept. 1979): $3

Maintenance Interval: > 16 years*

Projected Maintenance: > 1990**

Average Annual Shoaling Volume: 180 cy***

* No maintenance dredging required since construction in 1964.
** Estimate based on results of 1980 Condition Survey.
*** Estimate based on volumes computed from 1979 Condition Survey assuming dredging to 1-ft overdepth.

Table A-17

Data Sheet for the Federal Navigation Project in:
Tilghman Island Harbor

Location: Longitude, 76° 20'; Latitude, 38° 40'. Off Harris Creek at the town of Tilghman, Talbot County, Maryland.

Project Authorization: Adopted by the River and Harbor Act of 25 July 1912 (H. Doc. 400, 62d Cong., 2d sess.), modified by River and Harbor Act of 1919 (H. Doc. 796, 63d Cong., 2d sess.), and approved 13 May 1966 under general authority provided by section 107, River and Harbor Act 1960. Local interests are to provide dredged material placement sites (including retaining dikes if necessary) for future maintenance work. Project completed 9 March 1971.

Dredging Operations:

1971	Construction	63,680 cy	(overboard)
1980	Maintenance	23,211	(upland)

Latest Available Survey: Post-dredging Survey, March 1980 (File 3, map 230).

Latest Full Report: Annual Report of the Chief of Engineers (Baltimore District Extract), 1972, p. 4-12.

Project Costs (Total as of year indicated):

	1966	1971	1979
Const.	$296	55,127	56,830
O & M	$833	833	833

Average Annual O & M Costs (30 Sept 1979): $119

Maintenance Interval: 9 years*

Projected Maintenance: 1989*

Average Annual Shoaling Volume: 2,600 cy

* A more realistic estimate of the maintenance interval is 15 years as the 1980 work was partially justified by the fact that the work was conducted concurrently with that at Knapps Narrows and a single dredged material placement site was utilized for both projects.

Table A-18

Data Sheet for the Federal Navigation Project in Town Creek

Location: Longitude, 76° 10'; Latitude, 38° 42'. In Town Creek off the Tred Avon River at Oxford, Talbot County, Maryland.

Project Authorization: Adopted by the River and Harbor Act of 2 March 1945 (House Doc. No. 219, 76th Cong., 1st sess.). Local interests are required to furnish dredged material placement sites for future maintenance. Project completed 26 July 1949.

Dredging Operations:

1949	Construction	91,472 cy	(upland)

Latest Available Survey: Condition Survey, Jan 1980 (File 41, map 47).

Latest Full Report: Annual Report of the Chief of Engineers, 1950, p. 398.

Project Costs (Total as of year indicated);

	1950	1965	1971	1979
Const.	$43,220	43,220	43,220	43,220
O & M	$ -----	727	2,147	2,713

Average Annual O & M Costs (to 30 Sept. 1979): $93

Maintenance Interval: > 31 years*

Projected Maintenance: > 1990**

Average Annual Shoaling Rate: 1700 cy***

* No maintenance dredging required since construction in 1949.
** Estimate based on results of 1980 Condition Survey.
*** Estimate based on volumes computed from 1980 Condition Survey and assumes dredging to 1-ft overdepth.

Table A-19

Data Sheet for the Federal Navigation Project in the Tred Avon River

Location: Longitude, 76° 06'; Latitude, 38° 46'. In the Tred Avon River, near the town of Easton, Talbot County, Maryland.

Project authorization: River and Habor Acts of 14 June 1980 and 3 March 1981; formally adopted by River and Harbor Act of 25 July 1912 (H. Doc. 399, 62d Cong., 2d sess.); modified by River and Harbor Acts of 2 March 1919 (H. Doc. 27, 63rd Cong., 1st sess.) and of 27 Oct. 1965 (H. Doc. 225, 89th Cong., 1st sess.). Local interests to furnish dredged material placement sites for construction and future maintenance. Project 50% complete as per the 1965 modification.

Dredging Operations:

1880-81	Construction	No Data	
1913-14	Maintenance	35,984 cy	
1975	Construction*	215,000	(upland)

* New work as per the 1965 modification; project 50% completed; work remaining consists of deepening that portion of channel between sta 6+100 and 12+100 from 8 ft to 12 ft.

Latest Available Survey: Post-dredging Survey, April 1975 (File 41, map 46).

Latest Full Report: Annual Report of the Chief of Engineers (Baltimore District Extract), 1979, p. 4-11.

Project Costs (Total as of year indicated):

	1915	1950	1970	1975	1979
Const.	$12,693	12,693	13,596	489,886	528,130
O & M	$ 474	4,059	11,148	13,843	13,843

Average Annual O & M Costs (to 30 Sept 1979): $216

Maintenance Interval: > 20 years*

Projected Maintenance: > 1995*

Average Annual Shoaling Volume: Uncertain**

* Estimate as no data available for 12-ft channel; interval for 8-ft channel was 60 years.

** No data available as 1975 work involved deepening 8-ft channel to 12-ft.

Table A-20

Data Sheet for the Federal Navigation Project in the Choptank River

Location: Longitude, 75° 50'; Latitude, 38° 53'. In the Choptank River, near the town of Denton in Caroline County, MD.

Project authorization: River and Harbor Act of 14 June 1880 (S. Ex. Doc. No. 66, 46th Cong., 2d Sess, and Annual Report for 1880 p. 634) and modified by the River and Harbor Act of 3 July 1930 (H. Doc. No. 188, 70th Cong., 1st session) and by Section 107 of the River and Harbor Act of 1960 (approved 3 January 1969). The authorization for the 1969 modification was withdrawn by the Chief of Engineers on 22 January 1979. Status of terms of local cooperation uncertain. Project completed in 1931 as per the 1930 modification.

Dredging Operations:

1900-1911	Construction and Maintenance	192,500 cy	(overboard)
1914-1916	Maintenance	48,700	(overboard)
1931	Construction*	- no data -	
1953	Maintenance*	17,522	(overboard)
1963	Maintenance*	14,100	(overboard)

* Pealiquor Shoal (1930 modification) section only

Latest Available Survey: Condition Survey, Oct. 1977 (File 30, map 51)

Latest Full Report: Annual Report of the Chief of Engineers (Baltimore District Extract) 1979, p. 4-5.

Project Costs (Total as of year indicated):

	1918	1931	1953	1963	1975	1979
Const.	$78,996	84,296	84,296	84,296	95,438	96,796
O & M	$21,150	21,650	39,251	54,632	61,353	94,095

Average Annual O & M Costs (to 30 Sept 1979): $1,384

Maintenance Interval: 16 years

Projected Maintenance: 1979*

Average Annual Shoaling Volume: 1,000 cy**

** Based on previous maintenance operations. Future maintenance uncertain in view of withdrawal of 1969 modification.

APPENDIX B: IDENTIFICATION OF CANDIDATE DREDGED MATERIAL PLACEMENT SITES

The approach whereby candidate sites for dredged material placement (DMP) facilities were identified centered primarily on two broad areas of concern: compliance with existing guidelines and regulations governing the placement of dredged material and the economics associated with dredging and dredged material placement operations. Within each of these areas of concern are various criteria which are pertinent not only to the identification of prospective sites but also to the ranking of the sites with respect to their overall suitability. Thus, the application of the criteria during the site identification process was expected to maximize the potential that the sites so identified would meet the minimum regulatory agency requirements regarding site suitability and, hence, provide a DMP plan which could be most readily implemented.

A determination of site suitability must be made before a DMP operation can be conducted at the site. Such determinations are ultimately made by the various regulatory and project funding agencies based on a detailed and comprehensive assessment of the expected environmental and economic impacts of the activity. As the collection and analysis of the usually extensive data and information necessary to generate assessments of this type for the large number of projects involved was beyond the scope of this Study, the identification of candidate DMP sites was based primarily on general environmental concerns identified by existing regulations and guidelines pertaining to DMP activities. Moreover, site availability may be the limiting factor in the actual implementation of DMP operations at a given site in which case a detailed assessment of site suitability may not be warranted prior to an assessment of site availability. On the other hand, a determination of site availability and the conditions thereof would not be appropriate in the event that the suitability of the site would be highly questionable. The intent of the Study, then, is to provide the decision makers within the requisite funding and regulatory agencies with the necessary basic information which will enable them to compare proposed DMP alternatives and to comment on the viability of the proposed dredged material placement plan.

Site Identification Procedures

The evolution of a wide range of environmental concerns has imposed ever-increasing constraints on dredged material placement operations.[1,2] The potential impacts identified by a number of these concerns have been judged to be of a sufficiently adverse nature that the suitability of a DMP facility location can be evaluated on a yes/no basis. Siting a DMP facility in a location which would result in the placement of dredged material on areas containing shellfish beds, emergent aquatic vegetation (tidal marsh), submerged aquatic vegetation (seagrass beds), endangered species of fish and wildlife, and archeological resources is either strongly discouraged or prohibited by law.[3-8] These and other concerns, guidelines, and/or regulations have led to the following order of preference of environmentally acceptable locations:[9-12]

I. Terrestrial areas
   (a) Disturbed lands
   (b) Agricultural lands
   (c) Woodlands
II. Aquatic areas
   (a) Submerged bottomland
   (b) Marshland

The two types of DMP sites under consideration - aquatic and terrestrial - are sufficiently distinct as to necessitate the development of two siting procedures. In both cases, the siting procedure identifies areas which are potentially suitable for dredged material placement operations. The two procedures differ primarily in the degree to which a site has been determined to be suitable as a result of the criteria applied during the siting procedure. This difference stems primarily from the premise that the environmental consequences of dredged material placement in terrestrial areas are inherently less severe or can be more successfully mitigated than similar activities in aquatic areas. This difference is further established by virtue of the fact that the various guidelines and regulations currently governing dredged material placement activities more clearly define acceptable aquatic DMP practices than terrestrial DMP practices.[3-6] Additionally, the existing technology is such that technical and engineering problems associated with DMP operations can be dealt with most effectively if these operations are land-based.

While the primary emphasis in DMP siting is thus on terrestrial areas, wetland areas cannot be categorically dismissed from consideration. The latter areas are considered as viable alternatives primarily if suitable upland areas are not available or if the placement of dredged material in wetland areas would have associated therewith positive environmental and/or economic impacts.

Terrestrial Areas. The confined placement of dredged material in terrestrial areas will lead to modification in soil characteristics, site surface topography, and drainage patterns and, consequently, to alteration of the ecological function of the area. These changes may be either beneficial or detrimental depending upon the pre-placement function and the ultimate intended use of the area. Disturbed lands within the geographical bounds of the Study are generally those which have previously served as borrow areas, dredged material placement sites, or general landfill areas. Depending upon the historical usage of such areas, however, they may be in a state of recovery to the extent that they now constitute a viable habitat or serve a valuable ecological function. In general, however, areas of this type can be expected to have the highest potential for net positive or beneficial impacts associated with dredged material placement activities (i.e., habitat creation or restoration).

The environmental consequences of dredged material placement in agricultural or woodland areas are potentially more adverse than in disturbed areas. Each of these two types of areas will have a wide range of acceptability based on their current environmental and ecological significance and the potential impacts of the proposed activity. For example, a woodland area of marginal productivity would be expected to be a more suitable DMP site than a highly productive agricultural area. The reclamation of DMP sites is gaining acceptance as a method whereby adverse environmental impacts of the placement operation are mitigated. At a minimum, the reclamation of a site would result in restoration to its previous function. The potential for successful reclamation of this type is considerably greater for agricultural than for woodland areas as the salt content of the dredged material restricts vegetative establishment to shallow-rooted and/or salt-tolerant species.

A variety of economic factors influence DMP siting. These factors include the costs associated with dredged material transport, DMP facility construction and management, site reclamation, and land acquisition. As dredged material transport costs increase with increasing distance between the DMP site and the dredging area, the distance relationship between the two sites is of primary consideration. Construction activities in the marine environment can generally be expected to be considerably more costly than in terrestrial areas and, within the latter areas, site preparation and DMP facility construction costs associated with woodland areas can be expected to be the greatest. Finally, while land acquisition costs for aquatic areas are minimal, such costs for terrestrial areas are far greater with disturbed lands being the least costly within the latter category.

The dominant factors operative in the preliminary identification of potential DMP sites were considered to be the planar area requirements of the DMP facility, the proximity of the facility to the project dredging area, and the need for an acceptable site effluent discharge point. The planar area requirements refer to the size of area required for construction and operation of the facility, are specific for a given dredging project, and depend upon:

a. The expected volume and composition (physical, chemical, and structural properties) of the dredged material;
b. the expected facility location and the ecological function (disturbed land, cropland, woodland) and physical characteristics (topography, subsurface soil conditions) thereof;
c. the expected facility function and ultimate intended use.

The necessity of limiting the location of potential sites to areas within reasonable proximity to the dredging area derives from economic considerations regarding dredged material transport costs. Ideally, transport distance should be less than 5,000-ft in order to minimize these costs. The effluent exiting from a land-based facility is normally transported from the site by pipeline and discharged into a nearby waterbody. Not only must the site receiving the effluent be physically capable of handling the discharge volume, but consideration must be given to the environmental impacts of the discharge operation. Thus, in addition to the requirement that a potential site be located sufficiently close to a waterbody as to permit ready discharge of the effluent, the discharge point should be sufficiently removed from shellfish and seagrass beds and finfish breeding grounds as to reduce any potential deleterious effects.

The sites identified by the application of these criteria comprise a set of prospective sites which, in the light of the criteria whereby they were selected, are potentially suitable for DMP activities. The level of suitability can be further refined by evaluating the sites in terms of additional factors and information which relate to site suitability. For each terrestrial site identified utilizing the aforementioned criteria, the following additional site information was obtained:

1. proximity of site and effluent discharge points to freshwater sources, emergent wetlands, and charted shellfish and seagrass beds;
2. proximity of site to residential, recreational, and industrial areas;
3. soil characteristics;
4. existing and expected zoning and land use regulations;
5. accessibility;
6. property boundaries and ownership.

The following outline describes the methodology and the sources of information whereby candidate terrestrial DMP sites were identified.

I. The planar requirements of the facility were determined. These requirements were specific for a given dredging project and the expected terrestrial location (i.e., disturbed land, cropland, woodland).

Approach: The method whereby these requirements were established is given in Appendix C.

II. An inventory of areas which met the planar area requirements and were within reasonable proximity to the dredging area and an effluent discharge site was compiled.

Approach: Aerial photographs in the form of Maryland State Wetlands Map (1970) were utilized as the primary source of information as these maps delineated upland and wetland boundaries and the differentiation between various land uses was reasonably well-defined. Additional aerial photographs obtained from the USDA Stabilization and Conservation Service and local planning/zoning agencies were consulted as the need arose. Prospective areas where existing land use information based on aerial photography was questionable was substantiated by consultation with relevant agency representatives or by on-site inspections when permitted.

As areas previously utilized as DMP sites were the first preference, the locations of these sites were established by review of the records of previous dredging operations and by consultation with dredging project sponsors.

Once the location of a prospective site had been identified, the following procedure was applied:

a) the boundaries of the property on which the site was situated were established with reasonable certainty;

b) a 100-ft wide buffer zone was established along existing roads, wetlands and property line boundaries;

c) a 300-ft wide buffer zone was established around existing structures;

d) a determination was then made whether or not the planar area requirements could be met under the above constraints. These requirements were considered to be satisfied if an area of the size required to accommodate the DMP facility could be established within the area defined by the various buffer zones.

III. Additional data and information relevant to the sites thus identified was collected.

Approach: The specific data or information and source thereof are as follows-

1. Proximity of the site and effluent discharge point to:

a) emergent wetlands; State Wetland Maps (1970) prepared for the Maryland Department of Natural Resources;
b) charted shellfish beds and crabbing areas; State Shellfish Bed Maps (1961) prepared for the Maryland Department of Tidewater Fisheries;
c) charted seagrass beds; Submerged Aquatic Vegetation Maps (1978) prepared for the EPA Chesapeake Bay Program;
d) freshwater sources; local health department records.

2. Proximity of the site to residential, recreational, and industrial areas; zoning maps prepared by the local planning/zoning agencies.

3. Site soil characteristics; Soil Maps (1968) prepared by the USDA Soil Conservation Service.

4. Information pertaining to zoning and land use regulations; consultation with local planning and zoning officials;

5. Site accessiblity; maps prepared by the U.S. Geological Service, county maps, and aerial photographs;

6. Property owners names and addresses; records of the local taxing agencies.

Aquatic Areas. Land-based DMP operations basically consist of the hydraulic placement of a dredged material slurry in a sedimentation basin (i.e., a surface area enclosed by retaining structures) with the primary function of the basin being to retain and store the solids fraction and release effluent which meets applicable standards of water quality. Such an operation is relatively well-defined and generally independent of the ultimate use or function of the site, whether the resultant use or function thereof is planned or accidental. While the construction and utilization of aquatic-based DMP facilities which serve the same function as land-based facilities (i.e., dredged material retention and storage; compliance with water quality standards) are technically feasible, the costs associated therewith can adversely affect the economic feasibility thereof. Additionally, aquatic areas are considered to be more sensitive than terrestrial areas to the alterations in the physical characteristics of an area which normally accompany DMP operations as the alterations can produce marked changes in the ecological function of the area. Thus, in order to offset potential adverse environmental consequences as well as the increased costs associated with aquatic DMP operations, benefits other than serving as a means or a site for retention/storage of dredged material must accompany or provide justification for the use thereof. Clearly, then, the use of aquatic areas for dredged material placement operations is more highly dependent upon project objectives than is the use of terrestrial areas.

Benefits derived from the use of aquatic areas as DMP sites are viewed as productive uses of dredged material and generally center on the creation of land for a variety of functional uses including: recreational, industrial/commercial, agricultural, institutional, material transfer, waterway-related, multiple purposes and habitat creation.[13-16] Two approaches to the productive use of dredged material were considered by this Study as being applicable with respect to DMP activities in aquatic areas: shore erosion abatement, habitat creation, or a combination thereof.

Primary considerations regarding the placement of dredged material in aquatic areas are (1) the need for containment structures for retention of the dredged material during the placement operation and for the protection of the dredged material from wave and current induced erosion after completion of the placement operation and (2) the net environmental impact of the activity. These two factors are interrelated as they are influenced to a large degree by the physical forces which prevail at a proposed site.

The need for a retaining structure for DMP operations in aquatic areas is primarily dependent upon the requirement that the activity comply with applicable water quality standards. As was previously indicated, the costs associated with aquatic-based DMP facilities which are designed in such a way as to strictly adhere to these requirements may severely impact the economic feasibility of the project. Such facilities generally become cost-effective only if the water quality standards are relaxed thereby reducing the need for extensive and costly retaining structures, or if the composition of the dredged material is such that unconfined placement in aquatic areas will not violate water quality standards. State of Maryland regulations (Code of Maryland Regulations, Section 08.05.04.03) for shellfish harvesting waters specify that turbidity should not exceed 250 mg /liter at any time. Currently, the Baltimore District Corps of Engineers criteria require that the dredged material be composed of 80% or greater sand-size particles (i.e., retained by the U.S. No. 200 sieve) before being judged potentially suitable for possible unconfined deposition in the aquatic environment. Sand-size particles settle quickly and are not likely to be resuspended by current or wave actions, thus minimizing the possibility of any long-term periods of elevated turbidity.

Conceptually, the use of dredged material for shore erosion abatement purposes involves the placement of material in the nearshore area of an eroding shoreline resulting in the creation of shoal areas ranging in elevation from at or slightly below mean low water to slightly above mean high water. Wave energies are dissipated or markedly reduced by the artificial shoal area before reaching the shore, thereby reducing the rate of shoreline erosion. In the absence of stabilizing influences (e.g., vegetation, physical structures), the dredged material is subject to the site's wave and current forces and will shift about until reaching a stable profile. Clearly, the higher the wave and current energies at a site, the more susceptible will be the dredged material to transport to and from the area. In order to maximize the potential for successful shore erosion abatement utilizing this approach it is necessary to stabilize the dredged material either through the use of vegetation and/or physical structures. Without such measures the activity approximates unconfined placement of dredged material.

The environmental impact of DMP activities in aquatic areas can be qualitatively assessed in terms of the change in overall biological productivity at the site. In the broadest and most qualitative sense, adverse environmental impacts can be expected to be minimized if the placement activity occurs in areas of low productivity. Such areas can generally be characterized in terms of the physical forces, primarily waves and currents, which exist at a given site. The deposition of dredged material in high energy aquatic environments can, depending upon the design of the project, result in the creation of a lower energy system. As low biological productivity can qualitatively be equated with high energy environments, the conversion from a high to a low energy system conducive to increased biological productivity can result in a net positive environmental impact.

Aquatic areas which, because of the configuration of the land mass surrounding the area, offshore water depths, and orientation with respect to the dominant and prevailing winds, experience relatively low level physical forces can be expected to be of moderate to high productivity. Deposition of dredged material in these low energy areas for the purpose of habitat creation will generally result in the conversion of a subtidal area to an intertidal area containing emergent aquatic vegetation (i.e., tidal marsh). As both types of areas can be viewed as productive, the net environmental impact can be expected to be negligible. In this context, low energy aquatic areas are considered suitable for DMP activities provided that the objective is habitat creation. Areas containing shellfish beds, crabbing bottoms, and seagrass beds constitute highly productive areas irrespective of the energy regime which prevails.

Economic considerations relating to DMP siting in aquatic areas derive primarily from the costs of retention/protection structures, environmental monitoring, and dredged material transport. Projects requiring retention/protection structures (i.e., confined placement) will be significantly more costly than those which can be accomplished without such structures (i.e., unconfined placement). However, the potential benefits associated with the former projects (i.e., shore erosion abatement, positive environmental impact) may serve to offset the higher costs. Environmental monitoring is required of all DMP operations involving the deposition of dredged material in aquatic areas irrespective of the method whereby the material is deposited (i.e., confined or unconfined).[17] While such costs will be dependent upon the scope and objectives of the specific project, they can be expected to be of comparable orders of magnitude for each method of deposition. Dredged material transport costs are primarily a function of the distance between the DMP site and the project dredging area. These costs can be minimized by selecting sites which are in close proximity (i.e., $<$5,000-ft.) to the dredging area.

For the purpose of developing DMP plans utilizing aquatic sites, the following assumptions were made regarding DMP siting:

1. The primary emphasis is on high energy areas as
   -such areas are expected to be of lowest biological productivity and thus provide the greatest potential for positive environmental impacts;
   -such areas experience the highest rate of erosion and would thus derive the greatest benefit from shore erosion protection efforts.

2. A retention/protection (R/P) structure is required of all DMP activities in high energy areas as such structures will
   -retain the dredged material until it consolidates and vegetation can be established;
   -aid in controlling the migration of fine-grained dredged material from the area during the DMP operation.

3. Secondary emphasis is placed on low energy areas as
   -such areas have the greatest potential for successful habitat creation;
   -such areas have the greatest potential for unconfined placement of dredged material.

4. Only material meeting the criteria of 80% or greater sand-sized particles is suitable for unconfined placement.

These assumptions address, on a qualitative level, the environmental concerns associated with aquatic-based DMP activities and are not intended to replace the detailed environmental impact assessment which is required of all DMP activities as the investigations required to accomplish quantitative assessments of this type are beyond the scope of this Study.

The placement of dredged material along shorelines for the purpose of shore erosion abatement and/or habitat creation results in the creation of nearshore shoal and intertidal areas. It is further assumed that a retention/protection structure is required when the placement of dredged material occurs in high energy areas. A major factor, then, which must be considered in sites selected for this type of activity is the potential for interference with existing navigation facilities such as piers and wharves and with water-related recreational and commercial activities as well as possible aesthetic degradation or property devaluation as viewed by the landowner along whose property the activity occurs.

The aforementioned assumptions and economic/environmental considerations regarding DMP activities in aquatic areas served as the general basis whereby prospective aquatic DMP sites were identified. The dominant factors operative in the siting procedure were considered to be:

1. proximity of the site to:
    a) the project dredging area,
    b) charted shellfish beds, crabbing bottoms, and seagrass beds;
2. the extent of shoreline development;
3. the expected level of biological productivity at the site.

The general procedure and information sources utilized in site identification are described below.

I. Undeveloped shoreline areas which were within reasonable proximity to the project dredging area were inventoried and grouped into categories according to their energy regime.

Approach: Aerial photographs in the form of Maryland Department of Natural Resources were consulted to determine (1) the extent of shoreline development (i.e., piers, wharves, boathouses, etc.) and (2) the land type (i.e., wetland, terrestrial) landward of the shoreline. The latter information provided an indication of the maximum elevation to which the nearshore area of a prospective site could be raised. Additionally, emergent wetland areas (i.e., inter- and supra-tidal marshes) would be expected to have undergone the least development and property owner objections to the proposed activity would be expected to be minimized. Shore erosion rates were taken as a measure of the energy environment of the shoreline under consideration. Shore Erosion Rate Maps (1975) prepared for the Maryland Department of Natural Resources and the Maryland Coastal Zone Management Program were utilized for this purpose as these maps delineate portions of the shoreline which are undergoing varying rates of erosion.

The locations of existing shore erosion structures were determined using Shore Erosion Structure Maps (1975) prepared for the Maryland Department of Natural Resources and the Maryland Coastal Zone Management Program. These determinations were necessary in order to assess the feasibility of utilizing existing structures in conjunction with any R/P structures which may be required. As shore erosion abatement was one of the primary objectives of DMP activities in aquatic areas, implementation of a project in an area currently protected by physical structures was unnecessary.

This methodology provided a list of prospective sites along undeveloped and unprotected shores which were considered suitable for DMP activities on the basis of their expected biological productivity (i.e., energy environment) and expected project acceptability.

II. Data and information relevant to the potential impact of the proposed activity on shellfish beds, crabbing bottoms, and seagrass beds was determined in order to (1) delete from further consideration any prospective sites at which DMP activities would result in the immediate and total loss of the biota associated with these ecosystems and (2) to assess the potential impact on these ecosystems which may be in the vicinity of the prospective sites. The locations of charted shellfish beds and crabbing bottoms were obtained from State Shellfish Bed Maps (1961) prepared for the Maryland Department of Tidewater Fisheries. Submerged Aquatic Vegetation Maps (1978) prepared for the EPA Chesapeake Bay Program provided information regarding the location of charted seagrass beds.

III. Additional information relevant to the sites thus identified was collected.

Approach: The specific information and source thereof is as follows -

1. Site accessibility plays a significant role with regard to both the technical and economic feasibility of accomplishing aquatic based DMP activities of the type under consideration. Information regarding ingress/egress routes (e.g., water, emergent wetlands, terrestrial land, existing roads) was obtained from maps prepared by the U.S. Geological Service, county maps, and aerial photographs.

2. The planar area of a proposed site was obtained by planametric integration of an area bounded by the existing shoreline and the expected seaward limit of the placement area. This limit was determined by establishing a boundary having a configuration compatible with the configuration of the land mass contiguous with the proposed site and approximating the 2-ft (MLW) depth contour. The planar area was used to derive estimates of the capacity of the site.

3. Names and addresses of property owners whose land bordered the prospective sites were obtained from records of the local taxing agencies.

The site identification procedures described above were developed to address the major environmental and economic issues relevant to DMP operations in order that the site so identified would have a high probability of meeting regulatory and funding agency requirements for site suitability. In this regard, the prospective sites which were identified were selected as to avoid the significant adverse environmental impacts which would be expected to result from the direct placement of dredged sediments on biologically sensitive or productive areas. It would appear that this approach totally ignores the concerns associated with potential adverse impacts on cultural and archeological resources which can result from dredging/DMP operations. Admittedly the sites which were selected during the course of the Study have not been examined for the presence or absence of these resources at the level accomplished for biological resources. This approach was, however, deemed appropriate in view of the fact that areas containing cultural or archeological resources are less well-defined than biological resources and the evolution of these concerns has been sufficiently recent that inventories and mappings of the former resources are at this time generally not as comprehensive as for the latter. Moreover, relative to biological systems, archeological resources can be viewed as static and potential adverse impacts to the latter deriving from DMP operations can be mitigated in a greater variety of ways and more successfully than can the former. For example, DMP operations at terrestrial sites, portions of which were identified as having a high probability of containing significant archeological resources, have been permitted with the following constraints: (1) that only filling (i.e., dredged material deposition) operations were allowed and (2) that activities involving excavation within the area of archeological significance were prohibited. Finally, any of the proposed sites which might be considered in the development of definitive DMP plans would be subjected to a detailed and comprehensive assessment of site suitability and woud result in the identification of such resources.

With regard to the candidate sites which were identified during the course of this Study, it is reasonably certain that cultural resources in terms of historically significant structures will not be impacted as the site identification procedure for terrestrial areas excluded any potential site which would result in the destruction of any existing structure. It is questionable, however, whether the utilization of any of the prospective sites will impact archeological resources.

Clearly, application of the site identification procedures developed for use in this Study for future site selection should also include provisions for consulting any available mappings or records of known sites of archeological significance as the use of such sites would be prohibited. Currently available sources of information regarding known cultural or archeological resources within the study area which should be consulted include the following:

"The National Register of Historic Places" (Federal Register, 29 February 1974; and monthly supplements each first Tuesday thereafter).

"Records of Known Archeological Sites in the State of Maryland" maintained by the Division of Archeology, Maryland Geological Survey and on file at Maryland Historical Trust, Annapolis, Maryland.

"Maps of Known Archeological Sites in the State of Maryland" maintained by the Division of Archeology, Maryland Geological Survey and on file at Maryland Historical Trust, Annapolis, Maryland.

"1877 Outline Plan of Historical Sites in Talbot County, Maryland", Prepared by Anon. and on file at Maryland Historical Trust, Annapolis, Maryland.

"1877 Outline Plan of Historical Sites in Dorchester County, Maryland", Prepared by J. B. Isler and on file at Maryland Historical Trust, Annapolis, Maryland.

Site Availability

Either the availability or the suitability of a site may be the limiting factor in the actual implementation of DMP operations at a proposed site. While a detailed assessment of site suitability may not be warranted prior to an assessment of site availability, neither would a determination of a site's availability and the conditions thereof be appropriate in the event that the suitability of the site would be highly questionable. As the site identification procedures developed and described previously were intended to address the major environmental and economic issues relevant to DMP operations and, hence, provide candidate sites which would meet the minimum regulatory agency requirements of site suitability, the practicality of actually acquiring the sites thus identified for DMP activities was examined.

The responsibility for site acquisition depends largely upon the type of project as defined by the major source of project funding. Legislative authorization for Federally funded projects contains provisions for requiring that certain terms of local cooperation be complied with before funds are allocated for project construction. Thus, depending upon the extent of local cooperation required, either the Federal government (i.e., U. S. Army Corps of Engineers) or local government (i.e., appropriate County governing body) will be variously responsible for site acquisition as well as for DMP facility construction and operation. Maintenance of Federal navigation projects is legislatively mandated and the responsibilities of site acquisition and facility construction assigned by the original authorizing legislation will be in effect for maintenance operations. Dredging projects deriving funding from the State, by and large, require that the local government provide only the DMP site. Although State/County projects do not specifically provide for any future maintenance which may be required, it is reasonable to assume that site acquisition by local government would be a continuing requirement.

The terms (i.e., purchase, lease, free of charge) and conditions (i.e., site restoration, reclamation) under which a site is acquired will depend upon the location (i.e., aquatic, terrestrial) and the intended function (i.e., single-use, long-term use) of the DMP facility. Aquatic sites can serve either as long-term or as single-use sites, the former generally being associated with approaches to shore erosion abatement projects utilizing dredged material for shore and/or beach nourishment. Aquatic-based DMP activities which have as project objectives habitat creation as well as shore erosion abatement are generally considered as single-use sites as the realization of the project objectives results in the creation or restoration of a valuable habitat which would be adversely impacted to a high degree were the DMP operations to be repeated at the site. Site acquisition costs in either case are negligible and regulatory agency approval and permission of the landowner along whose shore the activity is proposed present the major obstacles with respect to site use.

Dredged material placement sites or facilities in terrestrial areas have been traditionally viewed as single-use sites with little or no consideration given to either the potential or the need for future use. Additionally, little or no provision was made for site reclamation or restoration as the sites were generally located in what were then considered as "marginally useful" areas (i.e., inter- and supra-tidal marshes). Thus, the landowner was most willing to provide the site free of charge in exchange for rights to the dredged material and, if necessary assume any costs related to reclamation of the area. The unavailability of such "marginally useful" areas either because of environmental constraints or technical and engineering problems associated with facility construction, has necessitatedthe use of "productive" (i.e., woodland, agricultural land) areas. Not only is the real estate value of such areas high, but landowners who elect to permit the activity under a lease arrangement can be expected to require that site reclamation be accomplished without incurring financial obligations.

Dredged material placement facility management/maintenance operations are desirable for single-use sites if site reclamation is required and is to be accomplished within the shortest possible time frame and with predictable results. Such operations are effectively required for long-term use sites in order to achieve optimum facility efficiency and utilization. The necessary management/maintenance operations can be most readily accomplished if the facility is controlled by the project sponsor thereby necessitating either long-term lease arrangements or purchase by the project sponsor.

The scarcity of suitable yet low cost DMP sites, together with the potential future need for purchase and/or long-term lease of a site and for site management, maintenance, and reclamation can be expected to lead not only to changes in site acquisition practices but also to increased costs. It was primarily for these reasons that assessments of site availability and the general terms and conditions thereof were limited to candidate sites in terrestrial areas. At the outset of the Study, once prospective sites had been identified, the property owner was contacted by a carefully worded letter which described the Study, the possibility that a portion of his land met the general DMP site suitability criteria, and a request that a meeting be arranged to discuss the possible utilization of the site should it be potentially available. Response was minimal with primarily only those owners which denied use of the site replying. As this then severely restricted the number of site alternatives, those not responding to the first letter were again contacted. Response to the second letter was greater than to the first and again was predominantly for denial of site use.

Meetings were arranged with those owners who expressed a willingness either to discuss the matter further or to permit the proposed activity. For the most part, however, land areas which were offered by owners consisted of wetlands and were thus considered unsuitable from an environmental standpoint. Such meetings served a useful purpose in so far as providing the landowner with information regarding the possible ramifications of DMP operations and did result in identification of a number of sites which were available.

Site acquisition and the terms of the site-use agreement ultimately, however, derive from negotiations between the designated governmental agency and the landowner. Moreover, the Study neither had the authority to accomplish any such negotiations nor wished to be potentially misrepresented as such. It was thus deemed advisable to discontinue further site availability assessments for fear of jeopardizing the potential availability of highly desirable candidate DMP sites.

It should be noted that such wariness on the part of the general public derives both from a lack of knowledge and understanding of dredging and DMP operations as well as from previous experience with these activities. Only if future DMP operations are accomplished with a landowner not incurring undue financial obligations or aesthetic degradation of his property will DMP sites be made readily available. At a minimum, then site reclamation should be considered a necessity. Furthermore, in certain instances, use of a leased site may totally depend upon such guarantees. Because of existing contractural procedures, the COE is at present not able to assume such obligations for sites acquired either by themselves or by the local project sponsor in spite of the fact that the COE may be the best able to provide the necessary funding. The local project sponsor, on the other hand, generally considers DMP operations solely from an economic viewpoint. This is of particular importance in view of the fact that under current practices and legislation, management and reclamation are notspecifically required and the costs thereof would, in many instances, be incurred by the local project sponsor. In light of the apparent difficulty with which local sponsors were able to provide funds for site acquisition and facility construction as required by previous Federal policies, it seems reasonable to presume that the local sponsor will resist the implementation of any DMP related operations which will result in increased financial obligations. Until such time as provisions are made for the funding and contractural procedures necessary to deal with these problems, DMP activities will continue to be accomplished without regard for facility management and site reclamation and, consequently, with little improvement in public image, ease of site acquisition, or overall environmental impact.

Candidate Dredged Material Placement Sites

A total of six Federal and two State/County projects were identified by the dredging needs assessment as requiring DMP sites (see Table 3; Section III.A of this report). The DMP siting procedures described above were utilized to select candidate sites for use in the development of DMP plans for these projects. The following data sheets provide summaries of the data and information which pertains to the prospective sites. Although more than one site may have been identified for a given project, only data sheets for those sites which were used as the basis for DMP plan development are presented in this report.

1. Tar Bay - Honga River, Back Creek, and Tyler Cove Projects

The locations of the Tar Bay-Honga River, Back Creek, and Tyler Cove navigation projects and the candidate DMP sites identified for these projects are shown in Figure B. Project dimensions are such that distances between individual channels and a centrally located site were expected to result in unreasonably high dredging costs. Additionally, area limitations were such that a centrally located site of the required size (i.e., planar area) was not available without encroaching on wetland areas. As a result, the projects were factored into two sectors and candidate sites were identified for each. Sector A contained the Honga River (HR) and Back Creek (BC) channels while the Tar Bay (TB), Barren Island Gap (BIG) and Tyler Cove (TC) channels comprised Sector B.

The projected 10-year dredged material volumes for various project combinations and the DMP facility planar area requirements for accommodation of these volumes are given in Table B. The planar area requirements were utilized in conjunction with the other site identification criteria described previously in this Appendix to select prospective DMP sites. The data sheets and site maps for the candidate sites which were identified and utilized in DMP plan development are given in Tables B-1, 2, 3, 5, 6, 7, 8, 10 and Figures B-1, 2, 3, 5, 6, 7, 8, 10 for Sector A and Tables B-12, 13, 14 and Figures B-12, 13, 14 for Sector B.

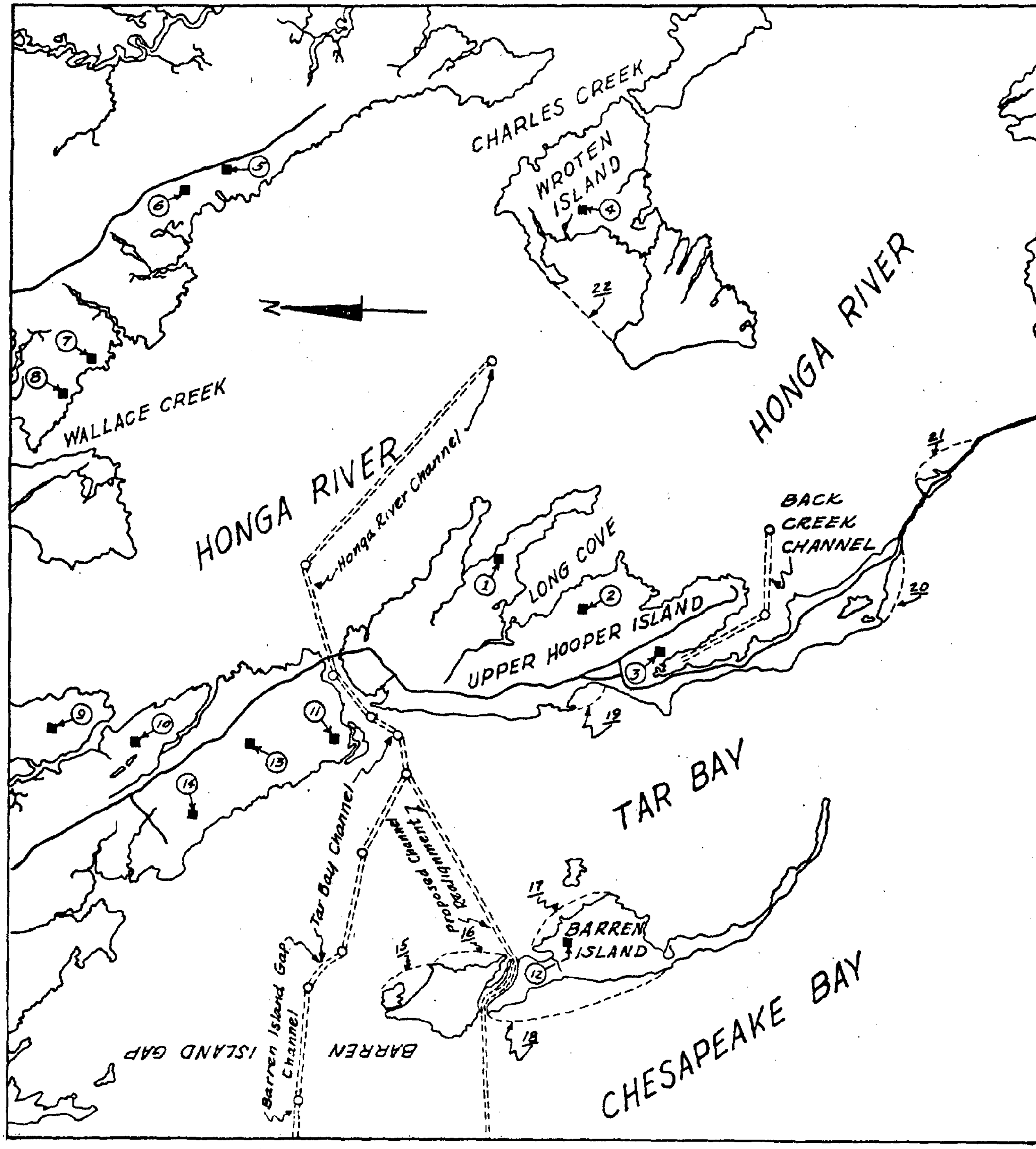


Figure B. Map showing the locations of the Federal navigation channels comprising the Tar Bay-Honga River and Back Creek projects, the proposed realignment of the Barren Island Gap and Tar Bay Channels, and the candidate dredged material placement sites.

Table B

Projected Dredged Material Volumes and the Corresponding Dredged Material Placement Facility Planar Area Requirements for Various Combinations of the Channels Comprising the Tar Bay-Honga River Federal Navigation Project.

Channel(s)[a]	Projected[b]		Area Requirements (acres)[c]	
	Date	Volume(cy)	Cropland	Woodland
Honga River (T)	1981 1993	120,000 96,000	20	24
Back Creek	1985	55,000	9	11
Honga River (T) Back Creek	1981 1993 1985	120,000 96,000 55,000	20	24
Honga River (U or L)	1981 1993	60,000 48,000	10	12
Honga River (U or L) Back Creek	1981 1993 1985	60,000 48,000 55,000	12	14
Tar Bay	1981 1989	84,000 96,000	18	18
Barren Island Gap	1981 1985 1989	56,000 56,000 56,000	15	15
Tar Bay Barren Island Gap	1981 1989 1981 1985 1989	84,000 96,000 56,000 56,000 56,000	32	32

a) Designation T refers to total channel; designations U and L refer to upper and lower segments, respectively.
b) Projected dates of maintenance dredging and the corresponding volumes of dredged material expected to be generated were obtained as described in Appendix A.
c) Determined as described in Appendices C and D.

Table B-1

Data Sheet for Candidate Dredged Material Placement Site

Dredging Project(s): Honga River and/or Back Creek channels of the Federally authorized Tar Bay-Honga River navigation project.

Site No.: 1

Location: County - Dorchester
Election District - No. 6
Nearest Town(s) - Honga and Fishing Creek, Md.
Maps - N.O.S. Nautical Chart SS4; U.S. Quadrangle "Honga".

Land Use and Zoning: Present- Maritime-Agricultural-Residential
Future- No change anticipated (1980-1990)

Ownership: Charles Rutledge, T/A Quartet Farm, P.O. Box 175, Jefferson, Md. 21755
Tax Map 93; Parcel 12; 134 acres.

Site Description:

a) Land use type and vegetation - Woodland (State Wetland Map No. 316, Dorchester County).

b) Soil type(s) - KpB, En, Et (Soil Conservation Service Map Nos. 44 & 45, Dorchester County).

c) Accessibility - directly accessible via private road from MD Route 335.

d) Proximity to residential/commercial/recreational areas - no significant residential or commercial areas are within 0.5 mile of the site; nearest residence is 300-ft. from the site; recreational activities at and in the immediate vicinity of the site are confined to hunting.

e) Proximity to charted seagrass and shellfish beds - site effluent would discharge into Long Cove; nearest charted seagrass bed is along the west shore of Wroten Island, a distance of approximately 7,000-ft. (Submerged Aquatic Vegetation Map, " Honga" Quadrangle); boundary of nearest charted shellfish bed (Back Creek oyster bar, 760A) is at the mouth of Long Cove, a distance of approximately 3,000-ft. (charted Shellfish Bed Map, Raydist Chart (No. 23).

f) Proximity to cultural and archeological resources - no officially designated archeological sites are located at or in the immediate vicinity of the site (MHT Map of Known Archeological Sites, "Honga" Quadrangle); one residence was indicated to be present near the site as of 1877 (Outline Plan of Historical Sites, Dorchester County).

(cont.)

Table B-1 (cont.)

g) Potential for contamination of freshwater sources - considered to be negligible as the depth of wells in the immediate vicinity of the site are on the order of 300-ft; the nearest freshwater well is approximately 300-ft. from the site.

Site Development: Possible retaining structure alignments for 13-acre facility would be expected to accommodate dredged material generated by the Back Creek project and either the upper or lower segments of the Honga River channel and would not directly impact either the existing private road or wetland areas as a 100-ft. buffer zone can be maintained between retaining structures and wetland areas. Facility construction and use will adversely impact woodland areas and result in the total loss of woodland habitat. Development of a 24-acre facility to accommodate the Back Creek project and the Honga River Channel would directly impact approximately 2-acres of wetland and 22-acres of woodland and necessitate the relocation of approximately 1,100-ft. of existing private road. Effluent from the facility would need to be piped through woodland areas to discharge into Long Cove, a distance of between 100- and 500-ft.

Site Availability: Property is owned by a group of individuals and used primarily for hunting activities. Discussions with property owners revealed a reluctance for use of woodland areas only and a willingness to meet with local and Federal government representatives to discuss specific portions of the property which might be available for use. The possibility of site purchase was not explored.

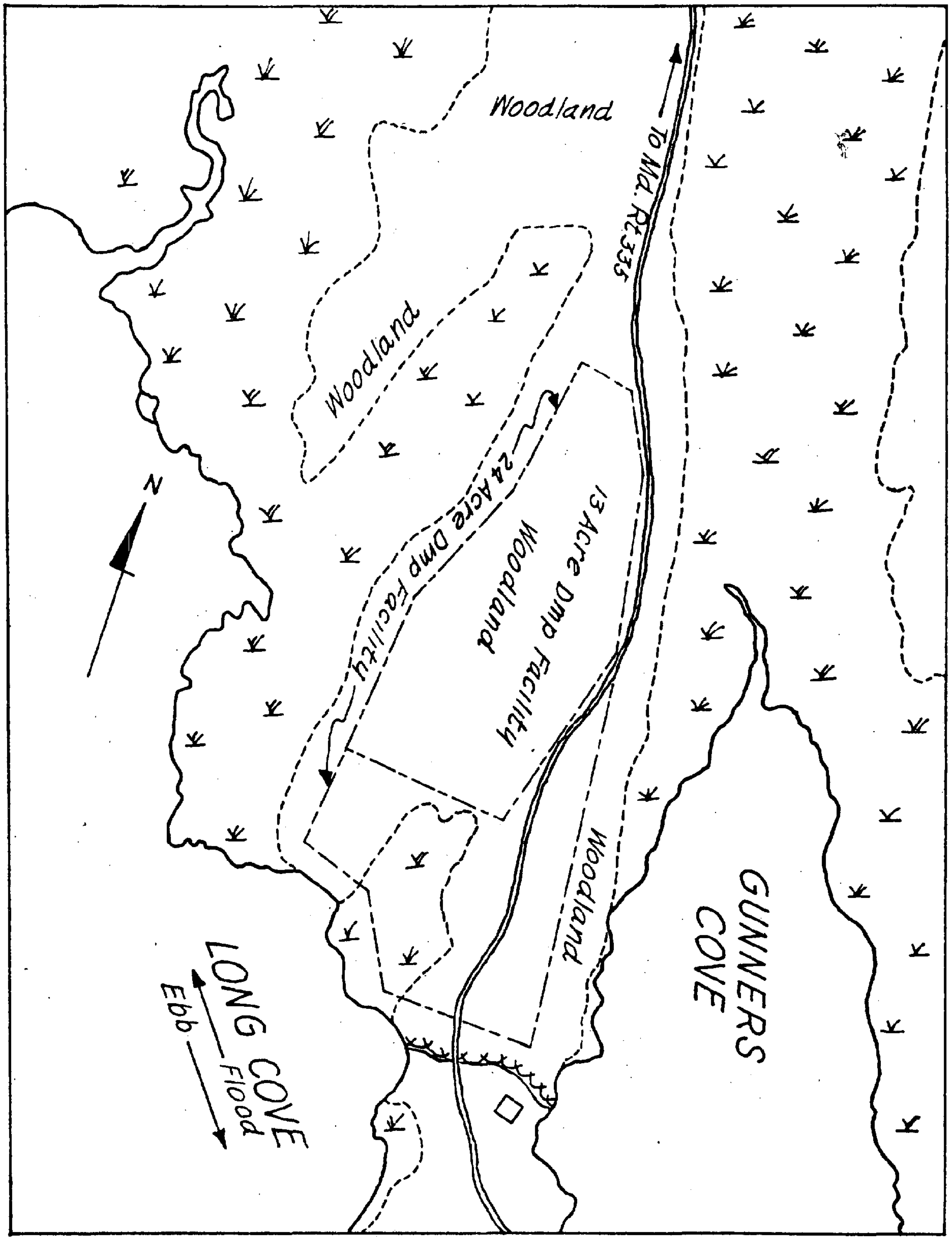


Figure B-1. Site map of candidate DMP site No. 1 for the Honga River and/or Back Creek channels of the Tar Bay-Honga River Federal navigation project (taken from State Wetlands Map No. 316, Dorchester County).

Table B-2

Data Sheet for Candidate Dredged Material Placement Site

Dredging Project(s) : Honga River and/or Back Creek channels of the Federally authorized Tar Bay-Honga River navigation project.

Site No.: 2

Location: County - Dorchester
Election District - No. 6
Nearest Town(s) - Honga and Fishing Creek, Md.
Maps - U.S. Quadrangle "Honga";
N.O.S. Nautical Chart 554

Land Use and Zoning: Present- Maritime-Agricultural-Residential
Future - No change anticipated (1980-1990)

Ownership: Harry L. Henry, Fishing Creek, Md., 21634
Tax Map 93; Parcel 12; 52 acres.

Site Description:

a) Land use type and vegetation - Woodland (State Wetland Map No. 317, Dorchester County)

b) Soil type(s) - En (Soil Conservation Service Map No. 43, Dorchester County)

c) Accessibility - Land approach: approximately 1,500 ft. from nearest road; potential routes include via wetlands and via woodlands; water approach: via Long Cove and crossing wetlands.

d) Proximity to residential/commercial/recreational areas-site located near the town of Fishing Creek; nearest residences are a minimum of 800 ft. from the site; recreational activities at and in the immediate vicinity of the site are confined to hunting.

e) Proximity to charted seagrass and shellfish beds - site effluent would discharge into Long Cove; nearest charted sea-grass bed is along the west shore of Wroten Island, a distance of greater than one mile (Submerged Aquatic Vegetation Map, "Honga" Quadrangle); boundary of nearest charted shellfish bed (Back Cove oyster bar, 760 acres) is at the mouth of Long Cove, a distance of approximately 1,600 ft. (Charted Shellfish Bed Map, Raydist Chart No. 23).

(cont.)

Table B-2 (cont.)

f) Proximity to cultural and archeological resources - no officially designated archeological sites are located at or in the immediate vicinity of the site (MHT Map of Known Archeological Sites, "Honga" Quadrangle); no structures were indicated to be present in the immediate vicinity of the site as of 1877 (Outline Plan of Historical Sites, Dorchester County).

g) Potential for contamination of freshwater sources - considered to be negligible as the depth of wells in the immediate vicinity of the site are on the order of 300-ft; the nearest freshwater well is approximately 800-ft. from the site.

Site Development: The upland area available at the site is of sufficient size to satisfy the planar area requirements of the DMP facilities designed to accommodate the dredged material expected to be generated by the dredging projects under consideration. Possible retaining structure alignment for the development of a 24-acre facility is shown in Figure B-2. Facility construction and use will adversely impact woodlands and result in the total loss of woodland habitat. Wetland areas will not be directly impacted as a minimum 100-ft. buffer zone can be maintained between facility retaining structures and wetlands. Effluent from the facility would need to be piped across wetland areas to discharge into Long Cove, a distance of approximately 500-ft. In order to achieve maximum facility utilization it would be necessary to construct approximately 1,500-ft. of access road, primarily through woodland areas.

Site Availability: Property owner indicated a willingness to permit use of woodland/wetland areas and a reluctance for use of woodland areas only. Although possibility of site purchase was not discussed, owner indicated a willingness to meet with local and Federal government representatives to discuss specific portions of the property which might be available for use.

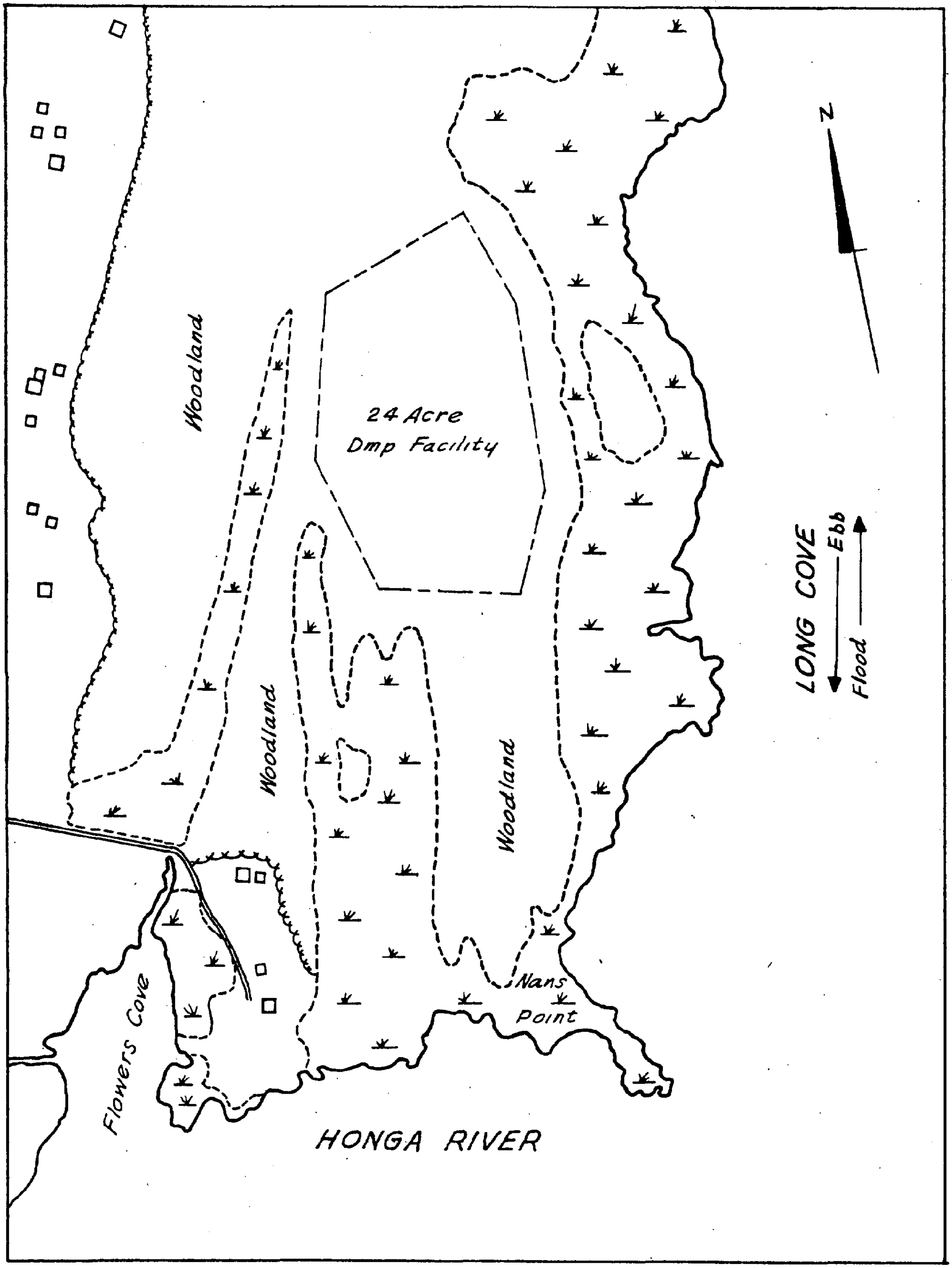


Figure B-2. Site map of candidate DMP site No. 2 for the Honga River and/or Back Creek channels of the Tar Bay-Honga River navigation project (taken from State Wetlands Map No. 317, Dorchester County).

Table B-3

Data Sheet for Candidate Dredged Material Placement Site

Dredging Project(s): Back Creek Channel of the Federally authorized Tar Bay-Honga River navigation project.

Site No.: 3

Location: County-Dorchester
Election District - No. 6
Nearest Town(s) - Fishing Creek, Md.
Maps - N.O.S. Nautical Chart 554; U.S. Quadrangle "Honga"

Land Use and Zoning: Present- Maritime-Agricultural-Residential
Future- No change anticipated (1980-1990)

Ownership: Calvert Cannon, Fishing Creek, Md. 21634
Tax Map 100; Parcel 73; 21 acres
Bernard J. Thien, 2318 St. Bedes Court, Reston, Va. 2209
Tax Map 93; Parcel 127; 15 acres

Site Description:

a) Land use type and vegetation - combination of upland area resulting from previous DMP activities, woodland, and wetland (State Wetland Map No. 317, Dorchester County).

b) Soil type(s)- Tm, Et (Soil Conservation Service Map No. 43, Dorchester County)

c) Accessibility- directly accessible via existing state, county, and private roads.

d) Proximity to residential/commercial/recreational areas- site is effectively located within the town of Fishing Creek; nearest residence is within 100-ft. of the proposed site.

e) Proximity to charted seagrass and shellfish beds - site effluent would discharge into Back Creek; nearest charted seagrass bed is along the west shore of Wroten Island, a distance in excess of one mile (Submerged Aquatic Vegetation Map, "Honga Quadrangle); boundary of nearest charted shellfish bed (Back Cove oyster bar, 760A) is at the mouth of Back Creek, a distance of approximately 3,500-ft. (charted Shellfish Bed Map, Raydist Chart No. 23).

f) Proximity to charted seagrass and shellfish beds - no officially designated archeological sites are located at or in the immediate vicinity of the site (MHT Map of Known

(cont.)

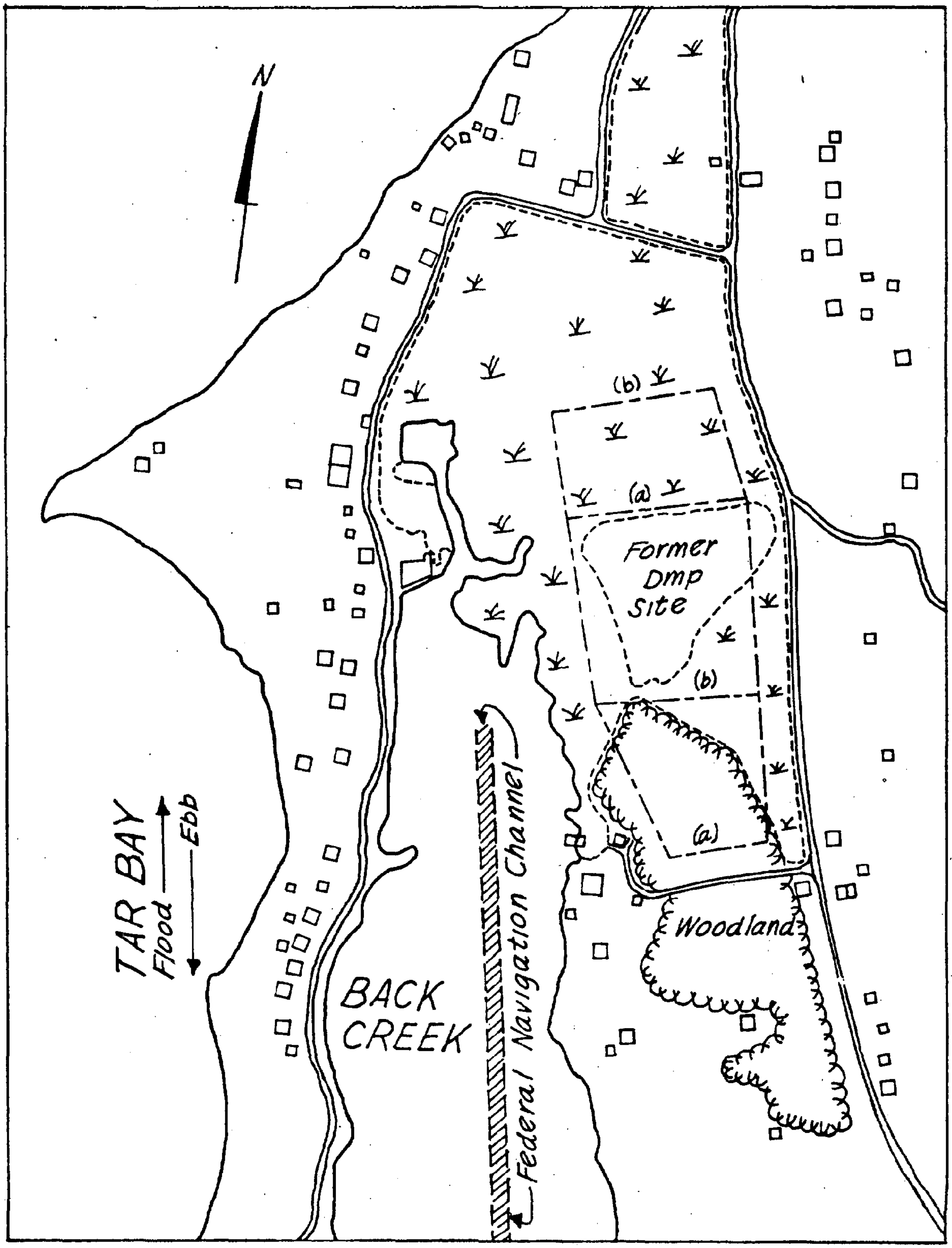
Table B-2 (cont.)

Archeological Sites, "Honga" Quadrangle); three residences were indicated to be in present near the site as of 1877 (Outline Plan of Historical Sites, Dorchester County).

g) Potential for contamination of freshwater sources - considered to be negligible as the depth of wells in the immediate vicinity of the site are on the order of 300-ft; the nearest freshwater well is approximately 100-ft. from the site; no contamination of freshwater sources was experienced during previous DMP activities at the site.

Site Development: Possible retaining structure alignments for two 11-acre facilities expected to accommodate the dredged material expected to be generated by the Back Creek project are shown in Figure B-3. Construction and use of either facility would utilize the DMP site created as a result of dredging operations conducted in 1956. Facility (a) would directly impact woodland and wetland areas and result in the total loss of approximately 7-acres of wetland habitat without impacting woodland habitat. Effluent from either facility would be required to be piped across approximately 100-ft of wetland to discharge into Back Creek.

Site Availability: No assessment was made regarding site availability. Development of facility (a) would involve a single parcel of land while facility (b) would involve portions of two properties in separate ownership.



Fiaure B-3. Site map of candidate DMP site No. 3 for the Back Creek channel of the Tar Bay-Honga River Federal navigation project (taken from State Wetlands Map No. 317, Dorchester County).

Table B-5

Data Sheet for Candidate Dredged Material Placement Site

Dredging Project: Honga River channel of the Federally authorized Tar Bay-Honga River navigation project.

Site No.: 5

Location: County - Dorchester
Election District - No. 5
Nearest Town - Crossroads, Md.
Maps - N.O.S. Nautical Chart 554; U.S. Quadrangle "Honga"

Land Use and Zoning: Present- Maritime-Agricultural-Residential
Future- No change anticipated (1980-1990)

Ownership: James Gabriel, 606 Church Street, Cambridge, Md. 21613
Tax Map 86; Parcel 122; 36 acres.
Dorchester Lumber Co., Linkwood, Md. 21835
Tax Map 94; Parcel 6; 994 acres.

Site Description:

a) Land use type and vegetation - Woodland and cropland (State Wetland Map No. 281, Dorchester County)

b) Soil type(s) - KpA, Eo, Et (Soil Conservation Service Map No. 44, Dorchester County.

c) Accessibility - Land approach: directly accessible via private road from MD Route 335 and county maintained road; water approach: from Honga River and crossing wetlands.

d) Proximity to residential/commercial/recreational areas: no significant residential or commercial areas are within 1 mile of the site; nearest residence is 300-ft. from the site; recreational activities at and in the immediate vicinity of the site are confined to hunting.

e) Proximity to charted seagrass and shellfish beds - site effluent would discharge into the Honga River; nearest charted seagrass bed is located approximately 6,000-ft. north of the site at the entrance to Wallace Creek (Submerged Aquatic Vegetation Map, "Honga" Quadrangle); nearest charted shellfish bed (Wallace Creek oyster bar, 916 acres) is immediately offshore of the site (Charted Shellfish Bed Map, Raydist Chart No. 23).

f) Proximity to cultural and archeological resources - no officially designated archeological sites are located at or

(cont.)

Table B-5 (cont.)

in the immediate vicinity of the site (MHT Map of Known Archeological Sites, "Honga" Quadrangle); two residences were indicated to be present near the site as of 1877 (Outline Plan of Historical Sites, Dorchester County).

g) Potential for contamination of freshwater sources - considered to be negligible as the depth of wells in the vicinity of the site are on the order of 300-ft.

Site Development- The largest DMP facility which could be developed at the site while maintaining a 100-ft. buffer zone between wetlands and existing roads is approximately 10-acres and would directly impact 10-acres of woodland habitat. Possible retaining structure alignment for a 19-acre facility is shown in Figure B-5 and would be comprised of 4.5-acres of cropland, 14-acres of woodland and 0.5-acre of wetland. As the latter facility would directly impact wetlands, site development would be primarily limited to construction of a 10- to 12-acre facility to accommodate only either the upper or lower segments of the Honga River channel. Effluent from the facility would need to be piped across wetland areas to discharge into the Honga River, a distance of between 300- and 400- ft.

Site Availability- No assessment was made regarding site availability. Site development would involve two parcels of land in separate ownership.

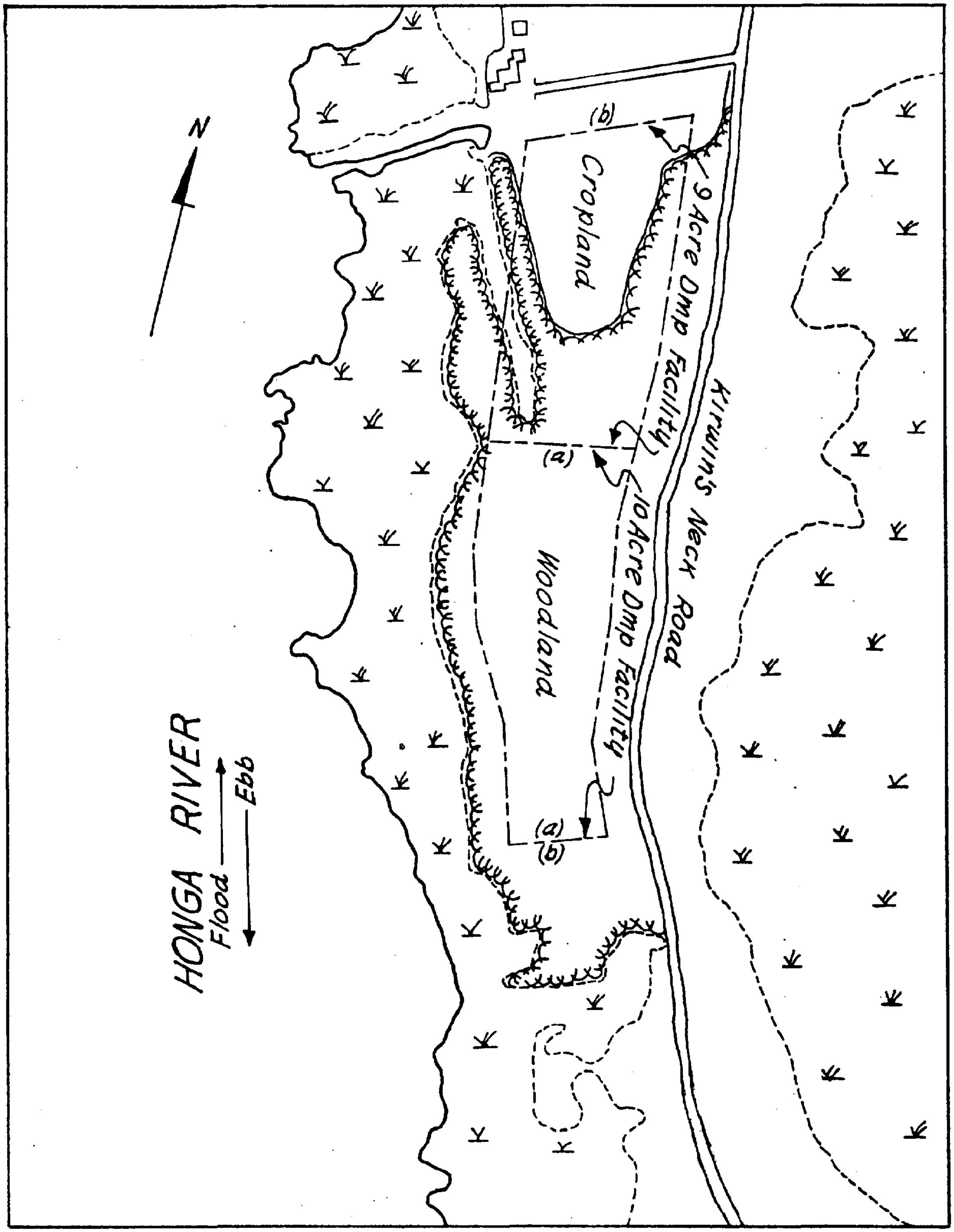


Figure B-5. Site map of candidate DMP site No. 5 for the Honga River channel of the Tar Bay-Honga River Federal navigation project (taken from State Wetland Map No. 281, Dorchester County).

Table B-6

Data Sheet for Candidate Dredged Material Placement Site

Dredging Project: Honga River channel of the Federally authorized Tar Bay-Honga River navigation project.

Site No.: 6

Location: County-Dorchester
Election District - No. 5
Nearest Town - Crossroads, Md.
Maps - N.O.S. Nautical Chart 554; U.S. Quadrangle "Honga"

Land Use and Zoning: Present- Maritime-Agricultural-Residential
Future- No change anticipated (1980-1990)

Ownership: James Gabriel, 606 Church Street, Cambridge, Md. 21613
Tax Map 86; Parcel 122; 136 acres.
Montchester Gun Club, c/o Clarence M. Coster, 4108 N. River Street, Arlington, Va. 22207
Tax Map 85; Parcel 31; 597 acres.
Richard W. Trice, P.O. Box 159, Preston, Md. 21655
Tax Map 86; Parcel 123; 10 acres.

Site Description:

a) Land use type and vegetation- Woodland and cropland (State Wetland Map Nos. 280-1, Dorchester County).

b) Soil Type(s) - KpA, Eo (Soil Conservation Service Map No. 44 Dorchester County).

c) Accessibility - Land approach: directly accessible via private road from MD Route 335 and county maintained road; water approach: from Honga River and crossing wetlands.

d) Proximity to residential/commercial/recreational areas - no significant residential or commercial areas are within 1 mile of the site; nearest residence is 300-ft. from the site; recreational activities at and in the immediate vicinity of the site are confined to hunting.

e) Proximity to charted seagrass and shellfish beds - site effluent would discharge into Honga River; nearest charted seagrass bed is located approximately 5000-ft. north of the site at the entrance to Wallace Creek (Submerged Aquatic Vegetation Map, "Honga" Quadrangle); nearest charted shellfish bed (Wallace Creek oyster bar, 916 acres) is immediately offshore of the site (charted Shellfish Bed Map, Raydist Chart No.23).

(cont.)

Table B-6 (cont.)

f) Proximity to cultural and archeological resources - no officially designated archeological sites are at or in the immediate vicinity of the site (MHT Map of Known Archeological sites, "Honga" Quadrangle); three residences were indicated to be present at or near the site as of 1877 (Outline Plan of Historical Sites, Dorchester County).

g) Potential for contamination of freshwater sources - considered to be negligible as the depth of wells in the immediate vicinity of the site are on the order of 300-ft.

Site Development - the largest area which could be developed at the site while maintaining a 100-ft. buffer zone between wetlands and existing roads and structures is approximately 30-acres and is comprised of a mixture of woodland and cropland areas. Possible retaining structure alignment for a 24-acre DMP facility expected to accommodate dredged material from the entire Honga River channel is shown in Figure B-6. Construction and use of this facility would directly impact woodland and cropland areas resulting in the loss of approximately 5-acres of cropland and 19 acres of woodland habitat. Development of a 12-acre DMP facility to be utilized for dredged material deriving from either the upper or lower segment of the Honga River channel could be accomplished with a variety of retaining structure alignments. Effluent from a facility developed at this site would need to be piped across wetland areas to discharge into the Honga River, a distance of between 300- and 600-ft.

Site Availability - No assessment was made regarding site availability. Depending upon the size of the facility, development could involve three parcels of land all of which are in separate ownership.

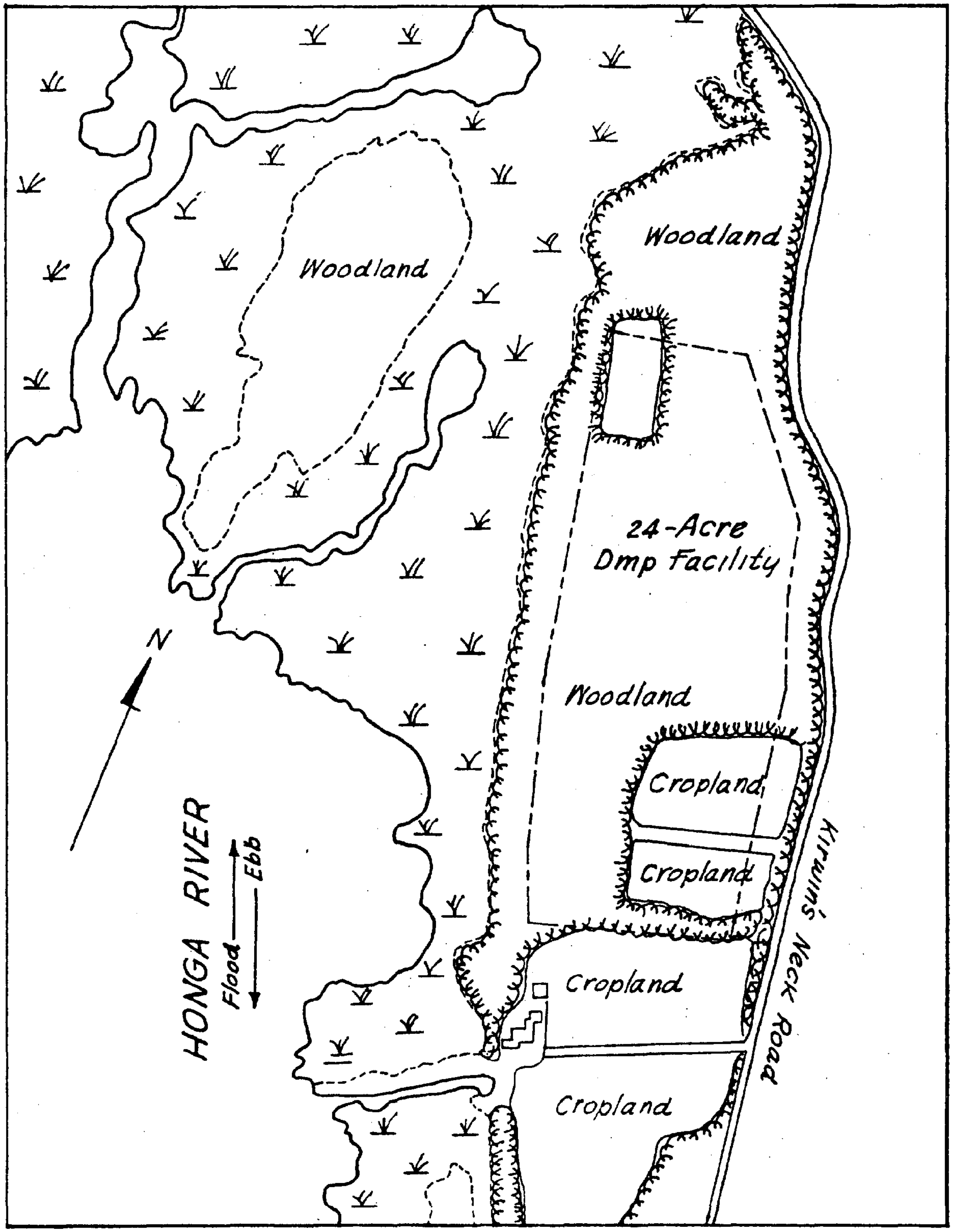


Figure B-6. Site map of candidate DMP site No. 6 for the Honga River channel of the Tar Bay-Honga River Federal navigation project (taken from State Wetlands Map Nos. 280 & 281, Dorchester County).

Table B-7

Data Sheet for Candidate Dredged Material Placement Site

Dredging Project: Honga River channel of the Federally authorized Tar Bay-Honga River navigation project.

Site No.: 7

Location: County - Dorchester
Election District - No. 5
Nearest Town - Crossroads, Md.
Maps - N.O.S. Nautical chart 554; U.S. Quadrangle "Honga"

Land Use and Zoning: Present - Maritime-Agricultural-Residential
Future - No change anticipated (1980-1990)

Ownership: Montchester Gun Club, c/o Clarence Coster, 4108 N. River St., Arlington, Va. 22207
Tax Map 85; Parcel 31; 597 acres.

Site Description:

a) Land use type and vegetation - Woodland (Wetland Map Nos. 280 & 299, Dorchester County).

b) Soil Type(s) - MkB2, MsA (Soil Conservation Service Map Nos. 39 & 44, Dorchester County).

c) Accessibility - Land approach: directly accessible via private road from MD Route 335 and county maintained road; water approach: from Honga River.

d) Proximity to residential/commercial/recreational areas - no significant residential or commercial areas are within one mile of the site; Recreational activities at and in the immediate vicinity of the site are confined to hunting.

e) Proximity to charted seagrass and shellfish beds - site effluent would discharge into Honga River; nearest charted seagrass bed is along and immediately offshore of the site (Submerged Aquatic Vegetation Map, "Honga" Quadrangle); nearest charted shellfish bed (Wallace Creek oyster bar, 916 acres) is immediately offshore of the site (Charted Shellfish Bed Map, Raydist Chart No. 23).

f) Proximity to cultural and archeological resources - two officially designated archeological sites are located in the immediate vicinity of the site (MHT Map of Known Archeological ites, "Honga" Quadrangle); three residences and a school were indicated.

(cont.)

were indicated to be present at or near the site as of 1877 (Outline Plan of Historical Sites, Dorchester County).

g) Potential for contamination of freshwater sources - considered to be negligible as the depth of wells in the immediate vicinity of the site are on the order of 300-ft.

Site Development: Possible retaining structure alignment for the largest DMP facility which could be developed at the site while maintaining a 100-ft buffer zone between wetlands and existing roads is shown in Figure B-7. The total area directly impacted by the construction and use of this facility is 16-acres and is comprised of approximately 15-acres of woodland and 1-acre of cropland. Although a facility of the size required to accommodate material deriving from dredging of the entire Honga River channel (i.e., 24-acres) cannot be developed without directly impacting wetland areas, adequate upland area exists to permit the development of a 12- to 16-acre facility for use in conjunction with dredging of the upper segment of the aforementioned channel. Effluent from the facility would be required to be piped across upland areas and the seagrass beds to a point approximately 400-ft. offshore to discharge into the Honga River, a total distance of between 500- and 600-ft.

Site Availability: Property is owned by a hunting club. Discussions with club member John Fisher regarding site availability indicated that further discussions regarding site use are warranted.

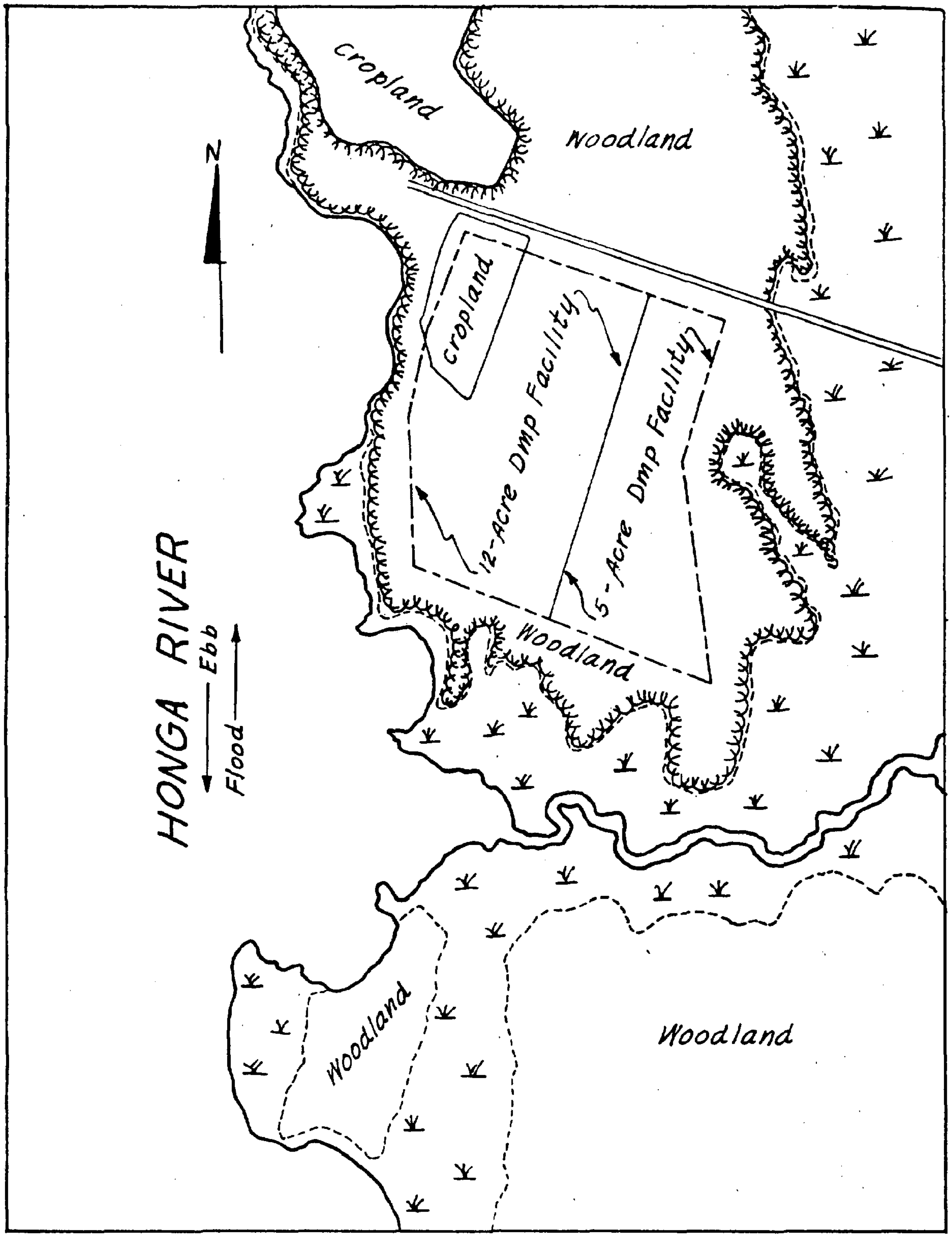


Figure B-7. Site map of the candidate DMP site No. 7 for the Honga River channel of the Tar Bay-Honga River Federal navigation project (taken from State Wetland Map Nos. 280 & 299, Dorchester County).

Table B-8

Data Sheet for Candidate Dredged Material Placement Site

Dredging Project(s): Honga River channel of the Federally authorized Tar Bay-Honga River navigation project.

Site No.: 8

Location: County - Dorchester
Election District- No. 5
Nearest Town- Crossroads, Md.
Maps- N.O.S. Nautical Chart 554; U.S. Quadrangle "Honga"

Land Use and Zoning: Present- Maritime-Agricultural-Residential
Future- No change anticipated (1980-1990)

Ownership: Dorchester Lumber Co., Linkwood, Md. 21835
Tax Map 94; Parcel 6; 994 acres.

Site Description:

a) Land use type and vegetation- Cropland and Woodland (Wetland Map No. 299, Dorchester County).

b) Soil Type- MkB2 (Soil Conservation Service Map No. 39, Dorchester County).

c) Accessibility- Land approach: directly accessible via private road from MD Route 335 and county maintained road; water approach: from either Wallace Creek or Honga River.

d) Proximity to residential/commercial/recreational areas - no significant residential or commercial areas are within one mile of the site; recreational activities at and in the immediate vicinity of the site are confined to hunting.

e) Proximity to charted seagrass and shellfish beds - site effluent would discharge into either Wallace Creek or the Honga River; nearest charted seagrass bed is along and immediately offshore of the site in the Honga River and extending into the mouth of Wallace Creek (Submerged Aquatic Vegetation Map, "Honga" Quadrangle); nearest charted shellfish bed (Wallace Creek oyster bar, 916 acres) is immediately offshore of the site (charted Shellfish Bed Map, Raydist Chart No. 23).

f) Proximity to cultural and archeological resources - two officially designated archeological sites are located in the immediate vicinity of the site (MHT Map of Known Archeological Sites, "Honga" Quadrangle); four residences and a school were indicated to be present near the site as of 1877 (Outline Plan of Historical Sites, Dorchester County).

(cont.)

Table B-8 (cont.)

g) Potential for contamination of freshwater sources - considered to be negligible as the depth of wells in the immediate vicinity of the site are on the order of 300-ft.

Site Development: Possible retaining structure alignment for a 20-acre DMP facility is shown in Figure B-8 and would accommodate the dredged material expected to be generated as a result of maintenance operations for the entire Honga River between 1980 and 1990. The area impacted by the construction and use of this facility is comprised of approximately 18-acres of cropland and 2-acres of woodland. Approximately 5-acres of the site is scheduled to be utilized for DMP operations associated with the State sponsored dredging project in Wallace Creek. Effluent from the facility would be required to be piped across upland and wetland areas and across existing beds of submerged aquatic vegetation to discharge into either the Honga River or Wallace Creek. Effluent pipeline distances would range between 300- and 500-ft.

Site Availability: The land on which the site is located is part of a 994-acre parcel owned by a lumber company. Although the property owners were not contacted regarding site availability, the apparent availability of the site for use in conjunction with the Wallace Creek project suggests that the potential for future use of the site is high.

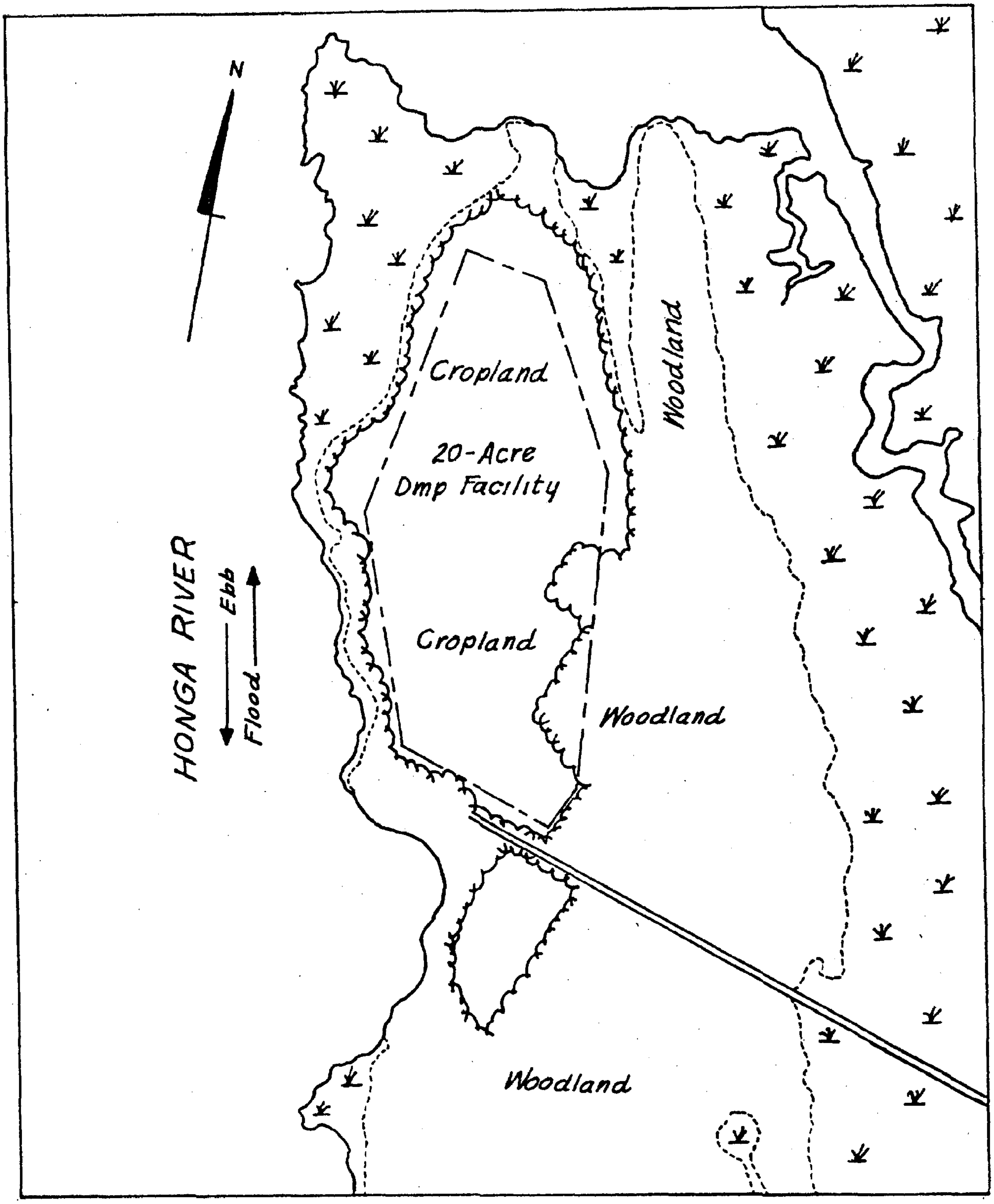


Figure B-8. Site map of candidate DMP site No. 8 for the Honga River channel of the Tar Bay-Honga River Federal navigation project (taken from State Wetland Map No. 299, Dorchester County).

Table B-12

Data Sheet for Candidate Dredged Material Placement Site

Dredging Project: Tar Bay and Barren Island Gap channels of the Federally authorized Tar Bay-Honga River navigation project.

Site No.: 12

Location: County- Dorchester
Election District - No. 6
Nearest Town(s) - Honga and Fishing Creek, Md.
Maps - N.O.S. Nautical Chart 554; U.S. Quadrangle "Barren Island"

Land Use and Zoning: Present - "Conservation"
Future - No change anticipated (1980-1990)

Ownership: James F. Jackson, III, 16449 Ed Warfield Road, Woodbine, Md. 21797
Tax Map 92; Parcel 1; 347-acres
James M. Simmons, 207 Belvedere Avenue, Cambridge Md.21613
Tax Map 92; Parcel 7; 8-acres

Site Description:

a) Land use type and vegetation - Woodland and former cropland (Wetland Maps Nos. 333 & 334, Dorchester County).

b) Soil Type - MsB, MsA, En, KpB (Soil Conservation Service Map No. 43, Dorchester County).

c) Accessibility - accessible only by water from either Tar Bay on the east or the Chesapeake Bay on the west.

d) Proximity to residential/commercial/recreational areas - site is located a minimum of one mile from any residential or commercial areas; recreational activities at and in the immediate vicinity of the site are confined to hunting.

e) Proximity to charted seagrass and shellfish beds - the nearest charted seagrass bed is located along and immediately offshore of the southern tip of the Island, a distance of approximately one mile (Submerged Aquatic Vegetation Map, "Barren Island" Quadrangle); the nearest charted shellfish bed (Tar Bay, 90-acres) is located approximately 2,000-ft. from the proposed site (Charted Shellfish Bed Map, Raydist Chart No. 23).

f) Proximity to cultural and archeological resources - an officially designated archeological site is located near the proposed DMP site and a potentially significant archeological site is indicated to be present at the proposed site (MHT Map of Known Archeological Sites, "Barren Island" Quadrangle); two

(cont.)

residences and a school were indicated to be present at the site as of 1877 (Outline Plan of Historical Sites, Dorchester County)

g) Potential for contamination of freshwater sources - considered to be negligible as the majority of wells are on the order of one mile from the site, and at a depth of 300-ft. or greater and DMP operations conducted previously near the site did not contaminate the freshwater source of the one well located on the Island.

Site Development: Possible retaining structure alignment for a 32-acre DMP facility is shown in Figure B-12. This facility is of adequate size to accommodate the dredged material expected to be generated by maintenance dredging operations for both the Tar Bay and Barren Island Gap channels between 1980 and 1990. Construction and use of the facility would directly impact approximately 27-acres of woodland and 5-acres of former cropland. Smaller facilities could be developed for use in dredging operations of either the Tar Bay (18-acres) or Barren Island Gap (15-acres) channels. Effluent from the facility would be required to be piped across wetland areas to discharge into Tar Bay, a distance of approximately 200-ft.

Site Availability - Property on which the site is located is comprised of two parcels of land each of which is in single ownership. The potential for site use was explored with the Island's major land holder (James F. Jackson) and found to be high as the owner indicated a willingness to enter into further discussions regarding site use. Contact with the second property owner was referred to the local sponsor.

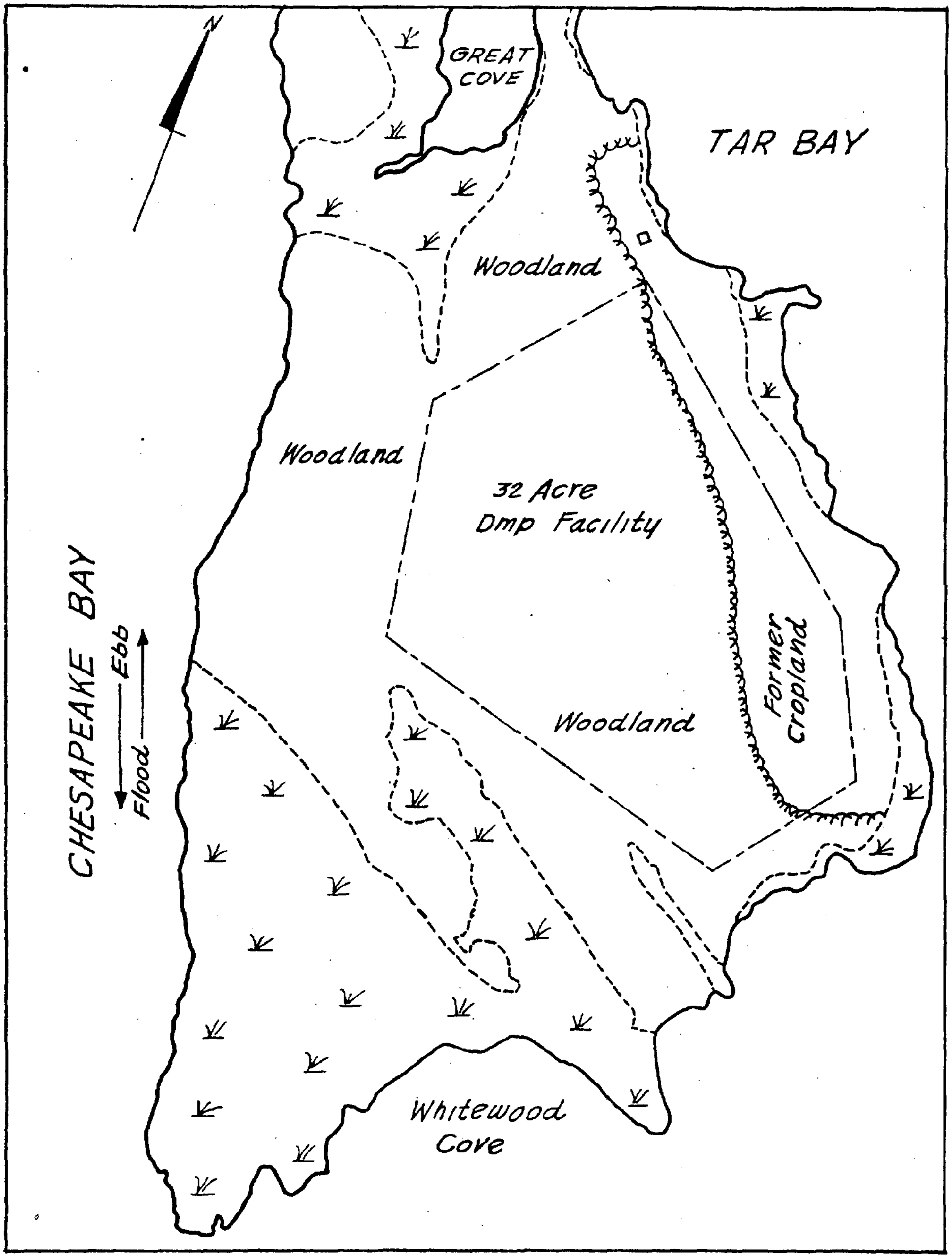


Figure B-12. Site map of candidate DMP site No. 12 for the Tar Bay and/or Barren Island Gap channels of the Tar Bay-Honga River navigation project (taken from State Wetland Maps Nos. 333 & 334, Dorchester County).

Table B-13

Data Sheet for Candidate Dredged Material Placement Site

Dredging Project: Tar Bay and Barren Island Gap channels of the Federally authorized Tar Bay-Honga River navigation project.

Site No.: 13

Location: County - Dorchester
Election District - No. 6
Nearest Town(s) - Honga, Md.
Maps - N.O.S. Nautical Chart 554; U.S. Quadrangle "Honga"

Land use and zoning: Present - Maritime-Agricultural-Residential
Future - No change anticipated (1980-1990)

Ownership: C. Mace Thomas, P. O. Box 404, Cambridge, Md. 21613
Tax Map 93; Parcel 18; 230-acres

Site Description:

a) Land use type and vegetation - Woodland (Wetland Maps Nos. 315 & 316, Dorchester County).

b) Soil Type - En (Soil Conservation Service Map No. 43, Dorchester County).

c) Accessibility - Land approach: directly accessible via private road from MD Route 335; water approach; from Tar Bay and crossing wetlands and woodlands.

d) Proximity to residential/commercial/recreational areas pf significant size are within one mile of the site, a residential development is planned for an area located approximately 1.5-miles north of the site; recreational activities at and in the immediate vicinity of the site are confined to hunting.

e) Proximity to charted seagrass and shellfish beds - the nearest charted seagrass bed is located along and immediately offshore of the southern tip of Barren Island, a distance of greater than 3-miles (Submerged Aquatic Vegetation Map, "Barren Island" Quadrangle); the nearest charted shellfish bed (Tar Bay, 90-acres) is located approximately one mile from the proposed site (Charted Shellfish Bed Map, Raydist Chart No. 23).

f) Proximity to cultural and archeological resources - a potentially significant archeological site is located in the immediate vicinity of the site (MHT Map of Known Archeological Sites, "Honga" Quadrangle); a residence was indicated to be present near the site as of 1877 (Outline Plan of Historical Sites, Dorchester County).

(cont.)

Table B-13 (cont.)

g) Potential for contamination of freshwater sources - considered to be negligible as the depth of wells in the immediate vicinity of the site are on the order of 300-ft. and previous DMP operations conducted near the site did not contaminate freshwater sources.

Site Development: Figure B-13 shows the possible retaining structure alignment for the largest DMP facility which could be developed at the site while maintaining a 100-ft. buffer zone between wetlands and existing roads. The total area impacted by the construction and use of this facility is 18-acres, is comprised of woodland, and would accommodate material deriving from dredging of either the Barren Island Gap or Tar Bay channels between 1980 and 1990. The facility would also have the capacity to accept material from the State and Federal projects in Tyler Cove. The development of a single facility of the size required to accommodate material generated by all of the aforementioned project could not be accomplished without severely impacting wetlands. The two smaller DMP facilities depicted in Figure B-13 could be developed as an alternative to the 18-acre facility or in conjunction with the 18-acre facility for use by either the Tar Bay or the Barren Island Gap channels or by both channels, respectively. Effluent from the 18-acre facility would be required to be piped across woodland and wetland areas to discharge into either Tar Bay (approximately 1,100-ft.) or a small tidal stream (approximately 800-ft.)

Site Availability - Property on which site is located is in single ownership. Initial contact with owner revealed a reluctance to permit use of site in view of previous experience with DMP activities conducted on same property. Subsequent discussions with owner, however, indicated a willingness to discuss further the possibility of site use.

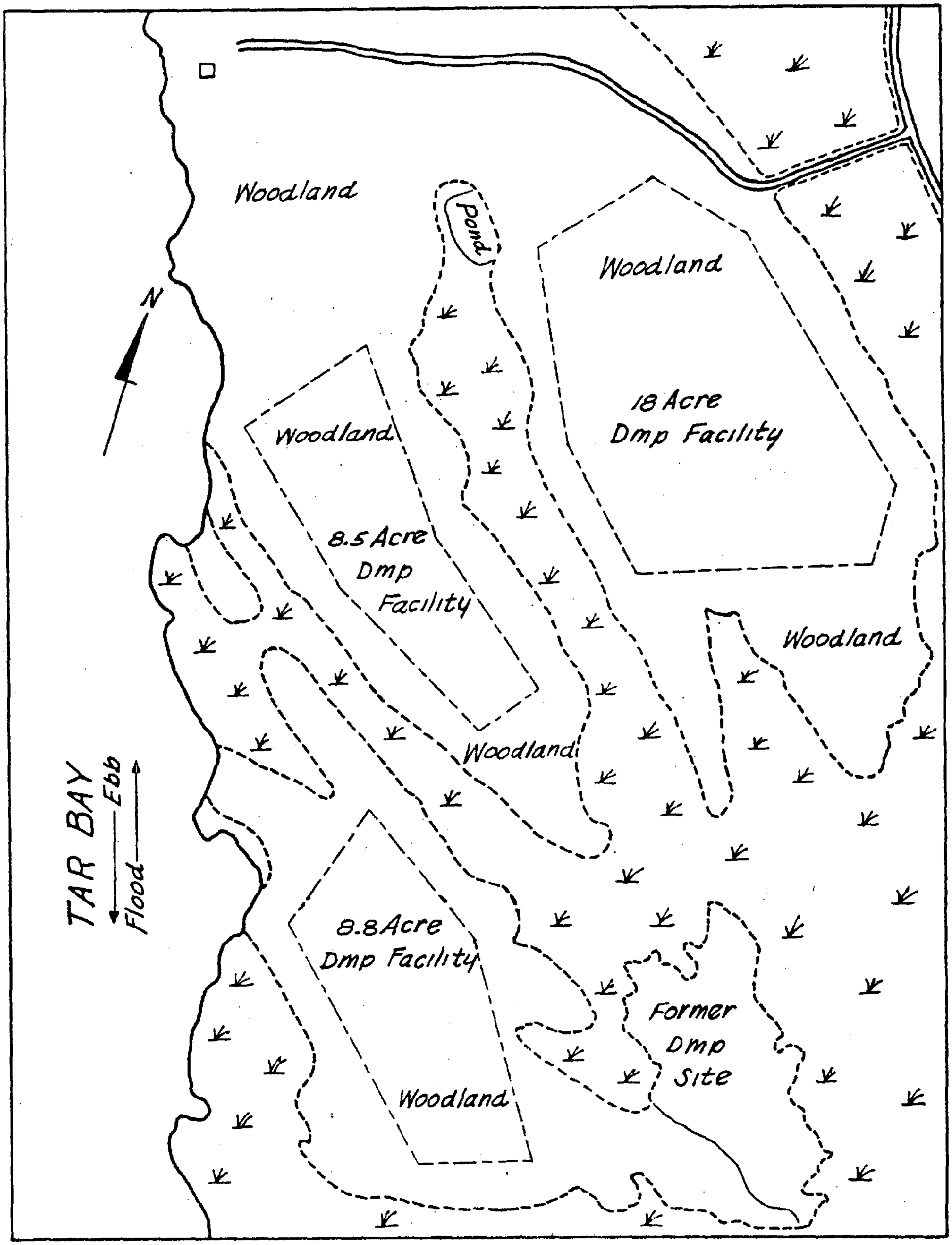


Figure B-13. Site map of candidate DMP site No. 13 for the Tar Bay and/or Barren Island Gap channels of the Tar Bay-Honga River Federal navigation project (taken from State Wetland Map Nos. 315 & 316, Dorchester County).

Table B-14

Data Sheet for Candidate Dredged Material Placement Site

Dredging Project: Tar Bay and Barren Island Gap channels of the Federally authorized Tar Bay-Honga River navigation project.

Site No.: 14

Location: County- Dorchester
Election District - No. 6
Nearest Town - Honga, Md.
Maps - N.O.S. Nautical Chart 554; U.S. Quadrangle "Honga"

Land use and zoning: Present - Maritime-Agricultural-Residential
Future - No change anticipated (1980-1990)

Ownership: Wm. D. Small and Larry E. Devilbiss, 36 Locust Street, Westminster, Md. 21157
Tax Map 84; Parcel 23; 117-acres

Site Description:

a) Land use type and vegetation - cropland and woodland (Wetland Map no. 332, Dorchester County).

b) Soil type - MsB, KpB, Em, En, (Soil Conservation Service Map No. 43, Dorchester County).

c) Accessibility - Land approach: directly accessible via private road from MD Route 335; water approach: from Tar Bay.

d) Proximity to residential/commercial/recreational areas- although no residential or commercial areas of significant size are in the immediate vicinity of the site, a residential development is planned for an area located approximately one mile north of the site; recreational activities at and in the immediate vicinity of the site is confined to hunting.

e) Proximity to charted seagrass and shellfish beds - the nearest charted seagrass bed is located a distance of greater than 3-miles from the site at the southern tip of Barren Island (Submerged Aquatic Vegetation Maps, "Barren Island" and "Honga" Quadrangles); the nearest charted shellfish bed (Tar Bay, 90-acres) is located approximately 1.5-mile from the proposed site (Charted Shellfish Bed Map, Raydist Chart No. 23).

f) Proximity to cultural and archeological resources - one officially designated archeological site is located near the proposed DMP site (MHT Map of Known Archeological Sites,

(cont.)

Table B-14 (cont.)

"Honga" Quadrangle) a residence and a church were indicated to be present in the immediate vicinity of the site as of 1877 (Outline Plan of Historical Sites, Dorchester County).

g) Potential for contamination of freshwater sources- considered to be negligible as the depth of wells in the immediate vicinity of the site are on the order of 300-ft.

Site Development- Two possible retaining structure alignments for 32-acre DMP facilities are shown in Figure B-14. A facility of this size is adequate to accommodate the dredged material expected to be generated by maintenance dredging operations for both the Tar Bay and Barren Island Gap channels between 1980 and 1990. The construction and use of either of these facilities would directly impact varying amounts of woodland habitat and cropland. Sufficient cropland area exists to permit the construction of a 15- to 18-acre facility which would provide adequate capacity for either the Tar Bay or the Barren Island Gap channel and would not directly impact woodland areas. Discharge of effluent from either of the sites into Tar Bay would require construction of a pipeline through and across woodland and cropland areas. The length of the effluent discharge line would range from 200- to 400-ft.

Site Availability- The property upon which the site located is in joint ownership. The potential for site availability was not evaluated.

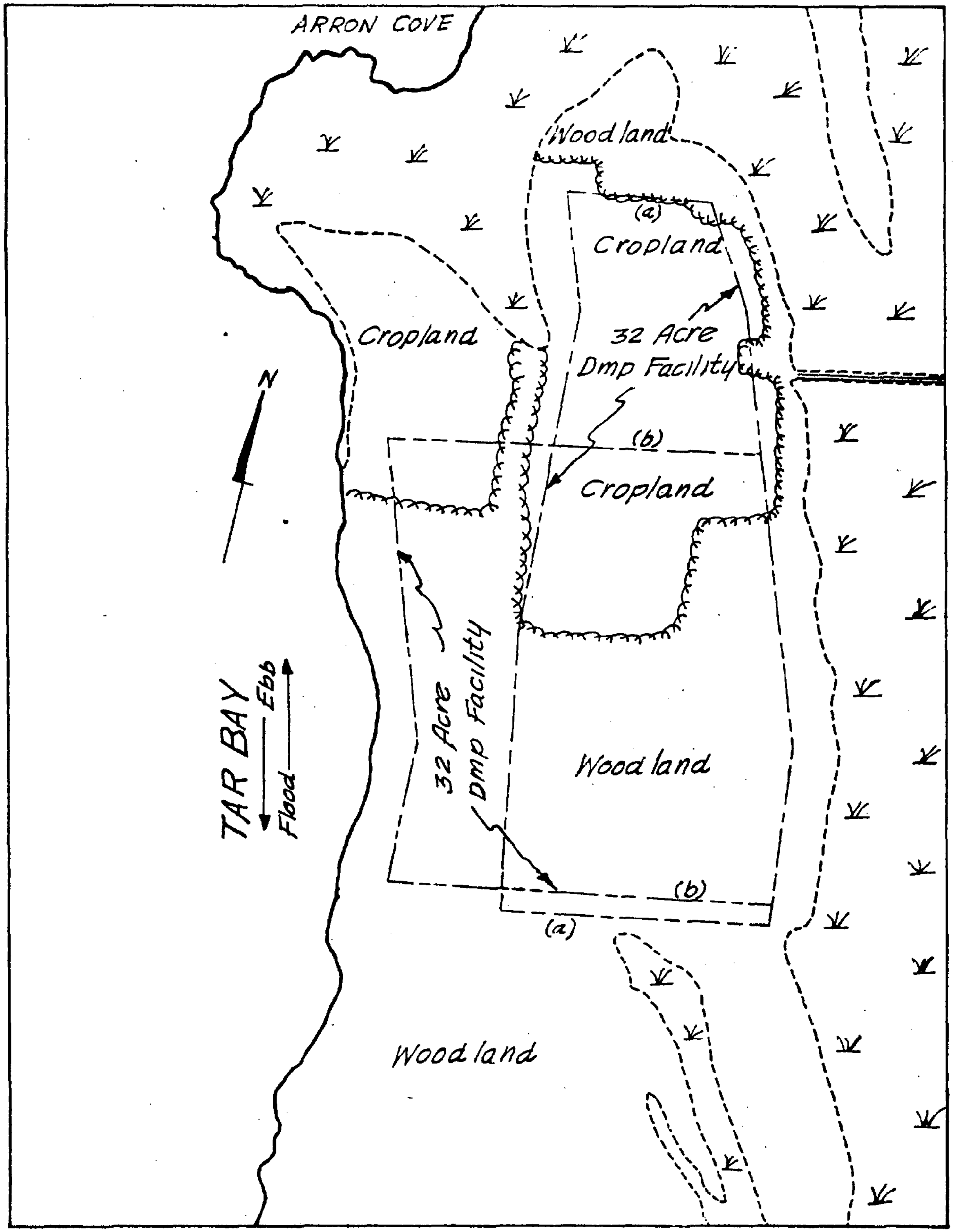


Figure B-14. Site map of candidate DMP site No. 14 for the Tar Bay and/or Barren Island Gap channels of the Tar Bay-Honga River Federal navigation project (taken from State Wetland Map No. 332, Dorchester County).

REFERENCES

1. National Environmental Policy Act of 1969 (42 U.S.C. Sec. 4340; Public Law 91-190).

2. Annotated Code of Maryland, "Wetlands and Riparian Rights", Title 9, Section 9-101 et. seq., Article Natural Resources (1974 Volume; 1976 Supp.), State of Maryland, Annapolis, Md.

3. "Interim Final Corps of Engineers Regulations", Federal Register, Volume 40, Number 144, 25 July 1975, pp. 31320-31343.

4. "Interim Final Environmental Protection Agency Regulations", Federal Register, Volume 40, Number 173, 5 September 1975, pp. 41292-41298.

5. "Guidelines for Review of Fish and Wildlife Aspects of Proposals In or Affecting Navigable Waters," Federal Register, Volume 39, Number 159, 15 August 1974, pp. 29552-29565.

6. State of Maryland, Code of Maryland Regulations, Title 08- Natural Resources, Subtitle 05 - Water Resources Administration, Chapter 04 - Water Pollution Control, p. 277; Chapter 07 - Wetlands Regulations, p. 397, Division of State Documents, Office of the Secretary, Annapolis, Md. 588 p., 1979.

7. Endangered Species Act of 1973 (Public Law 93-205).

8. Archeological and Preservation Act of 1974 (Public Law 93-291).

9. Fish and Wildlife Coordination Act of 1970 (16 U.S.C. Sec. 661 et. seq.; Public Law 85-264).

10. Federal Water Pollution Control Act Amendments of 1972 (33 U.S.C. Sec. 1251 et. seq.; Public Law 92-500).

11. Coastal Zone Management Act of 1972 (16 U.S.C. Sec. 1451 et. seq.; Public Law 92-583).

12. "Final Environmental Impact Statement - Proposed Coastal Zone Management Program for the State of Maryland," August 1978, Prepared by Office of Coastal Zone Management, NOAA, Department of Commerce, Washington, DC and Department of Natural Resources, Energy and Coastal Zone Administration, Annapolis, Md.

13. Walash, M. R., and Malkasian, M. D., "Productive Land Use of Dredged Material Containment Areas," Technical Report DS-78-2U, December 1978, U.S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

14. Huffman, R. T., etl. al., "Wetland Habitat Development with Dredged Material: Engineering and Plant Propagation," Technical Report DS-78-16, December 1978, Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

(cont.)

REFERENCES (cont.)

15. Hunt, L. J., et. al., "Upland Habitat Development with Dredged Material: Engineering and Plant Propagation," Technical Report DS-78-17, December 1978, Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

16. Phillips. R. C., Vincent, M. K., and Huffman, R. T., "Habitat Development Field Investigations, Port St. Joe, Floriday; Summary Report," Technical Report D-78-33, July 1978, Seattle Pacific College and Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

17. Annotated Code of Maryland, "Evaluating and Monitoring Dumping of Dredged Spoils," Section 8-1413.1, Article Natural Resources (1974 Volume; 1976 Supp.), State of Maryland, Annapolis, Md.

APPENDIX C: SIZING OF DREDGED MATERIAL PLACEMENT FACILITY CONTAINMENT AREAS

The dredged material placement (DMP) facilities associated with the various dredging projects covered by this Study are basically sedimentation basins consisting of a surface area surrounded by a confining structure. The primary function of such a facility is to remove and retain the solids fraction of an hydraulically placed dredged material slurry and release effluent meeting applicable water quality standards. Historically, the design of a DMP facility to function with respect to solids removal and retention was based on empirical relationships between the volume provided by the containment area and the expected volume of dredged material.[1] Generalizations regarding the expected material volume change (i.e., pre- *versus* post-dredging volumes) and rate of sedimentation were based on the characteristics (i.e., composition) of the material to be dredged. These generalizations were applied to the volume of material expected to be removed in the form of a bulking/settling factor and provided an estimate of the containment area volume requirement. As the volume of the containment area is related to the retaining structure design (i.e., allowed height and geometric configuration) and the area bounded by the retaining structure, a series of containment facility designs could be derived in terms of various combinations of retaining structure heights and planar surface areas.

This approach to DMP facility design has in the past proved to be generally adequate. In most cases, however, only the expected volume of channel sediment is determined to a reasonable degree of certainty and definitive data ragarding the composition of the material is rarely obtained through sampling and analysis. Lack of quantitative information regarding the rate of sedimentation of the dredged material also contributes to the uncertainty of the approach. Failures of the approach to provide an adequately designed containment facility are usually considered to be those cases in which the placement operation cannot be conducted continuously and still comply with applicable standards of effluent water quality (i.e., an undersized facility).

Over-sized facilities, however, also represent a failure of the approach in terms of economic (e.g., construction and land acquisition costs) and/or environmental (e.g., use of an unnecessarily large parcel of land) impacts.

More recently, detailed studies intended to develop procedures and guidelines for improvement of the design and overall efficiency of DMP facilities have refined the relationship between the containment area volume requirement and the volume and composition of the sediments to be dredged.[2] The methods for determining containment area requirements utilizing these procedures replace the previously used empirical bulking/settling factor with design data of a quantitative nature. Once obtained, the data can be utilized to derive not only containment areas design parameters, but also estimates of the long-term storage capacity of a facility[2] and the rate at which dewatering of the confined dredged material can be expected to occur under a given set of circumstances.[3]

While this refined approach to containment area sizing is expected to provide basic containment facility design parameters which will optimize the potential for efficient solids removal, both approaches generate an estimate of the required containment area volume. This, in turn, is utilized to derive estimates of the planar area requirements compatible with an allowed or assumed retaining structure design. These two design parameters comprise the dominant technical factors operative in the preliminary identification of sites for dredged material placement operations. Preliminary site identification generally proceeds in one of two ways. If large tracts of land are potentially available, land availability in terms of surface area is not a limiting factor. In this case a candidate site can be selected, preliminary retaining structure designs based on the site soils and foundation conditions made, and the planar area requirements compatible with the preliminary retaining structure design then determined. If land availability is the limiting factor, then a general dike design compatible with the general soils and foundation conditions expected to exist at a potential site can be assumed and the planar area requirements determined therefrom. Preliminary site identification is subsequently accomplished by identifying tracts of land which meet the planar area requirements. For the various dredging projects covered by this Study, land availability was considered to be a limiting factor and the planar area requirement was utilized as one of the primary criteria for preliminary DMP site identification (see Appendix B).

The utilization of the more quantitative approach to containment area sizing requires that specific design data be obtained.[2] Investigations of the channel sediments must be conducted to provide samples for laboratory testing and analyses and to adequately characterize the material to be dredged in terms of the relative proportions of fine- and coarse-grained sediments present in the dredging area. Requisite testing and analysis includes sediment characterization tests (e.g., determinations of natural water content, Atterberg limits, organic content, specific gravity and particle size distributions) and laboratory sedimentation tests. Naturally, the magnitude and scope of the sampling, testing and analyses are highly project specific. While it was desirable to utilize this approach to containment area sizing, the acquisition of the necessary design data for all projects under consideration was beyong the scope of this Study. As a result it was necessary to resort to the use of the empirical approach to containment area sizing in order to generate the data necessary for DMP siting.

The approach whereby estimates of containment area volume and planar area requirements were determined in this Study was modeled after that utilized by the Baltimore District Corps of Engineers.[4] Two approaches are employed by the District to compute planar area requirements and both rely upon a bulking/settling factor, the value of which is specific for a given type of material. The two methods differ primarily in the sizing factors for sand sediments. In the one case, separate bulking and settling factors

Material Type	Factor Bulking	Factor Settling	Area Sizing Factor
Sand	1.3	0.7	800 cy/acre-ft
Silt	2.0	0.9	670 cy/acre-ft
Sand	1.1-1.2		1300-1400 cy/acre-ft
General	1.8-2.0		800-900 cy/acre-ft
Silt	2.7		600 cy/acre-ft

explicit for a particular sediment type are applied to the expected volume and type of material to give the required containment volume. In the other, sizing factors of a more general nature, which apparently represent a combination of separate factors for bulking and settling are utilized. Presumably, the former method can be employed to compute a bulking/settling factor which is the weighted average of the two types of sediment if their relative proportions are known or can be reliably estimated for a given dredging project.

In order to utilize either of these empirical methods for containment area sizing, information must be obtained regarding the volume and composition of the material to be dredged. Reliable estimates of the expected volume of material are required in order to generate cost estimates for contracting purposes. These estimates are, however, generally obtained shortly before the expected maintenance work is to begin rather than on a routine basis. In most cases, then, it is necessary to rely on data from previous maintenance operations in order to derive containment area requirements for future dredging operations. Estimates of dredged material volumes obtained in this manner have a relatively high degree of uncertainty (see Appendix A). In almost all cases, definitive information regarding the dredged material composition is lacking and must be arbitrarily defined.

These uncertainties regarding volume and composition of the sediment, together with the lack of substantiating information regarding which of the two aforementioned empirical sizing methods have proved to be the most reliable led to the following assumptions regarding containment area sizing:

1. the containment area sizing factor would be taken as 2.5 representing contributions of 1.7 for an increase in material volume upon being dredged and 0.8 for settling in the containment area;
2. after completion of the dredging and placement operation the dredged material would occupy a volume equal to 1.7 times the expected volume;
3. the dredged material would dewater (see Appendix D) and consolidate to occupy a volume equal to 1.4 times the expected volume within a period of 4 years after placement in the containment area.

This approach provided containment area volume requirements for a DMP facility associated with a specific dredging project which were subsequently utilized to determine the planar area requirements necessary for use in the DMP siting procedure. The height of the retaining structure will determine the planar area requirements for a given containment area volume and will be dependent upon the prevailing foundation conditions as well as the suitability and availability of construction materials at the site. In general, foundation and soil conditions throughout the area covered by this Study can be expected to support earthen dikes ranging in height from 10-ft to 15-ft. For the purposes of this Study the following assumptions were made regarding the allowable dike heights and sequence of construction in various types of terrestrial areas:

1. Cropland Areas - dikes could initially be constructed at any height up to a maximum of 15-ft.
2. Woodland Areas - availability of borrow material would limit initial dike heights to 10-ft; if required, the maximum allowable height of 15-ft could be achieved through dike-raising techniques utilizing previously deposited dredged material.
3. Wetland Areas - dike heights would be limited to a maximum height of 10-ft.

In computing the planar area requirements based on an assumed or established dike height and the required containment area volume, allowance must be made for the need to maintain a minimum 2-ft of freeboard between the ponded surface water and the dike crest. Thus, for a dike constructed at a height of 10-ft, the value utilized in computing the planar area requirements is the effective dike height, in this case, 8-ft. It has been recommended that a minimum ponding depth of 2-ft be maintained between the ponded surface water and the dredged material for efficient solids removal. The settling factor of 0.8 incorporated in the sizing approach can be considered a ponding factor and will maintain an adequate ponding depth during the initial placement operation. However, as subsequent depositions occur, the depth of dredged material in the containment area increases and reduces the effective dike height. When the estimated height of the dredged material in a containment facility is 4-ft or less below the dike crest (i.e., 2-ft freeboard + 2-ft ponding depth), then the facility should be considered to be at maximum capacity.

The following examples illustrate the method whereby containment area volumes and planar area requirements for DMP facilities were determined.

Example 1

Objective - Determine the planar area requirement of a DMP facility which will be expected to accommodate the following dredging operations: 1981 - 60,000 cy; 1989 - 55,000 cy; 1993 - 48,000 cy.

Assumptions - (a) Potential land areas are woodland and cropland.
(b) Initial dike height in woodland areas limited to a maximum of 10-ft; maximum allowed height of 15-ft is achieved through dike-raising techniques using previously deposited dredged material
(c) Initial dike height in cropland areas is limited to the maximum allowed height of 15-ft.
(d) Dewatering of dredged material occurs between successive operations to a volume equal to 1.4 times the theoretical volume.

1. Determine containment area volume and planar area requirements.

Required storage volume:	1.7V
Required settling volume:	0.8V
Required containment area volume:	2.5V

Effective dike height = maximum allowed dike height - freeboard = 15 - 2 = 13 ft

$$\sum_{i=1}^{j} D_i + D_f = 13$$

where D_i = depth of dewatered dredged material resulting from placement operations 1, 2, ...j

D_f = depth required for final operation

$$D_i = \frac{1.4\ V_i}{1600\ A}$$

where V_i = volume (cy) of dredged material expected for placement operation i.
A = planar area (acres) of the facility; the value of 1600 represents the volume available in an area 1-ft deep and 1 acre in size (cy/acre-ft)

$$D_f = \frac{2.5\ V_f}{1600\ A}$$

where V_f = volume of material expected for the final placement operation.

V_1 = 60,000 cy $\quad V_2$ = 55,000 cy $\quad V_f$ = 48,000 cy

$V_2 = 0.9\ V_1 \quad V_f = 0.8\ V_1$

$$D_1 = \frac{1.4\ V_1}{1600\ A} \quad D_2 = \frac{1.4\ V_2}{1600\ A} = \frac{(1.4)(0.9)\ V_1}{1600\ A} \quad D_f = \frac{(2.5)(0.8)\ V_1}{1600\ A}$$

$$D_1 + D_2 + D_f = \frac{(1.4 + 1.3 + 2.0)\ V_1}{1600\ A} = 13$$

$$A = \frac{(4.7)(60{,}000)}{(13)(1600)} = 13.5 \text{ acres} \approx 14 \text{ acres}$$

2. Determine adequacy of dike heights for proposed placement sequence.
Containment area capacity: 14 acres x 1600 cy/acre-ft = 22,400 cy/ft
1981: Deposit 60,000 cy.
Required containment volume: 60,000 cy x 2.5 = 150,000 cy
Required containment depth: 150,000 cy ÷ 22,400 cy/ft = 6.7 ft
Required dike height: 6.7 ft + 2.0 ft = 8.7 ft

Any dike height in excess of 8.7 ft will be adequate for the first placement operation. Assume that dikes in cropland areas initially constructed at 10 ft and later raised to 15 ft.
Theoretical depth: 60,000 ÷ 22,400 = 2.7 ft
Storage depth: (1.7)(60,000) ÷ 22,400 = 4.6 ft
Dewatered depth: (1.4)(60,000) ÷ 22,400 = 3.8 ft
Effective dike height: 10.0 - 3.8 = 6.2 ft

1989: Deposit 55,000 cy.
Required containment volume: 55,000 x 2.5 = 137,500 cy
Required containment depth: 137,500 ÷ 22,400 = 6.1 ft
Required dike height: 6.1 + 2.0 = 8.1 ft

The effective dike height is 6.2 ft and thus not adequate. Assume that dikes are raised to the maximum allowed height of 15 ft.
Effective dike height: 6.2 + 5.0 = 11.2 ft

Theoretical depth: 55,000 ÷ 22,400 = 2.5 ft
Storage depth: (1.7)(55,000) ÷ 22,400 = 4.2 ft
Dewatered depth: (1.4)(55,000) ÷ 22,400 = 3.4 ft
Effective dike height: 11.2 - 3.4 = 7.8 ft

1993: Deposit 48,000 cy.
Required containment volume: 48,000 x 2.5 = 120,000 cy
Required containment depth: 120,000 ÷ 22,400 = 5.4 ft
Required dike height: 5.4 + 2.0 = 7.4 ft

The effective dike height is 7.8 ft and existing dikes are adequate.
Theoretical depth: 48,000 ÷ 22,400 = 2.1 ft
Storage depth: (1.7)(48,000) ÷ 22,400 = 3.6 ft
Dewatered depth: (1.4)(48,000) ÷ 22,400 = 3.0 ft
Effective dike height: 7.8 - 3.0 = 4.8 ft

3. Determine remaining capacity
Effective dike height: 4.8 - 2.0 = 2.8 ft
Available containment volume: 2.8 x 22,400 = 62,720 cy
Available capacity: 62,720 ÷ 2.5 = 25,088 cy

Summary: A 14 acre DMP facility could be developed in either cropland or woodland areas with final dike heights of 15 ft and would accommodate the expected dredging operations totalling 163,000 cy. The expected elevation increase would range between 7.3 ft (theoretical) and 10.2 ft (dewatered). The estimated capacity beyond the final placement operation is 25,000 cy.

Example 2

Objective - Determine the planar area requirement of a DMP facility which will be expected to accommodate the following dredging operations: 1981 - 120,000 cy; 1993 - 96,000 cy.

Assumptions - See Example 1.

1. Determine containment area volume and planar area requirements.

$V_1 = 120{,}000$ cy $\quad V_f = 96{,}000$ cy

$V_f = 0.8\, V_1$

$$D_1 = \frac{1.4\, V_1}{1600\, A} \qquad D_f = \frac{(2.5)(0.8)\, V_1}{1600\, A}$$

$$D_1 + D_f = \frac{(1.4 + 2.0)\, V_1}{1600\, A} = 13$$

$$A = \frac{(3.4)(120{,}000)}{(13)(1600)} = 19.6 \text{ acres} \approx 20 \text{ acres}$$

2. Determine adequacy of dike heights for proposed placement sequence.
Containment Area Capacity: 20 acres x 1600 cy/ac-ft = 32,000 cy/ft
1981: Deposit 120,000 cy.
Required containment volume: 120,000 x 2.5 = 300,000 cy
Required containment depth: 300,000 ÷ 32,000 = 9.4 ft
Required dike height: 9.4 + 2.0 = 11.4 ft

Under the existing assumptions, initial dike heights in woodland areas are limited to 10 ft. Thus, a 20 acre site is inadequate and the planar area must be increased as follows:
Effective dike height: 10.0 - 2.0 = 8.0 ft
Planar area requirement: $A = \frac{(2.5)(120,000)}{(8)(1600)} = 23.4$ acres $\approx$ 24 acres

Thus, the planar area requirements for a containment facility in woodland areas is 24 acres.

3. Determine adequacy of dike heights for proposed placement sequence utilizing 24 acre site.
Containment area capacity: 24 acres x 1600 cy/acre-ft = 38,400 cy/ft
1981: Deposit 120,000 cy.
Required containment volume: 120,000 x 2.5 = 300,000 cy
Required containment depth: 300,000 ÷ 38,400 = 7.8 ft
Required dike height: 7.8 + 2.0 = 9.8 ft

Initial dike heights of 10 ft are adequate.
Theoretical depth: 120,000 ÷ 28,400 = 3.1 ft
Storage depth: (1.7)(120,000) ÷ 38,400 = 5.3 ft
Dewatered depth: (1.4)(120,000) ÷ 38,400 = 4.4 ft
Effective dike height: 10.0 - 4.4 = 5.6 ft

1993: Deposit 96,000 cy.
Required containment volume: 96,000 x 2.5 = 240,000 cy
Required containment depth: 240,000 ÷ 38,400 = 6.3 ft
Required dike height: 6.3 + 2.0 = 8.3 ft

The effective dike height is 5.6 ft and thus not adequate. Assume that dikes are raised to maximum allowable height of 15 ft.
Effective dike height: 5.6 + 5.0 = 10.6 ft
Theoretical depth: 96,000 ÷ 38,400 = 2.5 ft
Storage depth: (1.7)(96,000) ÷ 38,400 = 4.3 ft
Dewatered depth: (1.4)(96,000) ÷ 38,400 = 3.5 ft
Effective dike height: 10.6 - 3.5 = 7.1 ft

4. Determine remaining capacity.
Effective dike height: 7.1 - 2.0 = 5.1 ft
Available containment volume: 5.1 x 38,400 = 195,840 cy
Available capacity: 195,840 ÷ 2.5 = 78,336 cy

Summary: A 24 acre DMP facility developed in woodland or cropland areas with final dike heights of 15 ft would accommodate the expected dredging operations totalling 216,000 cy. The expected elevation increase would range between 5.6 ft (theoretical) and 7.9 ft (dewatered). The estimated capacity beyond the final placement operation is 78,000 cy.

It should be noted that a 20 acre site would suffice if the initial dike could be constructed to 11.5 ft. This does not present problems for cropland areas as dikes are assumed to be initially constructed to 15 ft. In woodland areas it is assumed that initial dike heights were limited to 10 ft. This assumption was maintained in order to simplify the derivation and DMP facility costs (Appendix D).

With respect to the 24 acre site, dikes would only need to be raised to provide a final dike height of approximately 13 ft to accommodate the second placement operation. As before, a final dike height of 15 ft was assumed in order to simplify the derivation of dredging and DMP facility costs for use in comparing various dredging/DMP alternatives.

The DMP facility planar area requirements and capacities derived as illustrated above are based on certain assumptions and approximations regarding dredged material volume and composition, retaining structure design, and dewatering of the dredged material. Consequently, the results are of a qualitative nature and are inappropriate for use in definitive planning. The approach and results therefrom are, however, necessary and of general utility in DMP siting, derivation of DMP facility cost estimates, and comparison of various dredging/DMP alternatives on the basis of environmental and economic impacts.

It should be noted that the aforementioned refined approach to DMP facility design represents a considerable improvement with regard to ensuring that a facility will provide adequate storage volume and comply with applicable suspended solids standards and at the same time not be over-designed (i.e., over-sized and/or over-engineered). The application of this approach requires that investigations and testing of the channel sediments be conducted at a level beyond that which is currently accomplished and at increased costs. By and large the empirical approach to containment area sizing results in over-sized facilities. Although such facilities do, however, function adequately with respect to meeting effluent water quality standards, they impact an unnecessarily large area and are generally more costly to construct. Optimization of facility design utilizing the refined approach together with internal modifications (i.e., spur dikes or compartmentalization), the judicious placement of inlet (dredge pipe) and outlet (weir) structures, and weir design can be expected to produce benefits in the form of minimization of land area requirements which, in turn, leads to potential economic (i.e., reductions in land acquisition costs) and environmental (reduction in the size of area impacted) gains. These economic benefits may be of sufficient magnitude to offset the increased costs associated with the additional sediment sampling/testing and engineering/design required for application of the refined approach.

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APPENDIX D: DERIVATION OF DREDGED MATERIAL PLACEMENT FACILITY COST ESTIMATES

The dredged material placement (DMP) sites associated with the various dredging projects covered by this Study are basically containment facilities consisting of an area surrounded by a confining structure. The primary function of the facility is to remove and to retain and/or store the solid fraction of an hydraulically placed dredged material slurry and release effluent meeting applicable water quality standards. The total cost of such a facility can be factored into three categories, each of which is comprised of various elements contributing to DMP facility costs. These categories are as follows:

1. Development Costs - Elements of this category are considered to be those activities which are required in order to conduct dredged material placement operations including land acquisition, engineering, design, and construction;
2. Management Costs - Cost elements comprising this category are all necessary post- and/or interim-dredging activities required in order to meet previously established project objectives and include operation, maintenance, and environmental monitoring, protection, and control;
3. Reclamation Costs - Included in this category are cost elements associated with the implementation of procedures commensurate with the ultimate intended use of the site.

These costs depend upon a complex array of factors including the following:

1. Dredged material volume;
2. Dredged material composition: physical, chemical, and structural properties;
3. Facility size (area) and configuration (shape);
4. Facility location: aquatic, terrestrial, urban, rural, industrial;
5. Site physical characteristics: topography, subsurface soil conditions;
6. Site ecological functions: woodland, wetland, cropland;
7. Facility functions and ultimate intended use;
8. Environmental, legal, social, and institutional constraints.

The interrelationships among and between these factors are such that DMP facility costs are highly site and project specific. In the majority of cases, however, total site costs are dominated by various technical and engineering aspects, thereby making it possible to develop cost estimates for generalized cases. This approach was applied to candidate sites selected as part of this Study in order to provide, at a minimum, a semi-quantitative economic basis for comparing various DMP site alternatives. Additionally, the resultant cost information was expected to be of use to those agencies responsible for providing funds for the accomplishment of a proposed project.

It would appear that the approach, which focuses on the contribution to DMP facility costs made by engineering and technical aspects, ignores the significance of the environmental, legal and social impacts as they relate to DMP siting and costs. Admittedly, the latter factors have not been assigned discrete values and included as line items in the estimated costs. These factors have, however, contributed to the estimated costs by virtue of the fact that the candidate sites to which the approach is applicable were selected on the basis of existing regulatory agency criteria of which these factors are primary elements.

The basic approach and assumptions whereby estimates of DMP facility costs were derived for use in this Study were modeled after that utilized by the Baltimore District COE for preparing government estimates of such costs.[1] Thus, cost elements comprising the Site Development category were identified as those which would be expected to dominate the total cost of a DMP facility. Where appropriate, cost elements associated with Site Management and Site Reclamation were included. Cost estimates are for 1980 price levels and are based on cost data provided by the Baltimore District COE and obtained by consultation with local contractors and equipment vendors.

Certain facility design and construction parameters were required in order to generate preliminary estimates of DMP facility costs. These parameters and the assumptions and generalizations pertinent to their derivation are discussed in the ensuing sections.

Considerations Relevant to Land-Based Dredged Material Placement Facility Costs

Dredged Material Placement Facility Design

Previously, the design of a DMP facility to function with respect to dredged slurry solids removal and retention was based on empirical relationships between the volume provided by the containment area and the expected volume of dredged material.[2] As the volume of the containment area is related to the retaining structure design (i.e., allowable height, geometric configuration) and the planar surface area bounded by the retaining structure, the primary facility design parameter was then considered to be the planar area requirement. A DMP facility design based on this relationship was thus dependent upon retaining structure design and the expected volume and composition of dredged material and independent of the containment area shape.

More recently, detailed studies aimed at refining this relationship have resulted in the development of procedures and guidelines for improvement of the design and overall efficiency of DMP facilities.[3] The principal design parameters identified by these studies as affecting both the cost and operational efficiency of a DMP facility are the size (area requirement) and shape (geometry) of the containment area and the retaining structure design. These parameters, however, exhibit a complex interdependence by virtue of the fact that each is, to varying degrees, dependent upon a multitude of site and project specific factors. Area requirements, for example, are governed primarily by the volume and characteristics of the dredged material and by retaining structure design. The retaining structure design, in turn, is determined by the prevailing foundation conditions as well as the suitability and availability of construction materials at the site. The containment area shape will be influenced by the physical characteristics and existing ecological functions of the site. Finally, consideration must be given to the planned function of the facility (e.g., single- or long-term use) and the ultimate intended use of the site (e.g., wildlife habitat, industrial, commercial, residential, agricultural, or recreational development).

Containment Area Size. The area required for retention and storage of dredged slurry solids contributes to DMP facility costs in a variety of ways, foremost of which is in regard to land acquisition (i.e., purchase or lease) costs. The area of land which must be acquired for a facility can generally be expected to exceed that of the area estimated to be required for dredged material placement. The total area impacted by the facility and operation thereof will depend upon such factors as the land area required for the facility proper relative to the total land area available, the current land use (e.g., agriculture, recreation, etc.), the expected future land use (e.g., residential, commercial, industrial developmental potential), the function and lifetime of the facility, and the ultimate intended use of the site.

Land acquisition costs associated with DMP facilities are thus clearly dependent upon site conditions and project objectives. In order to develop preliminary estimates of DMP facility land acquisition costs for generalized cases it was assumed that the derivation of such costs would be based solely on the area required for dredged material retention and storage and the estimated unit cost of the land on which the facility would be located.

Containment Area Shape. The procedures utilized to determine the area required for removal of dredged slurry solids and concomitant compliance with applicable effluent standards provide an estimate of the area requirements which are theoretically independent of the shape of containment area.[3] In practice, however, the solids removal efficiency is a function of the containment area shape with square-shaped areas serving as the standard for comparison.[4] Increased containment area efficiencies can, in general, be expected to result as the length-to-width ratio of the area increases. These changes are of importance with respect to facility costs in that increases in the length-to-width ratio will result in increases in the total length of the retaining structure and, consequently, increased construction costs. Solids removal efficiencies for square-shaped or low length-to-width ratio containment areas are generally increased utilizing internal structures (i.e., spur dikes). The appropriate placement of inlet (dredge pipe) and outlet (weir) structures as well as the weir design can appreciably increase the efficiency of solids removal.

Containment area geometry (shape and internal configuration) will be governed by site conditions and project objectives. For the purposes of this Study, estimates of DMP facility costs assumed square-shaped containment areas and one spur dike.

Retaining Structure Design and Construction. Detailed methods and guidelines regarding the various factors to be considered in the design and construction of retaining structures which meet the needs of land-based DMP facilities have recently been developed.[5] The development of these guidelines was in response to the ever-increasing need for improvements in retaining structure design and construction to prevent expensive and environmentally damaging failures and to expand the function of a DMP facility beyond that of serving only to retain and store dredged materials.

Retaining structures for land-based DMP facilities consist primarily of earthen embankments (i.e., dikes), the final design (i.e., height and geometric configuration) of which is highly site and project specific. Site specificity relates to the availability of suitable construction materials and to the prevailing foundation conditions. The dependence of dike design on project objectives is illustrated by the need to consider the facility in terms of single- or long-term use.

Ideally, the final dike design for a DMP facility should be based on sound engineering principles. This approach, in turn, requires that adequate information regarding the arrangement and physical properties of the foundation and embankment materials at the site be obtained through field and laboratory testing. These investigations and tests include: topographic survey of site, subsurface soils sampling (disturbed and undisturbed sample borings), and soils testing (visual and SCS classification, water content, Atterberg limits, compaction, consolidation, permeability, shear strength and grain size analysis).

In practice, however, dike design and construction generally proceeds according to generalized specifications which have evolved as a result of previous experience and economic constraints. While it is to be expected that in the future there will be increased utilization of and reliance on more sophisticated approaches to dike design and construction, the site and project specific nature of the approaches precludes the development of estimated costs for engineering and design of dikes associated with the DMP facilities covered by this Study. For these reasons the standard dike design specifications established by the Baltimore District Corps of Engineers were adopted for use in the derivation of dike construction cost estimates. Retaining dikes designed according to these specifications will be of variable height up to a maximum of 15-ft with a crest width of 10-ft and side slopes of 2 (horizontal) to 1 (vertical).

Dredged Material Placement Facility Management

Factors which contribute to the management costs of a DMP facility include: the intended function of the facility[6], the ultimate intended use of the site[7], and the abatement of environmental problems (odors, insect breeding, wind and/or precipitation induced erosion of dredged material, groundwater contamination)[8]. The intended function of the DMP facilities required to accommodate dredging projects covered by this Study falls within one of the following categories:

Single Use - the facility is designed, constructed, operated and managed solely for the purpose of retention and storage of dredged material from a single dredging opration.

Long-term Use - the facility is designed, constructed, operated and managed for the purpose of retention and storage of dredged material from sequential dredging operations occurring over a 10-year period.

In either case, the major management effort is directed at reducing the water content of the dredged material (i.e., dewatering), thereby converting the semifluid fine-grained dredged material into a more stable soil form[9, 10].

The successful implementation of a dredged material dewatering program can increase the capacity of a facility as a result of (1) shrinkage and consolidation of the dredged material, brought about by a decrease in the water content, and/or (2) removal of the resulting stabilized dredged material for productive uses (e.g., dike-raising, general fill material, sanitary landfill cover material, etc.) In addition to these benefits, which are of particular importance to long-term use sites, is the fact that only if the confined dredged material is adequately stabilized can the site be rendered suitable for reclamation (i.e., productive land use and/or development). The degree of stabilization thus required, although dependent upon the composition of the dredged material and the nature of the planned reclamation, can generally not be expected to be achieved in the absence of an active dewatering program.

A wide variety of potential methods and techniques for dewatering and densification of fine-grained dredged material have been identified and include: physical (loading, drainage, dessication), mechanical (surface reworking and drainage), chemical (flocculants) and thermal internal heating[9]. While the technical applicability of these approaches has been evaluated and found to be practical, economic constraints severely limit the approaches which can be effectively utilized. The following treatments or combination thereof were determined to be the most economical and have the most widespread applicability[9,10].

1. placement of dredged material in thin (i.e., $\leq$ 3-ft thick) lifts;
2. improvement and maintenance of surface drainage by construction of perimeter and interior site trench networks.

Both of these treatments rely primarily on natural evaporative forces for dewatering. Achieving an even distribution of dredged material throughout a containment area is dependent upon the internal surface topography, the composition of the dredged material, and the size, shape, and internal configuration of the containment area. It should be noted also that the area requirement for thin lift placement is generally greater than that for removal and retention of a given volume of dredged material when the dike height is maximized. In view of the above, the ability to predict the feasibility of actually achieving a desired lift thickness is exceedingly difficult. Moreover, because of the increased costs expected to be associated with larger area requirements (e.g., land acquisition costs and increased construction costs) the potential difficulty of acquiring "areas which are larger than necessary" and the possible need for significantly altering the shape and/or internal configuration of a large containment area for efficient solids removal, the thin lift placement approach was not included in the DMP facility cost estimates.

Dewatering programs utilizing trenching techniques are subject to numerous contraints.[10] Containment area shape may either facilitate or inhibit trenching operations and hence, the cost thereof. Long narrow (i.e., high length-to-width ratio) areas are more easily filled and increase the probability of achieving the optimum surface topography gradient for surface drainage. However, the perimeter lengths of these areas are greater than for square-shaped or low length-to-width ratio areas. Costs for perimeter trenching are thus greater for the former areas. Until such time as the dredged material has developed adequate soil strengths to support conventional equipment (i.e., draglines), specialized equipment is required to construct the initial interior trench network. Additionally, the design of the interior trench network can be reliably determined only after the dredging operation is completed and data pertaining to the interior surface topography is available. In response to these uncertainties, DMP facility management cost estimates exclude costs associated with techniques involving the construction of interior trench networks.

Another major consideration relating to perimeter trenching is that concerning the stability and geometry of the perimeter dike. In general, perimeter trenching is accomplished utilizing a dragline operating from the crest of the dike. In certain instances, the perimeter dike may either have to be over-engineered relative to that required solely for dredged material retention and storage or be reshaped in order to accommodate the required trenching equipment. These concerns do not pose problems for single-use sites as the dikes can be reshaped without affecting their ability to retain the dredged material. In the case of long-term use sites utilized for sequential dredging operations, problems may be encountered if the containment facility dikes are initially constructed to their maximum allowable height. Facility design for long-term use sites assumes that the volume occupied by the dredged material in the containment facility decreases as a result of dewatering thereby providing additional capacity for subsequent dredging operations. Furthermore, this expected increase in capacity is included as an integral part of the facility design. If the initial dredging operation generates a markedly greater volume of material than the subsequent operations it may be necessary to initially construct the dikes to their maximum allowable height. Implementation of perimeter trenching operations in this case would thus necessitate either over-engineering of the retaining dikes or re-shaping with subsequent dike-raising, all at increased costs. On the other hand, if the volume of material generated by the initial dredging operation is such that the required dike height is substantially less than that which is allowed and ultimately required to accommodate all dredging operations, or if the initial dike heights are limited by the availability of borrow material, then dike-raising operations would be required to realize the full potential of the facility. As stable dredged material suitable for dike construction is a by-product of the perimeter trenching techniques this material could be productively utilized for dike-raising and the two operations would be complimentary.

The effectiveness of dredged material dewatering utilizing trenching techniques, is to a large extent, dependent upon trench dimensions (i.e., depth and width).[10] As trench dimensions, in turn, are a function of the stability of the dredged material, dewatering utilizing this method is a progressive technique requiring repeated trench deepening operations. The time lapse between successive operations is dependent upon the characteristics of the dredged material and the prevailing climatological conditions. While methods for estimating the rate of dewatering and, hence, the frequency of trenching have been developed, the predictive method requires a knowledge of the engineering properties of the dredged material obtained through sampling and laboratory testing and analyses.[10] Alternatively, periodic inspection of the trenches can be reliably used as the basis for determining the frequency of trench deepening. Clearly, then, trenching frequency is site and project specific.

In light of the above discussions which enumerate only the primary factors which must be considered in the formulation of a workable dewatering program, the development of DMP facility management cost estimates for generalized cases representative of those covered by this Study assumed the following:

1. that DMP facility management costs derive solely from a dewatering program utilizing progressive trenching techniques;
2. that only perimeter trenches are constructed and maintained;
3. that three trenching cycles will adequately dewater and stabilize the dredged material.

<u>Dredged Material Placement Facility Reclamation</u>

In its simplest form, the reclamation of a DMP facility consists of the following steps:

1. all structures erected and equipment installed for the purpose of operating and managing the facility are removed;

2. the site is graded to a topography compatible with that of the surrounding area;

3. a grass or cover crop is established.

As is the case with all aspects of dredged material placement operations, DMP facility reclamation is highly dependent upon site conditions.

The end result of the placement of dredged material in a containment area is, in essence, comparable to conventional construction practices involving the transport of fill material from a borrow area to a construction site. In the latter case, however, only the amount of fill material required to achieve a planned construction objective is moved to the site. This approach is clearly required of DMP activities which have specific objectives regarding the ultimate intended use of the site. By and large, however, DMP facilities are primarily designed to serve the functions of removal and storage of a known or expected volume of dredged sediments and release of effluent of acceptable quality. As this latter approach gives little or no consideration to site reclamation, various problems can arise during subsequent reclamation attempts. For example, the final **regrade** topography will be a function of the surface topography existing prior to facility construction and use, as well as the topography of the surrounding area. If confined to the area immediately bounded by the perimeter dike, regrade of a DMP site constructed on relatively level or gently sloping surfaces can generally be expected to result in a topography represented by an elevated area which slopes from the center to the vicinity of the former perimeter dike. Should such a situation be determined to be undesirable, corrective measures would need to be taken. Possible measures include:

1. Removal of an appropriate volume of material from the site, leaving only that required to achieve the desired final regrade topography.

2. Extend the area of regrade beyond that defined by the perimeter dike.

The first action requires that a new placement site be available for the dredged material which is removed as well as the expenditure of additional funds for material removal. The magnitude of these potential problems could possibly be reduced if there exists a market and a productive use for the material. The second action would result in impacting a larger area than was initially required by the placement operation and may not be feasible due to economic (acquisition of additional land) or land availability (all available land was occupied by the facility) constraints.

Locating DMP facilities on lands containing low areas (e.g., depressions, ravines, etc.) which, for one reason or another, are in need of elevational increases partially alleviates the potential problems enumerated above. However, the construction and operation of DMP facilities in areas of this type can generally be expected to present technical and operational problems. Although these problems are not insurmountable, their solution is oftentimes costly.

It is of paramount importance to establish a vegetative cover as rapidly as possible after the site is regraded as the dredged material is highly susceptible to wind and precipitation induced erosion at this point. This is particularly true with respect to precipitation run-off from the site as the previous sediment control structures (i.e., perimeter dikes and weirs) are no longer functional.

Dredged material retrieved from estuarine environments will generally have sufficiently high salt contents as to serverely restrict the type of vegetation which can be established. Although a reduction in soil salt content can be expected to be realized as a result of precipitation leaching, the process is oftentimes extremely slow and is dependent upon climatological and meteorological conditions.

While soil amendment procedures are available for aiding vegetative establishment on salt damaged soils, the results are highly variable.[11] The rapid establishment of shallow-rooted vegetation with varying salt-tolerant characteristics, however, can be reasonably assured if a cover of salt-free soil is placed on the regraded material. From the standpoint of soil characteristics and expected productivity, the most desirable type of cover material is topsoil. The DMP site, depending upon its location, may serve as the source of such material in which case all suitable cover material would need to be stripped and stockpiled prior to facility construction. Alternatively, suitable cover material may be obtained from an outside source and transported to the site.

In view of the preceding discussion, the successful implementation of even the simplest reclamation concept requires that reclamation plans be formulated concurrently with those for the design of the facility. The need for advance planning becomes even more acute when the site is ultimately intended to serve a specific productive land use function, examples of which include: recreational, agricultural, industrial, commercial, residential, and wildlife habitat development. The various factors governing the development of DMP facilities intended to serve primarily as dredged material retention/storage areas are clearly applicable to DMP facilities developed for a specific land use. The impacts associated with the latter case are considerably more complex and necessitate the consideration of additional factors pertinent to the planning and implementation thereof.

With few exceptions, the primary function of a DMP facility developed for the projects covered by this Study is to retain and store dredged material generated by the respective dredging projects. Where appropriate, possible productive use of the dredged material and/or the DMP site have been identified. The following assumptions and generalizations have been made for the purpose of generating preliminary estimates of the costs associated with the reclamation of DMP sites:

1. grading of the DMP site is limited to leveling that portion of the retaining dike having elevations greater than that of the dredged material;
2. the appropriate soil amendment procedures are implemented;
3. the area is capped by a layer of suitable cover material;
4. the area is vegetatively stabilized.

Derivation of Dredged Material Placement Facility Cost Estimates

The candidate site identification procedure (Appendix B) identified two types of terrestrial areas as most suitable for land-based DMP facilities - woodland and cropland areas. As the physical features of these two area types contribute significantly to the cost which can be expected to be associated with the development, management, and reclamation of a DMP facility, these two general cases were selected to serve as illustrative examples of the cost estimating procedure.

The items contributing to the total cost of a facility were grouped into three categories: development (site acquisition and preparation, facility construction), management (dredged material dewatering), and reclamation (site grading and stabilization). The various construction constraints applicable to the two cases and the cost estimating procedure are discussed below.

Development Costs

Site Preparation. Site preparation is primarily concerned with the removal of objectionable and obstructive material which would adversely affect dike stability, containment area efficiencies, and the implementation of dewatering and reclamation programs. Sound dike design and construction practices require that all organic material be removed from the dike alignment and borrow areas. Containment area efficiency can be appreciably reduced by the presence of aboveground material which would promote short-circuiting. Failure to remove standing timber and other vegetation which can interfere with equipment operation will impede activities associated with dewatering programs and site reclamation. Additionally, large amount of organic material underlying the dredged material can adversely affect the overall stability of the area.

For these reasons it is assumed that standing and fallen timber, stumps, roots, brush, and vegetation are to be removed from the site. In most cases, it is expected that such material will be placed in windrows and burned. This is assumed to hold true with the exception of marketable timber which should be removed for salvage. The timber salvage value, however, was not considered in the development of DMP facility costs.

Removal and stockpiling of topsoil for eventual use in site reclamation is also considered to be a component of site preparation. Equipment operational constraints are such that material transport is limited to 300-ft., beyond which operational efficiency decreases markedly. This decrease in efficiency approximates double handling of the material and, hence, leads to increased costs. As the costs derived herein assume square-shaped areas, each site was considered to be comprised of primary and secondary areas subject to topsoil removal as well as to placement of cover material. The primary area consists of a 300-ft. wide band at the perimeter of the site with the balance of the site constituting the secondary area. For sites up to 10-acres in size the primary area occupies greater than 99% of the entire site. As the total area of the site increases to greater than 10-acres, the secondary area comprises an increasingly greater proportion of the total area. The primary and secondary areas constitute approximately 26 and 9 acres, respectively, of a 35-acre site (Table D-1).

The DMP facility site preparation cost estimates were derived utilizing the unit costs given in Table D-2.

Construction. The costs associated with construction of the retaining structures (perimeter and interior dikes) were computed

Table D-1

Estimated Costs for Topsoil Removal From Square-Shaped DMP Sites of Selected Sizes

Area[a]			Estimated Cost[b]		
Primary	Secondary	Total	Primary	Secondary	Total
5.0	---	5.0	6,000	----	6,000
9.9	0.1	10.0	11,980	240	12,120
14.0	1.0	15.0	16,800	2,400	19,200
17.4	2.6	20.0	20,880	6,240	27,120
20.5	4.5	25.0	24,600	10,800	35,400
23.2	6.8	30.0	27,840	16,320	44,160
25.7	9.3	35.0	30,840	22,320	53,160

a) In acres. Acreages of primary and secondary areas were derived as described in text.
b) In dollars. Computed assuming that 0.5 ft of topsoil was removed at a cost of $1.50/cy and $3.00/cy for the primary and secondary areas, respectively.

Table D-2

Unit Costs Utilized in the Derivation of Estimated Costs for Dredged Material Placement Facility Development, Management and Reclamation

Site Preparation:

Clearing[a] - removal of all major aboveground vegetation (i.e., standing and fallen timber, shrubs, etc.) and belowground organic matter (i.e., stumps) ----- $900/acre

Grubbing[a] - removal of all significant belowground organic matter (i.e., root-raking) --------------- $400/acre

Stripping[b,c] - removal and stockpiling of topsoil
primary area --------------- $1,200/acre
secondary area ------------- $2,400/acre

a) Generally only required of sites in woodland areas.
b) Computed assuming 0.5-ft of topsoil was removed at a cost of $1.50/cy and $3.00/cy for primary and secondary areas, respectively.
c) Required of woodland and cropland areas.

Facility Construction:

Dike Construction and Stabilization -

	Construction[a]			Stabilization[b]		
	Initial	Raised	Total	Initial	Raised	Total
Perimeter Dike						
Woodland[c]	$16.65	$11.10	$27.95	$1.62	$1.06	$2.68
Cropland[c]	$33.30	----	33.30	2.18	---	2.18
Spur Dike						
Woodland[c]	9.75	6.30	16.05	---	---	---
Cropland[c]	18.75	----	18.75	---	---	---

Outfall Pipe (Lump Sum)------------------------------- $2,000
Outfall Weir (Lump Sum)------------------------------- $3,000
Equipment Mob/Demob (Lump Sum)--------------------------- $4,000

a) In dollars per linear foot (lf) of dike. Computed as in-place volume (cy)/lf x $1.50/cy. In place volumes based on dike geometries depicted in Figure D-1.
b) In dollars per linear foot (lf) of dike. Computed as: area of exterior slope and crest (sy)/lf x $0.45/sy. Slope and crest areas based on dike geometries depicted in Figure D-1.
c) Construction sequence described in text.

(cont.)

Table D-2 (cont.)

Facility Management:

Dredged Material Dewatering[a] -

Perimeter Trenching From Dike Crest	$1.40/lf
Equipment Mob/Demob (Lump Sum)	$2,000.

a) Costs are for a single trenching operation. Trenching costs are per linear foot (lf) of perimeter dike.

Site Reclamation:

Site Grading[a] -

Primary Area	$1.50/cy
Secondary Area	$3.00/cy

Site Stabilization -

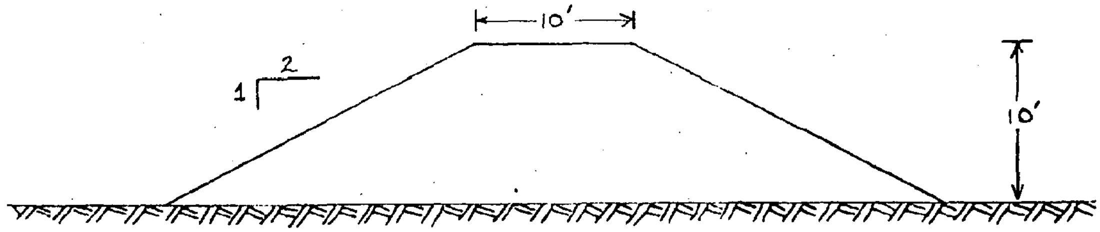
Finish grading and vegetative stabilization	$500/acre

a) Unit costs must be applied to volume of material moved as described in text.

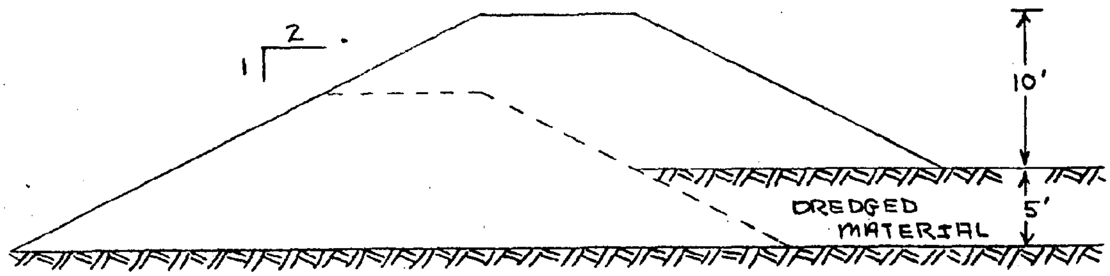
on the basis of the in-place material volume. The perimeter dike designs (height and cross-sectional geometry) for the two cases under consideration are depicted in Figure D-1. It was assumed that the availability of suitable borrow material for dike construction in woodland areas limited the initial dike height to 10-ft. If required, the maximum allowable height of 15-ft was achieved through dike-raising techniques using previously deposited dredged material. It was further assumed that a 5-ft thick lift of dredged material was present in the containment area at the time of dike-raising and that the raised portion of the dike was constructed as shown in Figure D-1. Dikes constructed at sites located in cropland areas were initially constructed at any height up to the maximum allowable height of 15-ft. The heights and cross-sectional geometries of the interior spur dikes are also shown in Figure D-1. Spur dike construction for the two cases was considered to be analogous to that previously described for the respective perimeter dikes.

As the retaining dikes are also expected to serve as a source of cover material for reclamation, it may be productive and cost-effective to utilize the topsoil removed from the site as a source of dike construction material as well as cover material. Conceptually, the construction could proceed in the following manner: (1) the topsoil removed from the containment area interior is stockpiled at the perimeter of the site; (2) the major portion of dike construction would be accomplished in the usual manner using subsoil borrow material from the containment area interior; (3) the balance of dike construction would proceed utilizing the previously stockpiled topsoil. Consideration must, however, be given to the suitability of the topsoil for use in dike construction. Utilization of the topsoil in the exterior half of the dike would provide excellent material for vegetative stabilization of the dike.

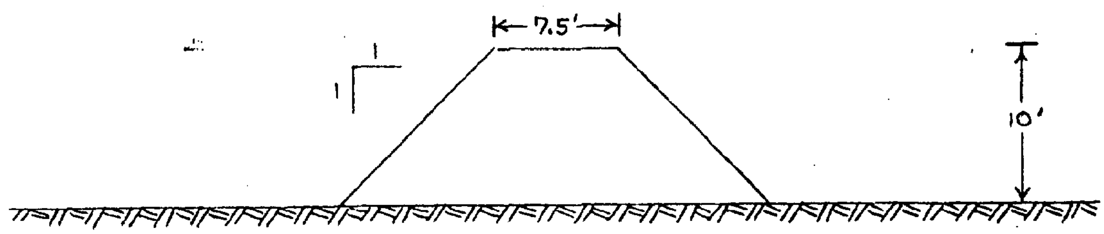
Additional items which were grouped under construction costs and were assigned discrete line items in the costing procedure include: dike stabilization, outfall weir construction and installation, and outfall pipe installation. Dike stabilization



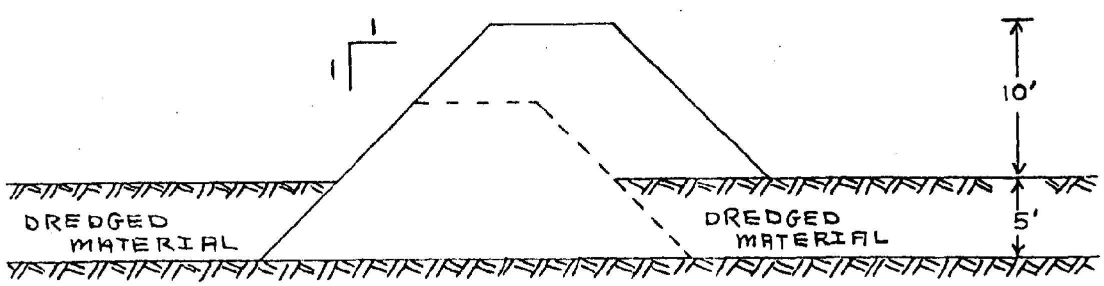
a. Perimeter dike constructed to initial height of 10-ft.



b. Perimeter dike raised to maximum allowed height of 15-ft.



c. Spur dike constructed to initial height of 10-ft.



d. Spur dike raised to maximum allowed height of 15-ft.

Figure D-1. Cross-sectional geometries of perimeter (a, b) and spur (c, d) dikes assumed for the purpose of deriving estimates of the planar area requirements and construction costs for land-based DMP facilities. Maximum structure height of 15-ft was assumed to be achieved in woodland areas by dike-raising (b, d).

refers to protecting the dike embankment materials from wind and precipitation induced erosion. Such protection is generally achieved through the establishment of a vegetative cover utilizing the appropriate soil amendment (soil fertility and p^H adjustment), seeding, and mulching procedures. The specific design and location of the outfall weir and outfall pipe are dependent upon the design of the containment facility. The length of the outfall pipe is determined by the distance between the outfall weir and the nearest waterway or discharge point which is judged suitable for accepting effluent discharged from the facility. As 100-ft is the minimum setback distance of a containment area from a waterway, the outfall pipe length was taken as 100-ft. The applicable costs for the above items are given in Table D-2.

With the exception of dike construction costs, all of the above include charges associated with equipment mobilization and demobilization. These charges will depend, among other factors, on the site accessibility (i.e., land and/or water access) and the equipment utilized. Dike construction operations were assumed to require the use of a dragline and a bulldozer and that access to the site was by land. Based on these assumptions, the equipment mob and demob charges for dike construction were set at $4,000.

Land Acquisition. The responsibility of acquiring the necessary land for the construction and operation of a DMP facility lies with the dredging project sponsor. Historically, sponsors of the dredging projects covered by this Study have viewed DMP facilities as serving only as single-use sites with little or no consideration given to the possibility that the site might be used for subsequent dredging operations. Consequently, DMP site acquisition was either on a short-term lease arrangement or, more commonly, provided by the land owner free of charge to the dredging sponsor. This was a workable and realistic approach as the maintenance interval for most of the dredging projects was sufficiently great (i.e., 15-

to 30-years) that the purchase or long-term lease of a site by a dredging sponsor was not warranted. While this approach is still valid for most of the dredging projects under consideration, there is an ever-increasing need for the acquisition of DMP sites which can serve as long-term use sites. Provided that a workable site-use agreement can be negotiated between the dredging sponsor and landowner, lease of the site may be adequate. However, while purchase of the site would be expected to be more costly than site leasing, the latter would provide greater flexibility with respect to site use, management, and reclamation.

The DMP facility will be expected to impact an area greater than that actually required for retention and storage of the dredged material. These impacts are both direct (e.g., the facility proper occupies 10 out of an available 15 acres of agricultural land) and indirect (e.g., facility operational activities disrupt hunting activities normally conducted in the vicinity of the facility). Thus, the acquisition of a desired site may be contingent upon acquiring a tract of land significantly larger than actually required for the facility. Additionally, land acquisition costs (purchase or lease) are highly variable, even within the same geographical area, and depend upon both the existing and expected future land use.

For the purposes of developing DMP facility costs attributable to land acquisition, costs were placed at the highest reasonable level that the land could generally be expected to bring. This approach was expected to somewhat offset the aforementioned uncertainties regarding the actual land area which must be acquired. The current market value of one acre parcels suitable for residential development in the vicinity of representative candidate DMP sites is between $2,000 and $3,000/acre. When included in the derivation of estimated costs for a DMP operation, land acquisition costs were set at $3,000/acre.

Management. The costs ascribed to management of a DMP facility are considered to be those associated with the implementation of dredged material dewatering programs. The dewatering program formulated for the purpose of deriving management cost estimates assumes that dewatering is achieved by the construction of a perimeter trench within the interior of the containment area. Construction procedures assume that the perimeter dike crest is adequately reshaped and stabilized to provide a suitable work surface for the operation of a small- to medium-sized dragline.

As the individual lift thickness of dredged material placed in a long-term use facility is significantly less (i.e., 3- to 4-ft) than that of a single use facility (i.e., 5- to 6-ft), dewatering of the former material will be expected to occur at a faster rate than will the latter. The long-term use sites developed for this Study are expected to be utilized for three successive dredging operations and it was assumed that a single trenching cycle would adequately dewater each lift. Because of the greater lift thickness of dredged material placed in single-use sites it was assumed that this type of facility would also require three trenching cycles for adequate dewatering. Thus, a total of three trenching cycles were conducted for both long-term and single-use sites.

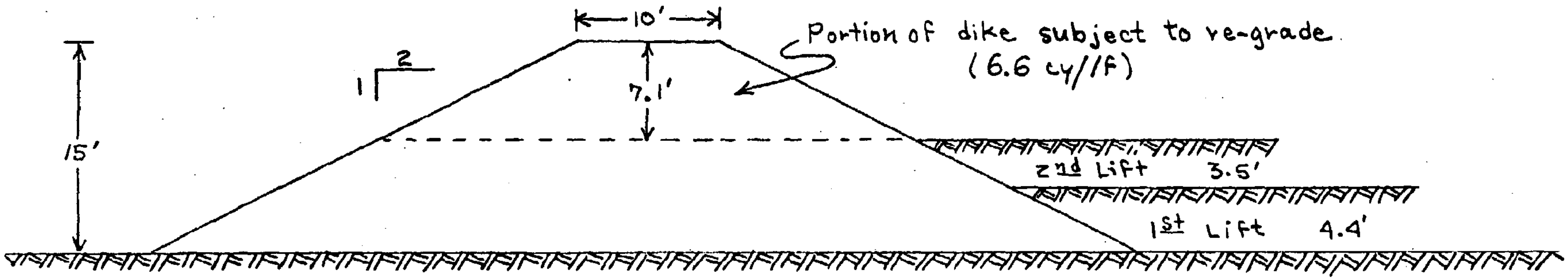
The unit costs utilized in the derivation of estimated costs associated with the site management activities described above are given in Table D-2.

Reclamation. The specific activities which are required in order to achieve reclamation of a DMP site will depend largely upon the ultimate intended use of the site, examples of which include development (i.e., recreational, agricultural, industrial, commercial, or residential use), wildlife habitat creation, or restoration to the site's pre-placement function. At a minimum, and irrespective of the intended site use, it will be necessary to grade the site to a suitable topography and to implement the necessary soil stabilization measures.

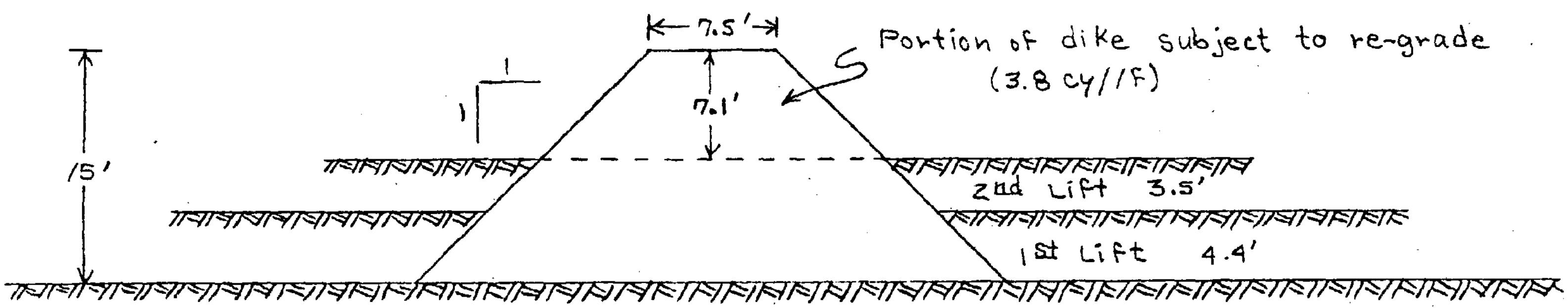
The final topography of the site must be compatible with that of the area surrounding the site as well as with the intended future use of the site. These requirements, together with the dredged material topography resulting from the DMP operation will determine the volume of material which must be moved during the site grading operation. In order to develop estimates of the costs associated with site grading it was necessary to ignore the site and project specificity of these factors and utilize a standardized approach as was employed in the deriviation of facility construction and management cost estimates. In so doing it was assumed that the placement operation resulted in the even distribution of the dredged material throughout the site, that site grading was limited to leveling that portion of the retaining structure having elevations greater than that of the dredged material, and that the embankment material would be evenly distributed throughout the containment area during the grading operation. The volume of material moved during the grading operation was computed on the basis of the dike geometry utilized previously in computing construction costs and the depth of dewatered dredged material within the containment area (Figure D-2). The cost of material transport for the grading operation was computed in the manner described for topsoil removal and stockpiling during the site preparation activities.

The costs associated with providing the regraded site with protection from wind and precipitation induced erosion were computed assuming that erosion protection was achieved by the establishment of a vegetative cover. Costs for vegetative stabilization were based on utilization of soil amendiment (i.e., soil fertility and pH adjustments), seeding and mulching procedures appropriate for establishment of shallow-rooted salt-tolerant species in salt-damaged soil.

The applicable costs for site reclamation accomplished as described above are given in Table D-2.



a. Perimeter dike.



b. Spur dike.

Figure D-2. Pictorial representation of the method whereby estimates were made of the volume of dike material available for use as cover and/or fill material during site reclamation. Estimated unit volumes (cy/lf) were computed on the basis of the dike cross-sectional geometries as depicted and utilized to compute the total volume of material to be moved and the costs thereof as illustrated in Table D-3.

The method whereby estimated DMP facility costs were derived for use in this Study is illustrated in Table D-3. This method was utilized to derive cost estimates for various sizes of land-based DMP facilities in woodland and cropland areas for the purpose of comparing the costs associated with various approaches to DMP operations (Tables D-4, D-5). The estimated costs for DMP facilities sized to accommodate a known or expected volume of dredged material deriving from a specific dredging project (see Appendix C) were used in conjunction with the estimated project dredging cost (see Appendix E) to generate an estimated total project dredging/DMP cost for the purpose of comparing various dredging/DMP alternatives.

Under current policies and legislation defining the extent of local cooperation for Federally authorized dredging projects, the local project sponsor (usually designated as the county government) is generally responsible only for provision of a "suitable" DMP site while the Federal project sponsor (i.e., the U.S. Army Corps of Engineers) is responsible for construction and operation of the facility. In this case, the Corps of Engineers (COE) assumes the costs for retaining structures while the county assumes the cost of providing the site, either through lease or purchase, and for site preparation. These two items, site preparation and facility construction, define the current approach to DMP operations.

Two types of land-based containment facilities were considered for the purpose of developing DMP plans for specific dredging projects: single- and long-term use. Dredged material placement facility management/maintenance operations are desirable for single-use sites if site reclamation is required and is to be accomplished within the shortest possible time frame and with predictable results. Such operations are effectively mandatory for long-term use sites in order to achieve optimum facility efficiency and utilization. The increasing scarcity of what were previously low-cost DMP sites (i.e., "marginally useful" areas such as inter- and supra-tidal wetlands), either because of environmental concerns or technical/engineering constraints associated with DMP facility development, is necessitating the use of

Table D-3

Approach to the Derivation of Estimated Costs for Development of a 24-acre Dredged Material Placement Facility in Woodland Area

Assumptions: (1) Containment area is square-shaped with one spur dike -

Length of Side	1022-ft.
Perimeter Dike Length	4088-ft.
Spur Dike Length	767-ft.

(2) A total of 216,000-cy of dredged material is deposited in the site with a final dewatered depth of 7.9-ft.

(3) Retaining dikes initially constructed to height of 10-ft. and raised to final height of 15-ft.

Site Preparation:

Clearing -	24 acres @ $900/acre	$21,600		
Grubbing-	24 acres @ $400 acre	9,600		
Stripping-	19.9 acres @ $1,200 acre	23,880		
	4.1 acres @ $2,400/acre	9,840		
		$64,920		
Total for Site Preparation			$64,920	

Facility Construction:

Stage I				
Dike Construction-				
Perimeter	4,088 lf @$16.65/lf	$68,065		
		-28,800	(credit to county)	
Spur	767 lf @ $9.75/lf	7,478		
Stabilization	4,088 lf @ $1.62/lf	6,623		
Outfall Weir-	Lump Sum	3,000		
Outfall Pipe-	Lump Sum	2,000		
Equipment Mob/Demob-	Lump Sum	4,000		
		$62,366		
Subtotal for Stage I			$62,366	
Stage 2				
Dike Raising-				
Perimeter	4,088 lf @$11.10/lf	$45,377		
Spur	767 lf @$ 6.03 lf	4,832		
Stabilization	4.088 lf @$ 1.06/lf	4,333		
Outfall Weir-	Lump Sum	3,000		
Equipment Mob/Demob-	Lump Sum	4,000		
Subtotal for Stage 2		$61,592	$61,592	
Total for Facility Construction				$123,908

(cont.)

Table D-3 (cont.)

Facility Management:

Dewatering-				
Trenching	4,088 lf @$1.40/lf	$5,723		
Equipment Mob/Demob	Lump Sum	2,000		
Total for single cycle		$7,723		
3 cycles @ $7,723/cycle			$23,169	
Total for Facility Management				$23,169

Site Reclamation:

Determine volume of dike material to be moved-

Height of dike above dredged material: 15-7.9 = 7.1		
Volume in perimeter dike: 6.37 cy/lf x 4,088 lf =	26,042	cy
Volume in spur dike: 3.81 cy/lf x 767 lf =	2,926	cy
Total volume to be moved:	28,968	cy

28,968 cy ÷ 24 acres = 1,207 cy/acre (≈0.8 ft.)

Rough Grading-			
Primary Area	1,207 cy/acre x 19.9 acres x $1.50/ cy	$36,029	
Secondary Area	1,207 cy/acre x 4.1 acres x $3.00/cy	14,846	
Finish Grading-	24 acres @$250/acre	6,000	
Stabilization-	24 acres @$250 acre	6,000	
		$62,875	
Total for Site Reclamation			$62,875

Subtotal For Facility Development	$274,872
Contingencies (15%)	41,231
Engineering & Design/Supervision & Administration (12%)	32,985
TOTAL	$349,088

Summary:	Site Preparation	$ 64,920
	Facility Construction	123,908
	Facility Management	23,169
	Site Reclamation	62,875
	Subtotal	$274,872
	Contingencies (15%)	41,231
	E&D/S&A (12%)	32,985
		$349,088
Cost/cy:		$1.62

Table D-4

Estimated Costs for 12- and 24-Acre Dredged Material Placement Facilities in Woodland Areas[a]

Cost Element	Conceptual Approach[b] Funding Agency[c] Federal	County	Total	Current Approach[b] Funding Agency[c] Federal	County	Total
12-Acre Facility[d]						
Site Preparation	$-------	$30,480	$30,480	$-------	$15,600	$ 15,600
Construction	112,704	-14,400[e]	98,304	112,704	------	112,704
Management	-------	18,147	18,147	-------	------	-------
Reclamation	-------	43,750	43,750	-------	------	-------
Subtotal	$112,704	$77,977	$190,681	$112,704	$15,600	$128,304
Contingencies(15%)	16,906	11,697	28,603	16,906	2,340	19,246
E&D/S&A (12%)[f]	13,524	9,357	22,881	13,524	1,872	15,396
TOTAL	$143,134	$99,031	$242,165	$143,134	$19,812	$162,946
Cost/cy			$ 2.24			$1.51
24-Acre Facility[d]						
Site Preparation	$-------	$64,920	$64,920	$-------	$31,200	$ 31,200
Construction	152,708	-28,800[e]	123,908	152,708	------	152,708
Management	-------	23,169	23,169	-------	------	-------
Reclamation	-------	62,875	62,875	-------	------	-------
Subtotal	$152,708	$122,164	$274,872	$152,708	$31,200	$183,908
Contingencies(15%)	22,906	18,325	41,231	22,906	4,680	27,586
E&D/S&A (12%)[f]	18,325	14,660	32,985	18,325	3,744	22,069
TOTAL	$193,939	$155,149	$349,088	$193,939	$39,624	$233,563
Cost/cy			$ 1.62			$ 1.08

a) Description of the costing procedure can be found in this Appendix.

b) Approaches defined by DMP operations: Conceptual Approach assumes all four operations indicated by cost elements; Current Approach assumes only site preparation and facility construction.

c) Costs are partitioned in accordance with current policies and legislation regarding extent of local cooperation for the majority of Federally authorized dredging projects examined by this Study.

d) Costs for 12- and 24- acre facilities are based on designs for accommodation of 108,000-cy and 216,000-cy, respectively, of dredged material (see Appendix C) and are exclusive of land acquisition costs.

e) Represents credit to county as portion of material used in dike construction derived from site preparation activities.

f) Engineering and design and supervision and administration costs are normally assumed by the Federal interest. Facility management and site reclamation, if the responsibility of the local interest would, however, have costs associated with E&D/S&A and these costs would need be assumed by that party.

Table D-5

Estimated Costs for 12- and 24-Acre Dredged Material Placement Facilities in Cropland Areas[a]

Cost Element	Conceptual Approach[b] Funding Agency[c]			Current Approach[b] Funding Agency[c]		
	Federal	County	Total	Federal	County	Total
12-Acre Facility[d]						
Site Preparation	$-------	$14,880	$ 14,880	$-------	$-------	$-------
Construction	112,704	-14,400[e]	98,304	112,704	-------	112,704
Management	-------	18,147	18,147	-------	-------	-------
Reclamation	-------	43,750	43,750	-------	-------	-------
Subtotal	$112,704	$62,377	$175,081	$112,704	$-------	$112,704
Contingencies(15%)	16,906	9,357	26,263	16,906	-------	16,906
E&D/S&A (12%)[f]	13,524	7,485	21,010	13,524	-------	13,524
TOTAL	$143,134	$79,219	$222,354	$143,134	$-------	$143,134
Cost/cy			$ 2.06			$ 1.33
24-Acre Facility[d]						
Site Preparation	$-------	$33,600	$ 33,600	$-------	$-------	$-------
Construction	152,708	-28,800[e]	123,908	152,708	-------	152,708
Management	-------	23,169	23,169	-------	-------	-------
Reclamation	-------	64,304	64,304	-------	-------	-------
Subtotal	$152,708	$92,273	$244,981	$152,708	$-------	$152,708
Contingencies(15%)	22,906	13,841	36,747	22,906	-------	22,906
E&D/S&A (12%)[f]	18,325	11,073	29,398	18,325	-------	18,325
TOTAL	$193,939	$117,187	$311,126	$193,939	$-------	$193,939
Cost c/y			$ 1.44			$ 0.90

a) Description of the costing procedure can be found in this Appendix.

b) Approaches defined by DMP operations: Conceptual Approach assumes all four operations indicated by cost elements; Current Approach assumes only site preparation and facility construction.

c) Costs are partitioned in accordance with current policies and legislation regarding extent of local cooperation for the majority of Federally authorized dredging projects examined by this study.

d) Costs for 12- and 24- acre facilities are based on designs for accomodation of 108,000-cy and 216,000-cy, respectively, of dredged material (see Appendix C) and are exclusive of land acquisition costs.

e) Represents credit to county as portion of material used in dike construction derived from site preparation activities.

f) Engineering and design and supervision and administration costs are normally assumed by the Federal interest. Facility management and site reclamation, if the responsibility of the local interest would, however, have costs associated with E&D/S&A and these costs would need be assumed by that party.

"productive" (i.e., woodland or cropland) areas. It is primarily because of the high real estate value of the latter areas that there will be increasing pressure to maximize utilization of these areas through the development of long-term use sites, where appropriate, and through site reclamation of both single- and long-term use sites. It is these four elements - site preparation, facility construction, facility management/maintenance, and site reclamation - which define the conceptual approach to land-based DMP operations. At present, however, there are no requirements at any level of government regarding either the type of facility which must be developed, the extent to which a facility must be managed/maintained, or the level of reclamation which must be accomplished at a site. This is of importance as under the current practices and legislation regarding DMP operations for Federal and State sponsored dredging projects the increased costs of DMP activities deriving from facility management/maintenance would, in many instances, be incurred by the local project sponsor (i.e., county governments).

The differences in estimated costs between DMP facilities developed under the current and conceptual approaches are on the order of 50-60% greater for the latter relative to the former, derive from the costs associated with management/maintenance and reclamation, and are largely independent of the size and location of the facility. The magnitude of the increases are greatest for facilities in cropland areas as the total facility cost is the lowest. In terms of local sponsor obligations, the cost increases incurred under the expected approach to facility development in woodland areas are on the order of 300-400% greater than for DMP operations accomplished under the current approach. This implies that, excluding land acquisition costs, the local sponsor could finance site preparation at from four to five facilities not utilizing management and reclamation operations with the funds which would be required to be expended for one DMP facility not employing these additional operations.

The cost differential between DMP operations conducted at a single large facility (i.e., 24 acres) and at two smaller facilities (i.e., 12 acres each) which accommodate a total volume of dredged material equal to that of the large facility is clearly in favor of the use of the former. Irrespective of the location and approach to DMP facility development, operations conducted at two small facilities can be expected to be on the order of 45% more costly than if conducted at one large facility. The estimated cost of the development of DMP facilities in woodland areas is greater than if the facility is located in cropland areas and derives solely from the difference in costs associated with site preparation (i.e., clearing and grubbing of woodland areas).

The costs associated with facility construction dominate the total cost of a facility and are on the order of 60% for the expected approach and in excess of 80% for the current approach. Moreover, because these costs are a function of the total length of the retaining structure(s), the costs for one large facility will be significantly lower than for two smaller facilities. The economic incentive for the development of a large site thus resides with the party or agency responsible for facility construction.

Land acquisition and site preparation costs are, in contrast, approximately in direct proportion to the facility planar area requirements. Thus, for terms of local cooperation requiring only site acquisition and preparation, it will be immaterial to the local sponsor whether DMP operations are conducted at one large site or at two smaller sites. Because long-term use and/or regional sites (i.e., one large <u>versus</u> several small) require that certain management activities be accomplished and because there are currently no requirements regarding management and/or reclamation of single-use sites, only if the costs for management of a long-term use facility not incurred by the local sponsor can the acquisition of such sites in lieu of single-use sites be expected to be actively pursued by the local sponsor.

In light of the apparent difficulty with which local sponsors were able to provide funds for site acquisition and facility construction as required by previous Federal policies, it seems reasonable to presume that local sponsors will resist the implementation of any additional DMP related operations which will result in increased financial obligations. Because of existing contractual procedures, the COE is at present not able to assume such obligations for sites acquired either by themselves or by the local sponsor in spite of the fact that the COE may be best able to provide such funding. Until such time as provisions are made for funding and contractual procedures necessary to deal with these problems, DMP activities will in all likelihood continue to be accomplished without regard for facility management and site reclamation.

Considerations Relevant to Aquatic-Based Dredged Material Placement Activities and Costs

Discussions in the preceding sections of this Appendix have centered on the various factors influencing the design and costs of DMP operations conducted at land-based facilities. These activities are relatively well-defined and typically consist of the hydraulic placement of a dredged material slurry in a sedimentation basin (i.e., a surface area enclosed by retaining structures) which removes and retains the solid fraction and releases effluent which meets applicable standards of water quality. The formulation and implementation of plans for such activities are primarily oriented toward dredged sediments retention/storage objectives rather than toward the ultimate intended use or function of the site.

In contrast, DMP activities in aquatic areas are more highly dependent upon project objectives which go beyond those of dredged material retention/storage and compliance with water quality standards. The alterations in the physical characteristics of an area which normally accompany DMP operations can produce significant changes in the ecological function of an area. As aquatic areas are considered to be more sensitive than terrestrial areas to such alterations, the former areas present a greater potential for adverse environmental impacts resulting from the activity. Although the construction and utilization of aquatic-based DMP facilities which serve the same functions as land-based facilities are technically feasible, the costs associated with the latter can oftentimes greatly exceed those of the former. Thus, in order to offset potential adverse environmental consequences as well as the increased costs generally associated with aquatic DMP operations, project objectives other than dredged material retention/storage must accompany or provide justification for the use thereof. Project objectives of the former type are generally viewed as productive uses of dredged material.

Productive uses of dredged material deriving from the use of aquatic areas as DMP sites generally center on the creation of land for a variety of functional uses. Because of the complex framework of legal, institutional, social, economic, technical, and environmental factors which are associated with the conversion of aquatic areas to terrestrial areas[7], only two approaches to the productive use of dredged material were considered by this Study as being applicable with respect to DMP activities in aquatic areas: shore erosion abatement and habitat creation or a combination thereof.

The use of dredged material for the purpose of shore erosion abatement can range from unconfined, alongshore/nearshore placement (i.e., beach nourishment) to confinement within a specific alongshore/nearshore area utilizing physical retaining structures (i.e., bulkhead, dikes, etc.). Between these two extremes is semi-confined placement within a groin field or behind offshore seawalls (i.e., continuous or headland breakwaters). Habitat creation projects, either alone or in conjunction with shore erosion abatement efforts, can encompass those ranging from habitats associated with shallow subtidal aquatic areas through intertidal areas to purely terrestrial areas.[12-14]

Although only certain of these options will be applicable at a given site, DMP sctivities are significantly more site specific for aquatic than for terrestrial areas. The DMP activities conducted in the latter areas are accomplished utilizing relatively well-defined practices which achieve the primary objective of dredged material retention/storage with minimum adverse environmental impact (i.e., confinement of dredged material). Although such activities are site specific, the approaches thereto are sufficiently straightforward that a general approach which requires a minimum amount of data and ignores certain site to site variations can be utilized to determine the requirements of DMP facilities which will be expected to accommodate a known or expected volume of dredged material. The expected environmental and economic impacts of various DMP site alternatives can be assessed in terms of these requirements. In the case of aquatic-based DMP activities, the large range of options for project design, the greater site to site variations, and the dependence of environmental impact on project design results in a significantly higher degree of site specificity. Consequently, only if such activities are dominated by certain environmental, technical, and/or engineering factors or by specific project objectives can assessments of the environmental and economic impacts be made for generalized cases in lieu of obtaining site specific data. However, because the complexity of technical and design factors associated with such projects requires that a greater number of generalizations and simplifying assumptions be made, the results derived from a standardized approach will be expected to be subject to the potential for substantially larger errors than will those for terrestrial DMP activities.

Project and Facility Design Considerations

The primary considerations relevant to the placement of dredged material in aquatic areas include (1) the environmental impact of the activity and (2) the need for physical structures to retain and protect the dredged material deposited at the site. The site identification procedures which were developed for use in this Study (Appendix B) considered, on a qualitative level, the potential environmental impacts of DMP activities in aquatic areas and led to certain assumptions regarding the selection of aquatic sites and the need for retention/protection (R/P) structures in certain cases. These assumptions included:

1. The primary emphasis in site selection is on high energy areas as
   - such areas are expected to be of lowest biological productivity and thus provide the greatest potential for positive environmental impacts;
   - such areas experience the highest rate of erosion and would thus derive the greatest benefit from shore erosion protection efforts.
2. A retention/protection (R/P) structure is required of all DMP activities in high energy areas as such structures will
   - retain the dredged material until it consolidates and vegetation can be established;
   - aid in controlling the migration of fine-grained dredged material from the area during the DMP operation.

3. Secondary emphasis is placed on low energy areas as
   - such areas have the greatest potential for successful habitat creation;
   - such areas have the greatest potential for unconfined placement of dredged material.
4. Only material meeting the criteria of 80% or greater sand-sized particles is suitable for unconfined placement.

In response to legal as well as environmental concerns associated with the potential for the creation of fast land by the placement of dredged material in aquatic areas[7], it was further assumed that such placement would be limited primarily to the creation of inter-tidal wetland areas ranging in elevation from mean low water (MLW) to +0.5-ft above mean high water (MHW).

The need for retaining structures for DMP activities in aquatic areas is eatablished by the requirement that the migration of dredged material from the site be minimized, both during and subsequent to the placement operation. The benefits which result from satisfying this requirement would be (1) compliance with applicable water quality standards, (2) minimization of the potential for adverse environmental impacts to areas adjacent to the site, and (3) enhancing the potential for successful shore erosion abatement and habitat creation. Only if a containment facility is appropriately sized, however, can compliance with applicable water quality standards be expected to be achieved during the DMP operation. Although the approaches to containment area sizing which are utilized for land-based DMP operations are applicable to aquatic-based activities (see Appendix C), the success of the former operations are not critically dependent upon achieving a final specific elevation at the conclusion of the placement operation. This, in turn, effectively precludes the use of the empirical approach to containment area sizing and necessitates the use of the recently developed refined approach.[3] The latter approach is based on design data obtained through sampling, characterization, and testing of the sediments to be dredged and enables project design to be optimized with respect to containment area sizing for efficient solids removal as well as achieving final elevations compatible with project objectives.

Land-based DMP operations, furthermore are not subject to the technical/engineering constraints that are operative in aquatic-based operations in terms of retaining structure design and containment area shape and size. That is, design requirements for DMP facilities in terrestrial areas are sufficiently flexible that minor changes in retaining structure design and in containment area shape and internal configuration can be made which increase the efficiency of the facility without significantly increasing the total facility cost. The size and shape of containment facilities as well as retaining structure design in aquatic areas is dependent upon the configuration of the land mass bordering the site, the hydraulic and energy regime, water depths, and bottom topography of the site, and project objectives.

Development of Project Cost Estimates

Economic factors relevant to DMP activities in aquatic areas are primarily those associated with

1. retention/protection (R/P) structures
2. pre- and post-placement environmental monitoring
3. vegetative establishment
4. project design and engineering

The specific costs deriving from these factors are highly interrelated and dependent upon project design. For example, the intended creation of a given habitat type generally requires that either a specific range or final elevation be obtained at the conclusion of the placement operation(s). Factors which must then be considered in project design include the type of placement (i.e., confined, semi-confined, unconfined), the placement sequence (i.e., single stage: one-time placement from a single dredging operation; multi-stage: incremental placements from sequential dredging operations), and the composition and expected volume of dredged material. These factors will, in turn, influence the scope and level of engineering investigations and design procedures which must be implemented in order to determine the extent of settlement of the dredged material due to self-weight consolidation and of compressible foundation soils, the facility requirements which will permit compliance with applicable water quality standards, and the design of R/P structures compatible with the energy regime and/or project objectives (i.e., permanent, semi-permanent, temporary). The costs of vegetative establishment will depend upon the area and range of suitable elevations ultimately created at the site, the prevailing energy regime, and the method of establishment. Finally, the scope and level of environmental monitoring will be dependent upon existing legislation[15] as well as that which may be deemed necessary to more accurately assess the net environmental impact of the activity.[16]

The development of estimated costs for DMP operations in aquatic areas concentrated on those associated with R/P structures. This was deemed appropriate in view of the fact that retaining structure costs dominated the total cost of DMP activities in terrestrial areas, the costs deriving from environmental monitoring were excluded from the estimated costs for land-based DMP activities, and of the aforementioned factors all but those associated with R/P structures were sufficiently site specific as to preclude developing estimated costs for generalized cases.

In light of preceding discussions and because of (1) the lack of definitive data regarding the composition, physical characteristics, and expected volumes of dredged material deriving from maintenance operations and (2) the absence of site specific data relating to nearshore water depths and bottom topography at candidate aquatic DMP sites, the assumed design of R/P structures was primarily in response to project objectives and to the energy regime which was expected to prevail at a given site. The assumptions which were necessary in order to permit a determination of site dredged material capacities and R/P structure design and, hence, estimates of the costs of DMP activities at candidate aquatic sites are as follows:

* The landward boundary of the placement area was defined by the existing shoreline. The expected seaward limit of the placement area was determined by establishing a boundary having a configuration compatible with that of the land mass contiguous with the proposed site and approximating the 2-ft MLW depth contour.

* Mean water depth throughout the proposed placement area was 2-ft MLW.
* Mean retaining structure height was +2-ft MLW (4-ft overall).
* Average depth of dredged material deposited at the site ranged from 2- to 4-ft.

These assumptions permit a determination of the planar area of the proposed site and the potential capacity of the site for various fill depths.

It should be noted that this approach to containment area design differs markedly from that employed for terrestrial DMP operations. In the latter case, containment area requirements were determined prior to site selection and the sites thus identified were selected to accommodate a known or expected volume of dredged material. With respect to aquatic sites, the capacity of the site was determined subsequent to site selection. Thus, only if the dredged materials consist largely of coarse-grained sediments approximating the COE criteria of suitability for unconfined placement in aquatic areas (i.e., sediment composition 80% sand-sized particles retained by the U.S. No. 200 sieve) will the site capacity computed in this manner represent a reliable estimate of the material volume required to produce a desired elevation or of the ability of the site to function with respect to dredged material solids removal and release of effluent meeting applicable water quality standards. Efficient removal of the solids fraction from dredged material slurries containing high proportions of fine-grained sediments as well as estimates of the elevation expected to result from the deposition of a given volume of such material will be questionable for the facilities designed in this manner.

These uncertainties, however, hold true primarily if the placement operation is of the single-stage type in which the site is utilized for a single dredging operation and where the estimated maximum capacity of the site and the expected dredged material volume are comparable. If, on the other hand, the estimated maximum capacity of the site as designed dramatically exceeds that of the expected volume of dredged sediments, then the site could be utilized and be expected to have a reasonably high potential for meeting applicable effluent water quality standards. While maximum utilization of the site in terms of the volume of dredged material retained and stored by the site will result in lower unit DMP costs, such costs must be viewed in the light of benefits which derive from the additional project objectives of shore erosion abatement/habitat creation.

Of the wide variety of R/P structure types which have been evaluated and found to be technically feasible for use in aquatic-based DMP activities[17], only three were initially considered for use in shore erosion abatement and habitat creation projects of the type under consideration by this Study. These structure types were selected on the basis of the expected availability of construction materials as well as compatibility with project objectives and site characteristics. All three are dike-type structures which differ primarily in materials from which they are constructed.

> Sand Dikes. Retaining structures constructed by the hydraulic placement of sand sediments have been demonstrated to be an efficient and economical method of constructing containment areas for confined DMP activities. The approach is particularly attractive if the dredged sediments can serve as the source of construction material. If, however, suitable construction material must be obtained by dredging of an area outside of the limits of the dredging project or if material must be trucked to the site from an upland borrow area, the use of such structures is environmentally and possibly economically questionable.
>
> In spite of the expected low cost, however, the use of sand dike R/P structures in conjunction with shore erosion abatement/habitat creation projects was dismissed from further consideration for the ensuing reasons. Candidate aquatic DMP sites were identified primarily on the basis of the energy regime which prevailed at the site and the prospective sites were thus situated in either very high or very low energy environments. The energy regimes at the former sites were judged to be sufficiently high that the structural integrity of the dike would be short-term without adequate erosion protection measures (e.g., revetment or riprap) which, in turn, would markedly increase the R/P structure costs. In the absence of such protection, the project objectives of shore erosion abatement/habitat creation would be seriously jeopardized and ultimately approximate unconfined placement of dredged material. The latter sites, on the other hand, were

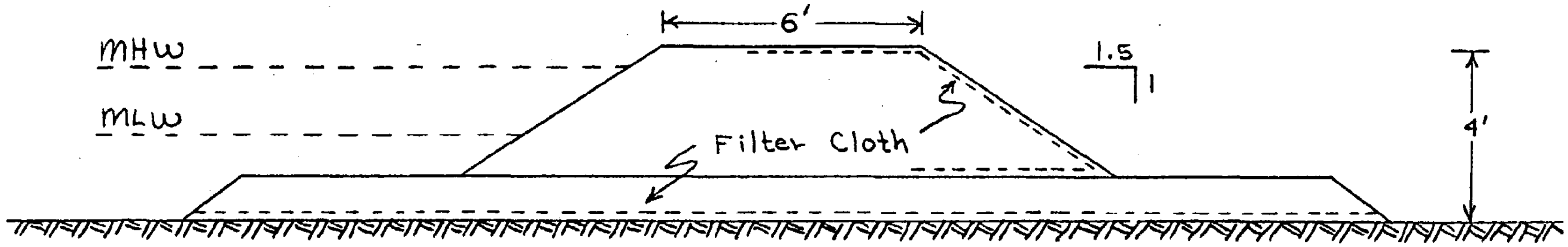
considered to be suitable for unconfined placement activities and the project objective of habitat creation could be expected to be realized without the need for R/P structures.

Filled Fabric Bag Dike. Synthetic fabric bags of varying dimensions, when filled with sand, sand-cement, or concrete, can be utilized to construct a wide variety of shore erosion protection structures (e.g., breakwaters, groins, revetments) as well as retaining dikes for DMP activities in aquatic areas. The life expectancy of any structure constructed from filled fabric bags will primarily be a function of the fill material placed in the bag as the fabric is subject to weathering, UV degradation, puncture by floating debris, or vandalism. Concrete-filled bags can be considered as equalling structures constructed of rock and, hence, permanent. A sand-filled bag structure is at best a temporary or semi-permanent structure as the structural integrity will be dependent upon the integrity of the fabric. However, barring puncture by floating debris, continually submerged sand-filled bags are protected from UV degradation and are thus well-suited for underwater placement.

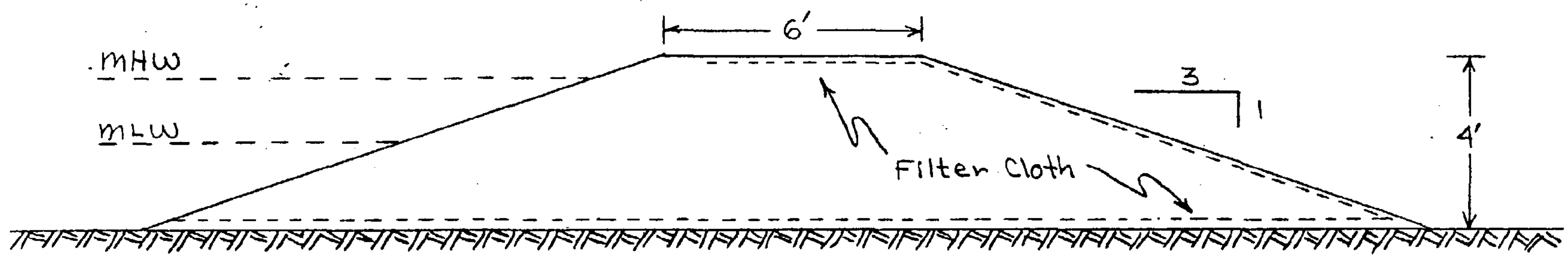
Rock Dike. Shore erosion protection structures and retaining dikes constructed of quarry-run rock are the most widely used structures where life expectancy requirements are high (i.e., permanent). Additionally, such structures are considered more environmentally acceptable than most other structures (e.g., bulkheads) as the former provide a habitat for various aquatic organisms.

The design of R/P structures on which estimated costs were based were modeled after similar structures designed by the Baltimore District COE in conjunction with proposed plans for shore erosion protection at Smith Island, Maryland.[18] This was deemed appropriate in view of the similarity in energy regimes which were expected to prevail at Smith Island and at the majority of candidate aquatic sites identified by this Study. It should be noted that, because actual structure design will be specific for a given site, the estimated costs which were derived based on the assumed structure design are intended for comparative purposes only.

The R/P structure designs for sand-filled fabric bag dike (semi-permanent) and rock dike (permanent) are illustrated in Figure D-3, together with the appropriate unit costs. Site facility costs were computed utilizing the appropriate structure unit costs, and the total



a. Permanent retention/protection structure of rock; estimated in-place unit cost: $215.72/linear foot.



b. Semi-permanent retention/protection structure of sand-filled fabric bags; estimated in-place unit cost: $97.33/linear foot.

Figure D-3. Assumed cross-sectional geometries and unit costs of permanent (a, rock) and semi-permanent (b, sand-filled fabric bag) retention/protection structures for aquatic-based DMP facilities.

linear footage of R/P structure for a given site. As with the facility cost estimates developed for land-based facilities, estimates of the cost of engineering and design/supervision and administration (E&D/S&A) and of contingencies were included as 12% and 15%, respectively. The estimated aquatic-based DMP facility costs were utilized in conjunction with project dredging costs (Appendix E) to drive estimates of the total dredging/DMP costs for specific dredging projects.

Unlike the approach to facility design for land-based DMP operations, that for aquatic-based facilities was dependent upon the site identified by the siting procedure rather than on the need to accommodate a specified volume of dredged material. Thus, the facility designs can be considered as site specific. As no adjustments were made in site design in order to accommodate a known or expected volume of dredged material deriving from a specific dredging operation, unit costs for DMP operations at these sites should not be directly compared with those determined for land-based operations.

The substantially greater costs which can be expected to be associated with aquatic-based DMP operations requiring R/P structures relative to land-based operations is evident from a comparison of retaining structure unit costs. Retaining structure costs for land-based operations are on the order of $30/lf, while the lowest cost structure proposed for aquatic-based operations is approximately 200% more costly (i.e., $97/lf). This cost differential in favor of the terrestrial-type structure prevails in spite of the fact that the structure height is approximately four times that of the aquatic-type structure. This, in turn, implies that a containment area of a fixed size (i.e., planar surface area) enclosed by the terrestrial-type structure will have a markedly greater capacity than will that utilizing the aquatic-type structure. In general, then, DMP activities in aquatic areas become cost-effective relative to those in terrestrial areas only if dredged material placement can be accomplished without the need for extensive retaining structures (i.e., unconfined or semi-confined placement) of if the costs of such structures can be offset by reduced dredging costs (i.e., dredged material transport distances are substantially less to the aquatic site than to the terrestrial site).

Use of Dredged Material Placement Cost Estimates

Estimated costs were derived for DMP activities associated with a specific dredging project and were utilized in conjunction with the estimated dredging cost for the project (see Appendix E) to generate a total estimated cost for a specific dredging project/DMP site combination. This approach provided an economic basis for evaluation of various dredging/DMP alternatives. Such costs can be considered to be project specific in that DMP costs were determined for facilities designed to accommodate a given volume of dredged material expected to be generated by a specific project. It should be noted, however, that the estimated DMP costs generated in this manner derive from a standardized approach as they ignore various site specific factors and rely on certain simplifying assumptions. Although judged to be suitable for comparative purposes, they should be considered inappropriate for use in definitive planning and/or for funding purposes as a much more detailed evaluation would be required before final selection of a dredging/DMP combination could be made. With regard to the latter purpose, however, the estimated costs are considered to be of general utility as they provide an indication of the order of magnitude which could result from changes in DMP practices (i.e., conceptual versus current approach). The following points should be noted regarding the estimated costs which were developed for DMP operations conducted at terrestrial sites.

The estimated DMP costs utilized for comparing dredging/DMP costs were derived assuming the conceptual approach rather than the current approach. This was deemed appropriate in view of the expected need for future DMP operations to include provisions for facility management/maintenance and site reclamation and the fact that certain DMP plans which were formulated were based on the use of multi-use sites which require that management/maintenance operations be accomplished to ensure optimum facility efficiency and utilization. The activities on which estimated costs for management/maintenance and reclamation were based represent the minimum operations necessary to accomplish those activities. Consequently, the costs arising from these activities represent the minimum costs for management/maintenance and reclamation. Unlike land acquisition costs, facility construction and management/maintenance and site acquisition costs are not directly proportional to the size of the site and precludes readily factoring out the costs for management/maintenance and reclamation when only the total estimated cost is presented for a DMP operation. As the cost differential between DMP operations conducted under the conceptual and current approaches was found to be on the order of 50-60% greater for the former relative to the latter and derives primarily from costs associated with management/maintenance and reclamation, a general estimate of the costs for DMP operations conducted under the current approach could be made by applying a factor of 0.55 to the costs derived for the conceptual approach.

Land acquisition costs were excluded as such costs are effectively in directly proportion to the size of the facility and would thus not be expected to appreciably alter the cost differential between two dredging/DMP alternatives which utilize sites of the same total area (i.e., between two sites of the same size or between a single large site and several small sites equal to that of the large site). If desired, DMP facility costs attributable to land acquisition can be estimated by assuming the highest reasonable value that the land could generally be expected to bring. This approach can be expected to somewhat offset the fact that land values are highly variable, even within the same geographical area, and the uncertainties regarding the actual land area which must be acquired. As the current (June 1980) market value of one acre parcels suitable for residential development in the vicinity of the majority of candidate DMP sites is between $2,000 and $3,000/acre, the unit cost for land acquisition can be approximated as $3,000/acre.

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APPENDIX E: DERIVATION OF DREDGING COST ESTIMATES

Under the current practices of the Baltimore District Corps of Engineers, dredging cost estimates and dredging contract bids are factored into two costs: dredging costs (extraction, transport, and discharge of a given volume of shoal material) and mobilization/demobilization costs (transfer of plant to and from the project site, plant assembly and disassembly, and construction of the dredged material placement facility). For the purposes of this Study dredging cost estimates were partitioned into dredging, mobilization/demobilization, and dredged material placement site costs. This appendix describes the method utilized to compute estimated dredging and mob/demob costs. The approach utilized to derive dredged material placement site costs is described in Appendix D.

Dredging Costs

Dredging costs are basically computed as the product of the unit time cost of the dredging plant and the total job duration.[1] The unit time cost of hydraulic pipeline dredging plants includes the costs associated with the operation, maintenance, and ownership of the dredge, pipeline, booster pumps, and attendant equipment as required by the project conditions. The total job duration is the sum of the time required to extract, transport and discharge a known or expected volume of material (i.e., dredging time) and other time factors associated with dredging operations. Adjustment for overhead and bond are included as a percentage of the estimated project dredging cost derived from the total job time and unit time cost of the dredging plant to provide a total estimated project dredging cost.

The dependency of dredging costs on project conditions is reflected in the method whereby estimates of the total job duration are derived. For hydraulic pipeline dredges, the dredging time is primarily a function of the production rate (i.e., cy/unit time). The production rate, in turn, is dependent upon dredge size (i.e., horsepower, pipeline diameter) pipeline length (i.e. distance between extraction and discharge sites), the nature and composition of the material being dredged (i.e., undisturbed (new work) and/or disturbed (maintenance work) sediments composed of coarse- and/or fine-grained material), the speed with which the dredge advances over the dredging area, and the need for booster pumps. The basic production rate for a given or assumed dredge size is adjusted by numerical values established for the aforementioned factors to provide a net production rate. The net production rate is subsequently used to compute the estimated length of time required to dredge (i.e., dredging time) a known or expected volume of material under the prevailing project conditions.

In order that the estimated dredging costs would have general applicability for the majority of the projects covered by this Study it was necessary to make certain simplifying assumptions and generalizations, the basis for which derived from consultation with dredging contractors[2] and personnel from the Baltimore District COE.[3] These assumptions and the corresponding rationale include:

Dredging plant (size and unit time costs)

* Hydraulic pipeline dredge, 12-in ---------------$161,000/MO
* Hydraulic pipeline booster pump, 12-in ---------$ 40,000/MO

Estimates of dredging costs were based on costs associated with the operation, maintenance, and ownership of a 12-in hydraulic pipeline dredge as it was this size dredge whereby maintenance dredging was accomplished for the majority of projects covered by this Study. Monthly costs, including payroll, were provided by the Baltimore District COE and are for May 1980 price levels.

* Pipeline, 12-in ------------------------------ $2/LF/MO

Monthly pipeline costs vary with the type of material being dredged (coarse sediments-sand; fine sediments-silt and clay) and the pipeline type (floating, submerged, shore). Previous maintenance dredging histories of the projects under consideration indicate that the dredged material can be expected to consist primarily of fine sand, silt, and clay (i.e., sediments which pass the U.S. No. 40 sieve). For projects with specific extraction and discharge sites, the choice of pipeline routes will be expected to vary from contractor to contractor, giving rise to differences in the proportions of the shore, floating, and submerged pipeline utilized. In most cases, the proportion of shore pipeline is less than 25% of the total pipeline length. In order to compensate for these uncertainties the pipeline monthly cost was taken as the average of the costs for the transportation of fine sediments using floating ($2.50/LF/MO) and submerged ($1.50/LF/MO) pipeline.

Production Rate Adjustment Factors

* Material Factor: 1.5

Dredge production rates vary with the type of material being dredged with free-flowing sand having an in situ density of 2,000 grams/l taken as the standard upon which basic production rates are determined. Increasing the proportion of fine sand, silt, and clay leads to decreased in situ densities and, hence, to increased production rates. The sediments expected to be encountered during maintenance dredging of the projects covered by this Study are primarily composed of fine sand, silt and clay. The material factor value of 1.5 is generally considered to be representative of the magnitude of the production rate increase expected to be associated with dredging of sediments of this type.

* Dredge Advance Factor: 0.9

Pipeline dredge production is limited either by the speed with which the dredge advances over the dredging area or by the rate at which the dredge excavates and transports the material. Dredging areas which involve undisturbed or compacted sediments usually have advance factors of unity as dredging is relatively continuous and time spent re-positioning the dredge is optimized. Maintenance dredging generally involves the extraction of easily dredged material with dredging depths of 2- to 3-ft. For such cases, dredging is intermittent as the dredge must shut down and be repositioned more frequently. The dredge advance factor value of 0.9 is applied to dredging cost estimates computed here as the projects under consideration consist solely of maintenance dredging.

* Booster Pump Factor: 0.8

The need for one or more booster pumps is determined by the dredge size, pipeline length, and sediment composition. The introduction of one or more booster pumps is usually required when the transport distances are beyond the capabilities of the dredge alone. While the addition of a booster pump does not physically alter the basic dredge production rate, its use increases the complexity of the operation thereby reducing the overall dredging efficiency. To account for the resultant reduction in efficiency, the basic production rate is adjusted by a standard booster pump factor value of 0.8.

* Pipeline Length:

Basic production rates for a given dredge size are constant for short line lengths where suction capabilities govern. These rates decrease with increasing line lengths and are ultimately limited by the ability of the dredge to pump the material increasingly longer distances. The maximum length for efficient production is that length before which the effluent velocity is reduced to the extent that the solids begin to settle out of the dredged slurry. The addition of one or more booster pumps is then required to transport the material distances greater than the maximum efficient line length.

For 12-in hydraulic pipeline dredges of average horsepower, production is maximized for line lengths up to 2,500-ft and decreases with increasing line lengths up to 5,000-ft. Booster pumps are required for each 5,000-ft increment of line length beyond the initial 5,000-ft and production is assumed to be reduced (i.e., booster pump factor) but constant for each booster and at any line length within each additional 5,000-ft increment.

In order to arrive at accurate production rates (and, hence, accurate dredging cost estimates) for a specific project, a detailed assessment of the change in production rates brought about by changes in line length as the dredge advances over the dredging area must be made. The maximum line length required for a project may cover only a small portion of the dredging area but markedly decrease to a shorter line length and remain relatively constant for the balance of the dredging area. By taking into account the extent to which the expected volume of shoal material is distributed throughout the dredging area, it is possible to arrive at a value for the total job duration which is the weighted average of the production rates for the long and short line lengths and the respective material volumes associated therewith. Alternatively, it could be assumed that, for the above case, the production rate associated with the longest line length would apply to the total dredging area. The latter approach would result in unrealistically low adjusted production rates and, in turn, long job times and high dredging cost estimates, particularly when the longer line length requires a booster pump and the shorter line lengths do not.

In order to simplify the costing procedure and still generate realistic dredging cost estimates, the conventional production rate adjustments relating to line lengths and the need for booster pumps were modified as follows:

1) booster pumps would be required for 5,000-ft line length increments beyond the initial 7,500-ft length;
2) production rates would decrease by 20% for the latter half of each additional 5,000-ft line length increment beyond the initial 7,500-ft length.

Project Dredging Costs

The unit price dredging cost estimates utilized in this Study were based on total job duration times and dredging plant costs compatible with line length increments of 2,500 ft and are compiled in Table E1. Total job duration times were computed using the appropriately adjusted production rates and an assumed 50,000-cy of shoal material. The inclusion of other time factors normally associated with dredging operations in the total job duration time can lead to variations in the cost of dredging a given volume of shoal material as these time factors are project dependent. Generally, dredging time comprises a minimum of 95% of the total job duration time with the remaining 5% largely contributed by time spent dredging any areas which, as determined by post-dredging project surveys, were not dredged to project and/or contract specifications.

The unit price cost computed for a volume of 50,000-cy was used as the base rate when estimating the total dredging cost for a specific project even though the actual project volume may have been greater or less than 50,000-cy. This was deemed appropriate in view of the fact that: (1) the volume of material expected to be removed from the majority of projects covered by the Study generally ranged between 35,000-and 75,000-cy, (2) the estimated costs, although in close agreement with actual costs for comparable project conditions, were utilized primarily for the purpose of comparing costs associated with various dredged material placement site alternatives, and (3) no attempt was made to anticipate cost increases for projects scheduled for accomplishment beyond 1980.

As was previously indicated the most accurate dredging cost estimates are determined by a detailed assessment of (1) the change in production rates (and, hence, dredging cost rates) brought about by changes in pipeline length as the dredge advances over the dredging area and (2) the expected volume and distribution of shoal material throughout the dredging area. The shoal material volumes expected to be associated with many of the projects under consideration are based on records of past project maintenance dredging. Such records generally provide information regarding only the volume of material removed for a given maintenance operation rather than details regarding distribution of the material throughout the dredging area. The uncertainties regarding the volume and distribution of shoal material for a given project and the previously described generalizations and assumptions inherent in the derivation of dredging cost rates resulted in the formulation of a general and less detailed approach for determining project dredging costs. This approach utilized various pipeline length parameters associated with specific project conditions and was judged to be adequate for the purposes of this study.

A determination of the dredging cost rate applicable to a project with specific extraction and discharge sites was based on the following pipeline length parameters: maximum, minimum, and average line lengths and the difference between the maximum and minimum line lengths. As dredging cost rates were computed for line length increments of 2,500-ft, maximum line length differences significantly greater than 2,500-ft could give rise to a wide range of possible dredging cost rates. Additionally, the maximum line length may be such that one or more booster pumps may be required for certain sections of a project but unnecessary for the total project dredging area. These considerations led to the identification of three cases which, together with other criteria based on line length parameters, comprised the general method whereby dredging cost rates were determined for a given project:

Case 1: The dredging cost rate for projects having maximum line length differences less than 2,000-ft was that corresponding to the average line length (i.e., the average of the maximum and minimum line lengths).

Case 2: The dredging cost rate for projects having maximum/minimum line length differences between 2,000- and 5,000-ft was that corresponding to the average line length provided that the maximum line length did not exceed the line length interval upper limit separating two dredging cost rates by 500-ft. The dredging cost rate was taken as that determined by the maximum line length when the above condition was not met.

Case 3: Dredging cost rates for projects having maximum line length differences greater than 5,000-ft were taken as the average of the rate for the maximum line length and that corresponding to the average line length.

It should be noted that strict adherence to these criteria can lead to the assignment of unrealistic dredging costs for a project, particularly if only the aforementioned line length parameters are utilized in the analysis. Thus, in order to derive the most reliable dredging cost estimates, the variation in line length between the discharge site and various extraction sites throughout the dredging area should be examined to determine the applicability of these criteria to a specific dredging project. Additionally, all available information pertaining to previous maintenance dredging operations should be obtained to serve as a basis for assessing the reliability of estimates derived utilizing this approach as well as to aid in the application of the approach.

Dredging Mobilization and Demobilization Costs

Dredging mobilization and demobilization costs are those costs incurred during the process of assembly, disassembly and transport of the necessary equipment to and from the project site. The unit time cost of the dredging plant and the time required to mobilize and demobilize the plan constitute the basis for computing mob/demob costs.[1] These costs, like dredging costs, are project dependent as project conditions determine dredging plant requirements and, hence, the unit time cost of the plant as well as the time required for mobilization and demobilization.

The unit time cost of the dredging plant includes the costs associated with the operation, maintenance, and ownership of the dredge, pipeline booster pumps, and attendant equipment. Additional costs include those relating to the rental and/or ownership and operation of one or more tugs as may be required for transfer of the dredging plant. Time elements contributing to the total mob/demob time include transfer of the plant to and from the project site, preparation of the plant for mobilization, and assembly/diassembly of the plant. The total estimated mob/demob costs include adjustments for overhead and bond as a percentage of the initial costs derived from the dredging plant unit time costs and the various mob/demob time factors.

The estimated mob/demob costs for dredging plants associated with line length increments of 2,500-ft are compiled in Table E-1.

These costs, together with the dredging costs, comprise the total project dredging cost for a given project.

As the dredging cost rates and the mob/demob costs were developed on the basis of line length increments of 2,500-ft, the mob/demob costs applicable to a specific project were selected using approaches similar to those utilized to establish the project dredging cost rate. For projects meeting the Case 1 and Case 2 criteria for determining project dredging cost rates, the project mob/demob cost was taken as that associated with the line length interval whereby the project dredging cost rate was established. The mob/demob cost for projects governed by Case 3 criteria was selected as that corresponding to the line length interval containing the maximum line length for the project.

Under favorable circumstances a significant savings in mob/demob costs can be realized if dredging operations for two or more projects in reasonably close proximity to one another can be conducted sequentially. The magnitude of the savings will depend largely upon the particular dredging plant requirements as determined by the respective project conditions. That is, for two projects requiring comparable dredging plants, all equipment required to be mobilized for one project can be expected to be effectively utilized for the second project. The mob/demob sequence becomes increasingly variable as the difference between the respective dredging plant requirements increases. For example, dredging of a project requiring a small plant could be accomplished first and the additional equipment necessary to construct a larger plant mobilized as required. Mobilization and use of the larger plant first would necessitate demobilization and either lay-up or transfer of a substantial portion of the plant as a smaller plant is required to accomplish dredging of the second project.

Estimates of the savings to be expected to result from the sequential dredging of two projects were computed for various conbinations of dredging plant requirements and several probable mob/demob sequences. The estimated savings were found to be the smallest for large differences between two dredging plants (i.e., plants differing by one or more booster pumps and 5,000-ft of pipeline) and the greatest for small differences between dredging plants (i.e., plants either identical or differing only by pipeline lengths of 5,000-ft or less). The estimated savings ranged between 15% and 30% of the total mob/demob costs given by the sum of the mob/demob cost for each dredging plant. For the purposes of this study the estimated savings in mob/demob cost for the sequential dredging of two projects was taken as 20% of the sum of the respective project mob/demob costs.

Table E-1

Estimated Dredging and Mobilization/Demobilization Costs of a 12-inch Hydraulic Pipeline Dredge for Selected Pipeline Lengths.[a]

Pipeline Length, L (ft x 10^{-3})	Dredging (Dollars/cy)	Mobilization/Demobilization (Dollars)
$0 < L \leq 2.5$	2.47	58,586
$2.5 < L \leq 5.0$	2.83	65,907
$5.0 < L \leq 7.5$	3.65	78,297
$7.5 < L \leq 10.0$[b]	4.58	116,555
$10.0 < L \leq 12.5$[b]	5.87	125,007
$12.5 < L \leq 15.0$[c]	7.04	179,785
$15.0 < L \leq 17.5$[c]	8.96	196,029

[a] Costs are for May 1980 price levels.

[b] Requires one booster pump.

[c] Requires two booster pumps.

The following examples are presented to illustrate the application of this approach in the development of dredging project cost estimates. Estimated costs developed for specific dredging projects were used in conjunction with estimated costs for dredged material placement (DMP) facilities sized to accommodate the volume of dredged expected to be generated by the project to provide a total estimated project dredging/DMP facility cost. The total project costs were ultimately used to compare various dredging/DMP site alternatives on the basis of cost.

Example 1

Estimated volume: 50,000 cy

	max	min	difference	mean
Linelength:	10,800	9,600	1,200	10,200

As the linelength parameters meet Case 1 criteria, the dredging and mob/demob costs are computed as:

Dredging - 50,000 cy @ $5.87/cy	$293,500
Mob/demob - Lump Sum	125,007
Subtotal	$418,507
Contingencies (15%)	62,776
TOTAL	$481,283

Example 2

Estimated volume: 75,000 cy

	max	min	difference	mean
Linelength:	10,300	6,800	3,500	8,600

As the linelength parameters meet Case 2 criteria, the dredging and mob/demob costs are computed as:

Dredging - 75,000 cy @ $4.58/cy	$343,500
Mob/Demob - Lump Sum	116,555
Subtotal	$460,055
Contingencies (15%)	69,008
TOTAL	$529,063

Example 3

Estimated volume: 100,000 cy

	max	min	difference	mean
Linelength:	14,400	6,800	7,600	10.6

As the linelength parameters meet Case 3 criteria, the dredging and mob/demob costs are computed as:

Dredging-100,000 cy@ [($7.04 + 5.87)/2]/cy	$646,000
Mob/Demob - Lump Sum	179,785
Subtotal	$825,785
Contingencies (15%)	123,868
	$949,653

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