REVISED DRAFT
Dredged Sediment Evaluation Report
Allen Harbor Landfill - Site 09
Naval Construction Battalion Center
Davisville, Rhode Island

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Prepared for

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1. INTRODUCTION

This Dredged Sediment Evaluation Report examines the potential for incorporating dredged marine sediment into the proposed remedial actions for the Allen Harbor Landfill (Site 09) at the Naval Construction Battalion Center located in Davisville, Rhode Island (NCBC Davisville). This summary report provides background information regarding the potential use of dredged sediment, presents tables of the analytical data from the available sediment samples, discusses the potential uses of the sediment in the Site 09 project based on physical and chemical parameters, and compares the anticipated costs of incorporating the dredged sediment to the costs from obtaining borrow materials.

1.1 BACKGROUND

As part of the remedial actions being considered for Site 09, Northern Division of the Naval Facilities Engineering Command (Navy) is evaluating the construction of a multimedia cap as well as marine shoreline wetlands. To date, a Draft Final Feasibility Study (FS) for Site 09 has been prepared; the Final FS is tentatively scheduled to be completed in October 1996. A Record of Decision (ROD) for Site 09 is tentatively scheduled to be signed by February 1997.

The Town of North Kingstown (the Town) is planning to dredge the entrance of Allen Harbor in an attempt to increase boating access to the harbor. Five sediment samples collected by the Town were analyzed for physical and chemical characteristics. Depending upon the characteristics of this marine sediment, the Navy may be able to incorporate some or all of the sediment into the construction of the Site 09 landfill cap and/or the shoreline wetlands (rather than purchasing borrow material). Furthermore, depending upon the anticipated expenses of dredging vs. obtaining borrow material, the Navy has indicated that they may consider assisting the Town with the planned dredging project.

1.2 SCOPE OF ACTIVITIES

Per a Technical Directive on 31 July 1996, the Navy requested EA Engineering, Science, and Technology (EA) to prepare this brief evaluation report for the feasibility of incorporating sediment dredged from the entrance to Allen Harbor as borrow material for the remedial actions at Site 09. This report will also assist the Navy's decision regarding the extent to which the Navy can reduce costs by not purchasing borrow material and, thereby, contribute to the Town's dredging project.

The general questions that the evaluation report was scoped to answer are as follows:

- "Do the sediment analytical and engineering data (previously collected) indicate that sediment to be dredged from the entrance to Allen Harbor will be chemically and physically acceptable for use at Site 09, either as borrow material for construction of the landfill cap or creation of wetlands?"

- "For what specific uses might the sediment be suitable (e.g., for slope cover, grading, bedding, barrier protection, wetlands sub-base, etc.)?"

- "What volume of borrow material is needed for each suitable use? What total volume of dredged sediment would meet the Navy's needs for the remedial action?" (Note: The volume of sediment that the Town will be dredging has not been established.)

- "What will be the Navy's cost impact to obtaining borrow material from the dredging project as opposed to obtaining an offsite commercial source?"

- "What is the estimated total cost of the dredging project and how does this cost compare with the estimated savings the Navy would realize by obtaining borrow material from the dredging project?" (This question relates directly to an evaluation of the extent to which the Navy can contribute to the dredging project.)

- "How and where should the dredged sediment be dewatered? What types of sediment and erosion control measures should be implemented for long-term storage (e.g., 1 to 2 years) of dredged sediment piles placed on Spink Neck beach prior to the Navy removing the sediment for use in the remedial action?"

EA has reviewed and prepared a summary of the analytical data package from CEIMIC Corporation (the Town's laboratory contractor) for the five sediment samples which were collected from the entrance to Allen Harbor (Tables 1 through 4). Validation of the data was not part of the scope for this evaluation report.

1.3 REPORT ASSUMPTIONS

The recommendations presented in this report are based upon the following assumptions:

- EA has prepared this report under the assumption that it will be used by the BRAC Cleanup Team (BCT) for discussion of potential reuse options for the Town's dredged sediment. The information included herein will be incorporated, as appropriate, into the Final FS for Site 09.

- The five sediment samples which were collected from the extent of the proposed dredging area at the entrance to Allen Harbor are assumed to be representative (grain size and chemistry) of the total volume of sediment which will actually be dredged.

- Data validation was not included as part of either the Town project or this report. Therefore, the reported chemical and physical data from CEIMIC was accepted as is.

- The remedial design which was considered in this report was the multimedia cap and shoreline wetlands which were presented as the preferred alternative in the Draft Final Proposed Remedial Action Plan for Site 09, dated 2 August 1996 (from Alternative 3 of the Draft Final FS, dated July 1996). Variations/refinements of the final design are likely.

- This report is intended only to present various conceptual options for use of dredged marine sediment as part of remedial actions at Site 09.

- Although schedules have not been provided, this report assumes that the Town's dredging project will occur within one year before remedial actions at Site 09 commence.

- Based upon personal communication with the Town's dredging consultant (Docko Inc. 9/96), it has been assumed that hydraulic dredging techniques will be employed rather than mechanical dredging.

- This evaluation report examines the volume of sediment that the Navy could incorporate into the existing conceptual design for remedial actions at Site 09. Incorporating sediment beyond the proposed scope for Site 09 actions has not been evaluated.

- The cost estimate comparisons presented in this report were not marked up for mobilization/demobilization, construction management, implementation and design, and contingency costs.

2. DREDGED SEDIMENT EVALUATIONS

2.1 SEDIMENT AVAILABILITY

Rather than purchasing borrow material from local vendors, the Navy may be able to utilize sediment from the dredging project planned by the Town of North Kingstown. This section presents the quantity and environmental quality of the dredged sediment.

2.1.1 Potential Quantity Available

This report evaluates the volume of sediment from the Town project which the Navy may be able to incorporate into remedial actions at Site 09. The Town has not established the volume which is to be dredged. Initially, the Town was considering a dredge volume of approximately 70,000 CY. However, currently, the Town may only dredge a volume of sediment which can be accommodated by the Navy. It is the Navy's understanding that the Town will need to dredge a minimum of 20,000 cubic yards (CY) in order to restore the width of the channel to the desired depth. The Town may wish to dredge a greater volume in order to extend the benefits of its project.

2.1.2 Chemical Characteristics

Five sediment samples were collected by a Town consultant from the proposed dredging area and were analyzed for chemical, TCLP, and physical characteristics (Tables 1 through 3, respectively) as well as additional geotechnical characteristics (e.g., sieve analysis). Although not presented in this report, the additional geotechnical data were used during the evaluation for use as capping material (Section 2.3.1). The analytical data for the sediment samples have not been validated.

Chemical data were compared to NOAA's Effect Range-Low (ER-L) guidance values [or, where ER-Ls were not available, NOAA's screening values (SV) were used]. TCLP data were compared to EPA's Toxicity Characteristic Criteria (40 CFR 261). ER-L and SV screening criteria were presented in the Draft Final Allen Harbor Landfill and Calf Pasture Point Marine Ecological Risk Assessment Report (EA 1996).

VOC were generally non-detect except for common lab contaminants (methylene chloride, acetone, 2-butanone), a trace amount of toluene (in 1 of 5 samples), and low amounts of carbon disulfide (3 of 5 samples). The reported concentrations for each of these VOC were below the screening criteria. It should be noted that methylene chloride and acetone were also detected in the blank samples.

Non-PAH SVOC were non-detect except for bis(2-ethylhexyl)phthalate in 2 of 5 samples (maximum reported value of 97 J μg/kg). There is no screening criterion for this compound. Samples were re-analyzed for PAH utilizing a method which allowed for a lower detection limit. As shown in Table 2, various PAH were detected; however, the concentrations were below the screening criteria.

PCBs and pesticides were non-detect. Metals concentrations were below the screening criteria.

For the TCLP analyses, TCLP-VOC, TCLP-SVOC, and TCLP-herbicides were non-detect. TCLP-metals were below EPA's Toxicity Characteristic Criteria (40 CFR 261).

Based upon a review of these data, the sediment from the entrance to Allen Harbor is chemically suitable for placement at the Allen Harbor Landfill either as part of the proposed multimedia cap or the proposed shoreline wetlands. Section 2.3 addresses the potential uses for the sediment based on the physical characteristics.

One concern raised by Todd Bober of Northern Division was whether the salt content of the sediment may generate analytical interferences. [This concern was raised based upon a past audit of the analytical lab (CEIMIC Corp.) for the analysis of salt water samples at an unrelated project site. The Navy's concern was whether such interferences would also apply to sediment samples for the Town's project.] In general, a high salt content has the potential to raise detection limits and/or generate false positive results during some chemical analyses, particularly for metals and inorganic compounds such as cyanide. Laboratories can address this with alternative analytical methods or by a specialized calibrating of the instruments (e.g., matrix matching the salt content of the calibration standards to that of the samples). CEIMIC has stated that they are experienced with such analyses and that the appropriate consideration was given during the analysis of these sediment samples (Miguel Muzzio, personal communication, 8/96). The infrared analysis method for TPH (method 418.1: which was used by CEIMIC) may be susceptible to salt interferences. However, based upon an overall examination of the analytical data, salt interferences do not appear to be of concern since the detection limits and resulting analyte concentrations were below the highly-conservative screening criteria (i.e., the salt content did not appear to adversely increase detection limits or generate high false positive measurements of the analytes). Based upon the concerns raised over CEIMIC's ability to analyze high salinity samples, additional information was requested from CEIMIC. CEIMIC's response (9/96) explained that potential interferences in the sediment sample analyses would not be expected due to the high dilution of the small sample volume and resulting acid digestate from the sediment samples. The explanation is technically acceptable and the sample data has been accepted as reported.

2.2 SEDIMENT DEWATERING

2.2.1 Dewatering Prior to Cap Construction

Physical characteristics (moisture content) of the sediment samples are described in Section 2.3.1. Sediment which is to be incorporated into the landfill cap for Site 09 will require dewatering. Dewatering of the sediment should be accomplished by passive means through placement of the wet sediment at a location where the water can be allowed to evaporate and/or drain into the ground or back into the harbor. The available data suggest that there would be no chemical concerns from the draining water. It should be noted that, due to the proposed hydraulic dredging technique, the volume of dredge spoil will be greater than the volume of pre-dredge, in-place material (i.e., sea water will be pumped up with the dredged material). The containment area for the dredge spoil will be designed to account for this additional water handling.

Dewatering will result in a volume reduction of the dredged sediment. Although it is not possible to predict the exact amount by which the volume of sediment will be reduced, an approximation was obtained based upon the physical parameters of the sediment (e.g., grain size, moisture content) as well as past experience with similar materials. The volume of sediment which is incorporated into the cap will be further reduced by compaction which will be required during construction of the cap. It is estimated that a volume of 70,000 CY of in-place sediment to be dredged would be reduced to approximately 45,000 CY following dewatering and compaction (i.e., 36% reduction in volume).

Currently, three locations are being considered for the passive dewatering of the dredged sediment (Spink Neck, onsite at Site 09, and on Calf Pasture Point). Details of these areas are presented below. In general, the amount of time required for dewatering depends on the ambient temperature and the thickness to which the material is spread. With a thin layer in the summer months, the dredged sediment could be dried within a few days. Thicker layers (reduced areal extent) could be used if the sediment was to be left for a longer period of time (e.g., months). This will be an important consideration due to space limitations (e.g., 20,000 CY of sediment spread to a 5 ft layer for dewatering would cover approximately 2.5 acres).

The Rhode Island Economic Development Corporation (RIEDC) has offered the use of a nearby beach (an off-Base location on Spink Neck to the southeast of Site 09) provided that the Navy guarantees the eventual removal of the sediment. A temporary structure for controlling sediment erosion would be required to retain the material at that location. The extent of the structure would depend on the amount of wave action and overland runoff at the selected location. The Town's dredging consultant has estimated that it would cost approximately $7/CY to dredge the sediment from the entrance to Allen Harbor (based upon a minimum 50,000 CY project). This estimate includes hydraulic dredging and upland disposal at Spink Neck beach. This does not include regrading of the sediment within the dewatering basin nor does it include post-dewatering transportation of the sediment to Site 09. Assuming a 1 mile trip to Site 09 (with loading and hauling using a front-end loader and dump trucks), it is estimated that transportation to Site 09 will cost approximately $3.50/CY.

The second (recommended) place for dewatering the dredged sediment is on the central/ western (flatter) portion of the landfill. Berms and/or constructed horizontal trenches would be used to channel decanted water away from the dredged material in order to minimize infiltration into the landfill. Discharge of the decanted water will need to meet the substantive requirements of a NPDES permit. By placing the sediment atop the landfill rather than the beach at Spink Neck, overall cap construction costs could be reduced by eliminating the need to transport the material a second time. However, the initial cost of dredging would be slightly increased due to increased piping and pumping requirements (although the Town consultant was unable to provide an estimate of this increase without additional site inspection, it is estimated that the dredging costs would be increased from $7/CY to approximately $9/CY). Once the sediment has been adequately dried, it could then be spread over the site for grading purposes and/or construction of the bedding layer for the multimedia cap. If the sediment is to be used for both the bedding layer and the barrier protection layer of the cap (i.e., requiring an impermeable membrane in between), then the construction of the cap could be staged or tiered such that an entire layer need not be constructed at one time (thereby avoiding substantial shuffling of the cap materials). For example, beginning at one end of the landfill, one construction team would place the bedding layer with a second construction team staggered behind them placing the impermeable and barrier protection layer on top of the completed bedding layer. Other scheduling issues may need to be addressed in order to coordinate sediment dewatering with shoreline cutback operations.

The third location being considered for dewatering of the sediment is on the Navy's property at Calf Pasture Point. Calf Pasture Point is a predominantly "made-land" area located to the northeast of Site 09 and which forms the northeastern shoreline of Allen Harbor (Figure 2). Calf Pasture Point is predominantly undeveloped, heavily overgrown, and contains marsh and wetlands areas, particularly along its southern portion. The Navy's IR Program Site 07 is located around the bunkers situated in the central portion of the area. Dewatering sediment within the southern portion (unless a non-marsh/non-wetland area can be located) or within the extent of Site 07 is not recommended. Costs for dewatering at the southern portion of Calf Pasture Point, if applicable, would be comparable to those for Spink Neck. The northern portion of Calf Pasture Point, which appears to be the most suitable location for the dewatering of dredged sediment, is a relatively flat, dry, overgrown area bounded by a chain-link fence and residential areas to the north. An access road runs along the western and northern border of Calf Pasture Point; this road (Sanford Road) runs past the western edge of Site 09. Two areas in the northern portion of Calf Pasture Point are covered with cracked asphalt which is overgrown with vegetation (tall grasses, shrubs). Provided that sufficient space is present, dredged sediment could be placed either (1) on one of the paved areas, (2) within the wooded areas (provided that these areas can be cleared of the existing thick vegetation such as trees and large shrubs), or (3) along the beach on the eastern or northeastern portion of Calf Pasture Point (this would require the location of a non-marsh area along the shoreline as well as the construction of some form of erosion control measure as described above for the option at Spink Neck). Sediment may or may not be able to be dewatered along the northern border (e.g., in the paved area in the northeastern corner of Calf Pasture Point or along the northeastern shoreline) due to potential concerns of the adjacent residential community. Costs with dewatering sediment in the northern portion of Calf Pasture Point are anticipated to be relatively high. First, since the northern portion of Calf Pasture Point is located nearly 1 mile from the proposed dredging area, the cost of dredging would be increased due to the increased piping and pumping requirements ($9/CY, as described for dewatering at Site 09). Second, additional costs would be incurred for site preparation (i.e., clearing of thick vegetation including trees) and/or construction of erosion controls/dewatering basin. Finally, the dewatered sediment would have to be transported back to Site 09, presumably along Sanford Road (approximately $3.50/CY, as previously described for dewatering at Spink Neck).

2.2.2 Dewatering Prior to Wetlands Creation

It is assumed that the sediment present at the entrance to Allen Harbor will be approximately the same density as the sediment which will be present in the constructed shoreline wetlands (i.e., no compaction required). However, the sediment which is to be dredged will have to be stored until wetlands construction begins (assuming the dredging project occurs before remedial actions for Site 09). This sediment may have to be stored at the selected dewatering location until remedial actions commence. Some volume reduction will occur, however, once the sediment is placed along the shoreline for wetlands creation, it should return to an approximation of the original in-place volume.

2.3 SEDIMENT USE

The following sections present the evaluation for the use of the dredged sediment in the proposed landfill cap and the shoreline wetlands.

2.3.1 Use in Construction of the Proposed Multimedia Cap

Geotechnical Evaluation of the Dredged Sediment

The objective was to evaluate whether the sediment dredged from the entrance to Allen Harbor would be suitable for re-use as construction material in the proposed multimedia cap as well as other various applications. The sediment was evaluated based on the laboratory test results of the representative soil materials obtained during sampling and suitability of those materials for construction purposes.

The laboratory test results are summarized in Table 4. The sediment is described as granular, wet, black, silty sand. The sediment is generally suitable as structural fill when compacted to a minimum dry density of 105.8 pcf within 2% of the optimum moisture content. Average optimum moisture content of the tested samples was 13.7%. Average natural moisture content of the same materials was 38.14%. Drying of the sediment will be necessary to achieve the required water content range. The time required for drying will depend on the ambient temperature and the thickness of the spread soil. The silty sand materials are sensitive to compaction moisture. During construction, field moisture content must be controlled within narrow limits (±2%) for effective compaction to ensure that the material is not too wet and potentially unstable. Various engineering controls are available to ensure slope stability, if necessary; these issues will be examined and addressed during the closure design process.

Once dewatered, the dredged sediment could be used for various applications in the construction of the proposed multimedia cap (Figure 1). It is anticipated that the sediment can be used for pre-cap grading as well as the bedding layer and the barrier protection layer of the proposed cap.

Due to the existing topography at Site 09, it was estimated in the Draft Final FS (EA 1996) that the Navy may need to obtain 9,000 CY of material for grading under the bedding layer of the cap. The dewatered sediment could be easily used for this grading since there are no physical specifications for under-cap grading material.

The dewatered sediment will be amenable for the 12-in. bedding layer of the cap (below the impermeable liner) since the organic content of the material is low (thus, potential post-construction settling of the bedding layer is not anticipated to be of concern). Since the sediment is a silty sand, rather than a silty clay, it may not be amenable as a low-permeability layer (as specified for a RCRA 'C' cap); however, low permeability may not a primary concern for the bedding layer of the proposed multimedia cap since the geocomposite liner will have a maximum permeability of 10^{-12} cm/sec, in accordance with capping requirements. The permeability of the compacted sediment should be sufficient to allow for gas (e.g., methane) transport from the fill material to the gas venting layer above the bedding layer.

The sediment would also be acceptable for the barrier protection layer (18 in. layer if a granular drainage layer is also used or a 30 in. layer if a geonet drainage layer is used in the cap); however, the sediment which is obtained from the Town's project should preferentially be placed underneath the impermeable layer. Although the sediment samples were chemically acceptable, some concerns may be raised by the BCT regarding potential overland runoff pathways from such a large volume of dredged material. Placement of excess dredge material, either underneath or on top of the liner, would affect the final geometry of the capping system. In this case, the cap design would have to account for the additional material in order to ensure adequate material placement and stability of the cap. These issues should be addressed during the final design of the cap.

The sediment will not be amenable for use as the vegetative support layer (topsoil is recommended) and the sediment is not recommended for use in any portion of the cap which may lie directly within the tidal zone (i.e., under the shoreline revetment). However, as stated in the Draft Final FS (EA 1996), the landfill cap may be terminated above the shoreline revetment due to slope stability concerns.

2.3.2 Use in Construction of the Proposed Tidal Fringe Marsh (Shoreline Wetlands)

Sediment dredged from the entrance to Allen Harbor could also be used for the construction of the proposed shoreline wetlands at Site 09. Based upon the physical/chemical data obtained from the five sediment samples collected in the vicinity of the proposed dredging project, the suitability for use of the sediment for the construction of the proposed fringing tidal marsh proposed to be constructed along the face of the landfill was evaluated. The approach of the evaluation was to compare those physical and chemical sediment characteristics to the characteristics of sediment normally found in tidal wetlands.

Particle Size

The substrate samples from the entrance to Allen Harbor have been identified as silty sand material (GeoTesting Express 6/96). The median particle size (by weight) of the five samples were consistent as fine sand (50% finer and coarser (by weight) than 0.07 to 0.1 mm in diameter). In general, less than 5% of the soil sample (by weight) was coarser than fine sand.

This material appears to be suitable for tidal marsh construction and is superior to coarser sand material for marsh production (Knutson and Steele 1988, Zedler 1996). Much of the proposed marsh is anticipated to be *Spartina patens* (salmeadow cordgrass), which is typically found in sandier, rather than muddier, substrates (Wiegert and Freeman 1990).

pH

The pH of aquatic sediment can be highly variable, generally controlled by oxygen and organic material levels in the sediment (Sverdrup et al. 1946). The pH values for the samples taken from the vicinity of the proposed dredging project (CEIMIC 6/96) were consistent overall and ranged from approximately 7.9 to 8.5.

These pH values are not unusual considering the pH of seawater ranges from 7.5 to 8.5 (Parsons et al. 1979) and are not expected to have an adverse effect on use as a salt marsh substrate. Once these sediments are amended with organic material and placed as a marsh substrate, it is expected that the pH values would decrease to circumneutral or acidic conditions.

Soluble Salts

The levels observed in the five sediment samples ranged from approximately 10,000 to 15,600 mg/kg soluble salts. Normal pore water salinity in salt marshes can be comparable to levels as high as 50,000 mg/kg and still support wetland vegetation (Wiegert and Freeman 1990). Zedler (1996) indicates that lower salt levels can improve initial colonization by salt marsh species. In terms of normal levels and this recommendation, it appears that the soluble salt levels in the samples will not be a problem for use as the substrate for salt marsh development.

Total Organic Carbon (TOC)

Measured TOC levels for the five samples ranged from 6,350 to 11,700 mg/kg (CEIMIC 6/96). This translates to a very low organic content. Considering that natural salt marshes can have soils with higher organic levels reaching 5% and higher (Zedler 1996, Mitsch and Gosselink 1986, and Kadlec and Knight 1995), additional organic material will need to be added to the dredged material prior to installation of plant material. This is a normal circumstance in wetland construction, and soil amendment often includes a broader range of soil improvement, including pH adjustment and fertilizer addition.

Nutrients and Cations

The levels of phosphorus, potash, calcium, and magnesium present in the samples are not indicative of unusually high or low values (Mitsch and Gosselink 1986). The lowest values observed were for phosphorus, which is typically the limiting nutrient in aquatic systems. As a component of the marsh construction, slow release fertilizer should be added to each planting hole prior to the installation of the marsh plant propagule (Knutson 1977).

2.4 COST ESTIMATES

The cost estimates in this section compare the costs for the Navy to purchase the required amount of borrow material from a local vendor vs. the costs for incorporating dredged sediment from the Town project.

2.4.1 Required Volume

<u>Multimedia Cap (15 acres)</u>

A cross-section of the proposed multimedia cap is presented in Figure 1. Based upon the Draft Final FS (EA 1996), the following in-place volumes of material would be required for construction of the 15-acre multimedia cap:

Clean Fill (pre-cap grading)	9,000 CY
Bedding Material (bottom 12 in. of cap)	24,200 CY
Clean Fill (assumed 30 in. barrier protection)	60,500 CY
Topsoil (top 6 in. of cap)	12,100 CY

It should be noted that the barrier protection layer can be reduced to 18 in. if the geonet drainage layer is replaced with a granular, 12-in. drainage layer constructed of a high-permeability borrow material. In either case, the total thickness of the cap above the impermeable liner will be a total of 36 in. (including topsoil), in accordance with capping requirements.

As stated in Section 2.2.1, the volume of the dredged sediment will be reduced by 36% due to dewatering and compaction. Therefore, in order to obtain the required volumes listed above, a greater volume of sediment would have to be available from the Town project. As stated in Section 2.3.1, the sediment could potentially be used for grading, the bedding layer, and the barrier protection layer.

Application	*In-Place Volume*	*Approx. Required Dredged Volume*
Grading	9,000 CY	14,100 CY
Bedding Material	24,200 CY	37,900 CY
Barrier protection	60,500 CY	<u>94,600 CY</u>
	TOTAL	146,600 CY

However, for construction of the multimedia cap, the dredged sediment is more appropriately considered for grading purposes and the bedding layer only (Section 2.3.1).

Wetlands

In addition to portions of the multimedia cap, the dredged sediment should be amenable for creation of the shoreline wetlands. The following volumes of sediment could be incorporated:

backfill excavated shoreline sediment	2,000 CY
wetland (sub-base plus top substrate)	5,000 CY
filling of geotextile tube retaining wall*	4,800 CY
TOTAL	11,800 CY

* - As outlined in the Draft Final FS (EA 1996), geotextile tube retaining walls may be used to contain the material placed along the shoreline for wetlands creation.

If borrow material is to be used for wetlands creation rather than dredged sediment, then the borrow material should be a fine-grained silty sand with a high organic content.

2.4.2 Cost Comparison for the Required Volume of Material

Cost estimates for dredging and upland placement at Spink Neck beach were provided by the Town's dredging consultant (Docko, 8-9/96). Cost estimates for borrow material were obtained from the previous Site 09 Design Analysis (EA 1994) as well as a local vendor (River Sand and Gravel, 8/96).

The following tables compare costs for using borrow material vs. dredged sediment. Remedial action components which would be unaffected (e.g., liner costs, gas venting layer costs, etc.) are not included in this comparison. Complete cost estimates for potential remedial actions at Site 09 are presented in the Draft Final FS (EA 1996).

Material Costs Using Borrow Material

Soil Type	Volume	Unit Cost (material + delivery)	Total Cost (rounded up to nearest $1,000)
Pre-Cap Grading	9,000 CY	$6.25/CY	$57,000
Bedding Material	24,200 CY	$6.25/CY	$152,000
Barrier Protection Layer (30-in.) plus Pre-Cap Grading	60,500 CY	$6.25/CY	$379,000
Topsoil	12,100 CY	$12.00/CY	$146,000
Fine-grained silty sand with organic material (for wetlands creation)	11,800 CY	$6.00/CY	$71,000
TOTAL			**$805,000**

The following cost table (page 13) considers the use of dredged sediment for grading, the bedding layer, and construction of the wetlands (up to 63,800 CY of the sediment to be dredged) with dewatering at Site 09. Sediment dredged in excess of what would be required for grading, bedding, and wetlands construction could be incorporated into the barrier protection layer along with borrow material. Variations to this assumed project scope are noted in the table.

Material/Associated Costs Using Dredged Sediment from the Town Project

Item	Volume/ Quantity	Unit Cost	Total Cost (rounded up to nearest $1,000)	Notes on Potential Variations
Hydraulic Dredging with Upland Placement on Site 09	63,800 CY	$9/CY	$575,000	Placement at S.N.: $7/CY = $447,000 Placement at C.P.P. also $9/CY
Dewatering +berms, etc. +O&M +permits	design will accommodate increase to due hydraulic dredging	Lump Sum Estimate	$100,000	Dewatering at S.N.: add $3.50/CY for subsequent transport to Site 09 Dewatering at C.P.P.: add $3.50/CY (as above) plus site preparation cost
DREDGING PROJECT SUBTOTAL(a)			**$675,000**	S.N., C.P.P.: transport for this volume(b) to Site 09 will add about $200,000
Barrier Protection Layer (30-in.) plus Pre-Cap Grading	60,500 CY	$6.25/CY	$379,000	
Topsoil	12,100 CY	$12.00/CY	$146,000	
Organic material mixed with sediment for top 1 ft of wetlands substrate (5% mixture)	1,600 ft long x 30 ft wide x 1 ft deep x 5% mixture = 90 CY	Estimate $20/CY for material and mixing	$2,000	peat would produce the best results but may be the most expensive material to obtain
TOTAL			**$1,202,000**	will vary for dewatering at S.N. and C.P.P. (see above)

S.N. = Spink Neck C.P.P. = Calf Pasture Point
(a) This subtotal reflects what the Town's costs may be without Navy assistance (not including disposal).
(b) Cost will depend on reduction of initial volume based on dewatering alone. (i.e., the aforementioned 36% volume reduction includes dewatering and compaction during cap construction)

The sediment reuse scenario presented in this report allows for the Navy to accept up to 63,800 CY. The Town is currently considering dredging a volume of sediment which can be accepted by the Navy. If the Town decides to expand their project beyond this volume, then the Navy may consider accepting additional sediment (so that the Town does not incur disposal costs for the sediment) by incorporating it into either a thicker bedding layer (over 12 in.) or as a portion of the barrier protection layer (in conjunction with borrow material). The additional costs incurred would be for additional dredging ($7 to 9/CY), dewatering (larger erosion control measures, potentially more pumping requirements depending upon dewatering location), transportation ($3.50/CY if dewatered at Calf Pasture Point or Spink Neck), grading, and compaction.

2.5 SUMMARY AND CONCLUSIONS

Based upon the analyses of the sediment samples from the entrance to Allen Harbor, the sediment is chemically suitable for placement at the Allen Harbor Landfill either as part of the proposed multimedia cap or the proposed shoreline wetlands since ER-L values and TCLP criteria were not exceeded.

Based upon the physical characteristics of the sediment samples, it is anticipated that this material is of sufficient quality to be incorporated into the multimedia cap for grading purposes, the bedding layer, and the barrier protection layer. The sediment will also be acceptable for the construction of the shoreline wetlands provided that the top layer it is mixed with organic material (e.g., peat, compost, or other vegetative material) prior to placement. Slow-release fertilizer should also be added to each planting hole during installation of the march plants. These are typical requirements for wetland creation projects.

However, based upon the evaluation presented in this report, the sediment to be dredged from the entrance to Allen Harbor is most appropriately considered for pre-cap grading, bedding material, and wetlands creation only (i.e., borrow material may be a more acceptable choice for the barrier protection layer). These three components will require a total volume of material (63,800 CY) which closely matches the original project scope by the Town (70,000 CY). It is further recommended that the sediment should be dewatered on top of the landfill (with drainage controls) rather than at Spink Neck or at Calf Pasture Point in order to prevent additional transportation expenses.

The overall project cost for incorporating dredged sediment into cap/wetlands construction is estimated to be more expensive than using borrow materials alone.

2.6 REPORT LIMITATIONS

The following limitations are reserved for the recommendations presented in this report:

- The information included herein will be incorporated, as appropriate, into the Final FS for Site 09. Modifications to currently proposed remedial actions (which may alter the final volume of sediment which can be accepted from the Town) may occur as part of the Final FS (due in October 1996) or during the Remedial Design phase following the signing of the ROD (February 1997).

- The recommendations herein are based upon unvalidated data from five sediment samples.

- This report does not establish construction procedures for Site 09.

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TABLE 1 SUMMARY OF RESULTS OF WHOLE-SEDIMENT CHEMICAL ANALYSES[a]

Parameter	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5
VOLATILE ORGANIC COMPOUNDS (μg/kg)					
Chloromethane	< 14	< 15	< 14	< 14	< 14
Bromomethane	< 14	< 15	< 14	< 14	< 14
Vinyl Chloride	< 14	< 15	< 14	< 14	< 14
Chloroethane	< 14	< 15	< 14	< 14	< 14
Methylene Chloride	18 B	22 B	15 B	17 B	18 B
Acetone	75 B	150 B	270 B	72 B	110 B
Carbon Disulfide	< 14	7 J	< 14	8 J	15
1,1-Dichloroethene	< 14	< 15	< 14	< 14	< 14
1,1-Dichloroethane	< 14	< 15	< 14	< 14	< 14
1,2-Dichloroethene (total)	< 14	< 15	< 14	< 14	< 14
Chloroform	< 14	< 15	< 14	< 14	< 14
1,2-Dichloroethane	< 14	< 15	< 14	< 14	< 14
2-Butanone	< 14	20	30	9 J	14
1,1,1-Trichloroethane	< 14	< 15	< 14	< 14	< 14
Carbon Tetrachloride	< 14	< 15	< 14	< 14	< 14
Bromodichloromethane	< 14	< 15	< 14	< 14	< 14
1,2-Dichloropropane	< 14	< 15	< 14	< 14	< 14
cis-1,3-Dichloropropene	< 14	< 15	< 14	< 14	< 14
Trichloroethene	< 14	< 15	< 14	< 14	< 14
Dibromochloromethane	< 14	< 15	< 14	< 14	< 14
1,1,2-Trichloroethane	< 14	< 15	< 14	< 14	< 14
Benzene	< 14	< 15	< 14	< 14	< 14
trans-1,3-Dichloropropene	< 14	< 15	< 14	< 14	< 14

TABLE 1 (Continued)

Parameter	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5
Bromoform	< 14	< 15	< 14	< 14	< 14
4-Methyl-2-Pentanone	< 14[b]	< 15	< 14	< 14	< 14
2-Hexanone	< 14	< 15	< 14	< 14	< 14
Tetrachloroethene	< 14	< 15	< 14	< 14	< 14
1,1,2,2-Tetrachloroethane	< 14	< 15	< 14	< 14	< 14
Toluene	< 14	3 J	< 14	< 14	< 14
Chlorobenzene	< 14	< 15	< 14	< 14	< 14
Ethylbenzene	< 14	< 15	< 14	< 14	< 14
Styrene	< 14	< 15	< 14	< 14	< 14
Xylene (total)	< 14	< 15	< 14	< 14	< 14
SEMIVOLATILE ORGANIC COMPOUNDS (μg/kg)[c]					
Phenol	< 440	< 480	< 510	< 460	< 420
bis(2-Chloroethyl)Ether	< 440	< 480	< 510	< 460	< 420
2-Chlorophenol	< 440	< 480	< 510	< 460	< 420
1,3-Dichlorobenzene	< 440	< 480	< 510	< 460	< 420
1,4-Dichlorobenzene	< 440	< 480	< 510	< 460	< 420
1,2-Dichlorobenzene	< 440	< 480	< 510	< 460	< 420
2-Methylphenol	< 440	< 480	< 510	< 460	< 420
2,2'-oxybis (1-Chloropropane)	< 440	< 480	< 510	< 460	< 420
4-Methylphenol	< 440	< 480	< 510	< 460	< 420
N-Nitroso-Di-n-Propylamine	< 440	< 480	< 510	< 460	< 420
Hexachloroethane	< 440	< 480	< 510	< 460	< 420
Isophorone	< 440	< 480	< 510	< 460	< 420
2-Nitrophenol	< 440	< 480	< 510	< 460	< 420

TABLE 1 (Continued)

Parameter	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5
2,4-Dimethylphenol	< 440	< 480	< 510	< 460	< 420
1,2,4-Trichlorobenzene	< 440	< 480	< 510	< 460	< 420
Naphthalene	< 440	< 480	< 510	< 460	< 420
4-Chloroaniline	< 440	< 480	< 510	< 460	< 420
Hexachlorobutadiene	< 440	< 480	< 510	< 460	< 420
4-Chloroaniline	< 440	< 480	< 510	< 460	< 420
Hexachlorobutadiene	< 440	< 480	< 510	< 460	< 420
4-Chloro-3-Methylphenol	< 440	< 480	< 510	< 460	< 420
2-Methylnaphthalene	< 440	< 480	< 510	< 460	< 420
Hexachlorocyclopentadiene	< 440	< 480	< 510	< 460	< 420
2,4,6-Trichlorophenol	< 440	< 480	< 510	< 460	< 420
2,4,5-Trichlorophenol	< 1100	< 1200	< 1300	< 1200	< 1000
2-Chloronaphthalene	< 440	< 480	< 510	< 460	< 420
2-Nitroaniline	< 1100	< 1200	< 1300	< 1200	< 1000
Dimethyl Phthalate	< 440	< 480	< 510	< 460	< 420
Acenaphthylene	< 440	< 480	< 510	< 460	< 420
2,6-Dinitrotoluene	< 440	< 480	< 510	< 460	< 420
3-Nitroaniline	< 1100	< 1200	< 1300	< 1200	< 1000
Acenaphthene	< 440	< 480	< 510	< 460	< 420
2,4-Dinitrophenol	< 1100	< 1200	< 1300	< 460	< 1000
4-Nitrophenol	< 1100	< 1200	< 1300	< 1200	< 1000
Dibenzofuran	< 440	< 480	< 510	< 460	< 420
2,4-Dinitrotoluene	< 440	< 480	< 510	< 460	< 420
Diethylphthalate	< 440	< 480	< 510	< 460	< 420
4-Chlorophenyl-phenylether	< 440	< 480	< 510	< 460	< 420

TABLE 1 (Continued)

Parameter	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5
Fluorene	< 440	< 480	< 510	< 460	< 420
4-Nitroaniline	< 1100	< 1200	< 1300	< 1200	< 1000
4,6-Dinitro-2-Methylphenol	< 1100	< 1200	< 1300	< 1200	< 420
N-Nitrosodiphenylamine (1)	< 440	< 480	< 510	< 460	< 420
4-Bromophenyl-phenylether	< 440	< 480	< 510	< 460	< 420
Hexachlorobenzene	< 440	< 480	< 510	< 460	< 420
Pentachlorophenol	< 1100	< 1200	< 1300	< 1200	< 1000
Phenanthrene	< 440	< 480	< 510	< 460	< 420
Anthracene	< 440	< 480	< 510	< 460	< 420
Di-n-Butylphthalate	< 440	< 480	< 510	< 460	< 420
Fluoranthene	< 440	< 480	< 510	< 460	< 420
Carbazole	< 440	< 480	< 510	< 460	< 420
Pyrene	< 440	< 480	< 510	< 460	< 420
Butylbenzylphthalate	< 440	< 480	< 510	< 460	< 420
3,3'-Dichlorobenzidine	< 440	< 480	< 510	< 460	< 420
Benzo(a)Anthracene	< 440	< 480	< 510	< 460	< 420
Chrysene	< 440	< 480	< 510	< 460	< 420
bis(2-Ethylhexyl)Phthalate	< 440	79 J	< 510	97 J	< 420
Di-n-Octyl Phthalate	< 440	< 480	< 510	< 460	< 420
Benzo(b)Fluoranthene	< 440	< 480	< 510	< 460	< 420
Benzo(k)Fluoranthene	< 440	< 480	< 510	< 460	< 420
Benzo(a)Pyrene	< 440	< 480	< 510	< 460	< 420
Indeno(1,2,3-cd)Pyrene	< 440	< 480	< 510	< 460	< 420
Dibenzo(a.h)Anthracene	< 440	< 480	< 510	< 460	< 420
Benzo(g.h.i)Perylene	< 440	< 480	< 510	< 460	< 420

TABLE 1 (Continued)

Parameter	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5
Polynuclear Aromatic Hydrocarbons (μg/kg)[d]					
Naphthalene	< 3.06[d]	< 3.06	< 3.06	< 3.06	< 3.06
Acenaphthalyene	< 4.39	< 4.39	< 4.39	< 4.39	< 4.39
Acenaphthene	< 5.84	< 5.84	< 5.84	< 5.84	< 5.84
Fluorene	< 0.93	< 0.93	< 0.93	< 0.93	< 0.93
Phenanthrene	5.1	5.0	18	7.9	8.6
Anthracene	4.3	3.8	6.2	4.9	4.6
Fluoranthene	11	11	23	14	16
Pyrene	42	41	61	39	49
Benzo(a)anthracene	4.2	3.7	9.0	5.2	4.7
Chrysene	< 0.22	< 0.22	19	11	< 0.22
Benzo(b)fluoranthene	15	12	21	15	18
Benzo(k)fluoranthene	8.0	< 0.33	< 0.33	< 0.33	< 0.33
Benzo(a)pyrene	13	15	23	14	17
Dibenzo(a,h)anthracene	< 0.90	< 0.90	< 0.90	< 0.90	< 0.90
Benzo(g,h,i)perylene	3.20 J	6.1	9.5	6.8	6.0
Indeno(1,2,3-cd)pyrene	3.6	4.9	8.4	4.9	8.1
Pesticides/PCB (μg/kg)					
alpha-BHC	< 0.0274[e]	< 0.0274	< 0.0274	< 0.0274	< 0.0274
beta-BHC	< 0.0146	< 0.0146	< 0.0146	< 0.0146	< 0.0146
delta-BHC	< 0.0168	< 0.0168	< 0.0168	< 0.0168	< 0.0168
gamma-BHC	< 0.0091	< 0.0091	< 0.0091	< 0.0091	< 0.0091

TABLE 1 (Continued)

Parameter	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5
Heptachlor	< 0.0135	< 0.0135	< 0.0135	< 0.0135	< 0.0135
Aldrin	< 0.0058	< 0.0058	< 0.0058	< 0.0058	< 0.0058
Heptachlor Epoxide	< 0.0373	< 0.0373	< 0.0373	< 0.0373	< 0.0373
Endosulfan I	< 0.0116	< 0.0116	< 0.0116	< 0.0116	< 0.0116
Dieldrin	< 0.0249	< 0.0249	< 0.0249	< 0.0249	< 0.0249
4,4'-DDD	< 0.0150	< 0.0150	< 0.0150	< 0.0150	< 0.0150
Endosulfan Sulfate	< 0.0189	< 0.0189	< 0.0189	< 0.0189	< 0.0189
4,4'-DDT	< 0.0131	< 0.0131	< 0.0131	< 0.0131	< 0.0131
Methoxyclor	< 0.0705	< 0.0705	< 0.0705	< 0.0705	< 0.0705
Endrin Ketone	< 0.0097	< 0.0097	< 0.0097	< 0.0097	< 0.0097
Endrin Aldehyde	< 0.0181	< 0.0181	< 0.0181	< 0.0181	< 0.0181
alpha-Chlordane	< 0.0047	< 0.0047	< 0.0047	< 0.0047	< 0.0047
gamma-Chlordane	< 0.0065	< 0.0065	< 0.0065	< 0.0065	< 0.0065
Toxaphene	< 1.1730	< 1.1730	< 1.1730	< 1.1730	< 1.1730
Aroclor-1016	< 0.2914	< 0.2914	< 0.2914	< 0.2914	< 0.2914

TABLE 1 (Continued)

Parameter	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5
Aroclor-1221	< 0.7746	< 0.7746	< 0.7746	< 0.7746	< 0.7746
Aroclor-1232	< 0.3199	< 0.3199	< 0.3199	< 0.3199	< 0.3199
Aroclor-1242	< 0.2246	< 0.2246	< 0.2246	< 0.2246	< 0.2246
Aroclor-1248	< 0.2813	< 0.2813	< 0.2813	< 0.2813	< 0.2813
Aroclor-1254	< 0.2412	< 0.2412	< 0.2412	< 0.2412	< 0.2412
Aroclor-1260	< 0.2934	< 0.2934	< 0.2934	< 0.2934	< 0.2934
Metals (mg/kg)					
Aluminum	3770	4560	3760	4940	2850
Antimony	< 12.6	< 13.2	< 14.4	< 14.7	< 13.4
Arsenic	3.2	3.2	3.9	3.0	2.7
Barium	10.9 B	11.1 B	59.0	12.8 B	7.4 B
Beryllium	0.33 B	0.47 B	0.38 B	0.43 B	< 0.25
Cadmium	< 0.48	< 0.50	0.69 B	< 0.55	< 0.51
Calcium	2630	7270	1240 B	8940	3280
Chromium	14.0	17.5	14.3	18.5	6.2
Cobalt	3.8 B	3.8 B	2.1 B	3.8 B	2.2 B
Copper	23.8	29.1	23.0	29.6	11.2
Iron	7990	10400	7950	11400	5910
Lead	10.9	17.0	13.3	20.3	7.1
Magnesium	2060	2560	2080	2660	1550
Manganese	76.0	88.9	75.8	96.6	67.0

TABLE 1 (Continued)

Parameter	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5
Mercury	< 0.07	0.08 B	< 0.07	< 0.07	0.15
Nickel	6.8 B	10.6	8.9 B	11.4	4.0 B
Potassium	873 B	1110 B	910 B	1150 B	629 B
Selenium	< 0.48	< 0.50	< 0.54	< 0.55	< 0.51
Silver	< 1.2	< 1.2	< 1.4	< 1.4	< 1.3
Sodium	3620	5030	3890	4530	2810
Thallium	< 0.71	< 0.75	< 0.81	< 0.83	< 0.76
Vanadium	10.2 B	13.0	11.0 B	14.8	7.3 B
Zinc	42.8	55.9	43.5	60.9	27.9
Cyanide	< 0.63	< 0.69	< 0.68	< 0.69	< 0.64

(a) Data from analytical testing report prepared by Ceimic Corporation, 5 July 1996.
(b) "<" indicates that analyte not detected above the quantitation limit shown. Refer also to Notes (d) and (e).
(c) Semivolatile organic compound (SVOC) results shown are per method number CLP OLM03.1.
(d) PAH were also analyzed per method number SW-846 8310, which has lower quantitation limits than CLP OLM03.1. The "<" symbol indicates that the analyte was not detected at a concentration above the method's detection limit, as opposed to the quantitation limit (which is higher than the detection limit).
(e) The "<" symbol indicates that the analyte was not detected at a concentration above the method's detection limit .

TABLE 2 SUMMARY OF RESULTS OF TOXICITY CHARACTERISTIC LEACHING PROCEDURE (TCLP) ANALYSES[a]

Parameter	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5
VOLATILE ORGANIC COMPOUNDS (µg/L)					
Vinyl Chloride	< 200[b]	NA	< 200	NA	< 200
1,1-Dichloroethene	< 200	NA	< 200	NA	< 200
Chloroform	< 200	NA	< 200	NA	< 200
1,2-Dichloroethane	< 200	NA	< 200	NA	< 200
Carbon Tetrachloride	< 200	NA	< 200	NA	< 200
Trichloroethene	< 200	NA	< 200	NA	< 200
Benzene	< 200	NA	< 200	NA	< 200
Tetrachloroethene	< 200	NA	< 200	NA	< 200
Chlorobenzene	< 200	NA	< 200	NA	< 200
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)					
Pyridine	< 40	NA	< 40	NA	< 40
1,4-Dichlorobenzene	< 40	NA	< 40	NA	< 40
2-Methylphenol	< 40	NA	< 40	NA	< 40
4-Methylphenol	< 40	NA	< 40	NA	< 40
Hexachloroethane	< 40	NA	< 40	NA	< 40
Nitrobenzene	< 40	NA	< 40	NA	< 40
Hexachlorobutadiene	< 40	NA	< 40	NA	< 40
2,4,6-Trichlorophenol	< 40	NA	< 40	NA	< 40
2,4,5-Trichlorophenol	< 100	NA	< 100	NA	< 100
2,4-Dinitrotoluene	< 40	NA	< 40	NA	< 40
Hexachlorobenzene	< 40	NA	< 40	NA	< 40
Pentachlorophenol	< 100	NA	< 100	NA	< 100

TABLE 2 (Continued)

Parameter	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5
Pesticides/PCB (µg/L)					
gamma-BHC	< 0.20	NA	< 0.20	NA	< 0.20
Heptachlor	< 0.20	NA	< 0.20	NA	< 0.20
Heptachlor Epoxide	< 0.20	NA	< 0.20	NA	< 0.20
Endrin	< 0.40	NA	< 0.40	NA	< 0.40
Methoxyclor	< 2.0	NA	< 2.0	NA	< 2.0
Toxaphene	< 20	NA	< 20	NA	< 20
Chlordane	< 4.0	NA	< 4.0	NA	< 4.0
Herbicides (µg/L)					
2,4-D	< 2.0	NA	< 2.0	NA	< 2.0
2,4,5-TP (Silvex)	< 2.0	NA	< 2.0	NA	<2.0
Metals (µg/L)					
Arsenic	< 2.0	NA	5.7 B	NA	3.5 B
Barium	73.7 B	NA	310 B	NA	154 B
Cadmium	3.3 B	NA	< 2.0	NA	6.7 B
Chromium	< 7.0	NA	< 7.0	NA	< 7.0
Lead	55.3 B	NA	83.2 B	NA	58.6 B
Mercury	0.22 B	NA	0.47 B	NA	0.44 B
Selenium	4.9 B	NA	5.7 B	NA	8.6 B
Silver	9.4 B	NA	6.7 B	NA	< 5.0

Notes:
(a) Data from analytical testing report prepared by CEIMIC Corporation, 5 July 1996.
(b) "<" indicates that the analyte was not detected above the quantitation limit shown.

TABLE 3 SUMMARY OF RESULTS OF MISCELLANEOUS CHEMICAL ANALYSES[a]

Parameter	Units	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5
SEM/AVS[b]	None	0.08	0.02	0.03	0.03	0.06
Total Petroleum Hydrocarbons	mg/kg[d]	< 63[c]	NA	< 77	NA	63
Inorganic Analytes						
Available Phosphorous (as P_2O_5)	mg/kg	< 2.91	< 3.20	< 3.05	< 3.16	< 2.93[e]
pH	Units	8.15	8.44	8.39	8.49	7.96
Soluble Salts	mg/kg	12,300	15,600	12,900	14,400	10,240
Total Volatile Solids	%	1.4	2.4	1.7	2.5	1.1
Total Solids	%	74.3	67.9	70.9	68.7	74.7
Total Organic Carbon	mg/kg	6,760	8,410	7,030	11,700	6,350
Soluble Calcium	mg/kg	358	398	189	405	301
Soluble Magnesium	mg/kg	359	458	366	438	305
Soluble Potash (as K_2O)	mg/kg	490	693	547	670	392

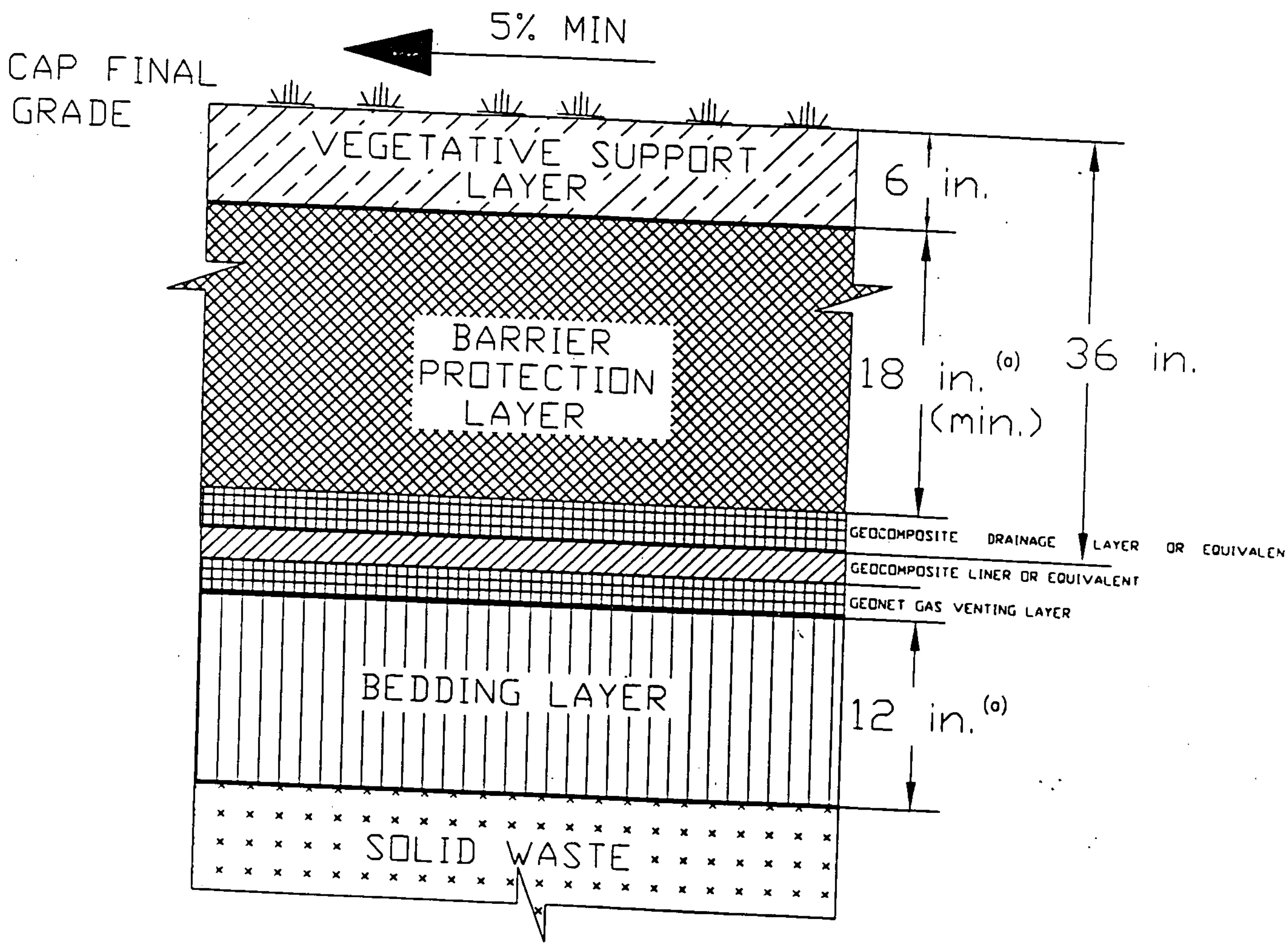
(a) Data from analytical testing report prepared by Ceimic Corporation, 5 July 1996.
(b) Simultaneously Extracted Metals (SEM) and Acid Volatile Sulfides (AVS).
(c) "<" indicates that the analyte was not detected above the method reporting limit shown.
(d) Reported on a dry weight basis.
(e) Results shown for Sample No. 5 are an average of the sample results and the duplicate result.

TABLE 4 ALLEN HARBOR DREDGED SEDIMENT LABORATORY GEOPHYSICAL TEST RESULTS

SAMPLE	SOIL DESCRIPTION	USCS	AASHTO	PLASTICITY	NMC %	OMC %	MDD pcf	c tsf	phi angle
Site # 1	Silty Sand	SM	A-4 (0)	NP	35.9	13.5	105.8		
Site # 2	Silty Sand	SM	A-4 (0)	NP	39.0				
Site # 3	Silty Sand	SM	A-2-4 (0)	NP	39.1	14.9	106.8		
Site # 4	Silty Sand	SM	A-4 (0)	NP	42.4				
Site # 5	Silty Sand	SM	A-2-4 (0)	NP	34.3	12.8	110.4		
Composite Sample								0.2	36.9

Legend:

USCS = Unified Soil Classification System
AASHTO = American Association of State Highway and Transportation Officials Classification System
NP = Non Plastic
NMC = Natural Moisture Content
OMC = Optimum Moisture Content
MDD = Maximum Dry Density
c = Cohesion Intercept
phi angle = Angle of Internal Friction



(a) POTENTIALLY USING SEDIMENT DREDGED FROM ENTRANCE TO ALLEN HARBOR

SITE 09 DREDGED SEDIMENT EVALUATION REPORT NCBC DAVISVILLE, RHODE ISLAND	
TYPICAL CROSS-SECTION OF MULTIMEDIA CAP	
DATE: SEPTEMBER 1996	PROJECT NUMBER: 29600.58.8300
DESIGNED BY: VRH	SCALE: NONE
DRAWN BY: JFW	FILE NAME: RCRA-CAP
CHECKED BY: JDR	DRAWING NUMBER: -
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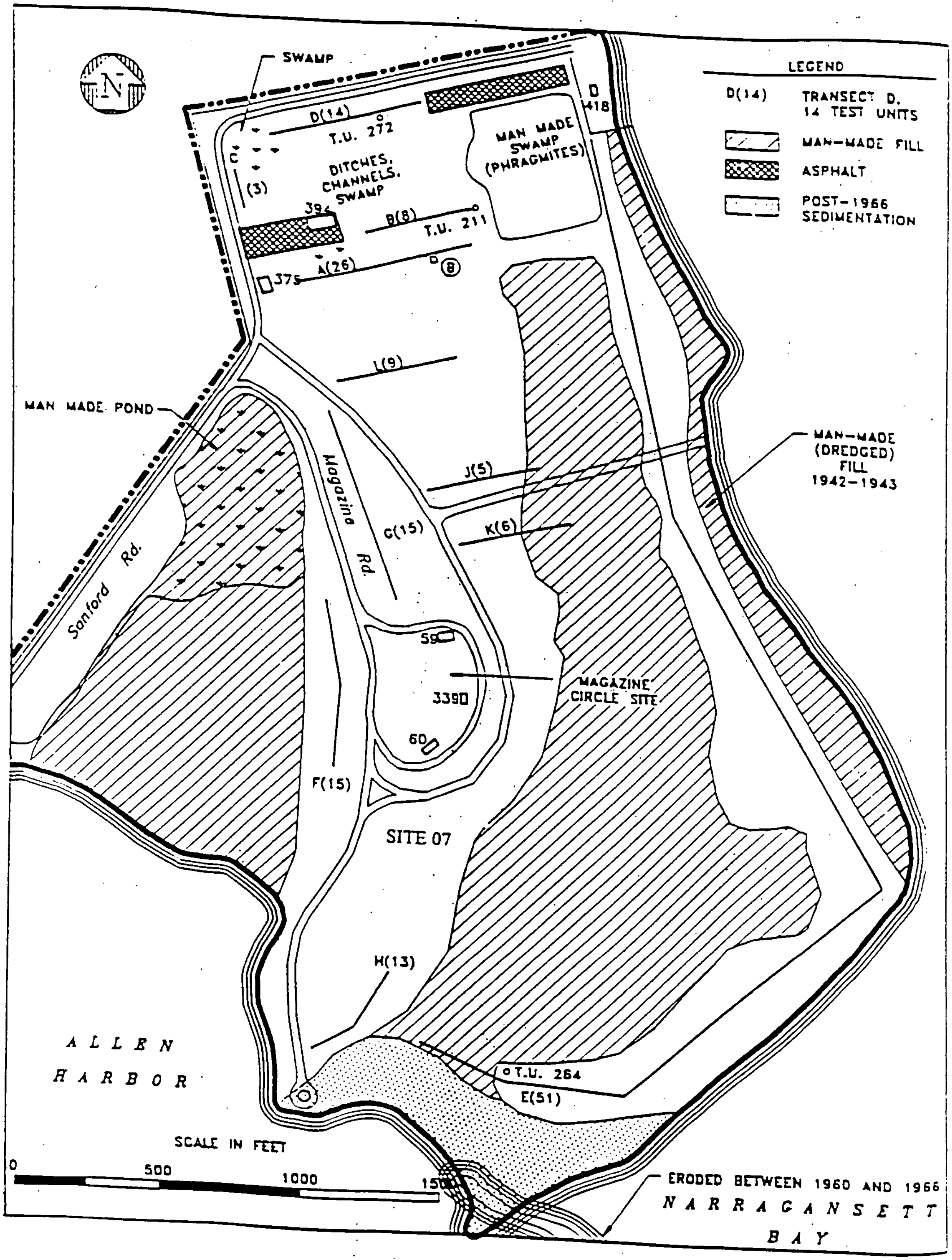

FIGURE 2 CALF PASTURE POINT, NCBC DAVISVILLE, RHODE ISLAND

Source: Ecology and Environment, 1994