APPENDIX A - SUMMARY OF PREVIOUS STUDIES

Cerco, C.F., Bunch, B. Cialone, M.A. and H. Wang. 1994. "Hydrodynamics and Eutrophication Model Study of Indian River and Rehoboth Bay, DE". Technical Report EL-94-5, US Army Engineer Waterway Experiment Station, Vicksburg, MS

Cerco *et al.* (1994) employed both a hydrodynamic and water quality model to examine conditions in Indian River and Rehoboth Bay. Bathymetry was obtained from a 1988 survey conducted by the Army Corps of Engineers, Philadelphia District. The hydrodynamic model was forced with water levels and velocities collected at the Indian River Inlet Coast Guard Station and were supplemented with winds obtained from the US Coast Guard, the Delmarva Light and Power Company and the Dover Air Force Base. The model was calibrated with data obtained from five USGS tide gauges, including one in Massey's Ditch. Four current meters were placed near Middle Island.

The model was run during the time period of 1988 through 1990. Both the water hydrodynamic and water quality models were shown to perform well. While reproducing amplitude well, the model predicts elevation with a 30 minute phase lead. This phase lead was attributed to the boundary condition at the inlet boundary. It was found that the system does not require a multi-layer grid, as the system is fairly shallow throughout and the depth variation is minimal with the exception of density gradients near the Millsboro Pond freshwater inflow.

A mechanistic sediment model designed to predict nutrient and oxygen exchange between the sediment and water was discarded as it did not appropriately account for benthic algae found in Indian River Bay. A calibrated empirical model was found to be much more suited to the conditions.

Focus was placed on the water quality of the inland bays, with many point and non-point sources included as inputs to the water quality model. The model proved to predict the various constituents well. Comparisons were sufficient with the data available.

Chrzastowski, M.J. 1986. "Stratigraphy and Geologic History of a Holocene Lagoon: Rehoboth Bay and Indian River Bay, Delaware". Ph.D. Dissertation, University of Delaware

Chrzastowski (1986) examined recent (Holocene) sedimentary deposits and the geologic history of Rehoboth Bay and Indian River Bay based on 96 vibracores collected as part of his research and 181 core records from previous investigations. Ancestral river valleys at Love/Herring Creek and Indian River underlie deposits of tidal stream mud, marsh mud, flood tidal delta/barrier sand, and lagoonal mud. The sand and lagoonal mud deposits are a relatively thin cover to the sediments deposited in tidal streams and fringing salt marsh.

Surfical samples indicated that fine sands are present in the eastern portions of the bays with a transition to silty sand, sandy silt, clayey silt and silty clay in the western portions of the bays and at the mouths of tributaries.

Kolluru, V.S. and M. Fichera 2003. "Development and Application of Combined 1-D and 3-D Modeling System for TMDL Studies"

Kolluru and Fichera (2003) developed a modeling system as a management tool for water quality studies of Delaware's Inland Bays, including Rehoboth Bay, Indian River Bay, and Little Assawoman Bay, with funding from the Delaware Department of Natural Resources. The system included 1-D stream networks as well as relatively coarse 3-D model grids of each of the bays. Both hydrodynamic and water quality simulations were performed. Tidal flux and stream discharges were used to force the model hydrodynamics. Volumetric flow comparisons and tidal elevations were used in calibration of the hydrodynamics. Water quality measurements including temperature, salinity, dissolved oxygen and various other water quality constituents, were compared with model results for water quality model calibration and verification.

Data collected during this study were provided to the Department of Natural Resources and were incorporated into the present study.

Raney, D.C., Doughty, J.O. and J. Livings. 1990. "Tidal Prism Numerical Model Investigation and Analysis Task of the Indian River Scour Study, Delaware". Report prepared for the Coastal Engineering Research Center, USACE. University of Alabama Bureau of Engineering Research Report No. 500-183.

Raney *et al.* (1990) used numerical modeling to assess the evolution of the increasing tidal prism for Indian River Inlet. The construction of jetties to stabilize the position of the inlet resulted in the increase of the tidal prism due to scour in the channel. They assessed the past and current hydrodynamic conditions in the inlet and examined the severe scour that occurs at specific positions within the inlet.

Field measurements were conducted by the U.S. Army Waterways Experiment Station, Coastal Engineering Research Center (CERC) to obtain existing conditions and provide calibration data for the WES Implicit Flooding Model (WIFM), which was used to simulate the hydrodynamics for the system. Data was collected during the neap and spring tides separately. Data collection during the neap tide included an offshore tide gauge near the inlet, a side scanning sonar survey within the inlet, a dye injection from two sites near the Indian River Inlet bridge during peak ebb and flood tides, and vertical profiles of currents in the inlet and in passes into Rehoboth Bay. The dye injections were visualized with aerial photography to assess the surface currents. The vertical current profiles were repeated in the spring tide. In addition flow fields near the jetty and bridge scour locations were also collected. A bathymetric survey of the entire system was conducted.

Raney *et al.* (1990) calibrated, verified, and used the numerical model to simulate historic hydrodynamics to observe the tidal prism evolution. The spring tide data collection was used to calibrate the model for a 63 hour period, June 29 to July 1, 1989. Typical ocean tide (CERC) and wind data ("old" USGS station north of the inlet) were used to force the model. Tide data

inside the bays was obtained from the United States Department of the Interior, Geological Survey (USGS) to calibrate the water levels inside the bay. Velocity measurements were recorded across Indian River Inlet, and on either side of Middle Island. Velocity was found to be fairly uniform over depth indicating that a depth-averaged model is applicable. They found the calibration to agree well, except at the Massey gauge, where the complexity of the bay geometry caused a significant difference between prototype values and model results.

The verification occurred only with tide gauges during a neap tide. It was shown in the calibration procedure that if surface elevations were similar, velocities were also similar. Verification resulted in good agreement between the numerical model's ranges and phases, however, there were differences in raw values. Since the model was proven to predict tidal ranges, it could be used to predict the tidal prism associated with the Inland Bays.

Raney *et al*. (1990) then used model to predict historical tidal prisms. Historical bathymetry was limited, and much of it had to be combined to approximate a bathymetry for a time period. 17 cases were run at various time periods from 1941 through 1988. They found that large changes in the hydrodynamics of the bay have occurred, but were most pronounced after 1970, with an almost linear increase in tidal range over time. They also found that velocities through the inlet remain similar despite the increase in depth of the inlet. The inlet was found to not have reached an equilibrium condition, and tidal prism and range were expected to continue to increase. Reduction of the tidal prism would require a reduction of the cross-section.

Schwimmer, R.A. 2001. "Rates and Processes of Marsh Shoreline Erosion in Rehoboth Bay, Delaware, U.S.A." Journal of Coastal Research, Vol. 17 No. 3, pp. 672-683

Schwimmer (2001) conducted marsh shoreline surveys at 6 locations in western Rehoboth Bay over a period of three years. Surveys were performed at five locations in Horse Island Marsh and one location on Marsh Island. Data on longer-term shoreline change at nine locations (three from the Horse Island area and six from Delaware Bay) were also obtained from previous studies.

Measured erosion rates on a yearly basis ranged from 9 ± 4 cm/year to 52 ± 4 cm/year. The greatest average rate of erosion over the entire three year period was 43 ± 4 cm/year on Marsh Island. These data as well as historical shoreline data were used to develop a predictive relationship between marsh erosion rate and wave power.

In addition, observations of three styles of marsh erosion were made in the study area, classified as 1) cleft and neck formation, 2) neck cut-off, and 3) undercutting with root mat toppling. A possible feedback mechanism was hypothesized that could account for iterations between these styles over time. Over relatively large distances, the marsh shoreline configuration was determined to be controlled by the antecedent topography rather than laterally variable shoreline rates of change.

Swisher, M.L. 1982. "The Rates and Causes of Shore Erosion Around a Transgressive Coastal Lagoon, Rehoboth Bay, Delaware", MS Thesis, University of Delaware. 210 p.

Swisher (1982) studied the rates and causes of coastal erosion around the northern, western, and southern shorelines of Rehoboth Bay. Both historical and short term shoreline change were analyzed. Natural shoreline processes such as sediment transport and storm erosion in conjunction with artificial processes such as dredging and development were examined to explain the highly variable shoreline change values which were calculated.

Historical trends were evaluated using four sets of aerial photography dated 1938, 1954, 1968 and 1981. The shoreline was divided into 68 sections from which average linear erosion rates were calculated between shoreline positions of consecutive years. The results indicated that the long term trends in shoreline change are extremely variable ranging from -9.5 m/yr to +13.8 m/yr. The average change rates for the entire northern shoreline ranged from -0.3 m/yr during the 1938-1954 time period to +1.1 m/yr during the 1954-1968 time period. The average rates for the western and southern shoreline ranged from -0.4 m/yr to -0.6 m/yr and -0.1 m/yr to -0.2 m/yr respectively. In general, most areas of the bay have been experiencing net erosion rates of -1 m/yr or less.

To examine short-term shoreline change, fifteen sites were selected along the bay shoreline and monitored from August 1981 to May 1982. Sites were monitored approximately every month to determine volumetric changes in profiles taken perpendicular to the shoreline. The net change between survey dates and cumulative change for the entire study period were calculated. The largest cumulative changes in profile area ranged from -11.3 m^2 along the southern shoreline to +4.8 m^2 along the northwest shoreline. Ten of the fifteen sites experienced a negative cumulative change over the study period.

The highest variation in shoreline change and largest overall erosion rates occur along the southern shoreline due to the long fetch, northern orientation, proximity to tidal currents, and high supply of dredge material. The western shoreline has had the least overall variation in shoreline changes attributed to the least amount of dredging and development. Results from both the long-term aerial photo study and the short term profile monitoring study also indicated that marsh shorelines eroded faster than beach shorelines.

Wong, K-C. 1987. "Tidal and Subtidal Variability in Delaware's Inland Bays" Journal of Physical Oceanography, Vol 17, pp. 413-422

During a three-month period from mid-September to mid-December 1984, water level data were obtained at Dewey Beach (northern end of Rehoboth Bay), Vines Creek (western end of Indian River Bay), Indian River Inlet, and at Breakwater Harbor. Dewey Beach and Vines Creek data were obtained from the US Geological Survey; Indian River Inlet and Breakwater Harbor data were made available by the National Oceanic and Atmospheric Administration (NOAA).

To examine tidal fluctuations, Wong (1987) applied harmonic analyses to determine harmonic constants for 27 tidal constituents. On the open coast, tides were found to be semi-diurnal in nature with M_2 being the dominant constituent. Tidal amplitudes of all major constituents were appreciably attenuated within the inland bays, with attenuation increasing to the west of Indian River Bay and into Rehboth Bay. Wong (1987) noted that due to the presence of multiple constituents with varying attenuation, the tides in the bays exhibit complicated patterns. For example during one period a strong diurnal inequality was observed while six days later, little inequality was noted.

Subtidal fluctuations were not attenuated to the same degree as the tidal fluctuations. Wong's analyses suggested that exchange between the inland bays and the ocean and subtidal frequencies was primarily caused by coastal sea level fluctuations induced by atmospheric forcing on the shelf. This low-frequency coastal forcing was noted to be an important exchange process that is virtually unattenuated in the bays, with the inland bays being pumped by the adjacent shelf water at low frequencies.

Wong, K-C and J. DiLorenzo. 1988. "The response of Delaware's Inland Bays to Ocean Forcing" Journal of Geophysical Research, Vol 93. No 10. pp. 12,525-12,535

Wong and DiLorenzo (1988) performed current meter observations and gathered water level data to analyze the forcing mechanisms of the inland bays. Current meters were deployed from May 23 to August 4, 1986 in Indian River Inlet and the southern entrance of Massey's Ditch. US Geological Survey (USGS) water level data were obtained and analyzed at Dewey Beach in Rehoboth Bay and Vines Creek in Indian River Bay. Additional water level data were obtained from NOAA at Indian River Inlet.

Very strong tidal currents with amplitudes on the order of 150 cm/sec were observed at Indian River Inlet. At Massey's Ditch, current amplitudes were significantly lower, on the order of 60 cm/sec. Both diurnal and semidiurnal tidal signals were evident in the water level time series within the bays. Tidal amplitudes at Dewey Beach (approximately 15 cm) were appreciably lower than those at Vines Creek (approximately 30-45 cm). At Indian River Inlet, tides were found to be primarily semidiurnal with amplitudes of approximately 50-60 cm. Semidiurnal tide amplitudes decreased more appreciably than diurnal tides within the bays. Wong and DiLorenzo considered the inland bays behavior similar to a low-pass filter wherein semidiurnal tides are dissipated more heavily than lower-frequency diurnal tides. The overall tidal variance of Rehoboth Bay was much lower than that of Indian River Bay, due to the indirect communication of that bay with the Atlantic Ocean. Subtidal fluctuations were largely unattenuated in the inland bays. Subtidal variability was primarily coastally forced, with local wind forcing playing only a secondary role.

Wong and DiLorenzo (1988) developed a conceptual frequency-dependent pumping model to examine the response of the bays to ocean forcing. Their results indicated that the model adequately describes the first-order, frequency dependent response of the inland bays to coastal sea level forcing.

Wong, K.-C. 1991. "The effect of coastal sea level forcing on Indian River Bay and Rehoboth Bay, Delaware". Estuarine, Coastal and Shelf Science 32:213-229.

In this paper, Wong (1991) extends the work of Wong and DiLorenzo (1988) in examining the frequency-dependent response of the bays to coastal sea level forcing from the Atlantic Ocean and Delaware Bay. An analytical model of the Indian River Inlet-Indian River Bay-Massey's Ditch-Rehoboth Bay-Lewes and Rehoboth Canal system was developed to examine the relative importance of coastal forcing from the Atlantic Ocean and Delaware Bay.

Analyses indicated that coastal forcing as conveyed via Indian River Inlet dominates the sea level and current responses in the inland bays at all frequencies. Coastal forcing from Delaware Bay could account for a sizeable fraction of the volume flux through the bays at very low frequencies (monthly or longer time scales), but the flow produces only slight sea level responses. The model further suggested that the response of the inland bays to coastal forcing depends strongly on the degree to which the two bays are coupled. Any modification of the connections (for example, at Massey's Ditch) would be expected to produce significant variations in the response characteristics of both bays.

Wong, K.-C. and X. Lu. 1994. "Low frequency variability in Delaware's inland bays". Journal of Geophysical Research 99(C6):12,683-12,695.

During the time span of September 25 to December 1, 1989, six current meters and one tide gauge were deployed in the inland bays by Wong and Lu (1994). Two current meters were deployed at locations across Indian River Inlet; two across Massey's Ditch, and two along the northern and southern reaches of the Lewes-Rehoboth Canal. A tide gauge was installed along the shore of Indian River Inlet adjacent to the location of the current meters. Additional water level data were obtained from USGS gauges at Pot Nets, Massey's Ditch, and Dewey Beach, and from NOAA gauges at Cape Henlopen and Atlantic City. Wind data were obtained from the US Coast Guard station just inside Indian River Inlet. Salinity was computed based on temperature and conductivity measurements.

Because this study was designed to examine subtidal variability, the data sets were filtered to remove short period tidal oscillations. Sea level was found to exhibit significant subtidal fluctuations with a peak value of 75 cm and standard deviation of 23 cm. Results suggested that subtidal sea level fluctuations at the entrance of the inland bays were produced by a combination of wind-forced motion on the shelf and southward propagation of free waves. Subtidal fluctuations within the interior of the bays were found to be highly coherent with those at the inlet. There is appreciable phase lag between sea level in Rehoboth Bay and that at Indian River Inlet; at the northern end of Rehoboth Bay the lag was found to be approximately 10 hours. Indian River Bay showed little to no phase lag.

Observed currents in the channels showed considerable subtidal fluctuations in excess of 25 cm/sec. Results indicated that most of the subtidal variability at timescales of 2 to 7 days were forced by coastal sea level fluctuations. At longer time scales, a two-layer residual circulation

pattern was found with a surface outflow and bottom inflow, consistent with density-induced gravitational circulation. Salinity variations at Indian River Inlet and Massey's Ditch were not found to be closely linked to atmospherically-induced coastal sea level fluctuations, but rather strongly influenced by the low-salinity discharge from Delaware Bay. Within the Lewes-Rehoboth Canal, however, salinity variations were closely related to the atmospherically forced flow through the canal.

APPENDIX B –DATA SOURCES

Environmental Conditions

Data	Information Available
Winds/Climate - Indian River Coast Guard Station	1975 to 1984
Winds/Climate – Georgetown Airport	1997 to 2006
Winds/Climate - Dover Air Force Base	2000 to 2006
Tides - Lewes	1957 to Present
Tides - Indian River Inlet	1977 to 1986
Tides - White Oak Point within Rehoboth Bay	July 10, 1984 to July 16, 1984
Tides – Millsboro Bridge, Indian River Bay	07/11/1984 15:00 - 07/17/1984
Tides – Oak Orchard, Indian River Bay	07/13/1984 00:00 - 07/18/1984
Tides (gauge height)- USGS Rehoboth Bay at Dewey Beach	1985-1997; October 2000 to Present
Tidal Benchmarks - Lewes and Indian River Inlet	
Currents – Various Locations	Measurements available from previous studies.
Waves – Dewey Beach (offshore CHL gauge)	Oct 1992- May 1995
Waves - Bethany Beach (offshore CHL gauge)	March 2006 – Present
Waves – WIS Station 156	1980 – 1999

Basemapping Data

Data	Information Available
Gnis_names	Feature Names (DataMIL)
Boundarylines	MD-DE Boundary (DataMIL)
De_outline_line	State outline (DataMIL)
Deldot_roads	DOT roads (DataMIL)
Hydrography_areas	Water bodies (DataMIL)
1997 DOQQs	Aerial images from state of Delaware
1992 DOQQs	Aerial images from state of Delaware
2002 DOQQs	Aerial images from state of Delaware – only available dynamically online
Misc Navigation Charts	NOAA
de_rb00	Benthic Mapping – includes SAV locations and depths in Rehoboth Bay. Collected in 2000 using RoxAnn acoustic sensor.
DataSources	Shapefile with mapped environmental conditions data sources

dtl_cnty	County boundaries
de_outline_line	Outline of State of Delaware
DE_shoreline/ Inland_Bays_Coastline_UTM18N	Approximate shoreline clipped from NOAA EVS shoreline
Dredging_Projects	Approximate location of historical dredging projects from list provided by DNREC

Bathymetry

Data	Information Available
de_rb00	Depths in Rehoboth Bay (not detailed in shallow areas ie < 1.4m) from 2000 RoxAnn survey
Geodas surveys: H08596 (1963), H08710 (1962), H09136 (1970), H09714 (1977), D00023 (1984)	XYZ points (most to MLW)
1988/1989 "Shore to Shore" USACE survey	Scanned images only of Indian River Inlet and Bay and Rehoboth Bay
Limited CADD files of Massey's Ditch, Lewes-Rehoboth Canal and Indian River Inlet and Bay	Extents are very limited but have recent data (Massey's – 2004, IRI – 2006, L-R Canal – 2006)
2004 survey from DNREC	XYZ Points
CADD files of Herring Creek, Guinea Creek, Love Creek, and Bald Eagle Creek	Depths of surveys conducted in 1998, 2000, 2001, and 2004

APPENDIX C – SUMMARY OF DREDGING PROJECTS

STATE DREDGE PROGRAM PROJECTS
1970 - PRESENT

"DIXIE I/DIAMOND STATE/BROADKILL"

DATE	PROJECT	QTY. DRED. (cu. yds.)	PURPOSE
1. May 1970	Acquired "Dixie I" Dredge		
2. July 1970 - June 1971	Love Creek	168,000	Navigational Channel
3. Oct. 1971 - Aug. 1972	White Creek	135,000	Navigational Channel
4. Nov. 1972 - May 1973	Lewes Beach	69,800	Beach Nourishment
5. Oct. 1973 - Dec. 1973	Bowers Beach	15,800	Beach Nourishment
6. May 1974 - Sept. 1974	Bowers Beach	28,800	Beach Nourishment
7. Dec. 1974 - Jan. 1975	South Bowers Beach	15,100	Beach Nourishment
8. Jan. 1975 - March 1975	Woodland Beach	27,000	Beach Nourishment
9. March 1975 - April 1975	Burton's Island Marina	6,000	Marina Facility
10. April 1975 - May 1975	Rehoboth Bay Sailing Association	2,100	Marina Facility
11. June 1975	South Shore Marina	3,000	Marina Facility
12. Sept. 1975 - July 1976	Rehoboth Bay Borrow Pits	166,035	Filling of Bay Trenches
13. July 1976 - Aug. 1976	Burton's Island Marina	8,500	Marina Facility
14. Nov. 1976 -	Major Maintenance and		

March 1977	Repairs		
15. March 1977 - Aug. 1977	Guinea Creek	75,450	Navigational Channel
16. Sept. 1977	Lewes Beach	11,400	Beach Nourishment
17. Oct. 1977	U of D/CMS Harbor (Lewes)	12,650	Harbor Facility
18. Nov. 1977 - Feb. 1978	Henlopen Acres Marina	7,500	Marina Facility
19. March 1978 - April 1978	Burton's Island Marina	9,000	Marina Facility
20. May, 1978 - Sept. 1978	Herring Creek	20,000	Navigational Channel
21. Oct. 1978 - Dec. 1978	Lewes Beach	31,000	Beach Nourishment
22. Dec. 1978 - Jan. 1979	Cozy Cove	17,745	Navigational Channel
23. Feb. 1979 - March 1979	U of D/CMS Harbor	7,986	Harbor Facility
24. March 1979 - July, 1979	Folly Pond/ Banning Park, Wilmington	28,000	Pond Restoration
25. July 1979 - Sept. 1979	Major Maintenance and Repairs		
26. Sept. 1979 - Nov. 1979	Slaughter Beach	20,000	Beach Nourishment
27. Nov. 1979 - Jan. 1980	Cedar Creek	20,000	Navigational Channel
28. Jan. 1980 - Feb. 1980	Del. Bay Launch Service (Slaughter Beach)	---	Marina Facility
29. Feb. 1980	Bill-Lin-Sue Marina (Slaughter Beach)	3,000	Marina Facility

30. March 1980 - Nov. 1980	Burton's Island Marina	112,940	Marina Facility
31. Dec. 1980 - Sept. 1981	Herring Creek	60,000	Navigational Channel
32. Oct. 1981 - Feb. 1982	Little River	87,200	Navigational Channel
33. March 1982 - May 1982	Burton's Island Marina	6,000	Marina Facility
34. May 1982 - Jan. 1983	Feeder Beach (North I. R. Inlet)	223,900	Beach Nourishment
35. Feb. 1983 - May 1983	Indian River, Millsboro	37,000	Navigational Channel
36. June 1983 - Aug. 1983	Wilson Creek	27,000	Navigational Channel
37. Aug. 1983 - Sept. 1983	Herring Creek/ Burton's Prong	5,000	Navigational Channel
38. Oct. 1983 - Jan. 1984	Mispillion River (Inlet Area)	9,000	Navigational Channel
39. Dec. 1983	Bowers Beach	3,000	Beach Nourishment
40. Jan. 1984 - March 1984	Summit North Marina	20,000	Marina Facility
41. April 1984 - May 1984	U of D/CMS Harbor	20,000	Marina Facility
42. June 1984	U.S. Coast Guard - Lewes	1,600	Mooring Facility
43. June 1984 - Aug. 1984	South Bowers Beach	22,000	Beach Nourishment
44. Aug. 1984 - Dec. 1984	Slaughter Beach	10,000	Beach Nourishment
45. Jan. 1985 - March 1985	Summit North Marina	60,000	Marina Facility

46. April 1985	Del. City Mooring Basin	18,000	Mooring Basin
47. May 1985	Mispillion River (Inlet Area)	5,000	Navigational Channel
48. June 1985 - Aug. 1985	Slaughter Beach	40,000	Beach Nourishment
49. Sept. 1985 - March 1986	Mispillion River Breach	50,000	Breach Closure
50. March 1986 - May 1986	Broadkill River	5,000	Navigational Channel
51. March 1986	Acquired "Diamond State" Dredge		
52. May 1986 - June 1986	Slaughter Beach	40,000	Beach Nourishment
53. June 1986 - March 1987	Broadkill River	68,000	Navigational Channel
54. May 1987	Massey's Ditch	10,000	Navigational Channel
55. June 1987	Murderkill River	10,000	Navigational Channel
56. June 1987 - Dec. 1987	Broadkill Beach	15,000	Beach Nourishment
57. Jan. 1988 - May 1988	Bowers Beach	50,000	Beach Nourishment
58. May 1988 - June 1988	Kitts Hummock	25,000	Beach Nourishment
59. June 1988 - Oct. 1988	Broadkill Beach	100,000	Beach Nourishment
60. Nov. 1988 - April 1989	Lewes Beach	111,000	Beach Nourishment
61. May 1989	Mispillion River Breach	12,000	Breach Closure
62. Aug. 1989 - Sept. 1989	Lewes-Rehoboth Canal	20,000	Navigational Channel

63. Nov. 1989 - March 1990	Feeder Beach (North I. R. Inlet)	180,000	Beach Nourishment
64. April 1990 - May 1990	Massey's Ditch	15,000	Navigational Channel
65. June 1990	Augustine Beach Boat Ramp	2,000	Boat Launching Facility
66. July 1990 - Aug. 1990	Pickering Beach	55,000	Beach Nourishment
67. Feb. 1991 - June 1991	Lewes-Rehoboth Canal	10,000	Navigational Channel
68. July 1991	Massey's Ditch	7,000	Navigational Channel
69. Aug. 1991	Murderkill River	7,000	Navigational Channel
70. Sept. 1991 - Dec. 1991	Indian River, Millsboro	40,000	Navigational Channel
71. Jan. 1992 - April 1992	Feeder Beach (North I. R. Inlet)	150,000	Beach Nourishment
72. April 1992	Augustine Beach Boat Ramp	2,000	Boat Launching Facility
73. May 1992 - Aug. 1992	Indian River, Millsboro	30,000	Navigational Channel
74. Aug. 1992	Murderkill River	6,000	Navigational Channel
75. Oct. 1992	Mispillion River Breach	25,000	Breach Closure
76. Nov. 1992 - March 1993	Major Maintenance and Repairs		
77. March 1993 - April 1993	Summit North Marina	5,600	Maintenance
78. April 1993	Augustine Beach Boat Ramp	2,000	Boat Launching Facility
79. June 1993 - Oct. 1993	Broadkill Beach	37,000	Beach Nourishment

80. Dec. 1993 - May 1994	Mahon River	40,000	Navigational Channel
81. May 1994 - June 1994	Roosevelt Inlet	15,000	Navigational Channel (DELRIVER Shoal)
82. June 1994 - Sept. 1994	Broadkill Beach	30,000	Beach Nourishment
83. Oct. 1994 - Dec. 1994	Major Maintenance and Repairs		
84. Jan. 1995 - March 1995	Quillen's Point	12,000	Navigational Channel
85. May 1995 - June 1995	Mispillion River (Inlet Area)	15,000	Navigational Channel
86. June 1995 - Sept. 1995	Mispillion River, Milford	40,000	Navigational Channel
87. Oct. 1995 - May 1996	Ted Harvey Wildlife Area	50,000	Beach Nourishment/ Dune Restoration
88. May 1996 - June 1996	Murderkill River	5,000	Navigational Channel
89. June 1996 - July 1996	Broadkill Beach	25,000	Beach Nourishment
90. Aug. 1996 - Oct. 1996	Kitts Hummock	32,850	Beach Nourishment
91. Oct. 1996 - Nov. 1997	Major Maintenance and Repairs		
92. Jan. 1998 - Feb. 1998	Ted Harvey Wildlife Area	3,000	Beach Nourishment/ Dune Restoration
93. March 1998 - May 1998	Bowers Beach	46,240	Beach Nourishment
94. May 1998 - July 1998	Major Maintenance and Repairs*		* Due to Permit Time of Year Restrictions

95. Aug. 1998 - Nov. 1998	Bowers Beach	40,000	Beach Nourishment
96. Dec. 1998 - April 1999	Ted Harvey Wildlife Area		Beach Nourishment/ Dune Restoration
97. May 1999 - Sept. 1999	Major Maintenance and Repairs*		* Due to Permit Time of Year Restrictions
98. Sept. 1999 - March 2000	Broadkill Beach	40,000	Beach Nourishment
99. March 2000 Jan. 2001	Major Maintenance and Repairs*		* Due to Dredge Sinking
100. March 2001 Nov. 2001	Pickering Beach	27,000	Beach Nourishment
101. Jan. 2002 - April 2002	Massey's Ditch Indian River (downstream)	15,000	Navigational Channel
102. Sept. 2002 - Dec. 2005	Slaughter Beach	114,970	Beach Nourishment*
103. July 2003 - Dec.. 2005	Broadkill Beach	152,170	Beach Nourishment*
104. Oct. 2004	"Diamond State" sold to Baltimore Dredges, LLC		
105. Sept. 2005	Acquired "Broadkill" Dredge		
106. Sept. 2006 - Present	U of D/CMS Harbor	24,000	Harbor Facility

* started by State: completed using a private contractor.

"BLUE HEN/INDIAN RIVER"

DATE	PROJECT	QTY. DRED. (cu. Yds.)	PURPOSE
1. March 1982	Acquired "Blue Hen" Dredge		
2. July 1982 - Dec. 1982	Jefferson Creek	38,820	Navigational Channel
3. Jan. 1983 - Sept. 1983	Lake Como, Smyrna	35,000	Pond Restoration
4. Oct. 1983 - July 1984	Bethany Loop Canal	25,650	Navigational Channel/ Drainage Relief
5. Sept. 1984 - March 1985	Cape Windsor	22,000	Navigational Channel
6. April 1985 - Oct. 1985	Silver Lake, Milford	20,500	Pond Restoration
7. Nov. 1985 - Feb. 1987	Pepper Creek - Phase I	70,000	Navigational Channel
8. Feb. 1987 - March 1988	Pepper Creek - Phase II	80,000	Navigational Channel
9. June 1988 - Aug. 1988	Lewes Beach (Roosevelt Inlet)	15,000	Beach Nourishment/ Shoal Removal
10. Dec. 1988 - Oct. 1990	Roy Creek	60,000	Navigational Channel
11. Jan. 1991 - Feb. 1991	Henlopen Acres Marina/ Sandy Bottoms	8,500	Marina Facility
12. Feb. 1991 - June 1991	Lewes-Rehoboth Canal	10,000	Navigational Channel
13. July 1991 - Oct. 1991	U of D/CMS Harbor	24,000	Harbor Facility

14. Nov. 1991 - March 1992	Major Maintenance and Repairs		
15. June 1992 - July 1992	Rehoboth Bay Sailing Association	1,800	Marina Facility
16. Sept. 1992 - Oct. 1992	Hunter's Pointe Condominiums	1,250	Navigational Channel
17. Nov. 1992 - April 1993	Pepper Creek	20,000	Navigational Channel
18. April 1993	Gull's Way Campground Marina	7,200	Marina Facility
19. Nov. 1993 - April 1994	Pepper Creek	20,000	Navigational Channel
20. June 1994 - July 1994	Vines Creek	6,500	Navigational Channel
21. August 1994	Hunter's Pointe Condominiums	500	Navigational Channel
22. Sept. 1994 - August 1995	Pepper Creek	30,000	Navigational Channel
23. Sept. 1995 - Nov. 1996	Major Maintenance and Repairs		
24. Dec. 1996 - March 1997	Quillen's Point	15,000	Navigational Channel
25. April 1997 - June 1997	Major Maintenance and Repairs		
26. June 1997 - August 1997	Cedar Landing Subdivision Lagoon & Access Channel	10,000	Navigational Channel
27. Sept. 1997 - Dec. 1997	White Creek (main channel)	30,000	Navigational Channel
28. Dec. 1997	Banks Harbor Marina	900	Marina Facility
29. Dec. 1997 - March 1998	Cedar Landing Subdivision Lagoon & Access Channel	10,000	Navigational Channel

30. April 1998 - Nov. 1998	Major Maintenance and Repairs*		* Due to Permit Time of Year Restrictions
31. Dec. 1998 - Jan. 1999	Rogers Haven Access Channel & Lagoon	10,000	Navigational Channel
32. Feb. 1999 - May 1999	White Creek (west prong)	5,000	Navigational Channel
33. May 1999 - Sept. 1999	Major Maintenance and Repairs*		* Due to Permit Time of Year Restrictions
34. Oct. 1999 - April 2000	White Creek (west prong)	10,000	Navigational Channel
35. Oct. 2000 - Feb. 2001	White Creek (east prong)	15,000	Navigational Channel
36. Feb. 2001 - April 2001	U of D/CMS Harbor	20,000	Harbor Facility
37. Oct. 2001 - Jan. 2002	Indian River, Millsboro	20,000	Navigation Channel
38. Jan. 2002 - March 2002	Massey's Ditch Indian River (downstream)	-	Assisted Diamond State with project
39. Sept. 2002 - Dec. 2002	Massey's Ditch	15,000	Navigational Channel
40. Sept. 2003 - Feb. 2004	Indian River Inlet Marina – Phase I	32,500	Marina Facility
41. Feb. 2004	"Blue Hen" Retired from Service		
42. Sept. 2004 - Feb. 2005	Indian River Inlet Marina – Phase II	32,500	Marina Facility (completed with leased dredge)
43. June 2005	Acquired "Indian River" Dredge		
44. Sept. 2006 - Present	Assawoman Canal		Navigational Channel

NEW CASTLE CONSERVATION DISTRICT DREDGE
1984 - PRESENT

"S. A. S. TRAPNELL/SEIDEL"

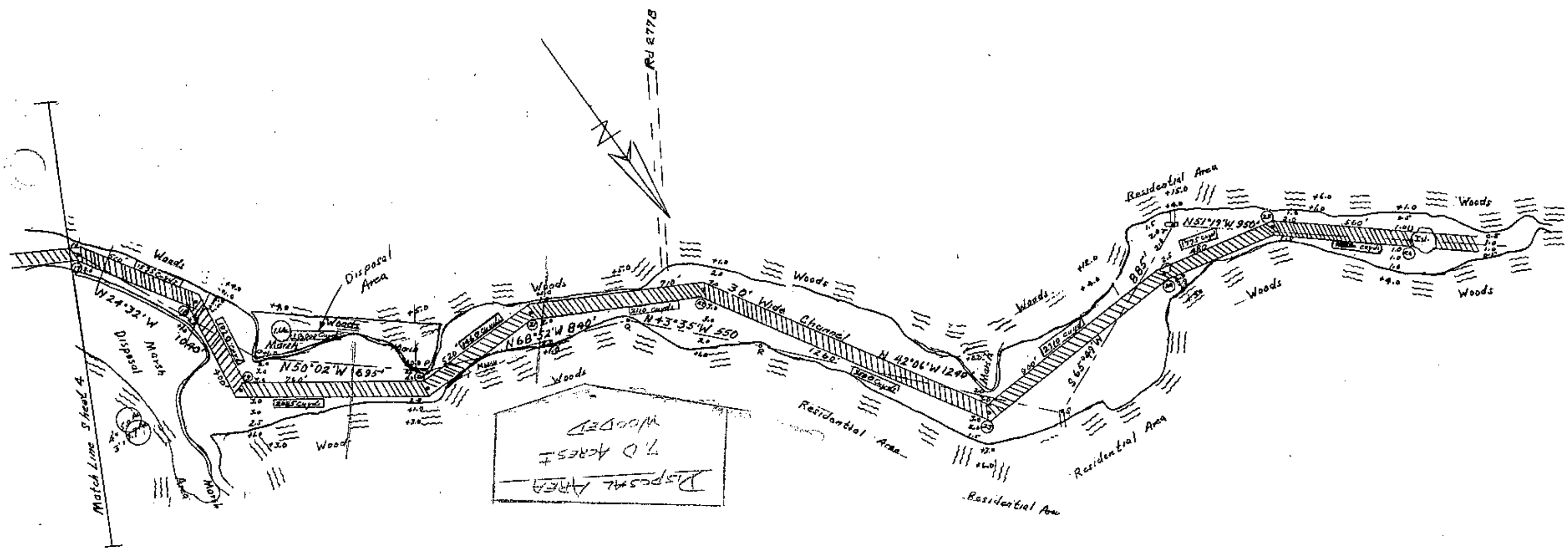
DATE	PROJECT	QTY. DRED. (cu. Yds.)	PURPOSE
1. April 1984	Acquired "Trapnell" Dredge		
2. May 1984 - Dec. 1985	Noxontown Pond (Middletown)	125,000	Pond Restoration
3. Jan. 1986 - March 1986	Major Maintenance and Repairs		
4. March 1986 - June 1986	Carousel Pond	30,000	Pond Restoration
5. July 1986 - Aug. 1986	Silver Lake, Milford	10,000	Pond Restoration
6. Sept. 1986 - Sept. 1987	Derby Pond	70,000	Pond Restoration
7. Oct. 1987 - April 1988	Smalley's Pond Project Set-up		
8. May 1988 - Aug. 1988	Delaware City Mooring Basin	19,700	Mooring Facility
9. Sept. 1988 - April 1989	Summit North Marina	50,000	Marina Facility
10. June 1989 - March 1991	Smalley's Pond	50,000	Pond Restoration
11. May 1991	Augustine Beach Boat Ramp	2,000	Boat Launching Facility
12. June 1991	Delaware City Mooring Basin	18,000	Mooring Facility
13. Nov. 1991 - Aug. 1993	Moores Lake	70,000	Pond Restoration

14. Sept. 1993 - March 1994	Major Maintenance and Repairs		
15. April 1994	Augustine Beach Boat Ramp	2,000	Boat Launching Facility
16. May 1994 - Dec. 1994	Delaware City Mooring Basin/Ft. Delaware Launching Facility	24,000	Mooring Basin/ Launching Facility
17. Jan. 1995 - May 1995	Major Maintenance and Repairs		
18. June 1995 - Jan. 1996	Indian River, Millsboro	20,000	Navigational Channel
19. Feb. 1996 - April 1996	Quillen's Point	10,000	Navigational Channel
20. June 1996	Augustine Beach Boat Ramp	2,000	Boat Launching Facility
21. July 1996 - Dec. 1996	U of D/CMS Harbor	16,000	Harbor Facility
22. Jan. 1997 - March 1997	Major Maintenance and Repairs		
23. April 1997	Augustine Beach Boat Ramp	2,000	Boat Launching Facility
24. May 1997 - June 1997	Rehoboth Bay Sailing Association	2,000	Marina Facility
25. June 1997 - July 1997	U of D/CMS Harbor	3,000	Harbor Facility
26. Aug. 1997 - Feb. 1998	Summit North Marina	40,000	Marina Facility
27. March 1998 - April 1998	Augustine Beach Boat Ramp	2,000	Boat Launching Facility
28. June 1998 - Oct. 1998	Summit North Marina	30,000	Marina Facility
29. Dec. 1998 -	The Cove	10,000	Marina Facility &

Feb. 1999			Access Channels
30. Feb. 1999 - May 1999	White Creek	-	Acted as Booster for Blue Hen
31. May 1999 - Sept. 1999	Major Maintenance and Repairs		
32. Sept. 1999 - Feb. 2000	Summit North Marina		Marina Facility
33. April 2000	Augustine Beach Boat Ramp	2,000	Boat Launching Facility
34. May 2000 - Sept. 2000	Major Maintenance and Repairs		
35. Oct. 2000 - Feb. 2001	White Creek	-	Served as Booster for Blue Hen
36. June 2003 - March 2004	Delaware City Mooring Basin	23,000	Mooring Basin/ Launching Facility
37. April 2004	Augustine Beach Boat Ramp	2,000	Boat Launching Facility
38. August 2004	U of D/CMS Harbor	2,300	Harbor Facility
39. Sept. 2004 - Feb. 2005	Indian River Inlet Marina – Phase II	-	Marina Facility (amount dredged included in State total)
40. Feb. 2005	"Trapnell" sold to Baltimore Dredges, LLC		
41. June 2005	Acquired "Seidel" Dredge		
42. July 2005 - Dec. 2005	Delaware City Mooring Basin	24,000	Mooring Basin/ Launching Facility
43. April 2006	Augustine Beach Boat Ramp	2,000	Boat Launching Facility
44. June 2006 - Present	Garrisons Lake	115,000	Pond Restoration

APPENDIX D – HISTORICAL DNREC DREDGING PLANS

LOVE CREEK 1970



C. Kenneth Carter & Assoc.
Fenwick Island, Delaware.
C. Kenneth Carter
Sept 1969 P.L.S. 243

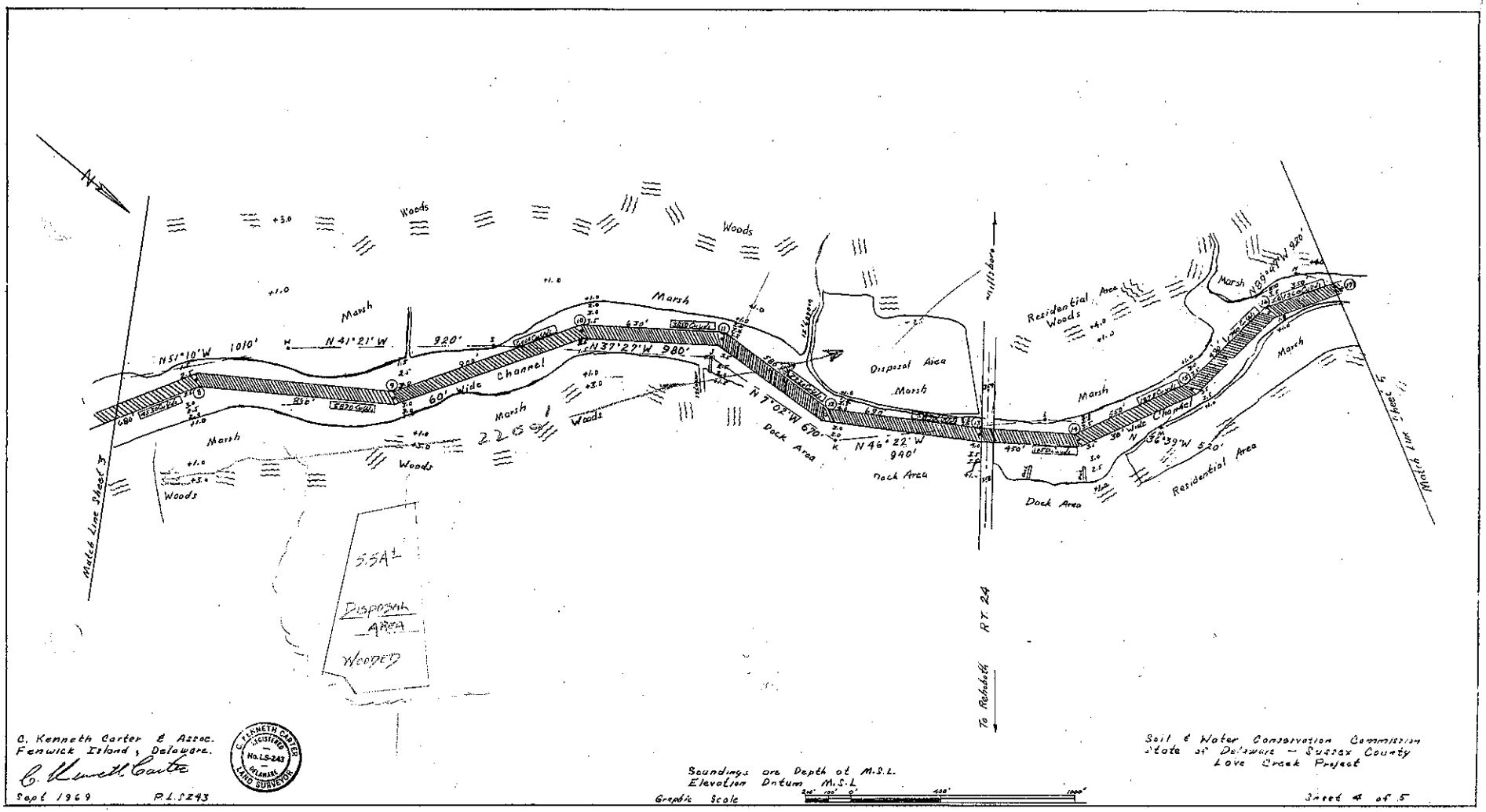
C. KENNETH CARTER REGISTERED No. LS-243 DELAWARE LAND SURVEYOR

Soundings are Depth at M.S.L.
Elevation Datum M.S.L.

Graphic Scale 200' 100' 0 400' 1000'

Soil & Water Conservation Commission
State of Delaware - Sussex County
Love Creek Project

Sheet 6 of 6



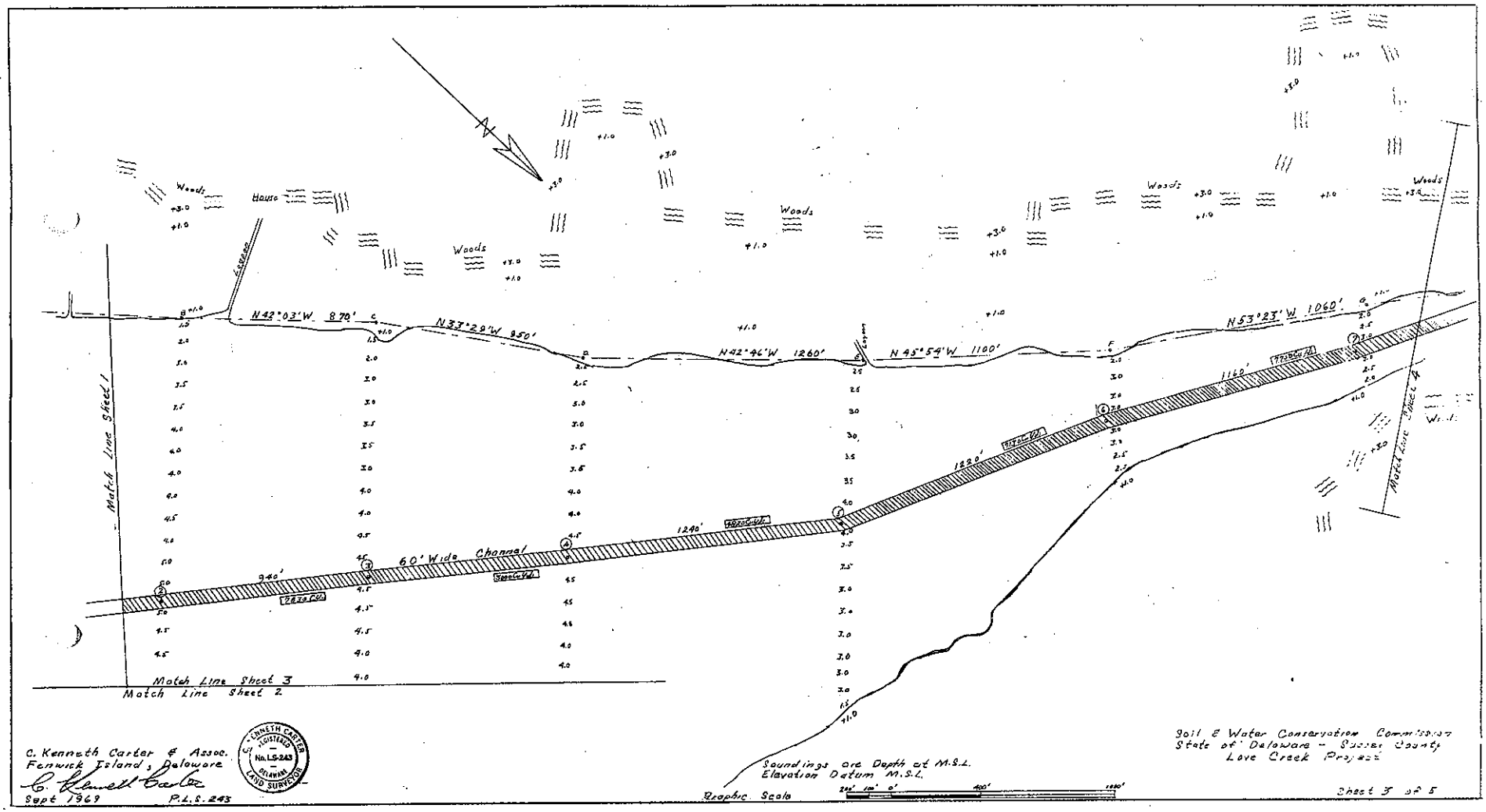
C. Kenneth Carter & Assoc.
Fenwick Island, Delaware.
C. Kenneth Carter
Sept 1969 P.L.S 243

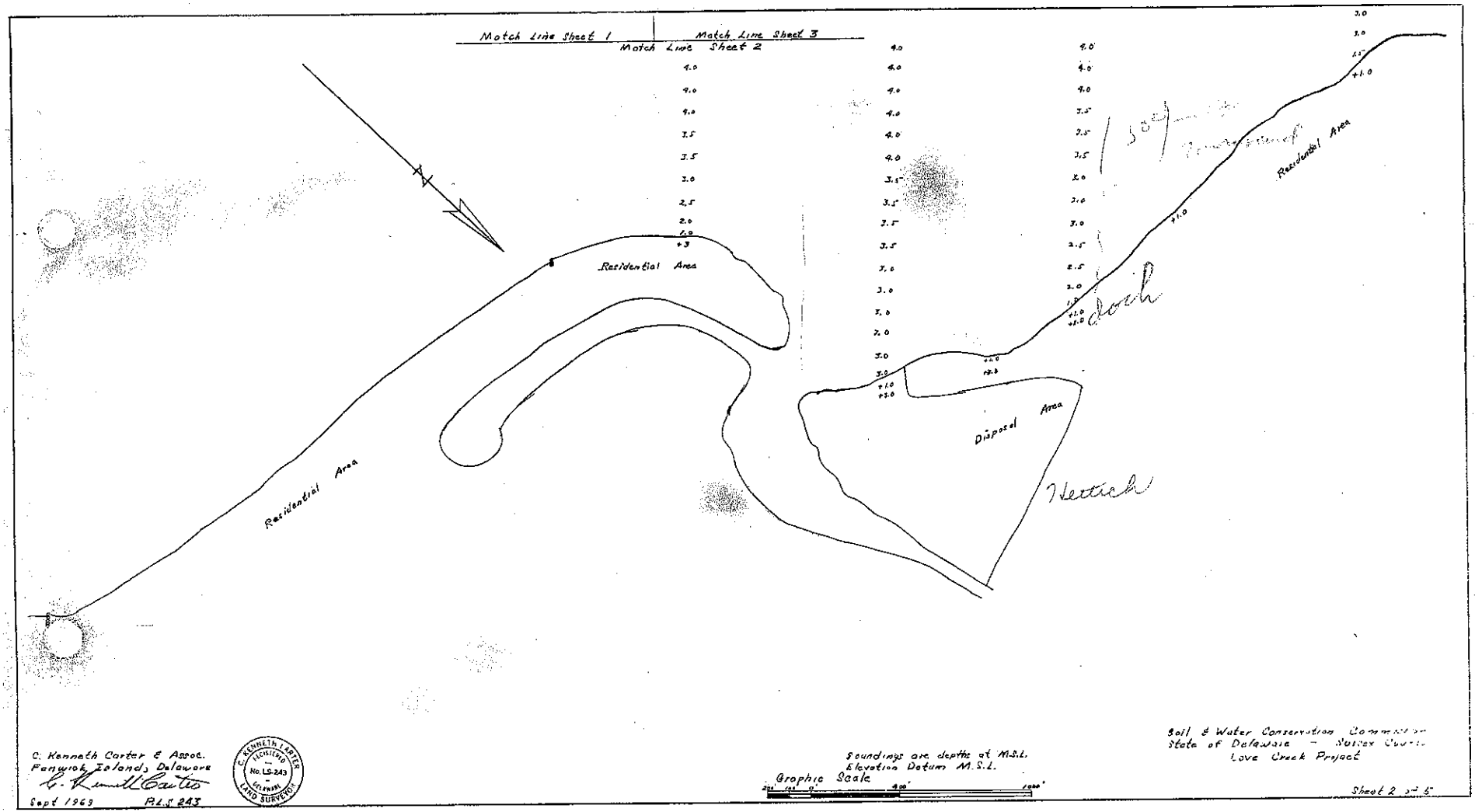
C. KENNETH CARTER REGISTERED No. LS-243 DELAWARE LAND SURVEYOR

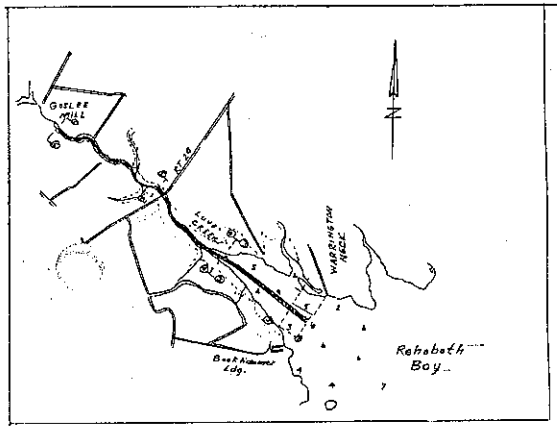
Soundings are Depth at M.S.L.
Elevation Datum M.S.L.
Graphic Scale 200' 100' 0' 400' 1000'

Soil & Water Conservation Commission
State of Delaware — Sussex County
Love Creek Project

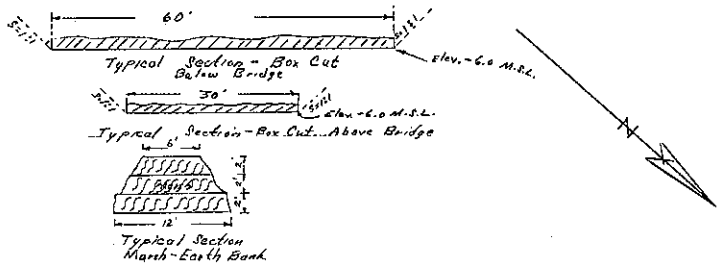
Sheet 4 of 5

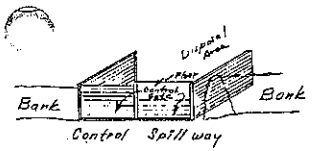

Woods
House
Woods
Woods
Woods
Woods
N42°03'W 870'
N33°29'W 950'
N42°46'W 1260'
N45°54'W 1100'
N53°23'W 1060'
60' Wide Channel
940'
1240'
1220'
1160'
Match Line Sheet 1
Match Line Sheet 3
Match Line Sheet 2
Match Line Sheet 4
Soundings are Depth at M.S.L.
Elevation Datum M.S.L.
Graphic Scale
C. Kenneth Carter & Assoc.
Fenwick Island, Delaware
C. Kenneth Carter
Sept 1969 P.L.S. 243
C. KENNETH CARTER REGISTERED No. LS-243 DELAWARE LAND SURVEYOR
Soil & Water Conservation Commission
State of Delaware - Sussex County
Love Creek Project
Sheet 3 of 5

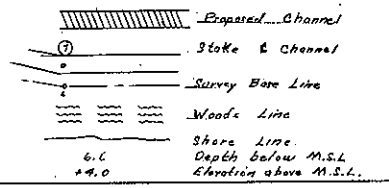

Match Line Sheet 1
Match Line Sheet 3
Match Line Sheet 2
Residential Area
Residential Area
Residential Area
Disposal Area
Hettich
Soil & Water Conservation Commission
State of Delaware - Sussex County
Love Creek Project
Soundings are depths at M.S.L.
Elevation Datum M.S.L.
Graphic Scale
Sheet 2 of 5
C. Kenneth Carter & Assoc.
Fenwick Island, Delaware
Sept 1969
P.L.S 243
C. KENNETH CARTER
REGISTERED
No. LS-243
DELAWARE
LAND SURVEYOR

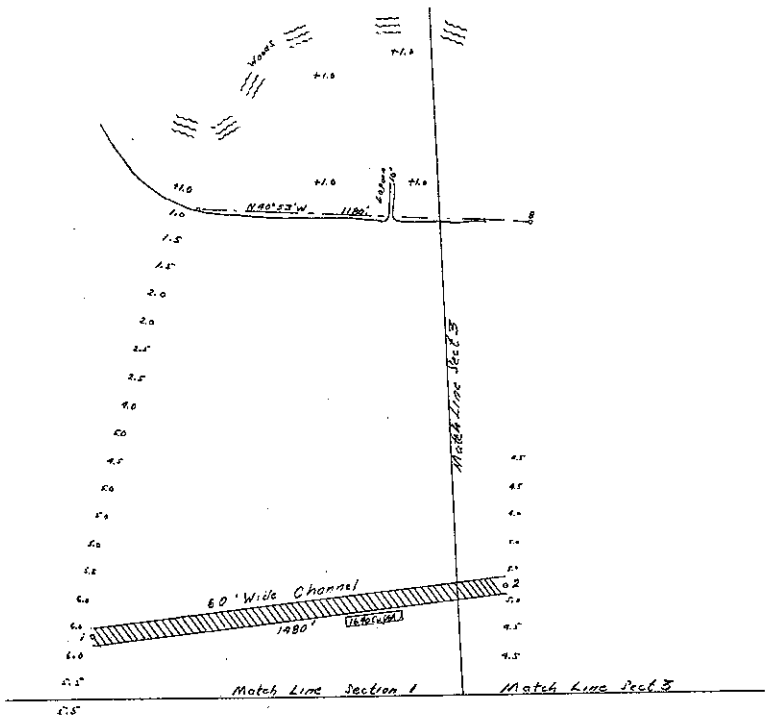


Vicinity Map
C & G.S 411









Total L.F Bank 7,500'
Total Disposal Area = 17 Ac.
Total Cu. Yds Dredge = 83,400 cu yds.

NOTE:
To Convert to M.L.W. subtract 1.5' from M.S.L.

Soundings are depths at M.S.L.
Elevations Datum M.S.L.
Graphic Scale
0 400 1000'

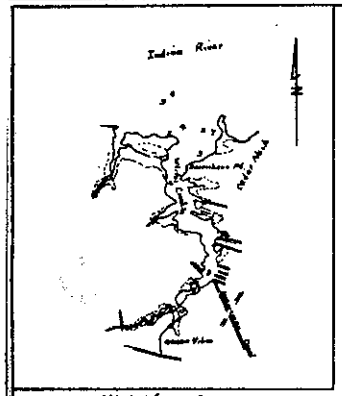
C. Kenneth Carter & Assoc
Fenwick Island, Delaware
Sept 1969 P.L.S. 243

C. KENNETH CARTER REGISTERED No. LS-243 DELAWARE LAND SURVEYOR

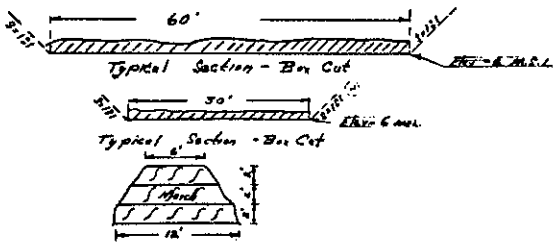
Soil & Water Conservation Commission
State of Delaware - Sussex County
Love Creek Project

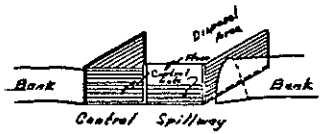
Sheet 1 of 5

WHITE CREEK 1971



Vicinity Map
C.E.B.S. 411





NOTES:
Total Lin. Feet 40' Channel 11,610 L.F
Total Lin. Feet 45' Channel 5,810 L.F.
Total Cu. Yds. 134992 cu yds.

Proposed Channel

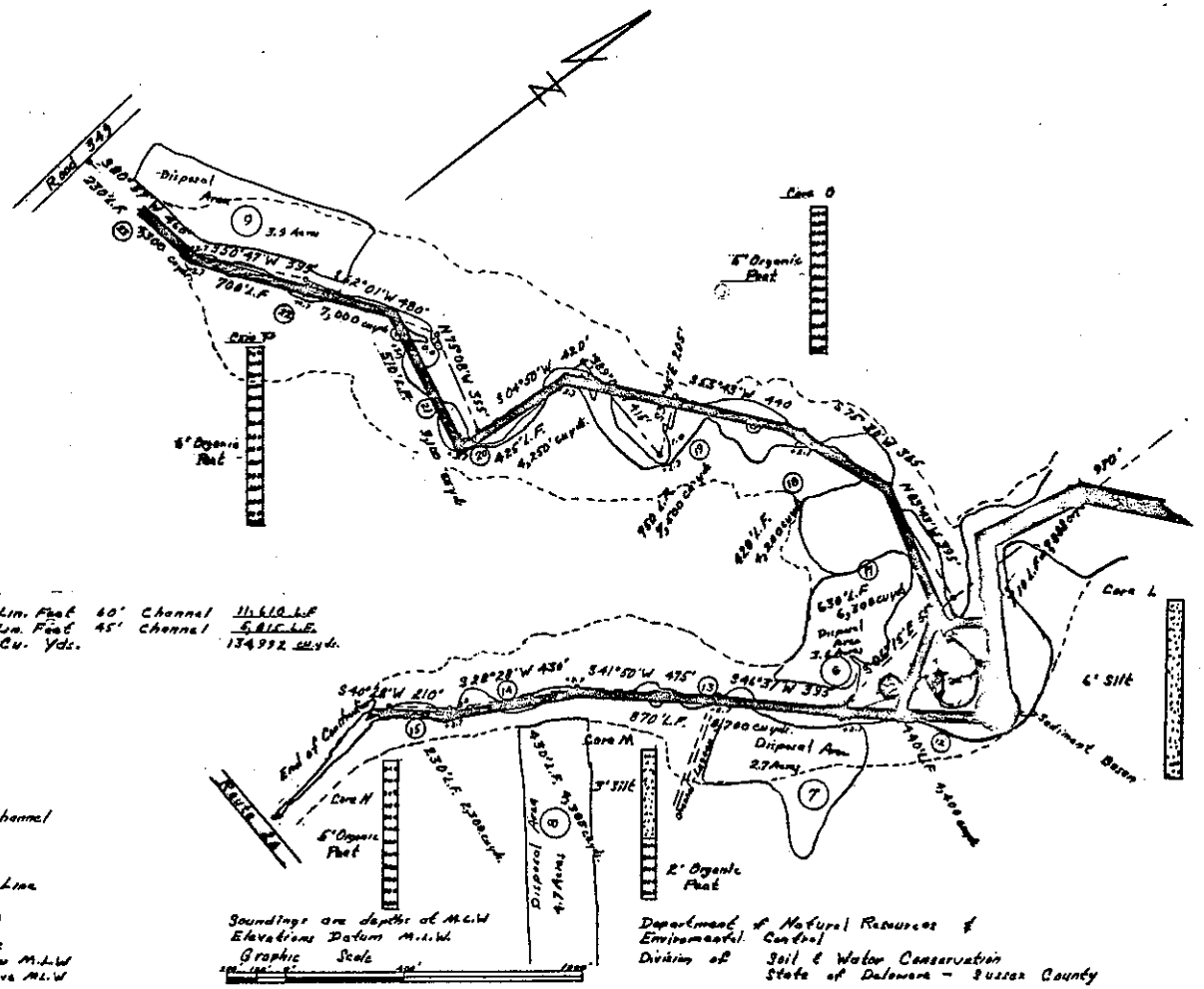
Survey Base Line

Woods Line

Shore Line

6.0 Depth below M.L.W

+4.0 Elevation above M.L.W



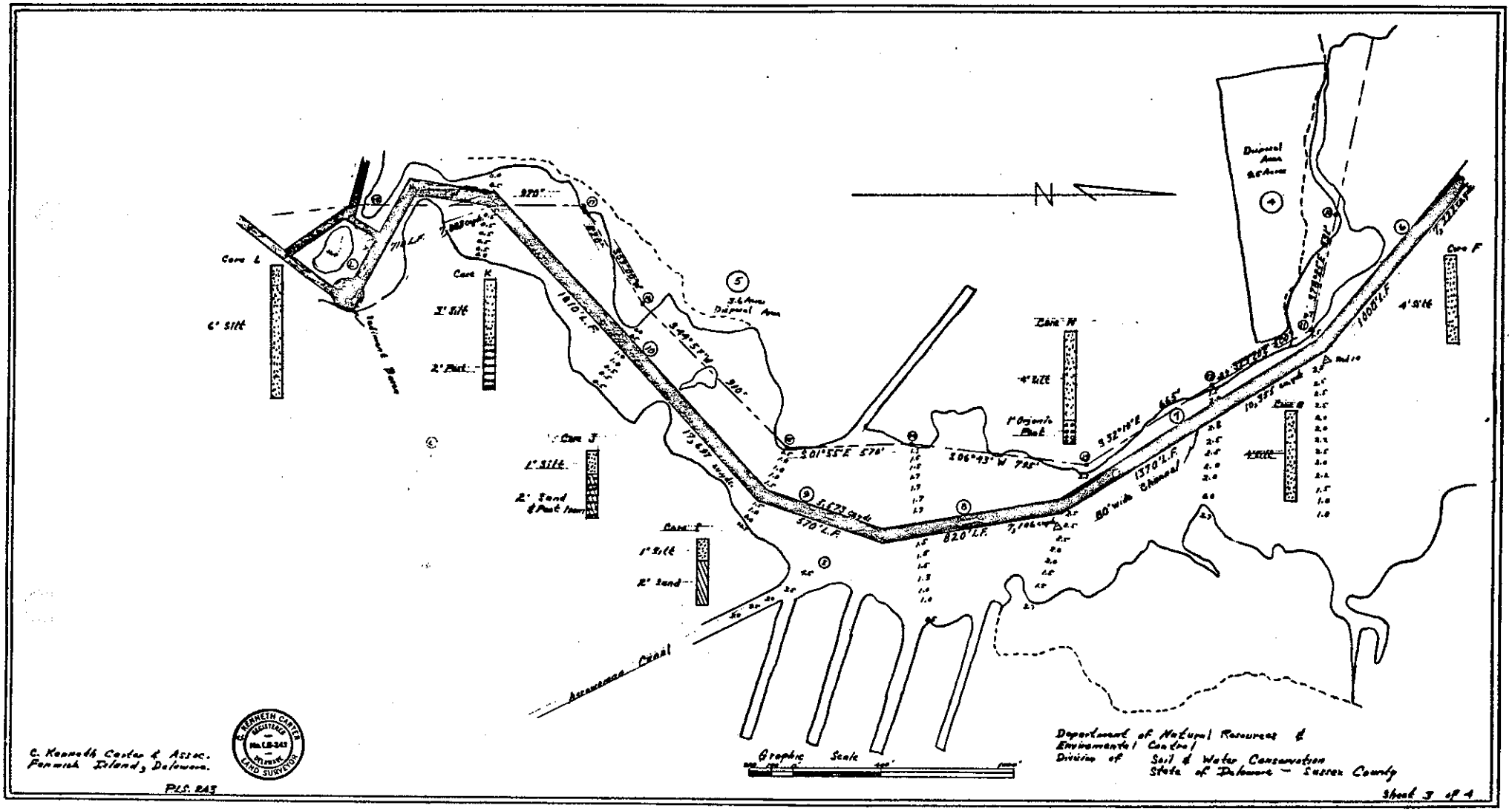
Soundings are depths at M.L.W
Elevations Datum M.L.W.
Graphic Scale

Department of Natural Resources & Environmental Control
Division of Soil & Water Conservation
State of Delaware - Sussex County

C. Kenneth Carter & Assoc.
Fenwick Island, Delaware

C. KENNETH CARTER — MARYLAND — No. LS-243 — DELAWARE — LAND SURVEYOR

P.L.S. 243



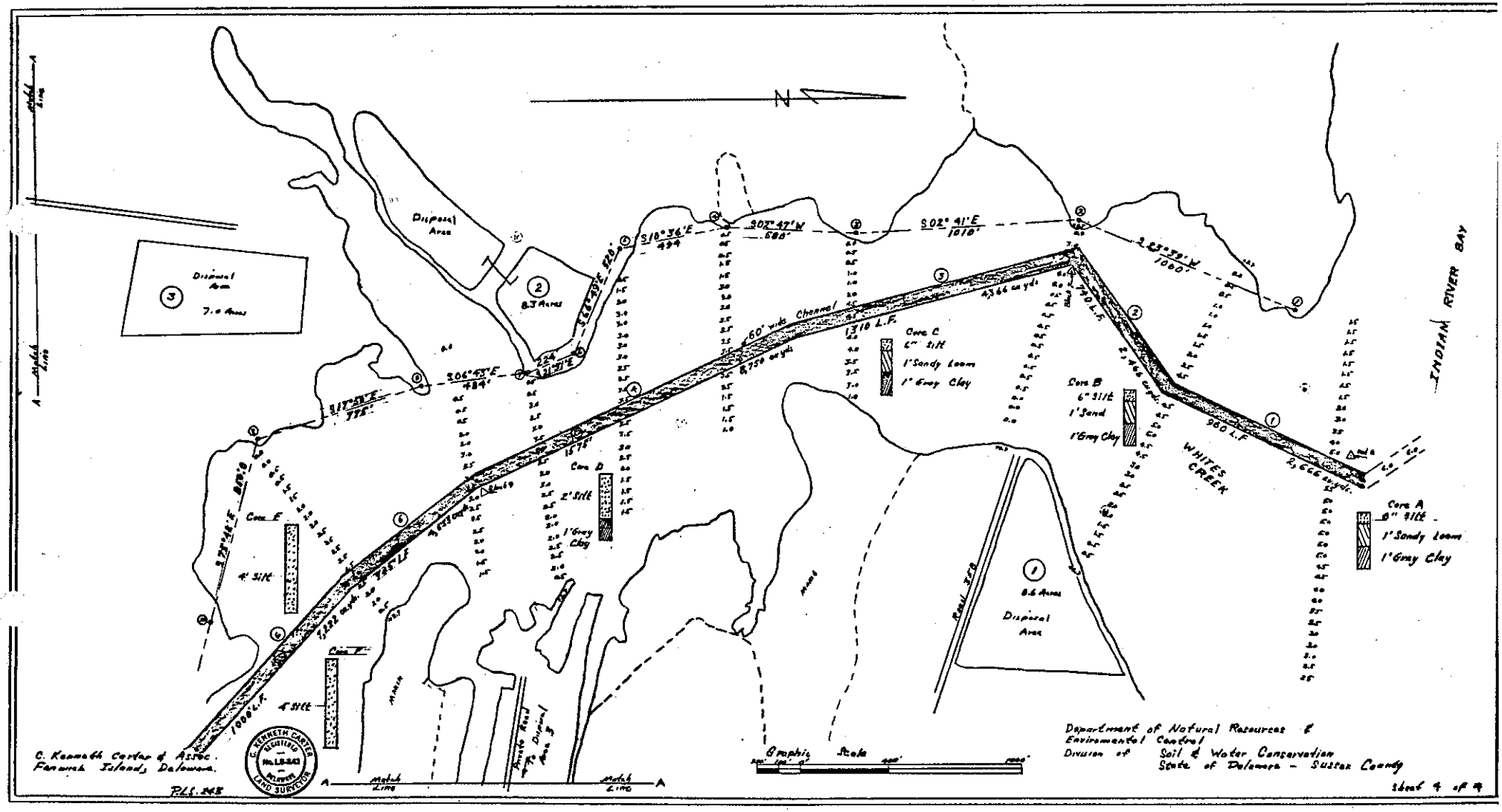
C. Kenneth Carter & Assoc.
Fenwick Island, Delaware.

C. KENNETH CARTER REGISTERED No. LS-345 DELAWARE LAND SURVEYOR

P.L.S. #45

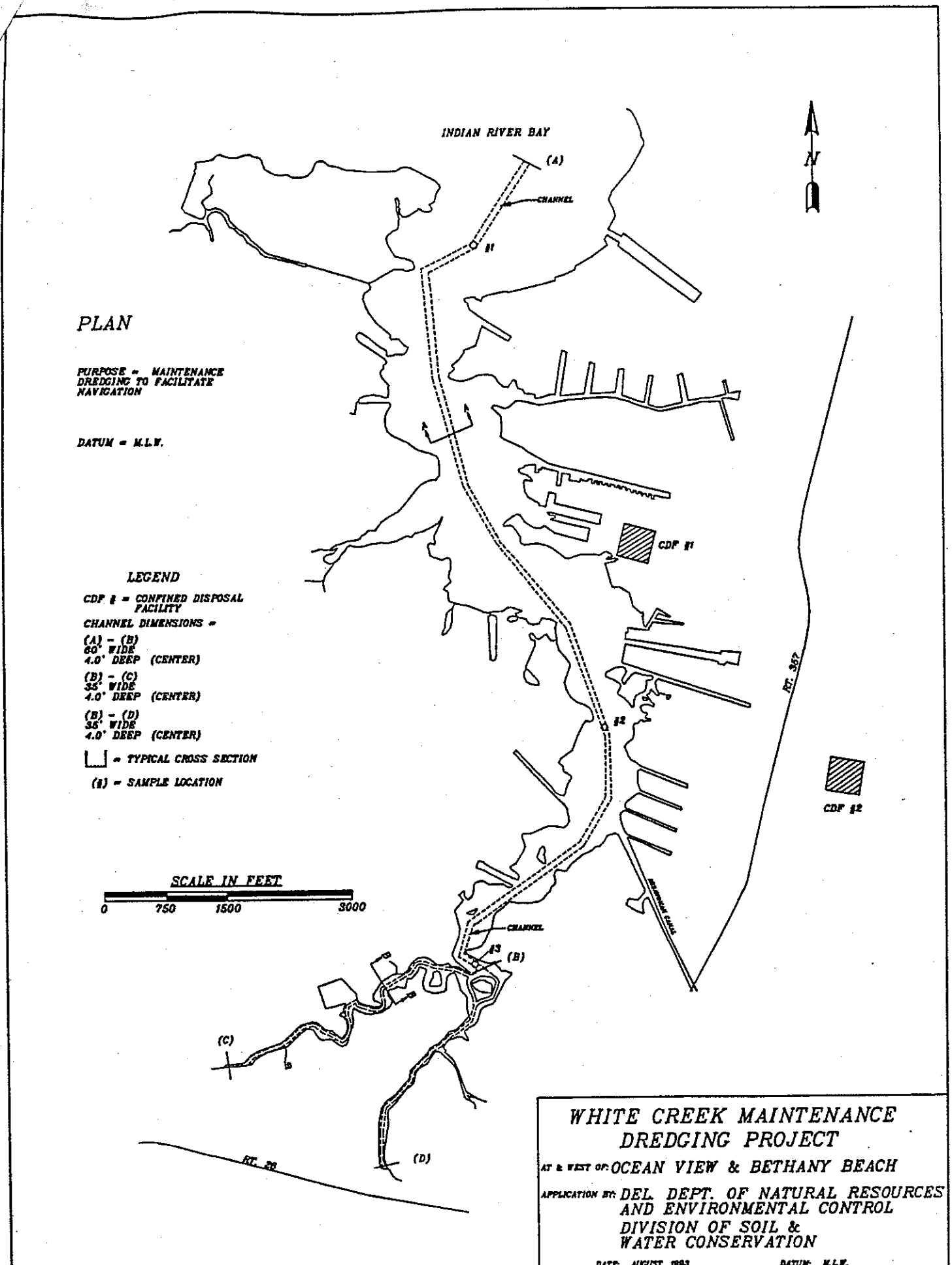
Department of Natural Resources & Environmental Control
Division of Soil & Water Conservation
State of Delaware — Sussex County

Sheet 3 of 4



N
Disposal Area
Disposal Area
7.0 Acres
8.3 Acres
S 18° 36' E
494
S 02° 47' W
588'
S 02° 41' E
1010'
S 23° 39' W
1060'
S 06° 43' E
484'
S 17° 58' E
775'
60' wide Channel
1310 L.F.
4,366 cu yds
8,750 cu yds
740 L.F.
2,466 cu yds
960 L.F.
2,666 cu yds
Core C
6" Silt
1' Sandy Loam
1' Gray Clay
Core B
6" Silt
1' Sand
1' Gray Clay
Core A
6" Silt
1' Sandy Loam
1' Gray Clay
Core D
2' Silt
1' Gray Clay
Core E
4' Silt
Core F
4' Silt
1000' L.F.
Disposal Area
8.6 Acres
Road 358
Private Road To Disposal Area 3
INDIAN RIVER BAY
WHITES CREEK
Match Line
Match Line
Match Line
Match Line
Graphic Scale
C. Kenneth Carter & Assoc.
Fenwick Island, Delaware.
C. KENNETH CARTER
REGISTERED
No. LS-243
DELAWARE
LAND SURVEYOR
P.L.S. 243
Department of Natural Resources &
Environmental Control
Division of Soil & Water Conservation
State of Delaware - Sussex County
Sheet 4 of 4

WHITE CREEK 1997


INDIAN RIVER BAY
(A)
CHANNEL
#1
N
PLAN
PURPOSE = MAINTENANCE DREDGING TO FACILITATE NAVIGATION
DATUM = M.L.W.
CDF #1
LEGEND
CDF # = CONFINED DISPOSAL FACILITY
CHANNEL DIMENSIONS =
(A) - (B)
60' WIDE
4.0' DEEP (CENTER)
(B) - (C)
35' WIDE
4.0' DEEP (CENTER)
(B) - (D)
35' WIDE
4.0' DEEP (CENTER)
= TYPICAL CROSS SECTION
(#) = SAMPLE LOCATION
#2
RT. 367
CDF #2
SCALE IN FEET
0
750
1500
3000
CHANNEL
#3
(B)
(C)
(D)
RT. 26
WHITE CREEK MAINTENANCE DREDGING PROJECT
AT & WEST OF: OCEAN VIEW & BETHANY BEACH
APPLICATION BY: DEL. DEPT. OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL & WATER CONSERVATION
DATE: AUGUST, 1993
DATUM: M.L.W.

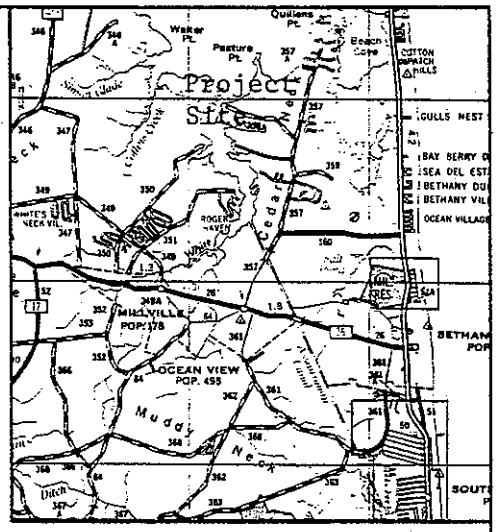
WHITE CREEK
MAINTENANCE DREDGING PROJECT

AT & WEST OF: OCEANVIEW & BETHANY BEACH

APPLICATION BY: DEL. DEPT. OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL & WATER CONSERVATION

DATE: AUGUST,1993 DATUM: M.L.W.

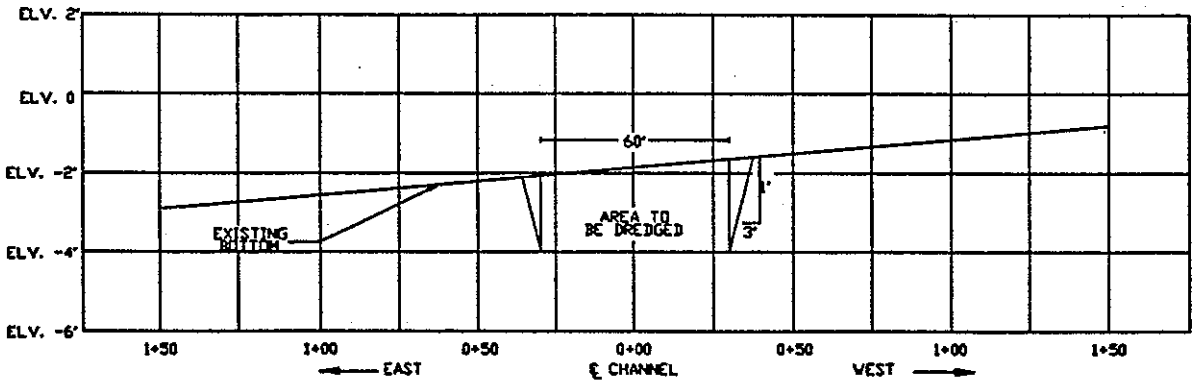
SCALE AS SHOWN



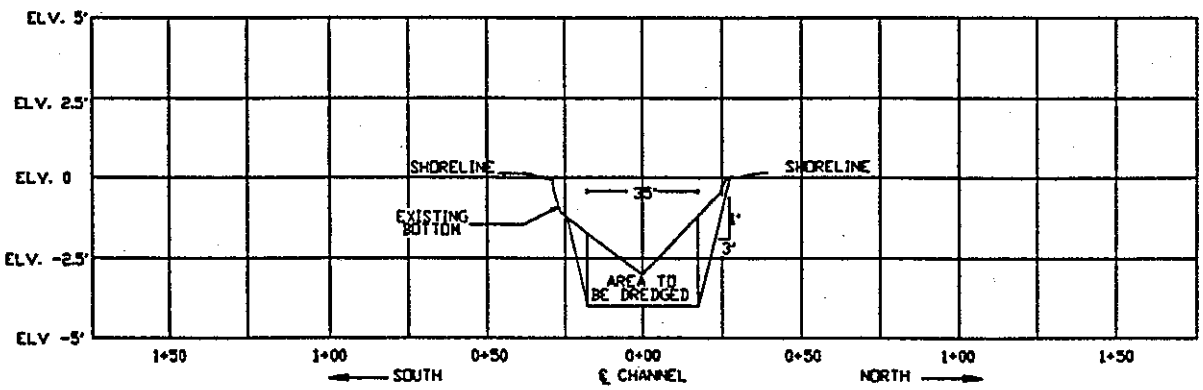
LOCATION MAP

TYPICAL CROSS-SECTIONS

CROSS-SECTION A-A

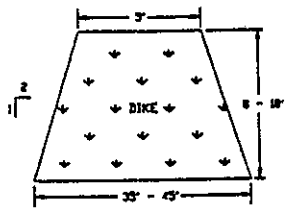


CROSS-SECTION B-B



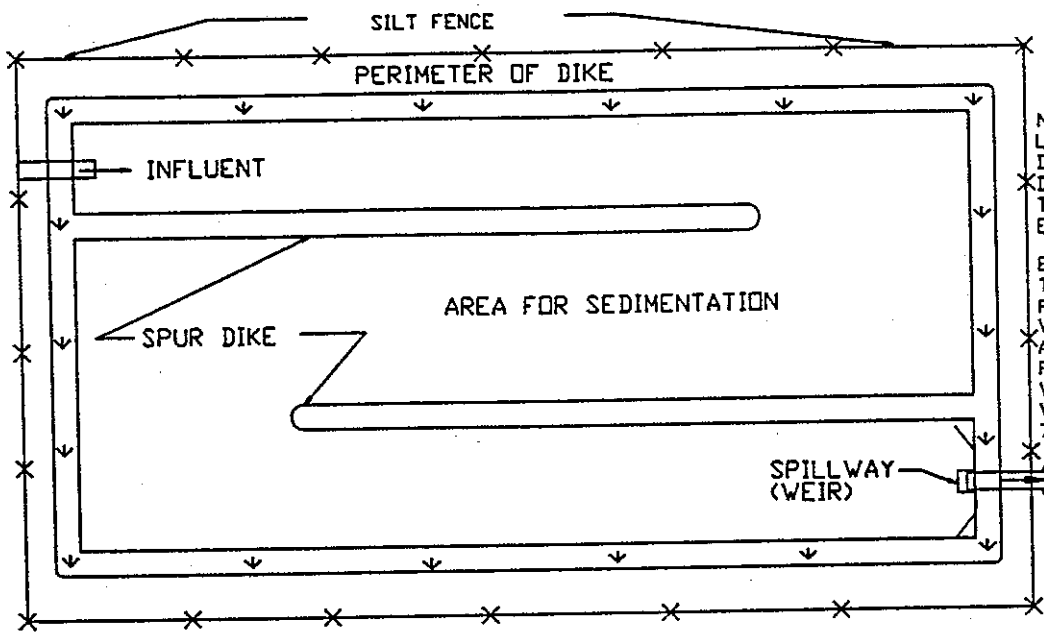
TYPICAL CONFINED DISPOSAL FACILITY DESIGN

(NO SCALE)



CROSS SECTION OF DIKE

PLAN VIEW
7 ACRE SITE

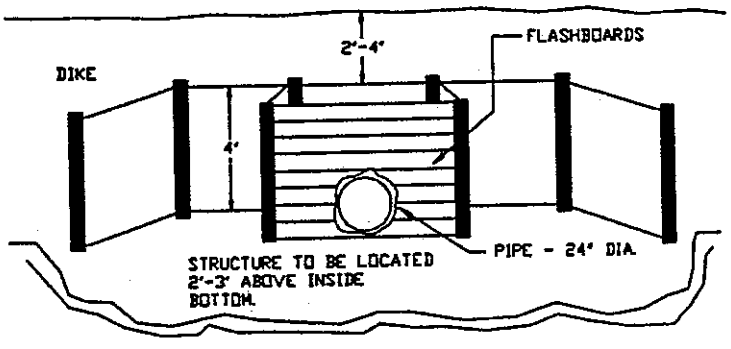


NOTES:
LOCATION AND SIZE OF SPUR DIKES WILL VARY IN EACH DISPOSAL FACILITY DUE TO THE UNIQUE FEATURES OF EACH.

EROSION AND SEDIMENT CONTROL MEASURES (E.G. SILT FENCE, SEEDING OF DIKE WALLS) WILL BE IMPLEMENTEDPAN AT EACH FACILITY IN COMPLIANCE WITH THE DELAWARE SEDIMENT AND STORM WATER REGULATIONS DATED 7/1/91.

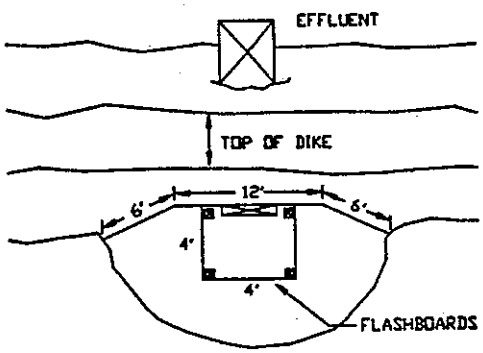
SPILLWAY (WEIR) DESIGN

PLAN VIEW



FLASHBOARDS WILL BE ADDED AS WATER LEVEL RISES.

TOP VIEW



WHITE CREEK
MAINTENANCE DREDGING PROJECT

AT & VEST OF: OCEANVIEW & BETHANY BEACH

APPLICATION BY: DEL. DEPT. OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL & WATER CONSERVATION

DATE: AUGUST,1993 DATUM: M.L.W.

ASSAWOMAN CANAL 2006

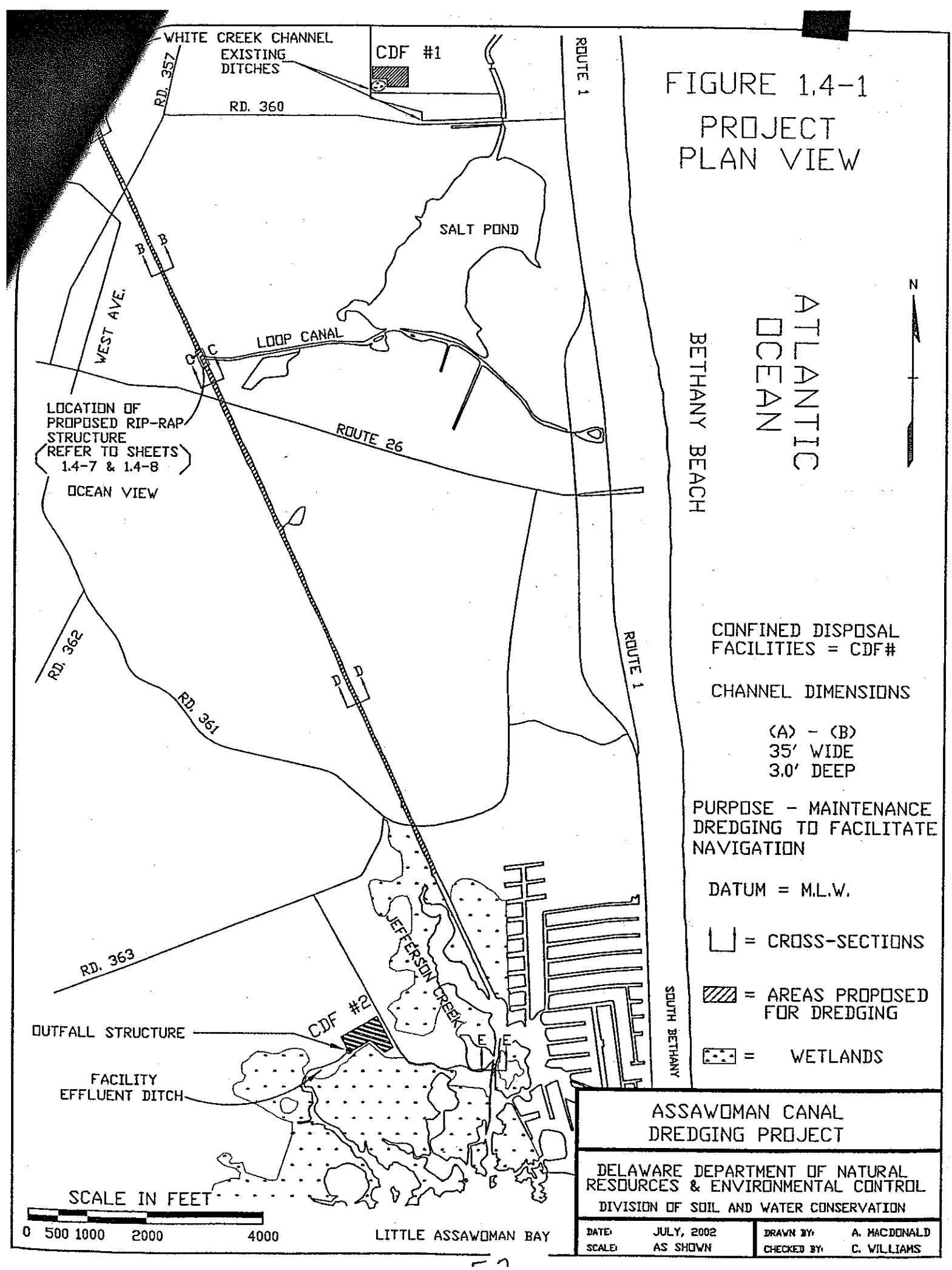


FIGURE 1.4-1
PROJECT PLAN VIEW

CONFINED DISPOSAL FACILITIES = CDF#

CHANNEL DIMENSIONS

(A) - (B)
35' WIDE
3.0' DEEP

PURPOSE - MAINTENANCE DREDGING TO FACILITATE NAVIGATION

DATUM = M.L.W.

= CROSS-SECTIONS

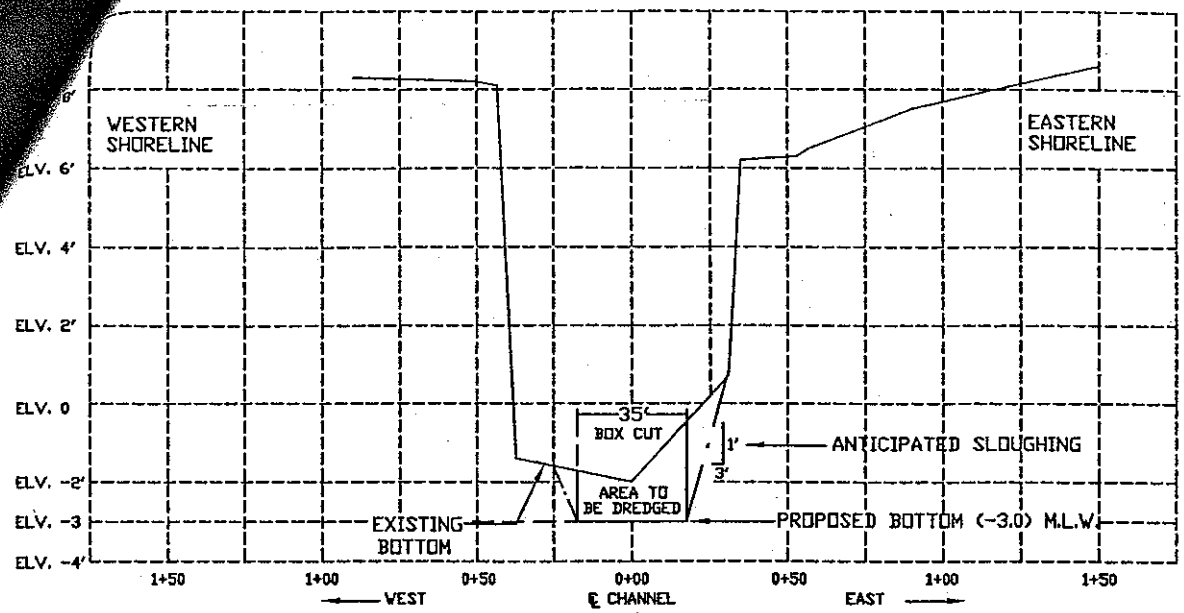
= AREAS PROPOSED FOR DREDGING

= WETLANDS

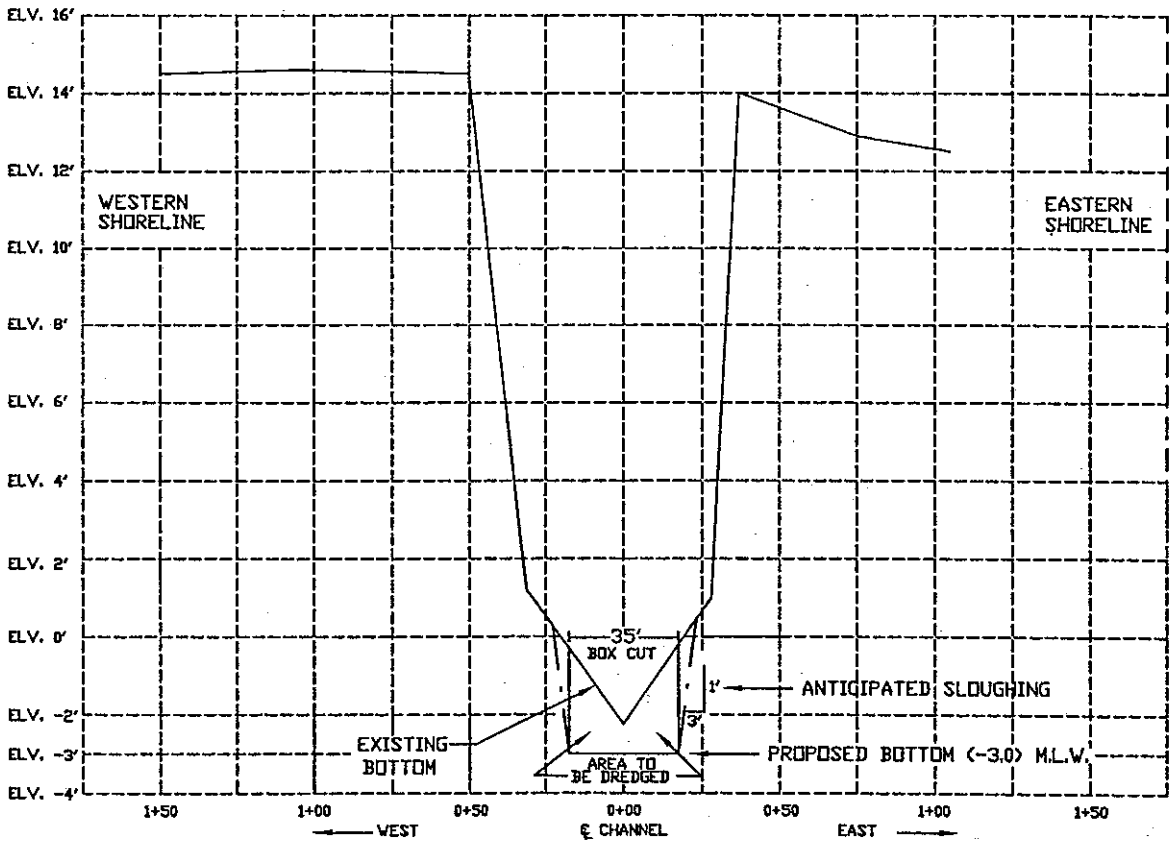
ASSAWOMAN CANAL DREDGING PROJECT

DELAWARE DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION

DATE:	JULY, 2002	DRAWN BY:	A. MACDONALD
SCALE:	AS SHOWN	CHECKED BY:	C. WILLIAMS



CROSS-SECTION "A-A"
WORK AREA #1



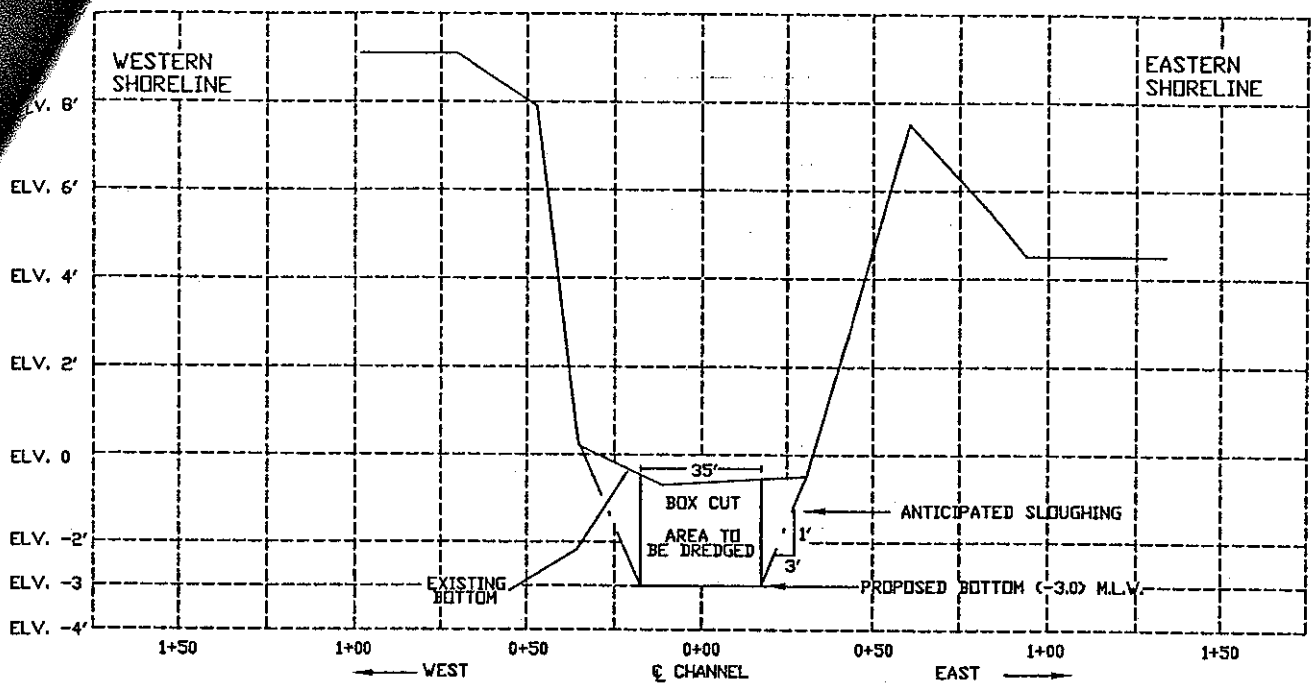
CROSS-SECTION "B-B"
WORK AREA #2

FIGURE 1.4-2 (SHEET 1 OF 3)
CROSS SECTIONS

ASSAWOMAN CANAL
DREDGING PROJECT

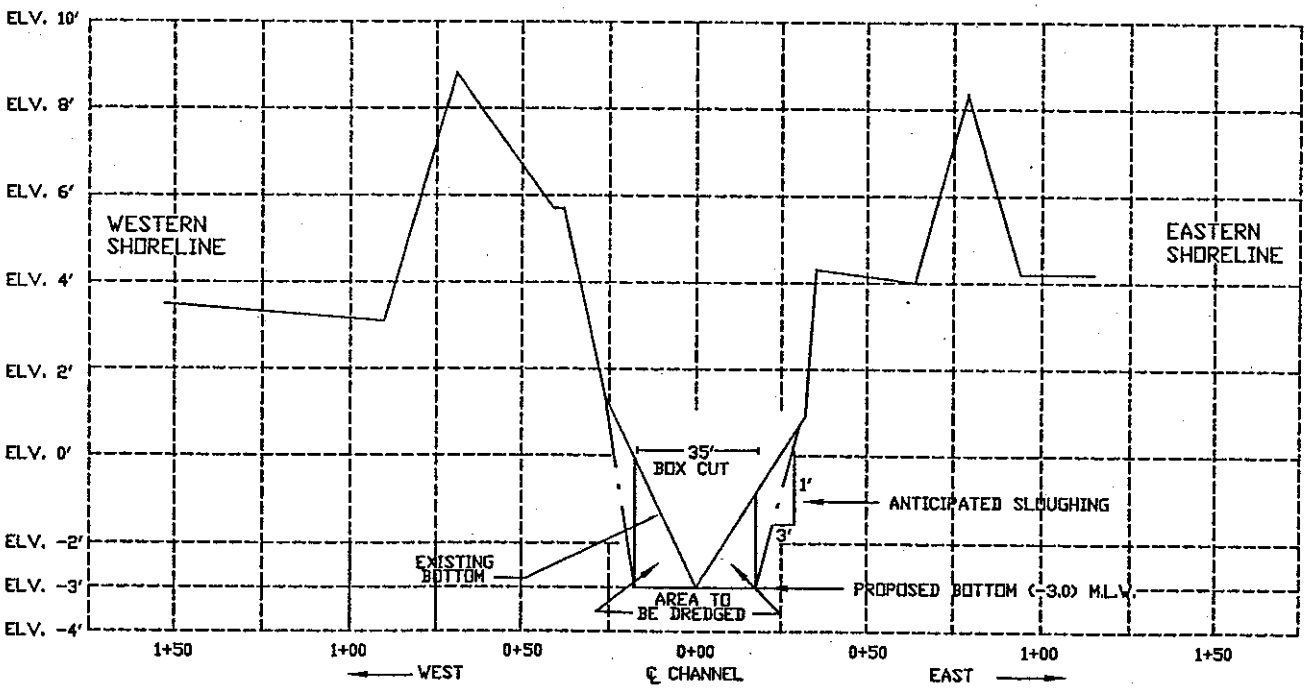
DELAWARE DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION

DATE:	JULY, 2002	DRAWN BY:	A. MACDONALD
SCALE:	AS SHOWN	CHECKED BY:	C. WILLIAMS



CROSS-SECTION "C - C"

WORK AREA #3



CROSS-SECTION "D - D"

WORK AREA #4

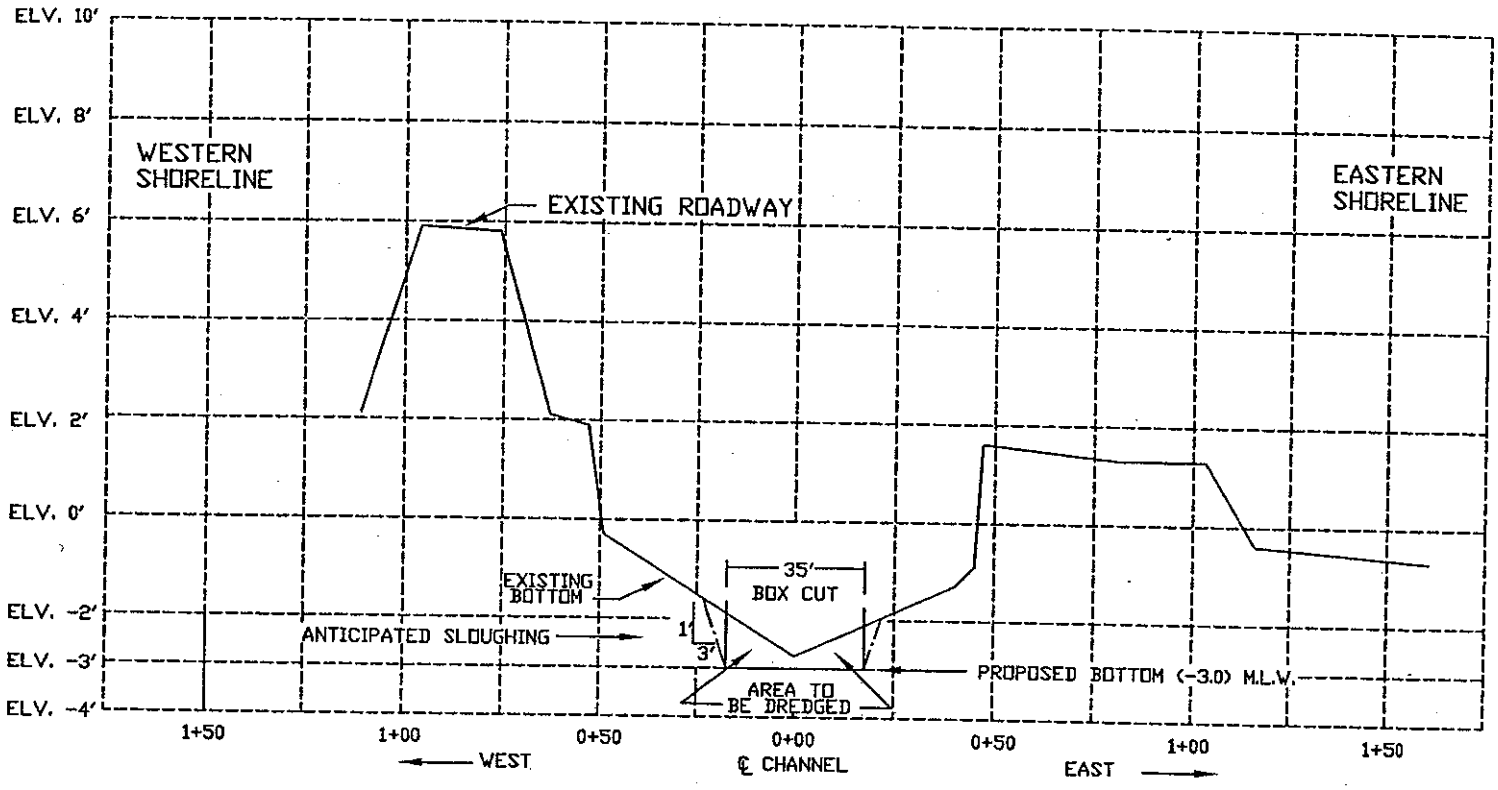
FIGURE 1.4-2 (SHEET 2 OF 3)

CROSS SECTIONS

ASSAWOMAN CANAL DREDGING PROJECT			
DELAWARE DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL DIVISION OF SOIL AND WATER CONSERVATION			
DATE:	JULY, 2002	DRAWN BY:	A. MACDONALD
SCALE:	AS SHOWN	CHECKED BY:	C. WILLIAMS

FIGURE 1.4-2 (SHEET 3 OF 3)

CROSS SECTIONS

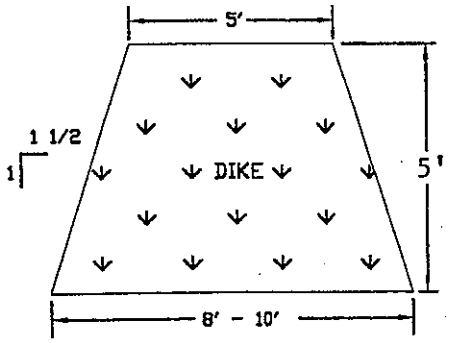


CROSS-SECTION "E - E"

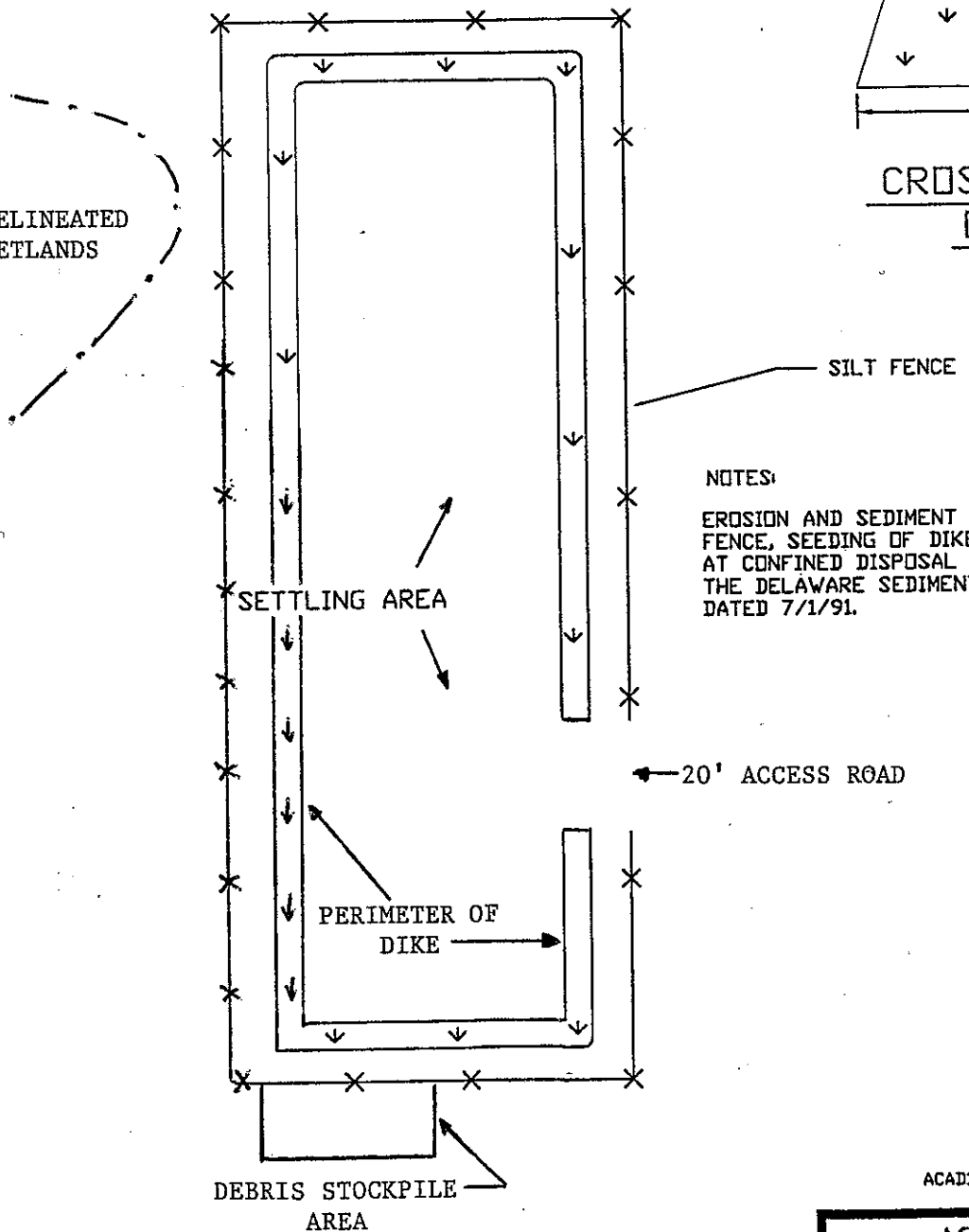
WORK AREA #4

ASSAWOMAN CANAL DREDGING PROJECT			
DELAWARE DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL DIVISION OF SOIL AND WATER CONSERVATION			
DATE:	JULY, 2002	DRAWN BY:	A. MACDONALD
SCALE:	AS SHOWN	CHECKED BY:	C. WILLIAMS

PLAN VIEW
2.5 ACRE SITE(±)



CROSS SECTION
OF DIKE



NOTES:

EROSION AND SEDIMENT CONTROL MEASURES (E.G. SILT FENCE, SEEDING OF DIKE WALLS) WILL BE IMPLEMENTED AT CONFINED DISPOSAL FACILITY #1 IN COMPLIANCE WITH THE DELAWARE SEDIMENT AND STORM WATER REGULATIONS DATED 7/1/91.

FIGURE 1.4-3

CONFINED DISPOSAL FACILITY #1 DESIGN FOR MECHANICAL DREDGING OPERATIONS

ACAD14\CEW\PERMITS\ASSCNP97.DWG

ASSAWOMAN CANAL
DREDGING PROJECT

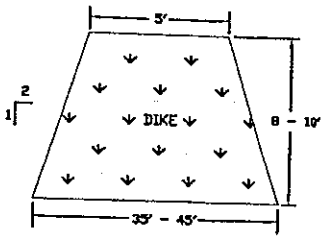
DELAWARE DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION

DATE: August 2006
SCALE: As Shown

DRAWN BY: A. MACDONALD
CHECKED BY: C. VILLIAMS

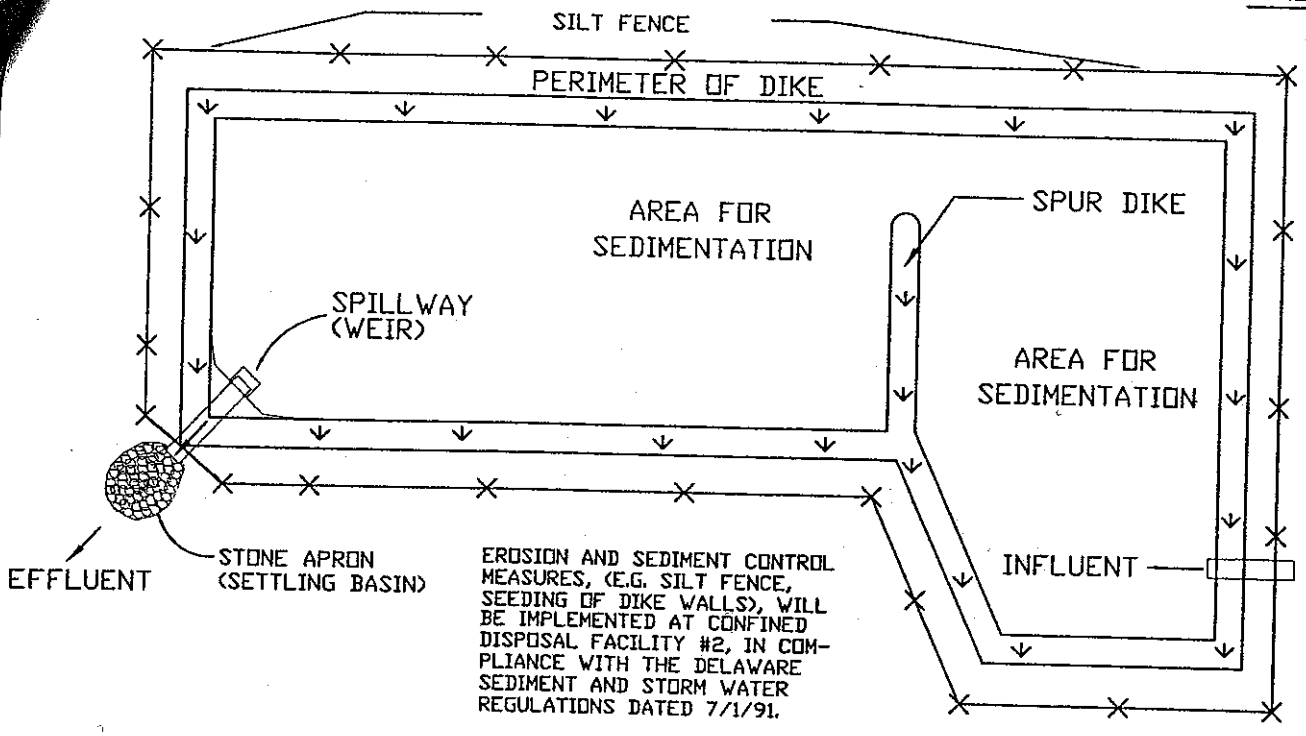
CONFINED DISPOSAL FACILITY DESIGN

(NO SCALE)



CROSS SECTION OF DIKE

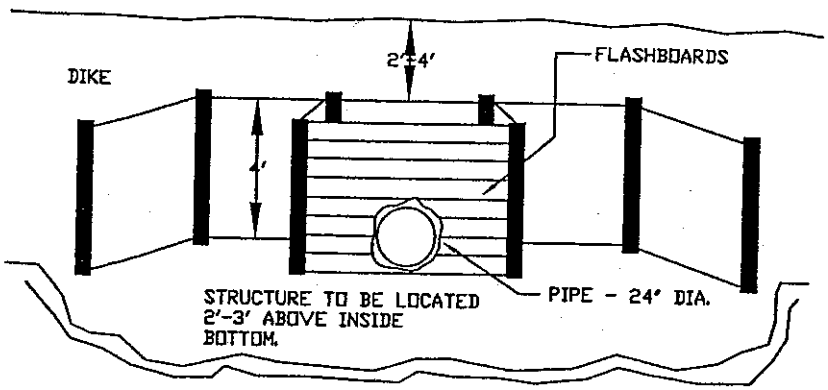
PLAN VIEW
7 ACRE SITE



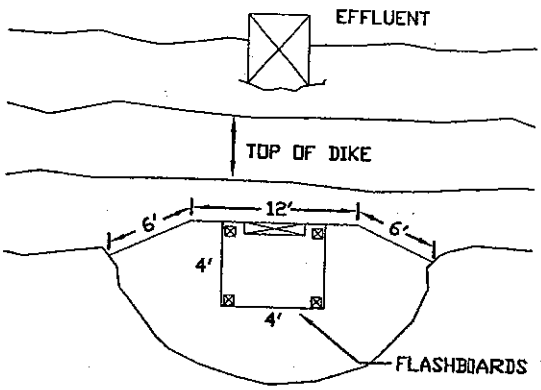
EROSION AND SEDIMENT CONTROL MEASURES, (E.G. SILT FENCE, SEEDING OF DIKE WALLS), WILL BE IMPLEMENTED AT CONFINED DISPOSAL FACILITY #2, IN COMPLIANCE WITH THE DELAWARE SEDIMENT AND STORM WATER REGULATIONS DATED 7/1/91.

SPILLWAY (WEIR) DESIGN

PLAN VIEW



TOP VIEW



FLASHBOARDS WILL BE ADDED AS WATER LEVEL RISES.

FIGURE 1.4-4

CONFINED DISPOSAL FACILITY #2 DESIGN FOR HYDRAULIC DREDGING ACTIVITIES

ASSAWOMAN CANAL DREDGING PROJECT

DELAWARE DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION

DATE:	JULY, 2002	DRAWN BY:	A MACDONALD
SCALE:	AS SHOWN	CHECKED BY:	C WILLIAMS

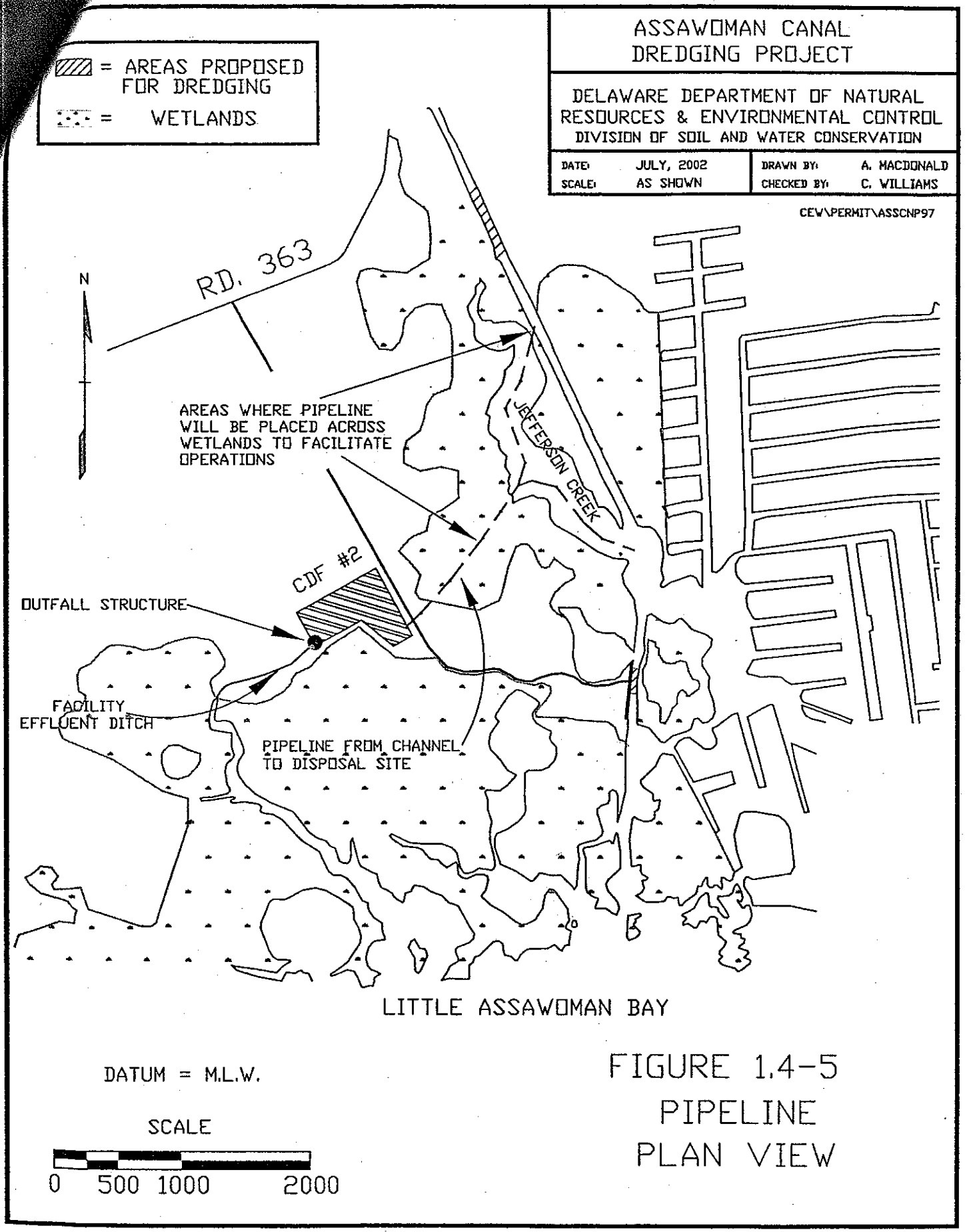
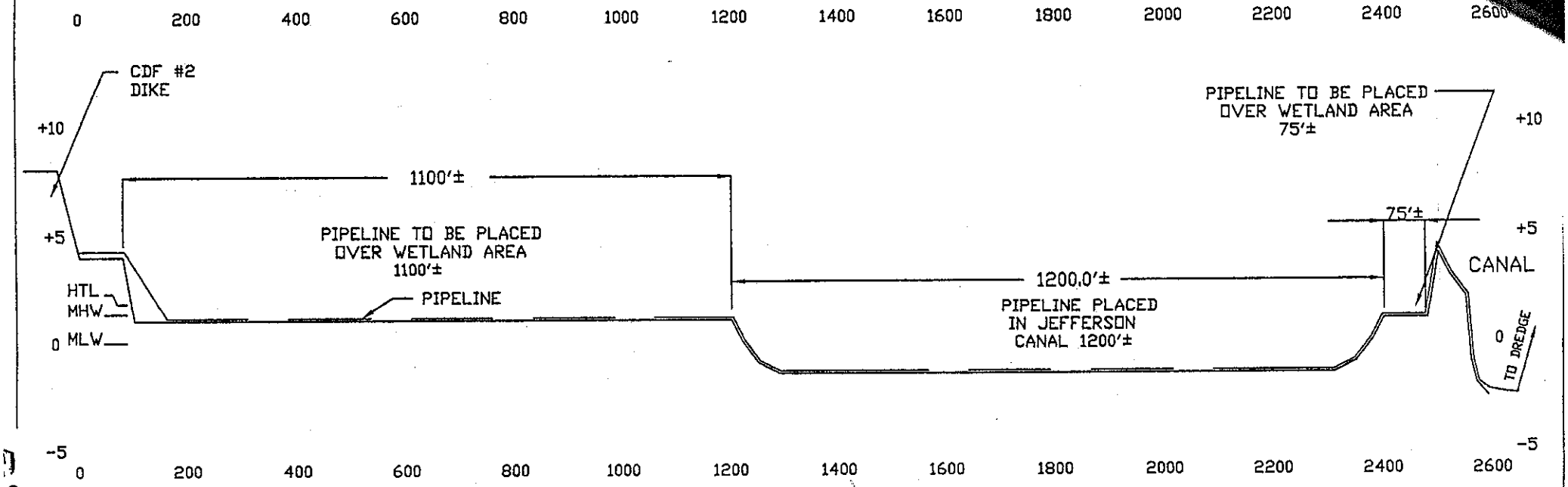


FIGURE 1.4-5
PIPELINE
PLAN VIEW



DREDGE PIPELINE ROUTE FROM CANAL TO CDF #2
(WHEN DREDGING IN A NORTHWESTERLY DIRECTION)

(SCALE AS SHOWN)

HTL = +1.8

MHW = +1.3

MLW = 0.0

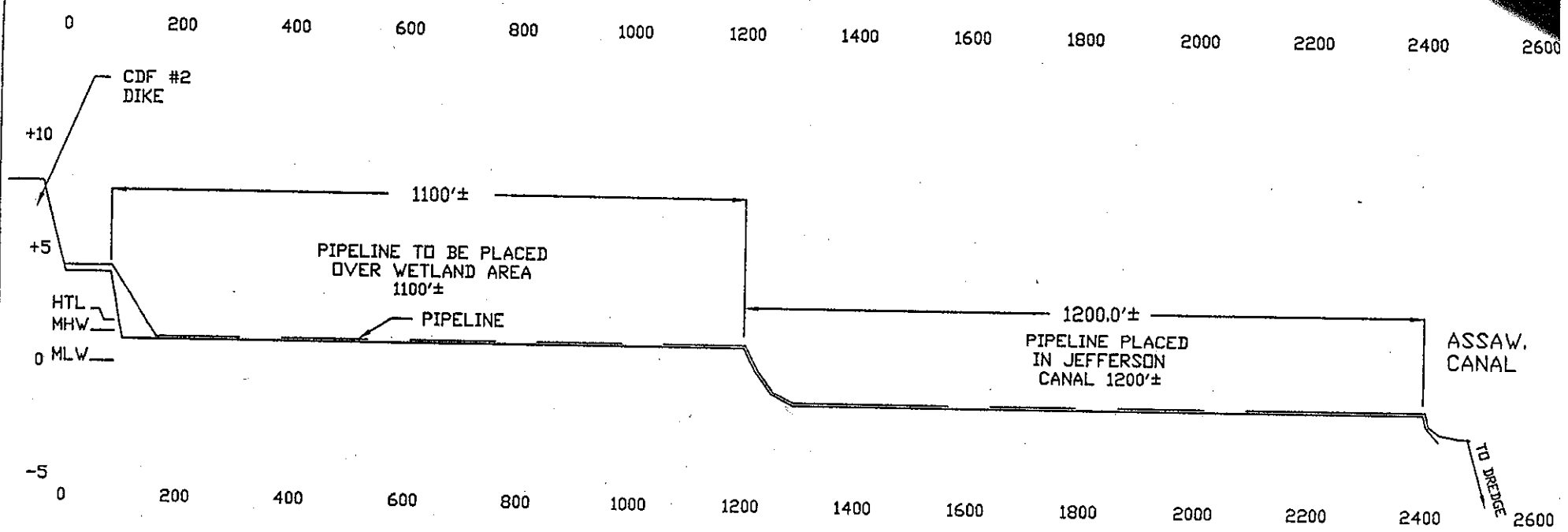
FIGURE 1.4-6
(SHEET 1 OF 2)

DATUM = M.L.W.

ASSAWOMAN CANAL
DREDGING PROJECT

DELAWARE DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION

DATE:	JULY, 2002	DRAWN BY:	A. MACDONALD
SCALE:	AS SHOWN	CHECKED BY:	C. WILLIAMS



DREDGE PIPELINE ROUTE FROM CANAL TO CDF #2
(WHEN DREDGING IN A SOUTHERLY DIRECTION)

(SCALE AS SHOWN)

HTL = +1.8

MHW = +1.3

MLW = 0.0

FIGURE 1.4-6
(SHEET 2 OF 2)

DATUM = M.L.W.

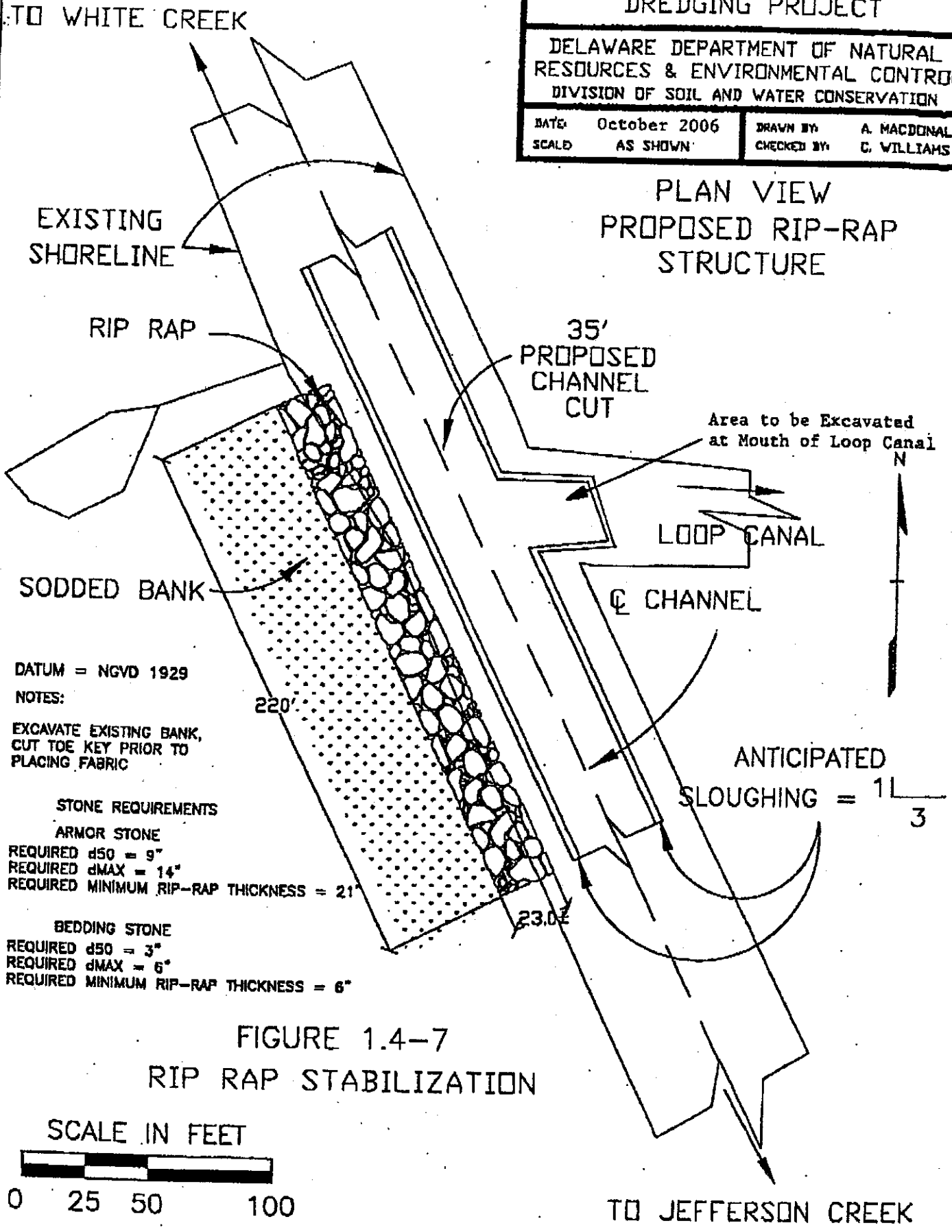
ASSAWOMAN CANAL DREDGING PROJECT	
DELAWARE DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTR DIVISION OF SOIL AND WATER CONSERVATION	
DATE: JULY, 2002	DRAWN BY: A. MACDON
SCALE: AS SHOWN	CHECKED BY: C. WILLIAM

ASSAWOMAN CANAL DREDGING PROJECT

DELAWARE DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION

DATE:	October 2006	DRAWN BY:	A. MACDONALD
SCALE:	AS SHOWN	CHECKED BY:	C. WILLIAMS

PLAN VIEW PROPOSED RIP-RAP STRUCTURE



DATUM = NGVD 1929

NOTES:

EXCAVATE EXISTING BANK, CUT TOE KEY PRIOR TO PLACING FABRIC

STONE REQUIREMENTS

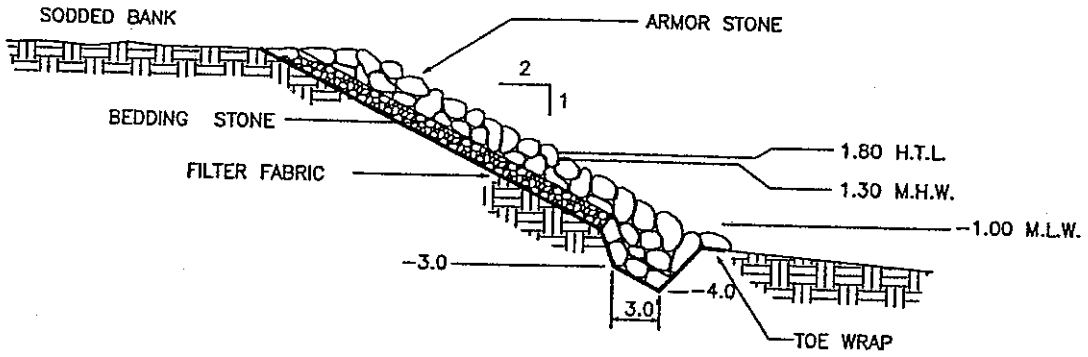
ARMOR STONE
REQUIRED d50 = 9"
REQUIRED dMAX = 14"
REQUIRED MINIMUM RIP-RAP THICKNESS = 21"

BEDDING STONE
REQUIRED d50 = 3"
REQUIRED dMAX = 6"
REQUIRED MINIMUM RIP-RAP THICKNESS = 6"

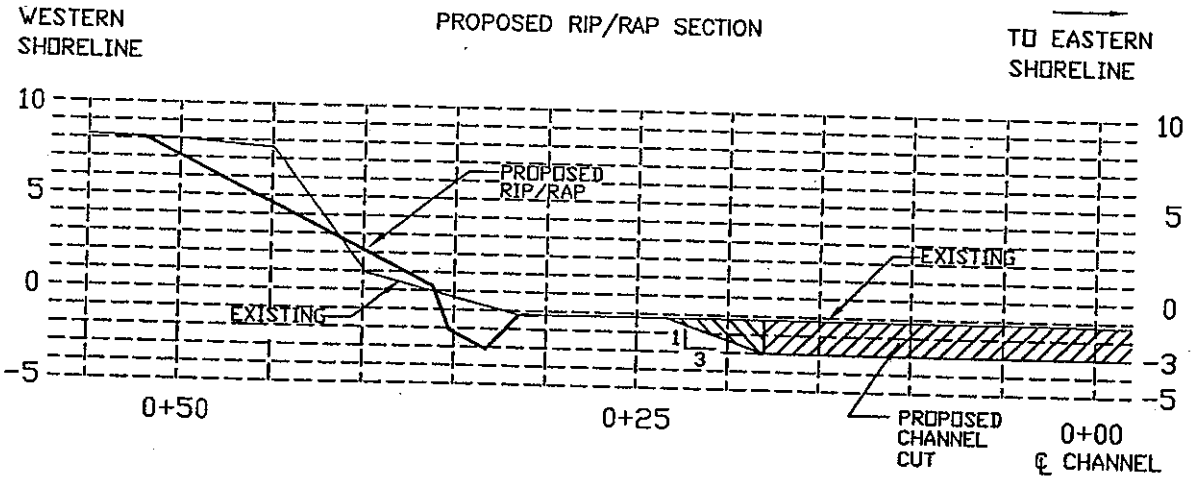
FIGURE 1.4-7
RIP RAP STABILIZATION

SCALE IN FEET
0 25 50 100

DESIGN SECTION



NO SCALE



NOTES:

EXCAVATE EXISTING BANK, CUT TOE KEY PRIOR TO PLACING FABRIC

STONE REQUIREMENTS

ARMOR STONE
REQUIRED d50 = 9"
REQUIRED dMAX = 14"
REQUIRED MINIMUM RIP-RAP THICKNESS = 21"

BEDDING STONE
REQUIRED d50 = 3"
REQUIRED dMAX = 6"
REQUIRED MINIMUM RIP-RAP THICKNESS = 6"

DATUM = NGVD 1929

FIGURE 1.4-8
RIP RAP STABILIZATION

ASSAWOMAN CANAL
DREDGING PROJECT

DELAWARE DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION

DATE:	JULY, 2002	DRAWN BY:	A. MACDONALD
SCALE:	AS SHOWN	CHECKED BY:	C. WILLIAMS

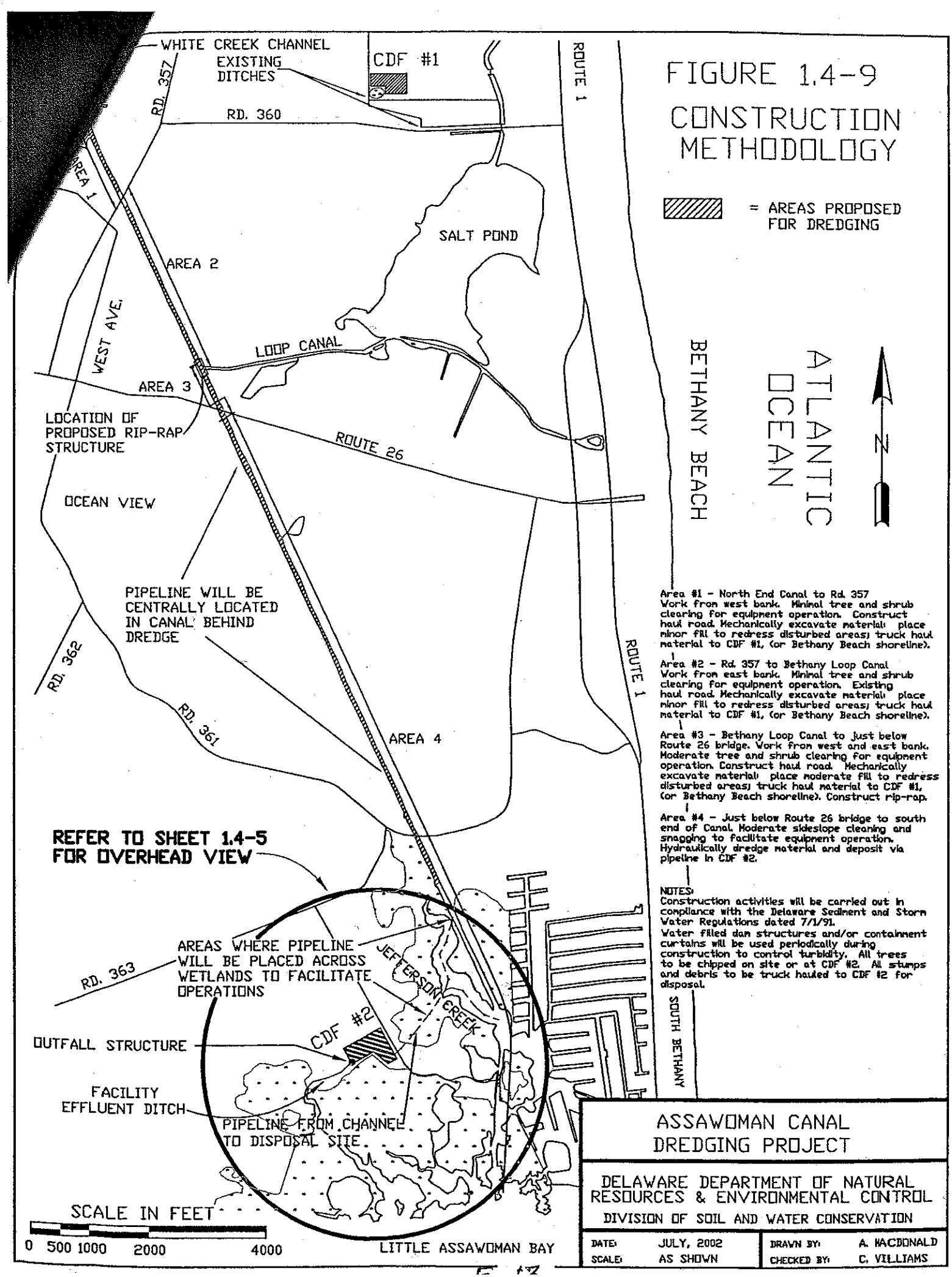


FIGURE 1.4-9
CONSTRUCTION METHODOLOGY

▨ = AREAS PROPOSED FOR DREDGING

Area #1 - North End Canal to Rd. 357
Work from west bank. Minimal tree and shrub clearing for equipment operation. Construct haul road. Mechanically excavate material; place minor fill to redress disturbed areas; truck haul material to CDF #1, (or Bethany Beach shoreline).

Area #2 - Rd. 357 to Bethany Loop Canal
Work from east bank. Minimal tree and shrub clearing for equipment operation. Existing haul road. Mechanically excavate material; place minor fill to redress disturbed areas; truck haul material to CDF #1, (or Bethany Beach shoreline).

Area #3 - Bethany Loop Canal to just below Route 26 bridge. Work from west and east bank. Moderate tree and shrub clearing for equipment operation. Construct haul road. Mechanically excavate material; place moderate fill to redress disturbed areas; truck haul material to CDF #1, (or Bethany Beach shoreline). Construct rip-rap.

Area #4 - Just below Route 26 bridge to south end of Canal. Moderate sideslope clearing and snagging to facilitate equipment operation. Hydraulically dredge material and deposit via pipeline in CDF #2.

NOTES:
Construction activities will be carried out in compliance with the Delaware Sediment and Storm Water Regulations dated 7/1/91.
Water filled dam structures and/or containment curtains will be used periodically during construction to control turbidity. All trees to be chipped on site or at CDF #2. All stumps and debris to be truck hauled to CDF #2 for disposal.

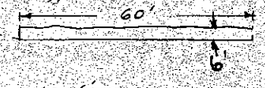
ASSAWOMAN CANAL DREDGING PROJECT

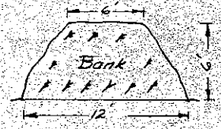
DELAWARE DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION

DATE:	JULY, 2002	DRAWN BY:	A. MACDONALD
SCALE:	AS SHOWN	CHECKED BY:	C. VILLIAMS

HERRING CREEK AND GUINEA CREEK 1977

Typical Section - Box Cut





Typical Bank

NOTES :

All data Mean Low Water

Proposed Channel 60' wide

Survey Base Line

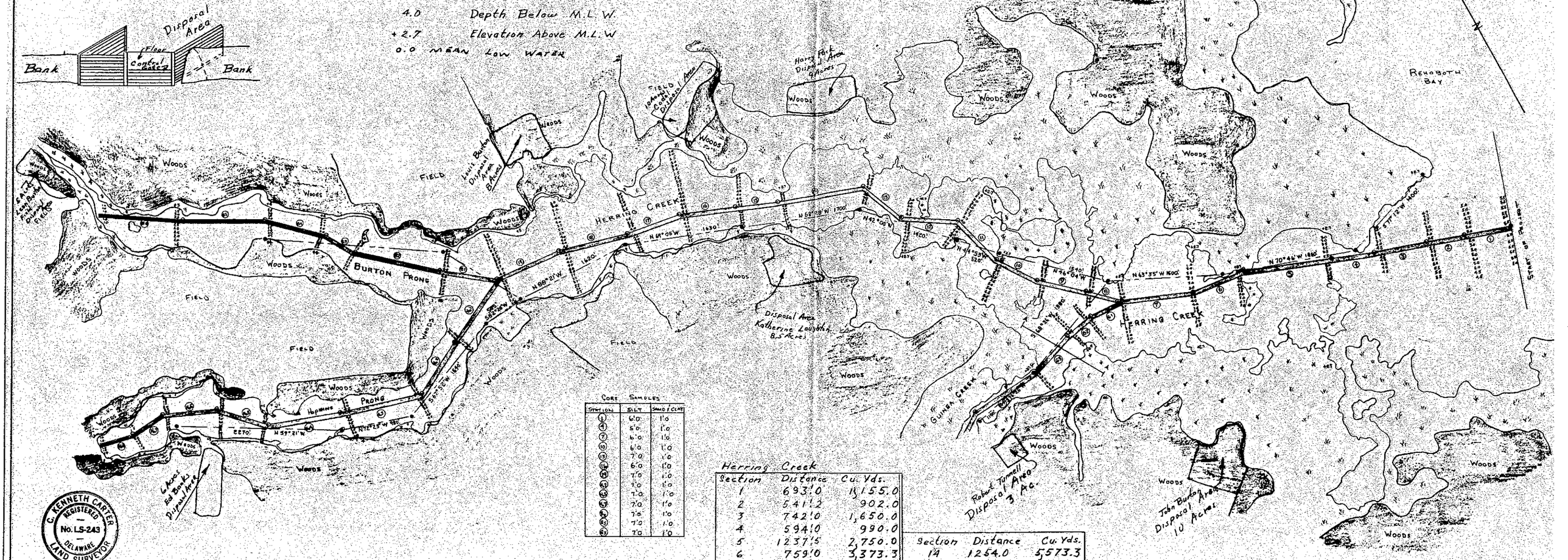
Woods Line

Shore Line

4.0 Depth Below M.L.W.

+2.7 Elevation Above M.L.W.

0.0 MEAN LOW WATER



Core Samples		
Stations	Silt	Sand & Clay
1	6'0	1'0
4	5'0	1'0
7	6'0	1'0
8	6'0	1'0
9	7'0	1'0
10	6'0	1'0
11	7'0	1'0
12	7'0	1'0
13	7'0	1'0
14	7'0	1'0
15	7'0	1'0
16	7'0	1'0
17	7'0	1'0
18	7'0	1'0
19	7'0	1'0

Herring Creek

Section	Distance	Cu. Yds.
1	693.0	13155.0
2	541.2	902.0
3	742.0	1,650.0
4	594.0	990.0
5	1237.5	2,750.0
6	759.0	3,373.3
7	990.0	4,730.0
8	528.0	3,109.3
9	693.0	4,620.0
10	627.0	3,483.3
11	759.0	3,373.3
12	792.0	3,080.0
13	676.5	2,630.8

Section	Distance	Cu. Yds.
14	1254.0	5573.3
15	594.0	2,310.0
16	792.0	2,640.0
17	759.0	2,951.6
18	1303.5	5,793.3
19	930.6	4,136.0
Total	15,265.3	59,251.2

C. KENNETH CARTER REGISTERED No. LS-243 DELAWARE LAND SURVEYOR

Plans BY:

C. Kenneth Carter & Assoc

C. Kenneth Carter

Fenwick Island, Delaware

P.L.S. 243

Graphic Scale

330' 0 660' 1980'

Department of Natural Resources And Environmental Control

Division of Soil & Water Conservation

State of Delaware - Sussex County

sheet 2

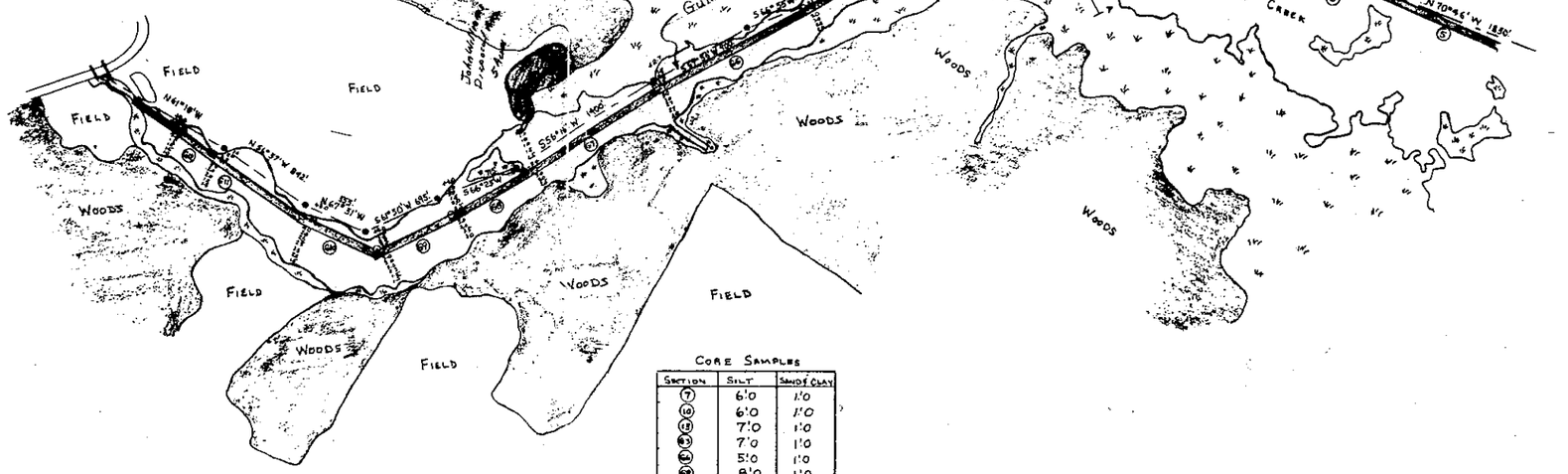
Guinea Creek		
Section	Distance	Cu. Yds.
G-1	495.0	2,640.0
G-2	488.4	2,984.6
G-3	693.0	4,620.0
G-4	970.2	6,252.4
G-5	831.6	5,359.2
G-6	1419.0	8,408.8
G-7	1353.0	9,020.0
G-8	712.8	4,752.0
G-9	693.0	4,620.0
G-10	693.0	4,620.0
G-11	937.2	6,248.0
G-12	792.0	6,160.0
TOTAL	10,078.2	65,685.0

Hopkin's Prong		
Section	Distance	Cu. Yds.
H-1	1.056.0	4,693.3
H-2	841.5	3,740.0
H-3	1138.5	5,060.0
H-4	990.0	4,400.0
H-5	742.5	3,300.0
H-6	759.0	3,795.0
H-7	481.8	3,479.6
H-8	462.0	3,080.0
Total	6,471.3	31,547.9

Burton Prong		
Section	Distance	Cu. Yds.
B-1	798.6	3,549.3
B-2	1188.0	7,260.0
B-3	462.0	3,336.6
B-4	877.8	4,876.6
B-5	1155.0	7,058.3
B-6	1155.0	10,908.1
TOTAL	5,636.4	36,988.9

Total Lin. Ft. Channel = 36,501.3

Total Cu. Yds. of Project = 193,473.2



CORE SAMPLES

SECTION	SILT	SAND & CLAY
7	6'0	1'0
10	6'0	1'0
13	7'0	1'0
B3	7'0	1'0
B4	5'0	1'0
B5	8'0	1'0
B6	7'0	1'0
B8	4'0	1'0

C. KENNETH CARTER REGISTERED No. LS-243 DELAWARE LAND SURVEYOR

Plans By:

C. Kenneth Carter & Assoc.

C. Kenneth Carter

Newark Island, Delaware.

P.L.S. 243

Graphic Scale

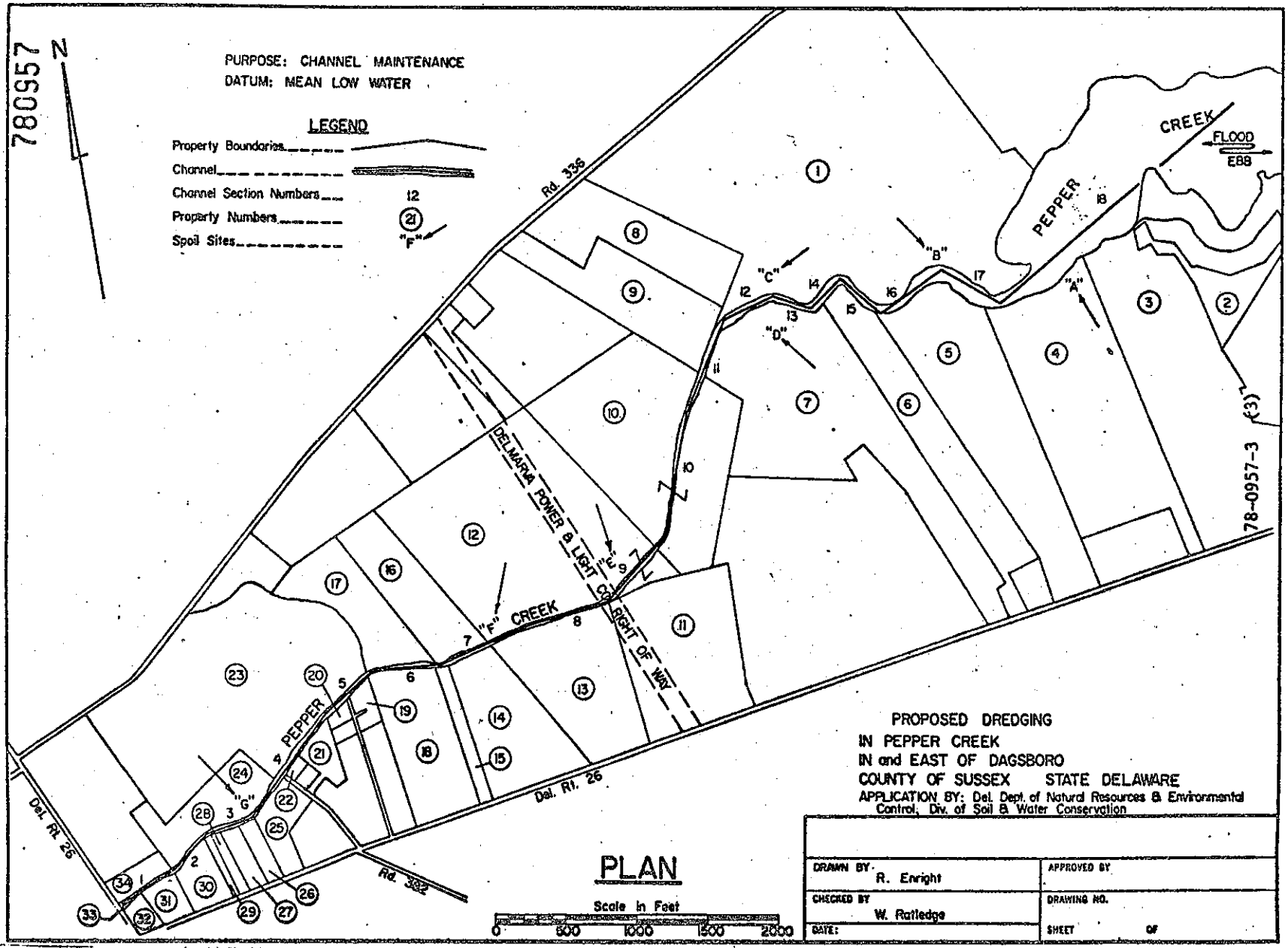
330' 0 660' 1980'

Department of Natural Resources And Environmental Control

Division of Soil & Water Conservation

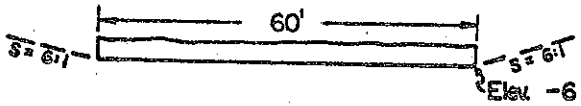
State of Delaware - Sussex County

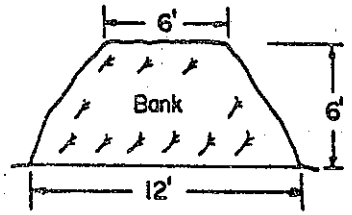
PEPPER CREEK 1979


780957
N
PURPOSE: CHANNEL MAINTENANCE
DATUM: MEAN LOW WATER
LEGEND
Property Boundaries
Channel
Channel Section Numbers 12
Property Numbers (21)
Spoil Sites "F"
Rd. 336
CREEK
FLOOD
EBB
PEPPER
"A"
"B"
"C"
"D"
"E"
"F"
"G"
DEL MARVA POWER & LIGHT CO. RIGHT OF WAY
PEPPER CREEK
Del. Rt. 26
Rd. 382
78-0957-3
PROPOSED DREDGING
IN PEPPER CREEK
IN and EAST OF DAGSBORO
COUNTY OF SUSSEX STATE DELAWARE
APPLICATION BY: Del. Dept. of Natural Resources & Environmental Control, Div. of Soil & Water Conservation
PLAN
Scale in Feet
0 500 1000 1500 2000
DRAWN BY: R. Enright
APPROVED BY
CHECKED BY: W. Rutledge
DRAWING NO.
DATE:
SHEET OF

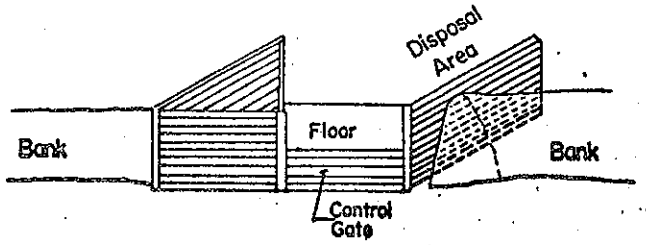
780957

Typical Section — Box Cut





Typical Bank



NOT TO SCALE

SECTION		DISTANCE	CUBIC YARDS
1.	N 65° 30' 00" E	462.0'	8,555
2.	N 47° 00' 00" E	330.0'	4,888
3.	N 82° 14' 00" E	330.0'	4,277
4.	N 45° 30' 00" E	858.0'	7,944
5.	N 56° 11' 00" E	462.0'	3,422
6.	S 85° 05' 00" E	462.0'	3,422
7.	S 74° 30' 00" E	660.0'	4,900
8.	N 83° 30' 00" E	594.0'	4,400
9.	N 51° 15' 00" E	594.0'	4,400
10.	N 17° 55' 00 E	924.0'	9,240 — 5676
11.	N 30° 59' 00" E	726.0'	7,260 — 6402
12.	N 74° 39' 00" E	396.0'	3,960
13.	N 77° 30' 00" E	264.0'	2,640
14.	N 51° 40' 00" E	400.0'	4,000
15.	S 41° 10' 00" E	425.0'	4,250
16.	N 62° 50' 00 E	528.0'	5,280
17.	S 50° 50' 00" E	528.0'	5,280 — 8943
18.	N 58° 45' 00" E	2310.0'	23,100 — 11253

45'

2541

60'

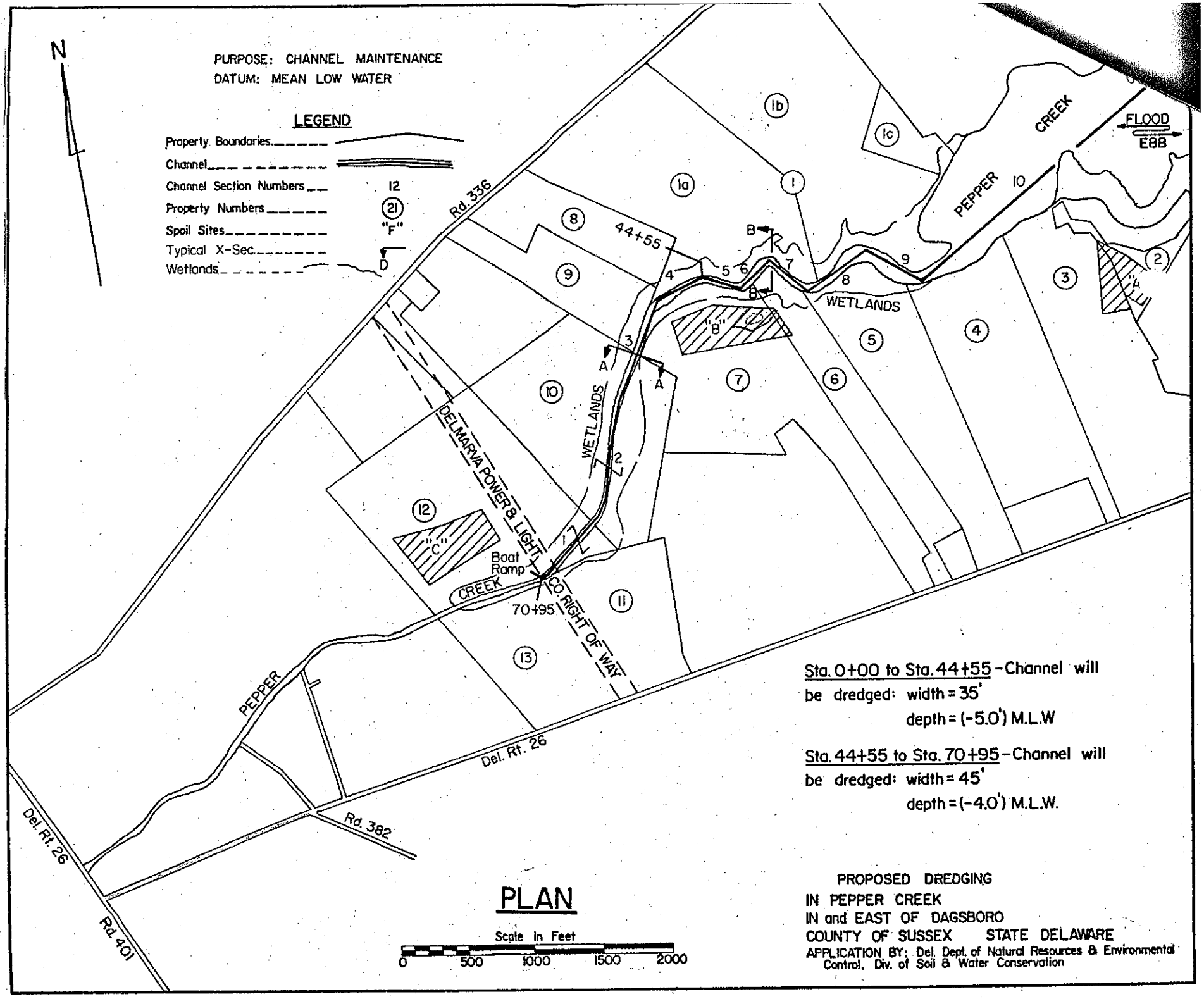
SECTION	MUD & SILT	SAND & CLAY
4	0'-0"	3'-5"
7	0'-0"	3'-4"
10	1'-0"	3'-0"
13	1'-5"	3'-5"
16	4'-6"	1'-0"
18	5'-6"	1'-0"

78-0957-3 (4)

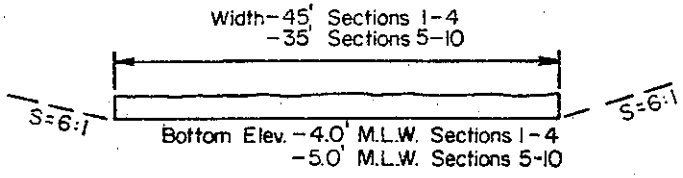
PROPOSED DREDGING
IN PEPPER CREEK
IN and EAST OF DAGSBORO
COUNTY OF SUSSEX STATE DELAWARE
APPLICATION BY: Del. Dept. of Natural Resources & Environmental Control, Div. of Soil & Water Conservation

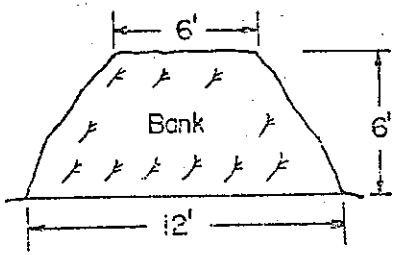
DESIGNED BY	APPROVED BY
CHECKED BY	DRAWING NO.
DATE:	SHEET OF

PEPPER CREEK 1987

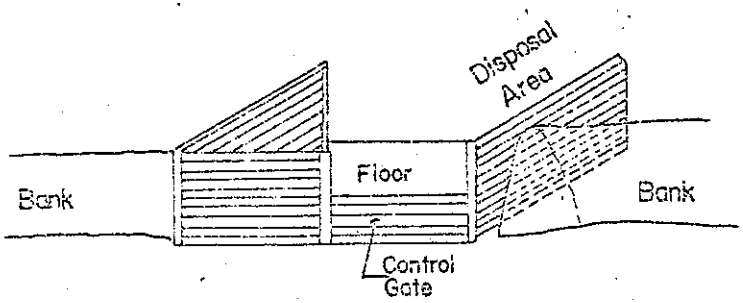

N
PURPOSE: CHANNEL MAINTENANCE
DATUM: MEAN LOW WATER
LEGEND
Property Boundaries
Channel
Channel Section Numbers 12
Property Numbers (21)
Spoil Sites "F"
Typical X-Sec D
Wetlands
Rd. 336
1a
1b
1c
1
2
3
4
5
6
7
8
9
10
11
12
13
44+55
70+95
A
B
"A"
"B"
"C"
WETLANDS
PEPPER CREEK
FLOOD
EBB
DELMARVA POWER & LIGHT CO. RIGHT OF WAY
Boat Ramp
CREEK
PEPPER
Del. Rt. 26
Rd. 382
Del. Rt. 26
Rd. 401
Sta. 0+00 to Sta. 44+55 - Channel will be dredged: width = 35' depth = (-5.0') M.L.W
Sta. 44+55 to Sta. 70+95 - Channel will be dredged: width = 45' depth = (-4.0') M.L.W.
PLAN
Scale in Feet
0 500 1000 1500 2000
PROPOSED DREDGING
IN PEPPER CREEK
IN and EAST OF DAGSBORO
COUNTY OF SUSSEX STATE DELAWARE
APPLICATION BY: Del. Dept. of Natural Resources & Environmental Control, Div. of Soil & Water Conservation

Typical Section — Box Cut





Typical Bank

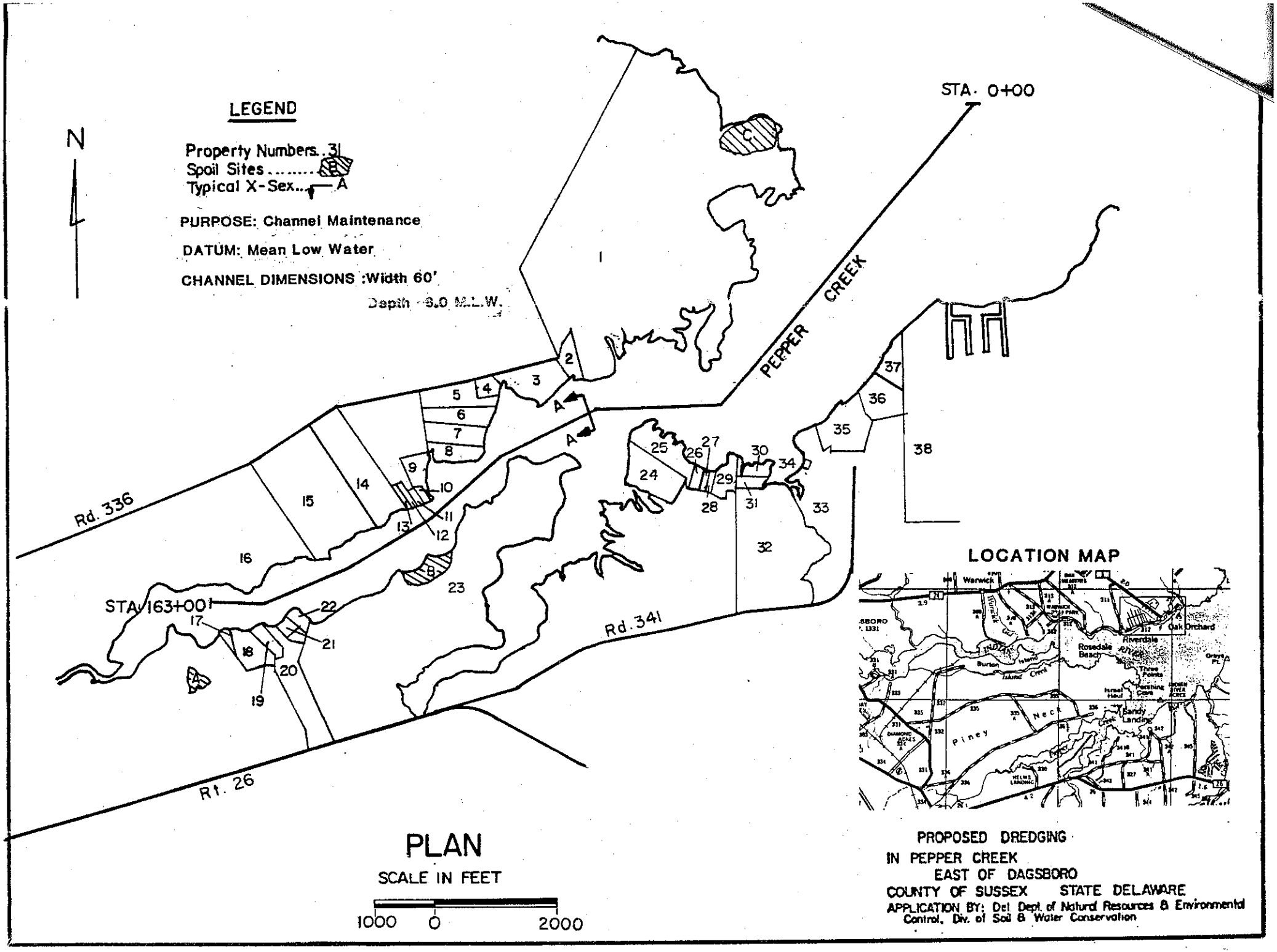


NOT TO SCALE

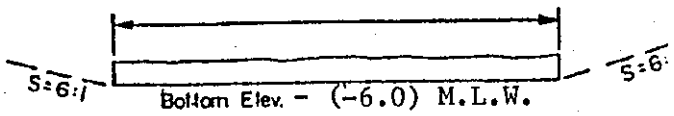
SECTION	DISTANCE	CU. YRS.
1. N 51° 15' 00" E	594.0	7,080
2. N 17° 55' 00" E	924.0	9,980
3. N 30° 59' 00" E	726.0	7,260
4. N 74° 39' 00" E	396.0	3,480
5. N 77° 30' 00" E	264.0	2,200
6. N 51° 40' 00" E	400.0	3,100
7. S 41° 10' 00" E	425.0	2,750
8. N 62° 50' 00" E	528.0	2,850
9. S 50° 50' 00" E	528.0	3,300
10. N 58° 45' 00" E	2,310.0	23,100

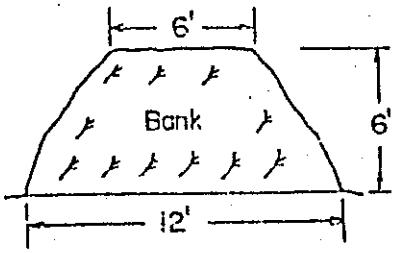
SECTION	MUD & SILT	SAND & CLAY
2	1'-0"	3'-0"
5	1'-5"	3'-5"
8	4'-5"	1'-0"
10	5'-8"	1'-0"

PROPOSED DREDGING
IN PEPPER CREEK
IN and EAST OF DAGSBORO
COUNTY OF SUSSEX STATE DELAWARE
APPLICATION BY: Del. Dept. of Natural Resources & Environmental Control, Div. of Soil & Water Conservation

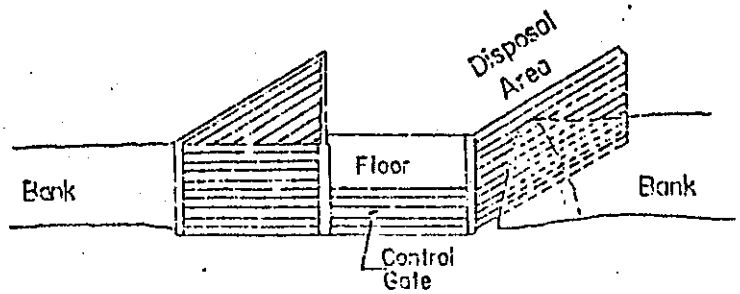

LEGEND
Property Numbers..31
Spoil Sites.....B
Typical X-Sex...A
PURPOSE: Channel Maintenance
DATUM: Mean Low Water
CHANNEL DIMENSIONS :Width 60'
Depth -6.0 M.L.W.
N
STA. 0+00
PEPPER CREEK
Rd. 336
STA. 163+00
Rd. 341
Rt. 26
LOCATION MAP
Warwick
Oak Orchard
Riverdale
Rosedale Beach
Burton Island
Island Creek
Three Points
Pershing Cove
Israel Haul
Sandy Landing
Piney Neck
Diamond Acres
Helms Landing
PLAN
SCALE IN FEET
1000 0 2000
PROPOSED DREDGING
IN PEPPER CREEK
EAST OF DAGSBORO
COUNTY OF SUSSEX STATE DELAWARE
APPLICATION BY: Del. Dept. of Natural Resources & Environmental Control, Div. of Soil & Water Conservation

Typical Section — Box Cut





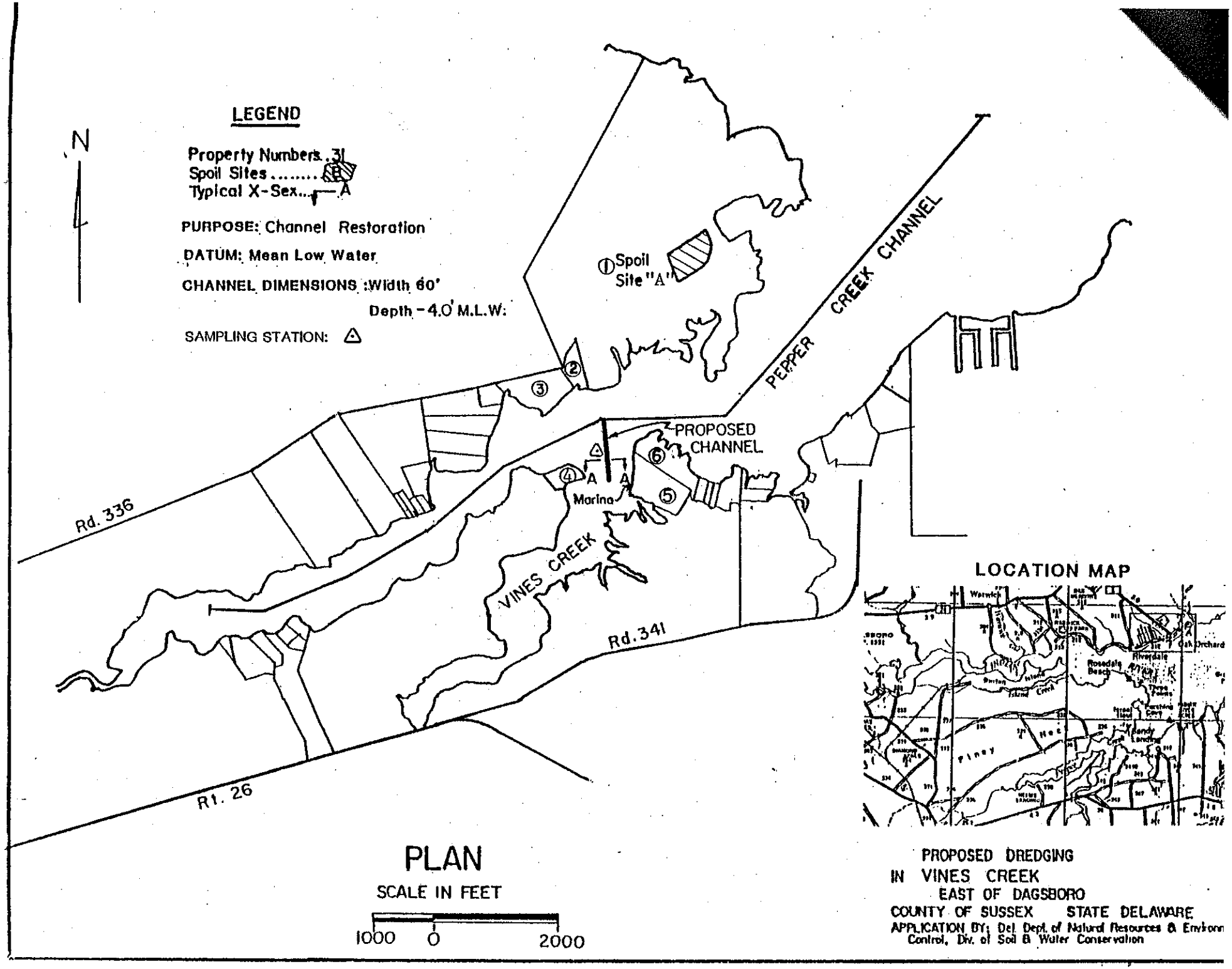
Typical Bank



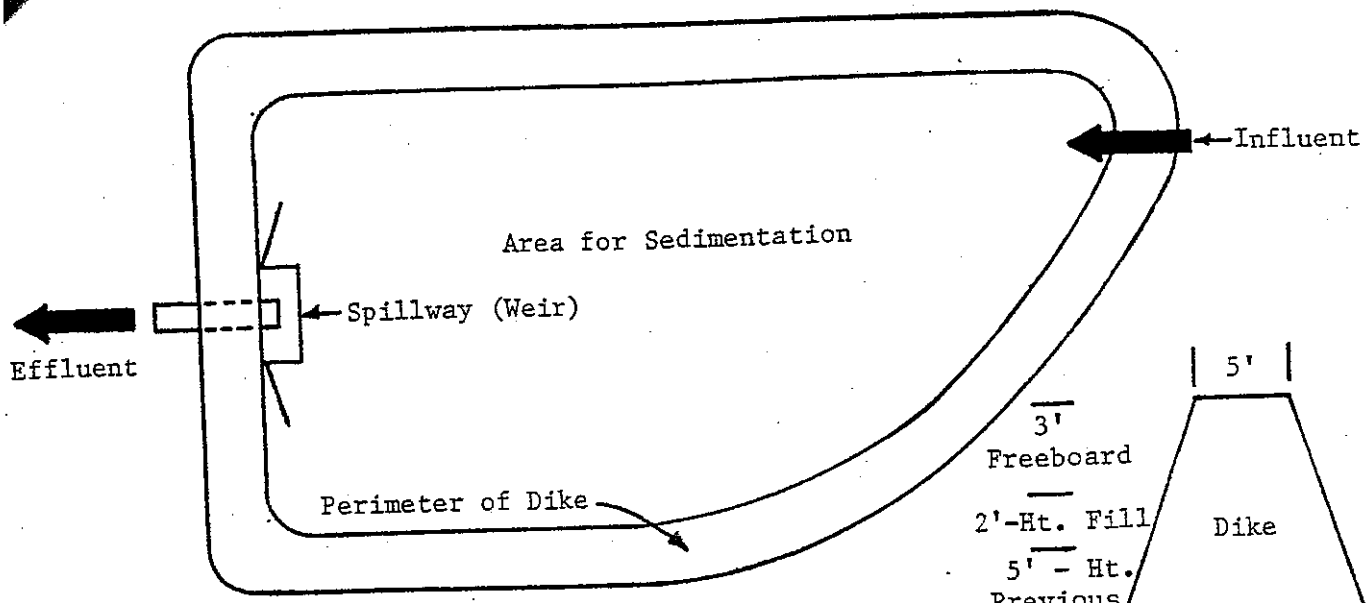
NOT TO SCALE

PROPOSED DREDGING
IN PEPPER CREEK
EAST OF DAGSBORO
COUNTY OF SUSSEX STATE DELAWARE
APPLICATION BY: Del Dept. of Natural Resources & Environmental Control, Div. of Soil & Water Conservation

VINES CREEK 1988

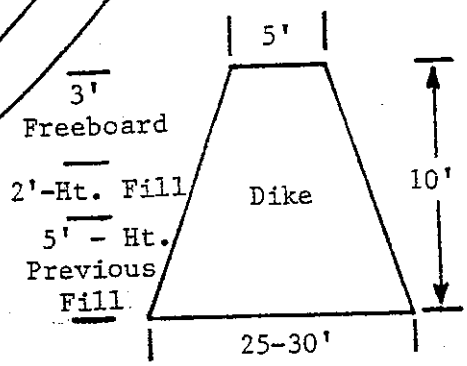

LEGEND
Property Numbers..31
Spoil Sites.....B
Typical X-Sec...A
PURPOSE: Channel Restoration
DATUM: Mean Low Water
CHANNEL DIMENSIONS :Width 60'
Depth -4.0' M.L.W.
SAMPLING STATION:
N
① Spoil Site "A"
②
③
④
⑤
⑥
PEPPER CREEK CHANNEL
PROPOSED CHANNEL
A
A
Marina
Rd. 336
VINES CREEK
Rd. 341
Rt. 26
PLAN
SCALE IN FEET
1000 0 2000
LOCATION MAP
PROPOSED DREDGING
IN VINES CREEK
EAST OF DAGSBORO
COUNTY OF SUSSEX STATE DELAWARE
APPLICATION BY: Del. Dept. of Natural Resources & Environ Control, Div. of Soil & Water Conservation

DISPOSAL SITE DESIGN

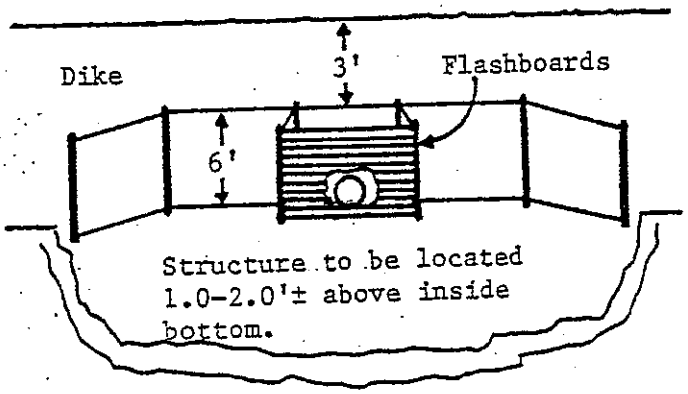


PLAN VIEW OF DISPOSAL AREA

5 Acre Site



CROSS-SECTION OF DIKE

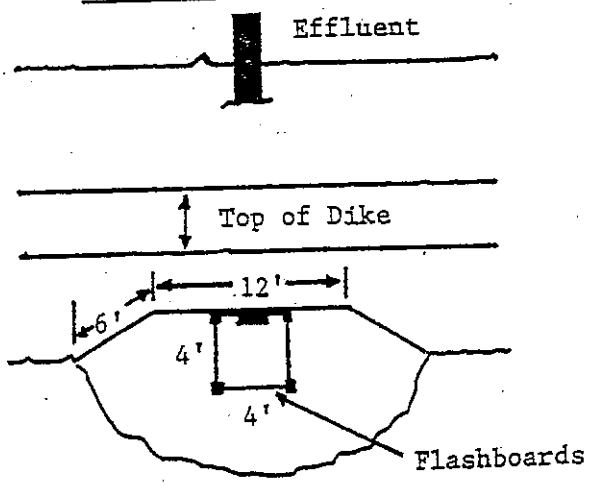


VIEW OF SPILLWAY

Outflow Pipe - 24" Diameter

Flashboards to be added as water level rises.

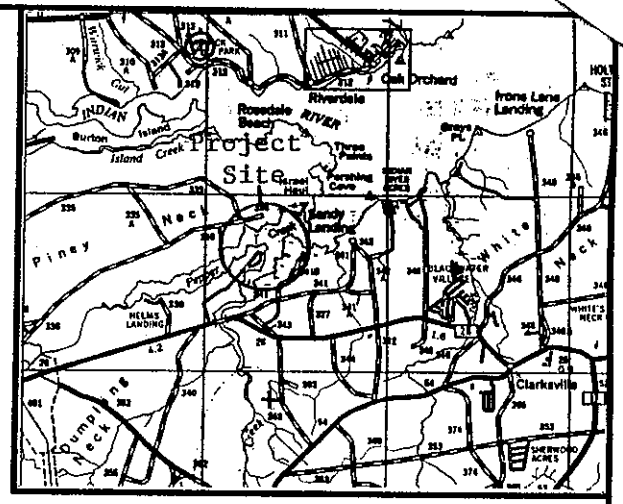
TOP VIEW OF SPILLWAY



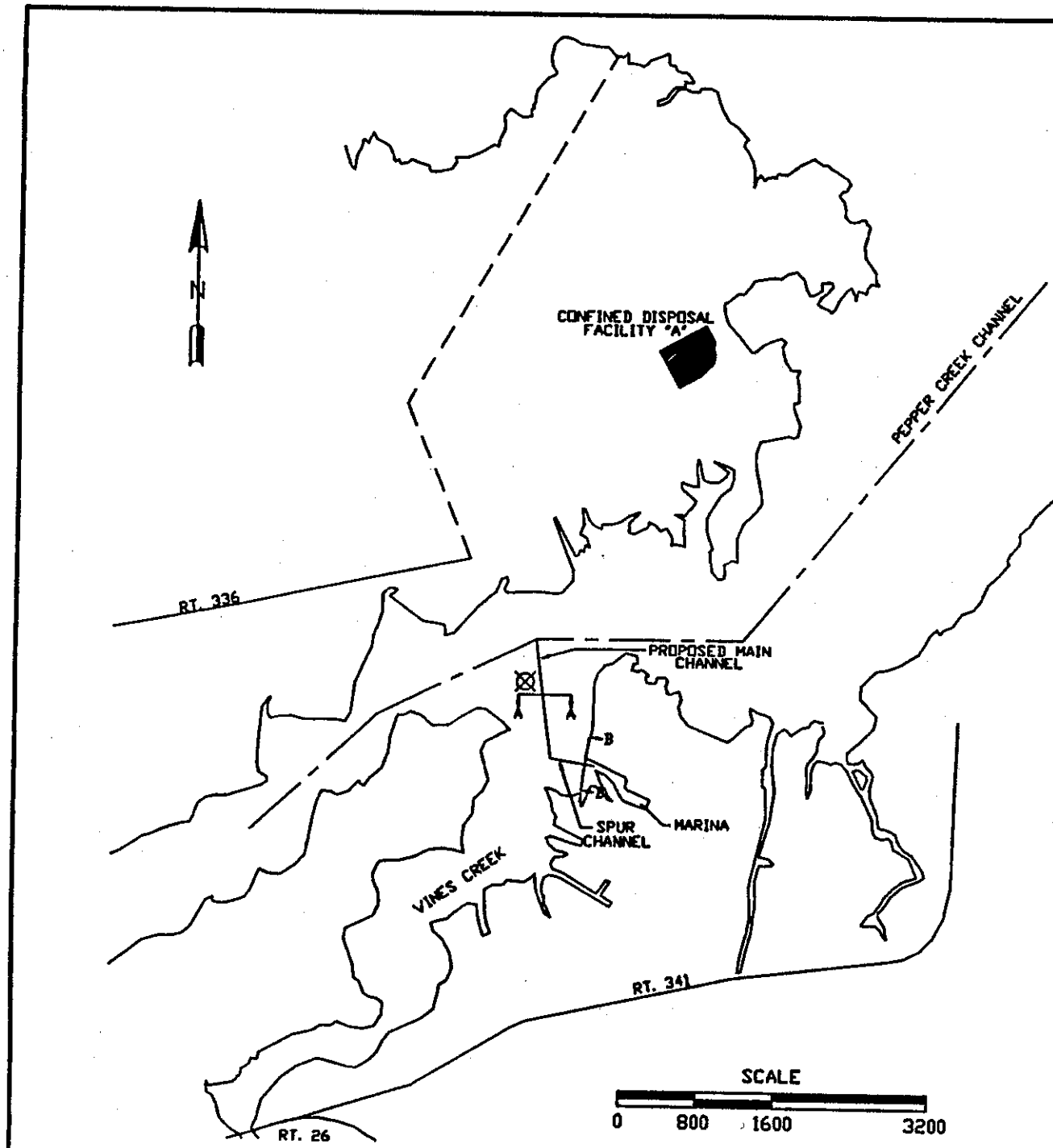
VINES CREEK DREDGING PROJECT
COUNTY OF SUSSEX
STATE : DELAWARE

Application by: Delaware Department of Natural Resources and Environ. Control, Division of Soil and Water Conservation

VINES CREEK 1993



LOCATION MAP



LEDGEND

TYPICAL X-SEC.

SAMPLING STATION

CHANNEL DIMENSIONS:
MAIN CHANNEL 60' WIDE, (-4.0)' MLW DEEP
SPUR CHANNEL 35' WIDE, (-4.0)' MLW DEEP

VINES CREEK DREDGING PROJECT

COUNTY OF SUSSEX
STATE: DELAWARE

APPLICATION BY: DEL. DEPT. OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL & WATER CONSERVATION

DATE: OCTOBER 1993

DATUM: M.L.W.

INES CREEK DREDGING PROJECT

COUNTY OF SUSSEX
STATE: DELAWARE

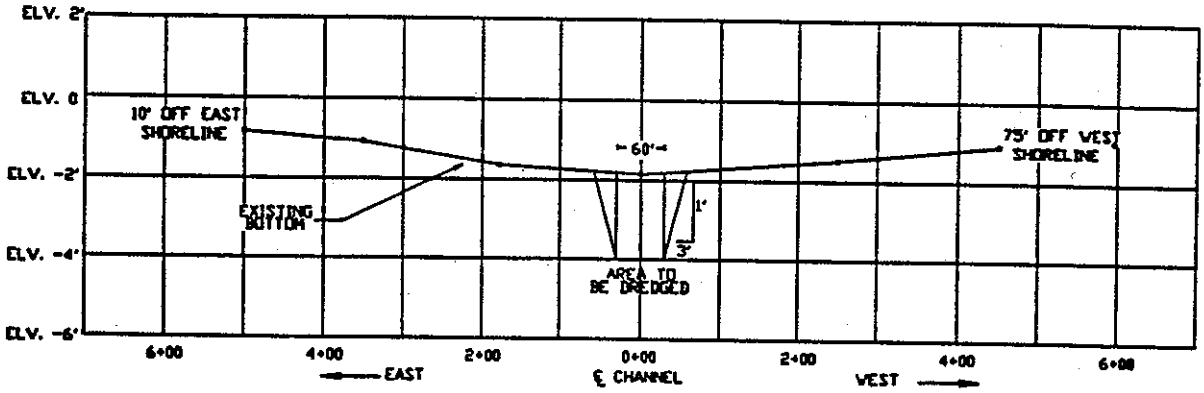
APPLICATION BY: DEL. DEPT. OF NATURAL RESOURCES
AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL &
WATER CONSERVATION

DATE: OCTOBER, 1993 DATUM: M.L.W.

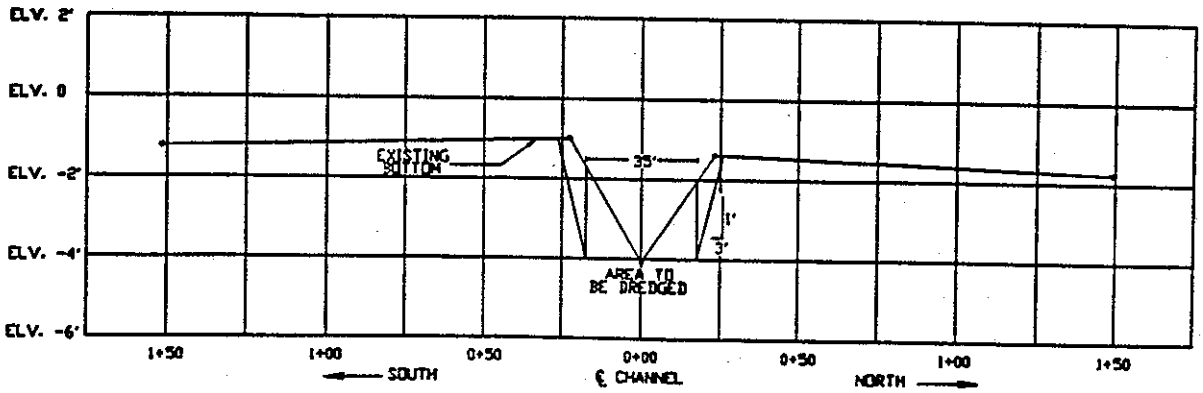
SCALE AS SHOWN

TYPICAL CROSS-SECTIONS

CROSS-SECTION A-A

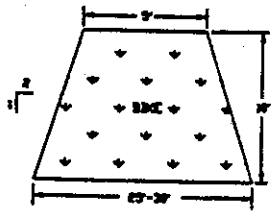


CROSS-SECTION B-B



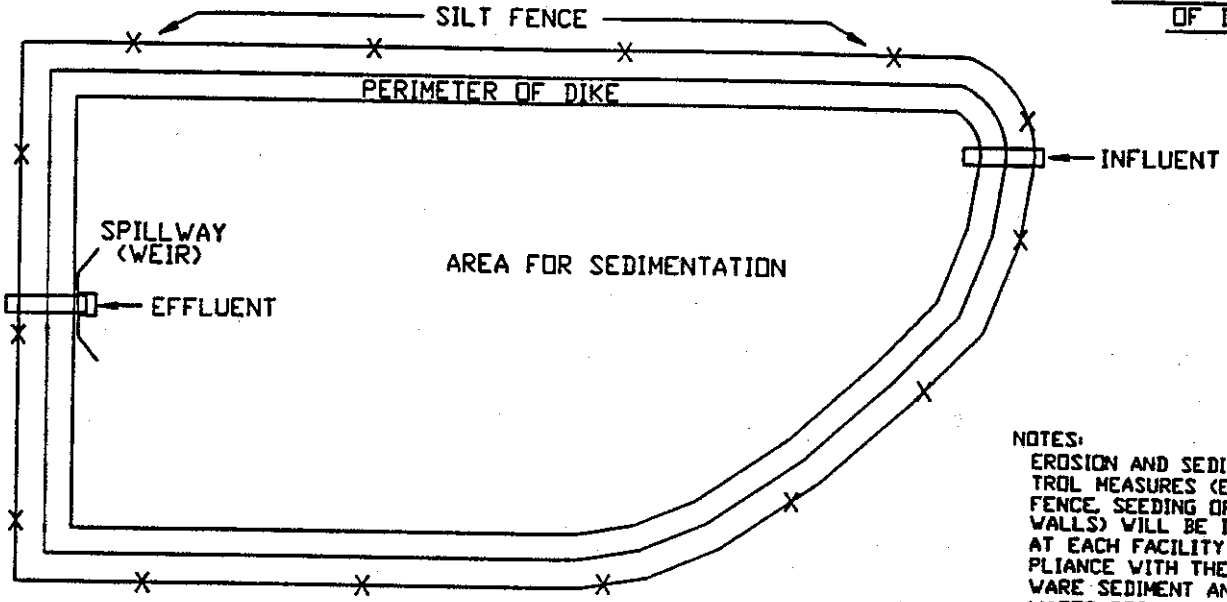
TYPICAL CONFINED DISPOSAL FACILITY DESIGN

(NO SCALE)



CROSS SECTION OF DIKE

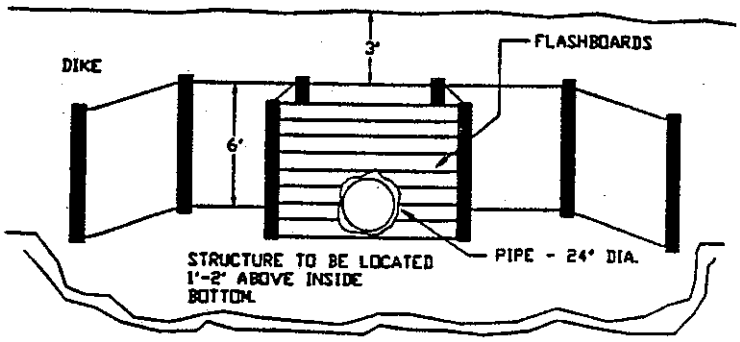
PLAN VIEW
5 ACRE SITE



NOTES:
EROSION AND SEDIMENT CONTROL MEASURES (E.G. SILT FENCE, SEEDING OF DIKE WALLS) WILL BE IMPLEMENTED AT EACH FACILITY IN COMPLIANCE WITH THE DELAWARE SEDIMENT AND STORM WATER REGULATIONS DATED 7/1/91.

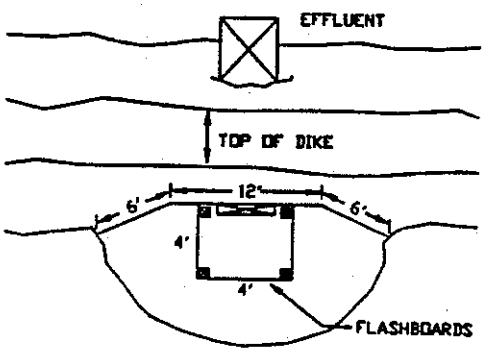
SPILLWAY (WEIR) DESIGN

PLAN VIEW



FLASHBOARDS WILL BE ADDED AS WATER LEVEL RISES.

TOP VIEW



VINES CREEK DREDGING PROJECT

COUNTY OF SUSSEX
STATE: DELAWARE

APPLICATION BY: DEL. DEPT. OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL & WATER CONSERVATION

DATE: OCTOBER, 1993 DATUM: M.L.W.

MASSEYS DITCH 1987

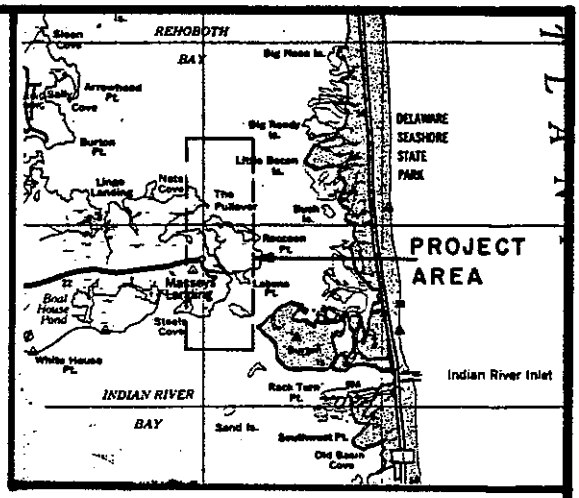
N

PURPOSE IMPROVE NAVIGATION IN FEDERALLY AUTHORIZED CHANNEL

DATUM MEAN LOW WATER

A
A

TYPICAL CROSS-SECTION



LOCATION MAP

6' Curve

REHOBOTH BAY

1 0 1 2 3 4

SCALE IN MILES

PROPOSED SPOIL SITE

To Millsboro

MARINA

LONG NECK

Big Ditch

Little Ditch

INDIAN RIVER BAY

6' curve

Burton Island

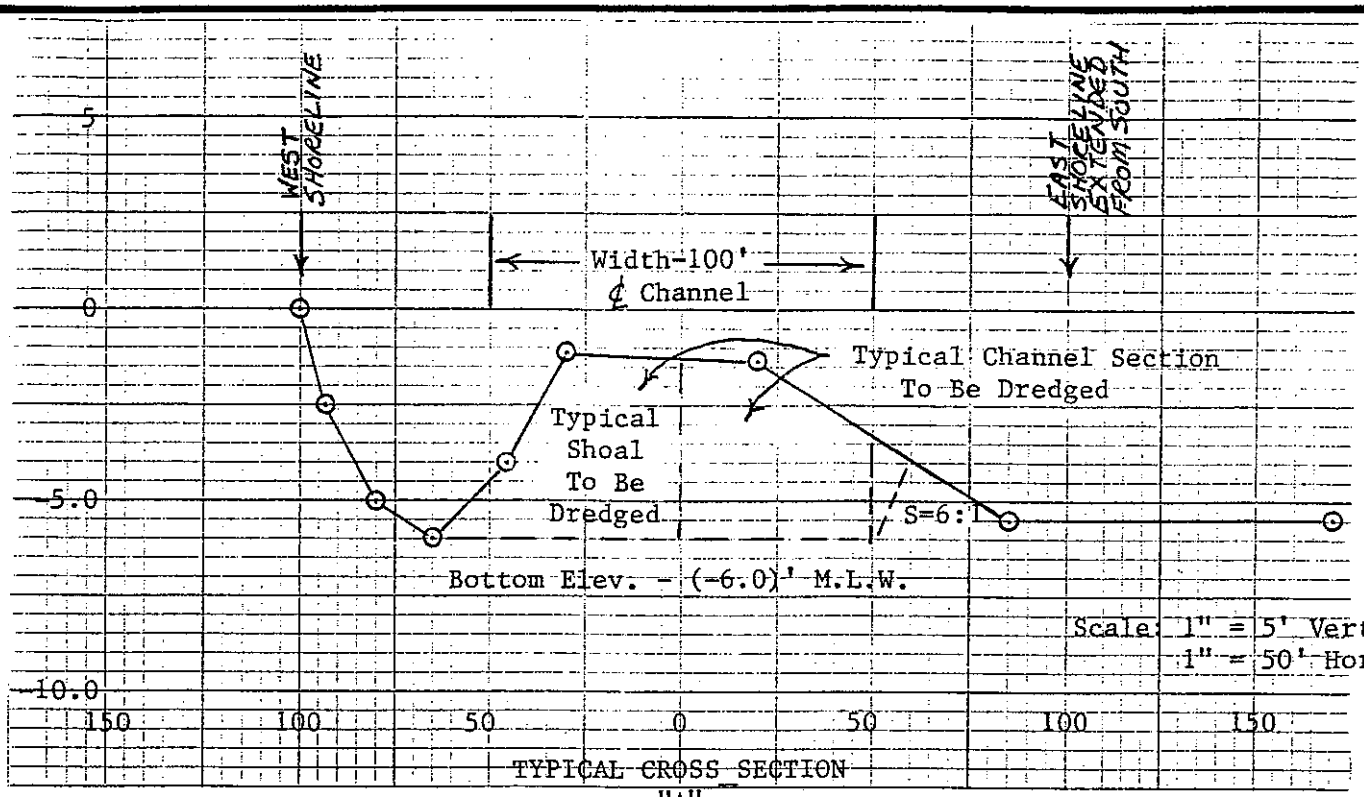
Balders Pond

PLAN

1000 0 1 2 3 4 5000

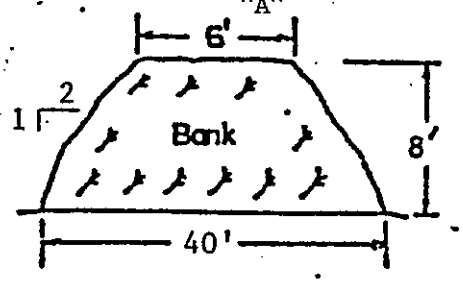
SCALE IN FEET

PROPOSED MAINTENANCE DREDGING OF FEDERALLY AUTHORIZED CHANNEL AT MASSEYS DITCH
SUSSEX COUNTY, DELAWARE
APPLIC. BY DEP OF NAT. RESOURCES & ENVIRONMENTAL CONTROL
DIV. OF SOIL & WATER CONSERV



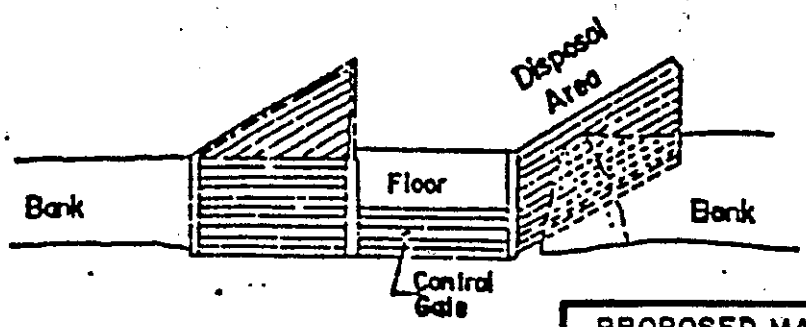
TYPICAL CROSS SECTION

"A"



Typical Bank

SPOIL SITE DIKE



NOT TO SCALE

PROPOSED MAINTENANCE DREDGING OF FEDERALLY AUTHORIZED CHANNEL AT
MASSEYS DITCH
SUSSEX COUNTY, DELAWARE
APPLIC. BY. DEP. OF NAT. RESOURCE & ENVIRONMENTAL CONTROL
DIV. OF SOIL & WATER CONSERV.

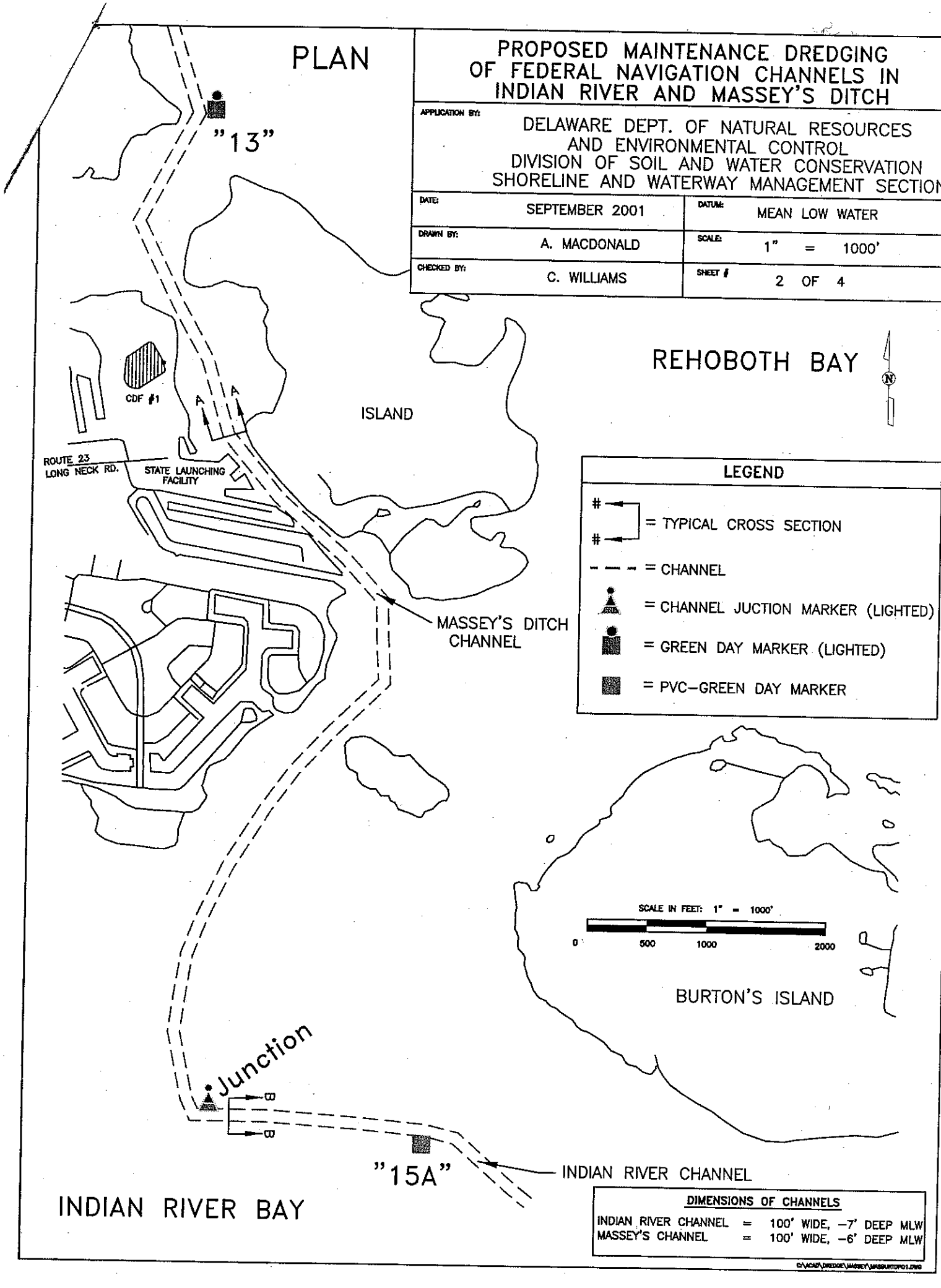
MASSEYS DITCH 2002

PLAN

PROPOSED MAINTENANCE DREDGING OF FEDERAL NAVIGATION CHANNELS IN INDIAN RIVER AND MASSEY'S DITCH

APPLICATION BY:
DELAWARE DEPT. OF NATURAL RESOURCES
AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION
SHORELINE AND WATERWAY MANAGEMENT SECTION

DATE:	SEPTEMBER 2001	DATUM:	MEAN LOW WATER
DRAWN BY:	A. MACDONALD	SCALE:	1" = 1000'
CHECKED BY:	C. WILLIAMS	SHEET #	2 OF 4



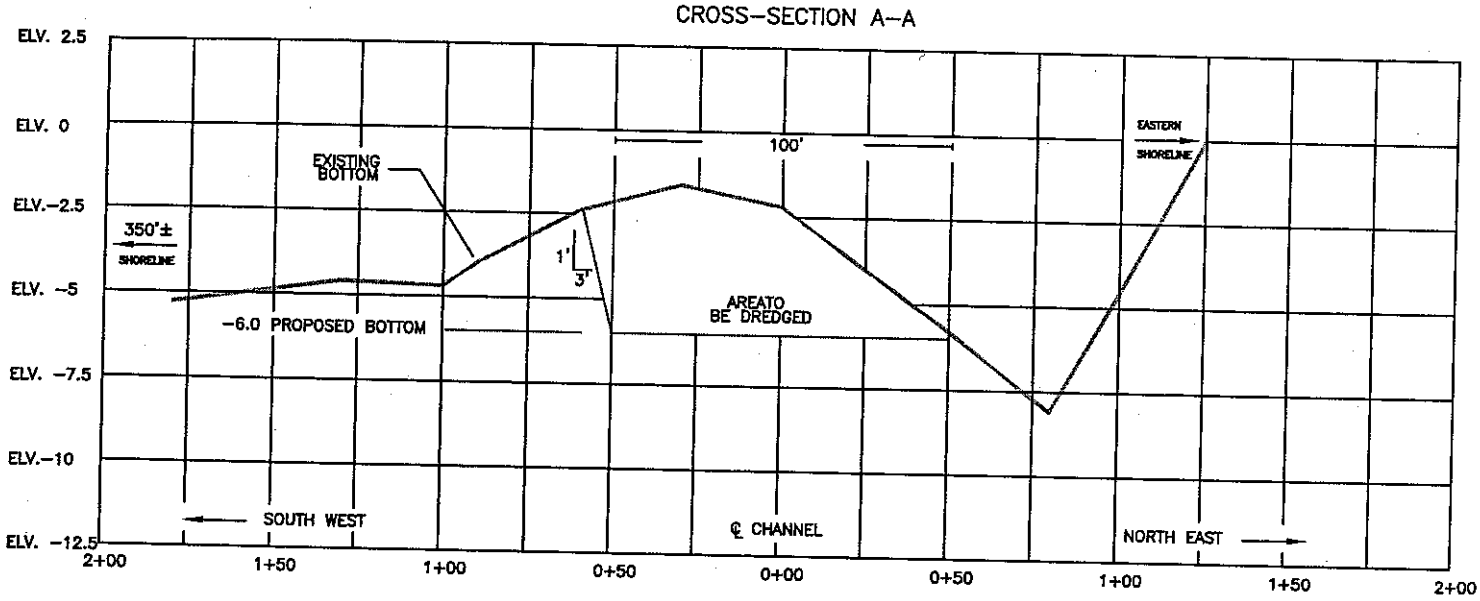
DIMENSIONS OF CHANNELS		
INDIAN RIVER CHANNEL	=	100' WIDE, –7' DEEP MLW
MASSEY'S CHANNEL	=	100' WIDE, –6' DEEP MLW

G:\ACAD\DREDGE\MASSEY\MASSKEYPOI.DWG

TYPICAL CROSS-SECTIONS

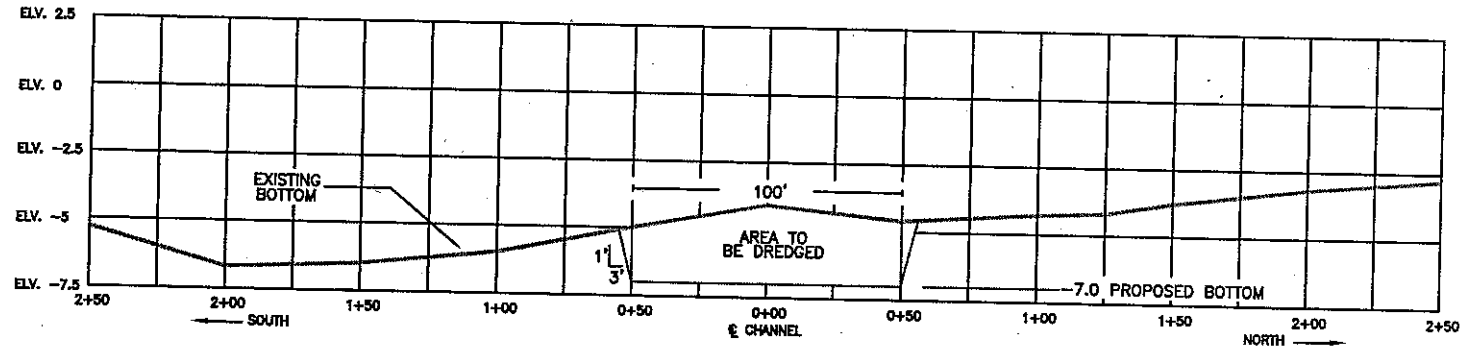
MASSEY'S DITCH CHANNEL

CROSS-SECTION A-A



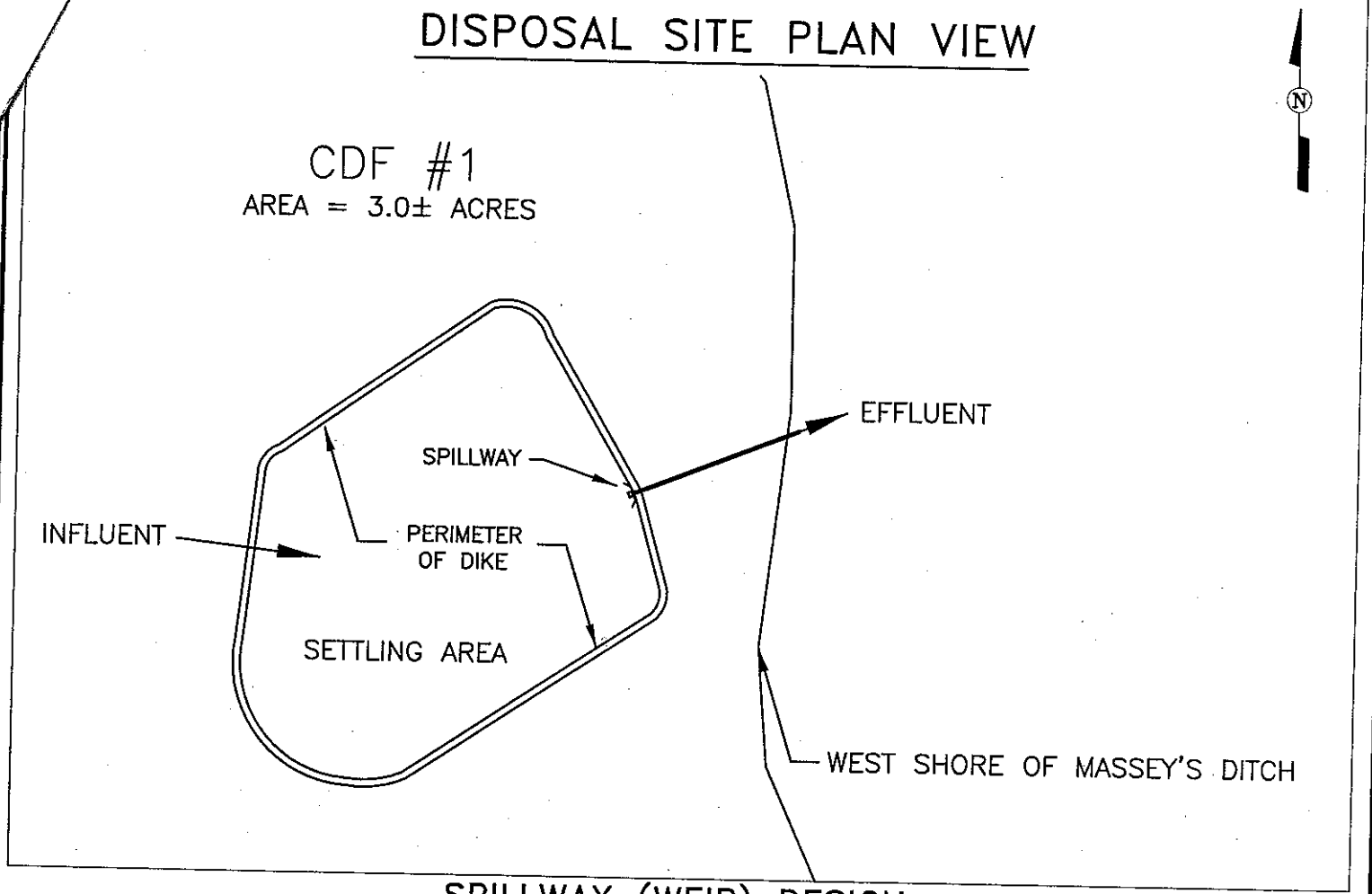
INDIAN RIVER CHANNEL

CROSS-SECTION B-B

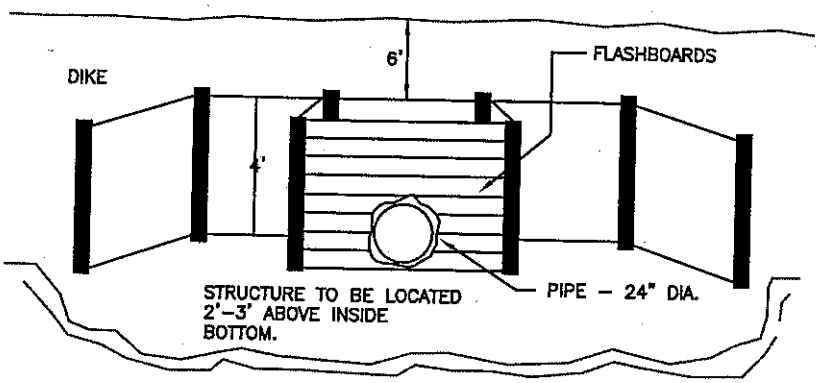


PROPOSED MAINTENANCE DREDGING OF FEDERAL NAVIGATION CHANNELS IN INDIAN RIVER AND MASSEY'S DITCH	
APPLICATION BY: DELAWARE DEPT. OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL DIVISION OF SOIL AND WATER CONSERVATION SHORELINE AND WATERWAY MANAGEMENT SECTION	
DATE: SEPTEMBER 2001	DATUM: MEAN LOW WATER
DRAWN BY: A. MACDONALD	SCALE: NONE
CHECKED BY: C. WILLIAMS	SHEET #: 3 OF 4

DISPOSAL SITE PLAN VIEW

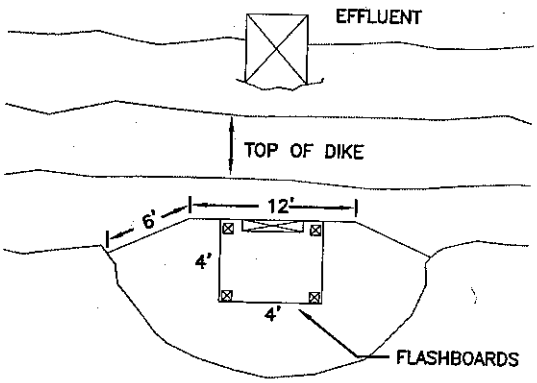


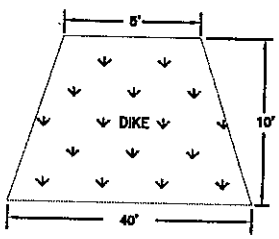
SPILLWAY (WEIR) DESIGN



FLASHBOARDS WILL BE ADDED AS WATER LEVEL RISES.

TOP VIEW





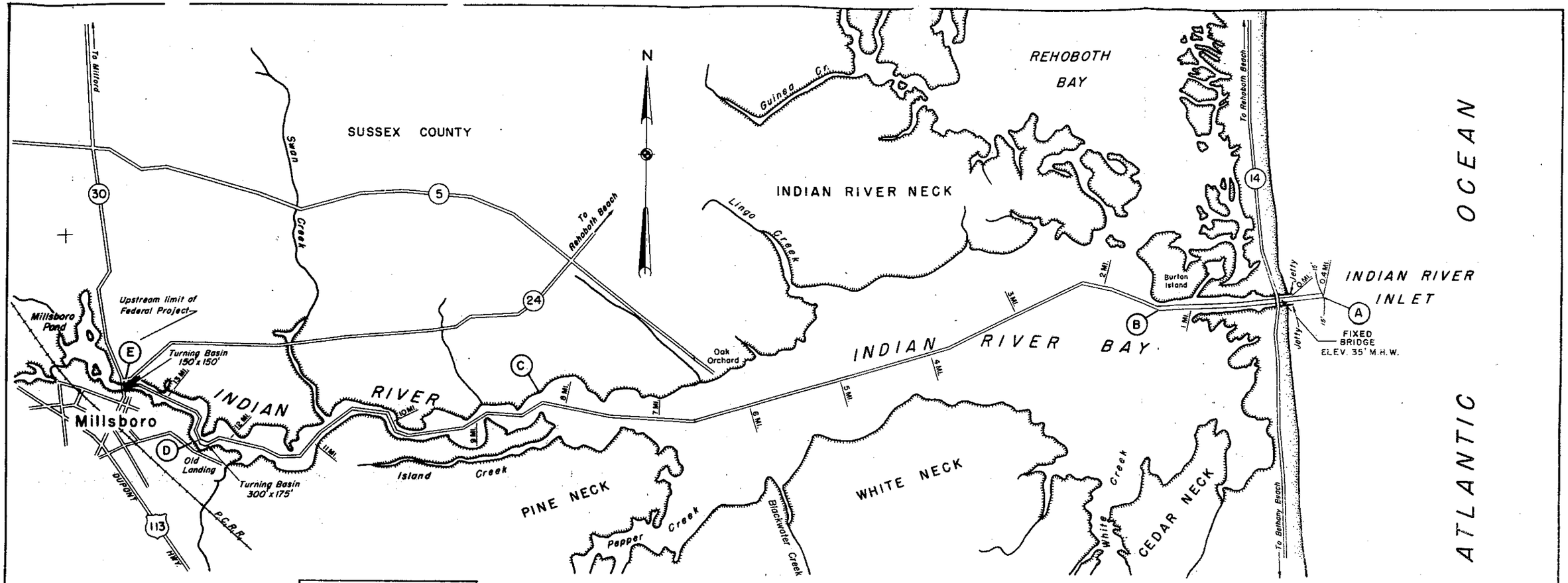
CROSS SECTION OF DIKE

PROPOSED MAINTENANCE DREDGING OF FEDERAL NAVIGATION CHANNELS IN INDIAN RIVER AND MASSEY'S DITCH

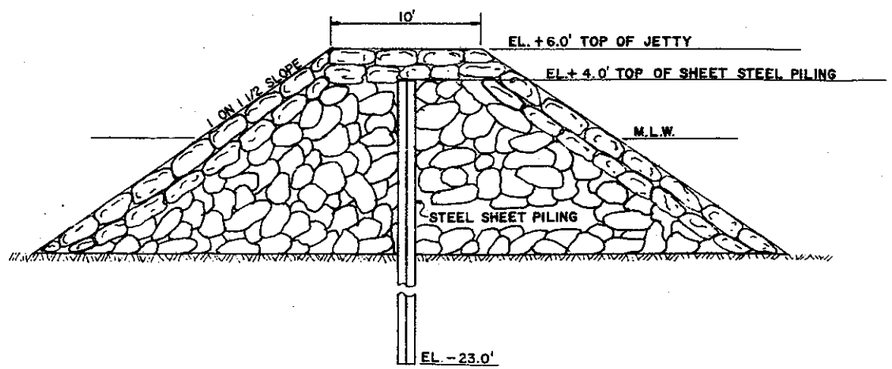
APPLICATION BY:
DELAWARE DEPT. OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION
SHORELINE AND WATERWAY MANAGEMENT SECTION

DATE:	SEPTEMBER 2001	DATUM:	MEAN LOW WATER
DRAWN BY:	A. MACDONALD	SCALE:	NONE
CHECKED BY:	C. WILLIAMS	SHEET #:	4 OF 4

INDIAN RIVER 1977



CHANNEL DIMENSIONS		
LOCATION	DEPTH	WIDTH
A – B	15 FT.	200 FT.
B – C	9 FT.	100 FT.
C – D	9 FT.	80 FT.
D – E	4 FT.	60 FT.



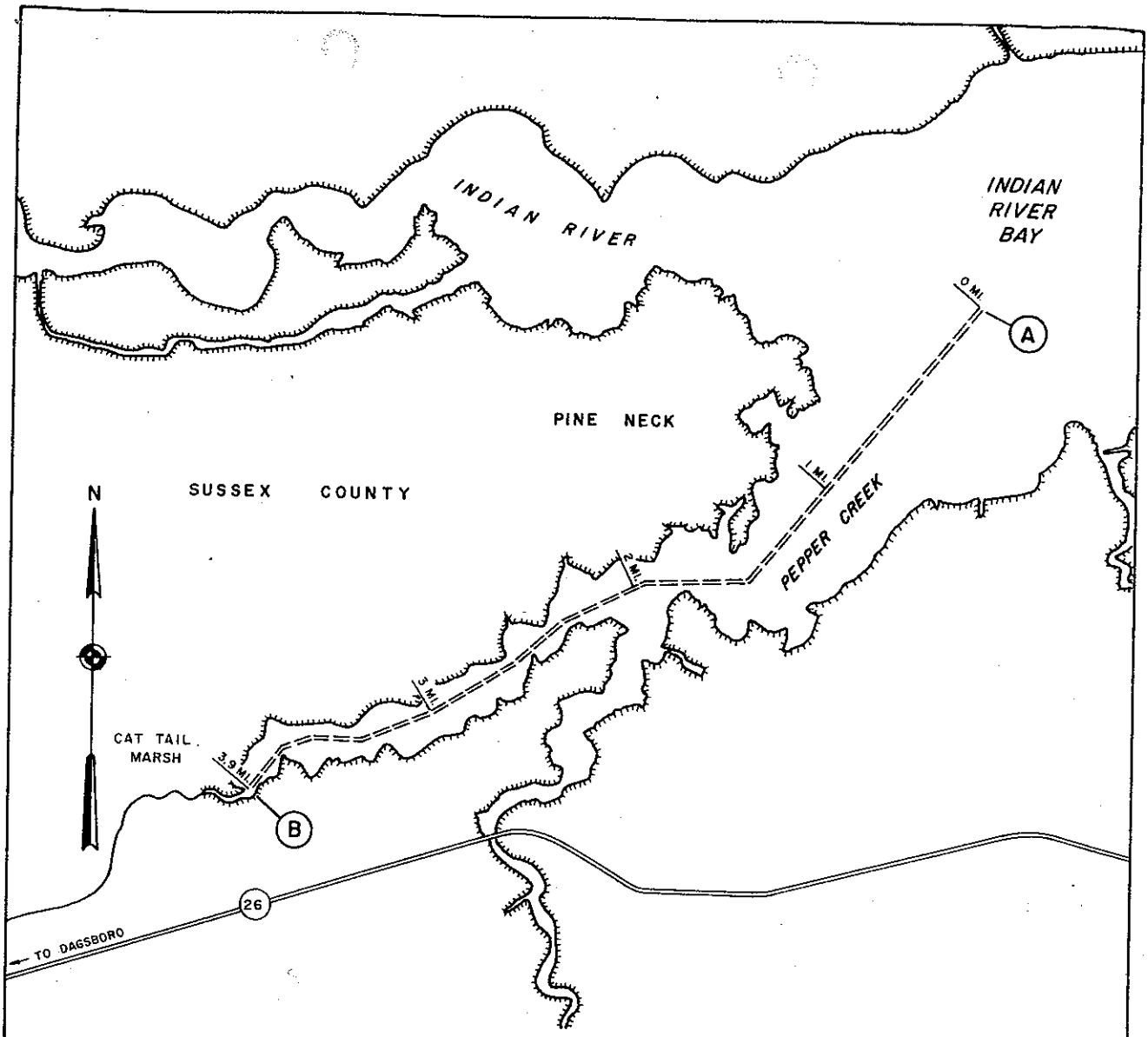
TYPICAL SECTION OF JETTY
SCALE 1"= 5'

SCALE IN MILES
1 0 1

INDIAN RIVER INLET AND BAY STUDY
INDIAN RIVER INLET AND BAY PROJECT

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
MARCH 1979

PLATE 2



CHANNEL DIMENSIONS		
LOCATION	DEPTH	WIDTH
A - B	6 FT.	60 FT.

SCALE IN FEET

1,000 0 1 2 3 4 5,000

INDIAN RIVER INLET AND BAY STUDY

PEPPER CREEK PROJECT

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
MARCH 1979

PLATE 3

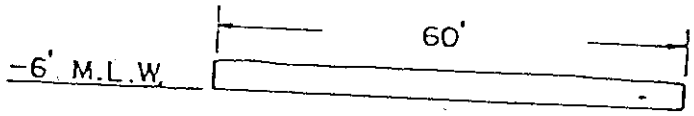
INDIAN RIVER 1983

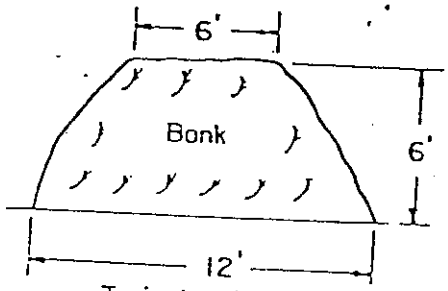
PROPOSED DREDGING

PURPOSE: NAVIGATION AND RECREATION CHANNEL
DATUM: MEAN LOW WATER
ADJACENT PROPERTY OWNERS
See attached sheet

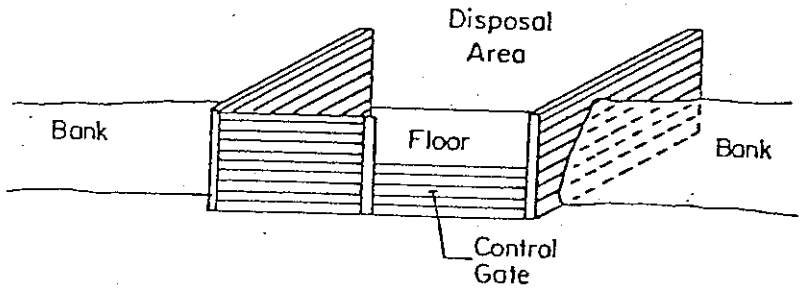
IN: Indian River
AT & EAST OF: Millsboro, Sussex Co., Delaware
APPLICATION BY: Del. Dept. of Natural Resources and Environmental Control
Div. of Soil and Water Conservation

Typical Section — Box Cut





Typical Bank



NOT TO SCALE

PROPOSED DREDGING

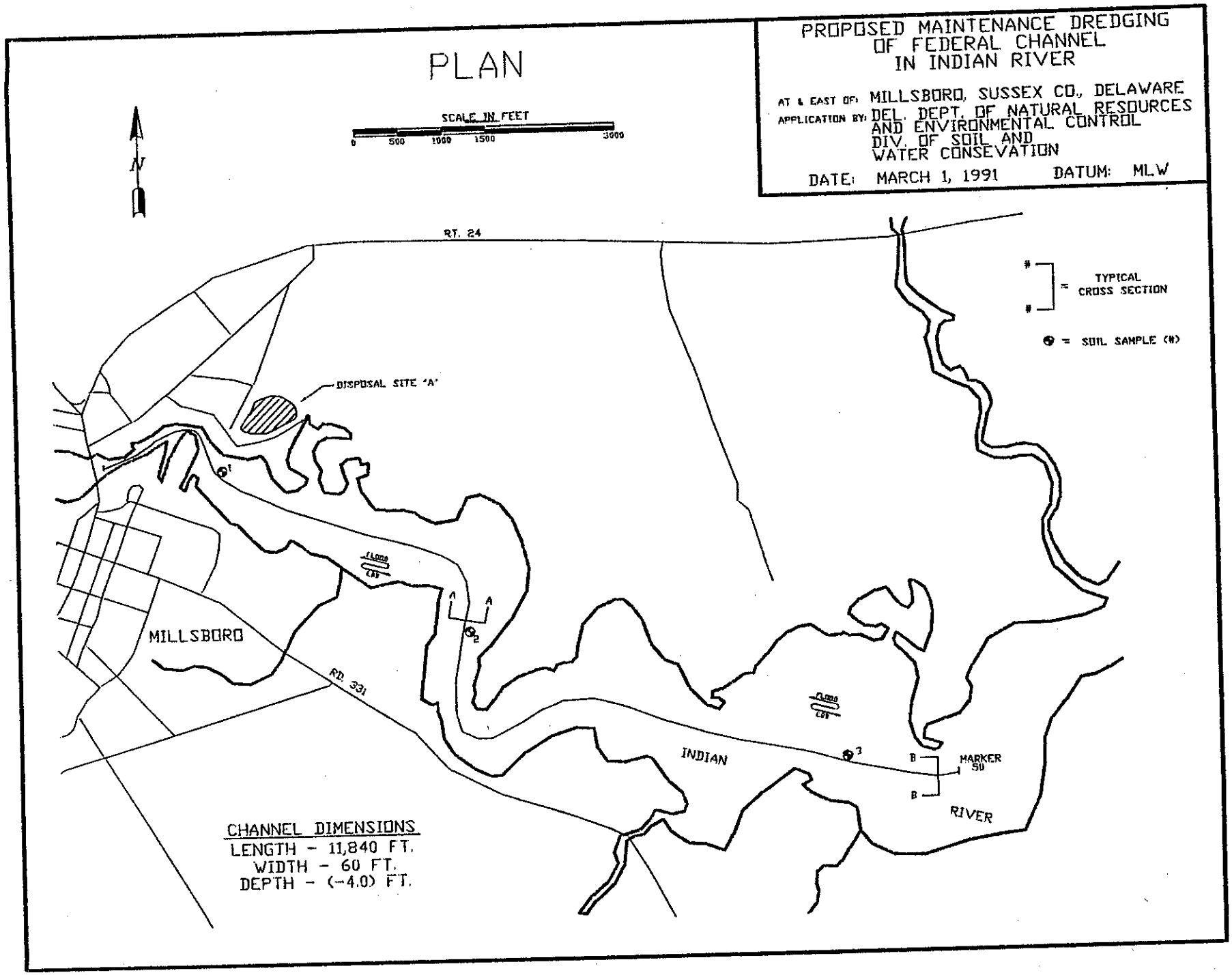
IN Indian River

AT & EAST OF Millsboro, Sussex Co., Delaware

APPLICATION BY Del. Dept. of Natural Resources and Environmental Control Div. of Soil and Water Conservation

INDIAN RIVER 1992

PLAN


PROPOSED MAINTENANCE DREDGING
OF FEDERAL CHANNEL
IN INDIAN RIVER
AT & EAST OF: MILLSBORO, SUSSEX CO., DELAWARE
APPLICATION BY: DEL. DEPT. OF NATURAL RESOURCES
AND ENVIRONMENTAL CONTROL
DIV. OF SOIL AND
WATER CONSEVATION
DATE: MARCH 1, 1991
DATUM: MLW
SCALE IN FEET
0
500
1000
1500
3000
N
RT. 24
DISPOSAL SITE 'A'
MILLSBORO
RD. 331
INDIAN
RIVER
MARKER 50
= TYPICAL CROSS SECTION
= SOIL SAMPLE (#)
CHANNEL DIMENSIONS
LENGTH - 11,840 FT.
WIDTH - 60 FT.
DEPTH - (-4.0) FT.

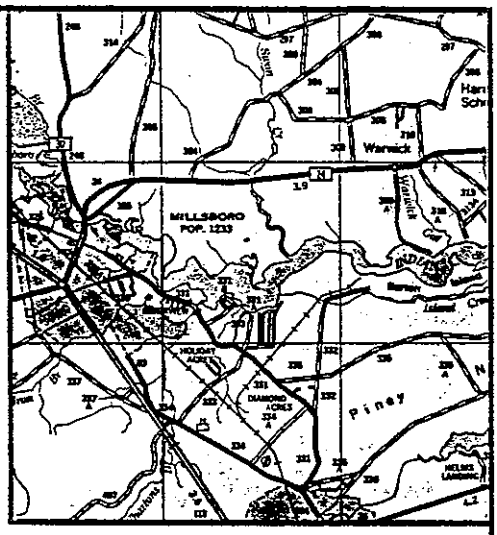
PROPOSED MAINTENANCE DREDGING OF FEDERAL CHANNEL IN INDIAN RIVER

AT & EAST OF: MILLSBORO, SUSSEX CO., DELAWARE

APPLICATION BY: DEL. DEPT. OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL DIV. OF SOIL AND WATER CONSEVATION

DATE: MARCH 1, 1991 DATUM: MLW

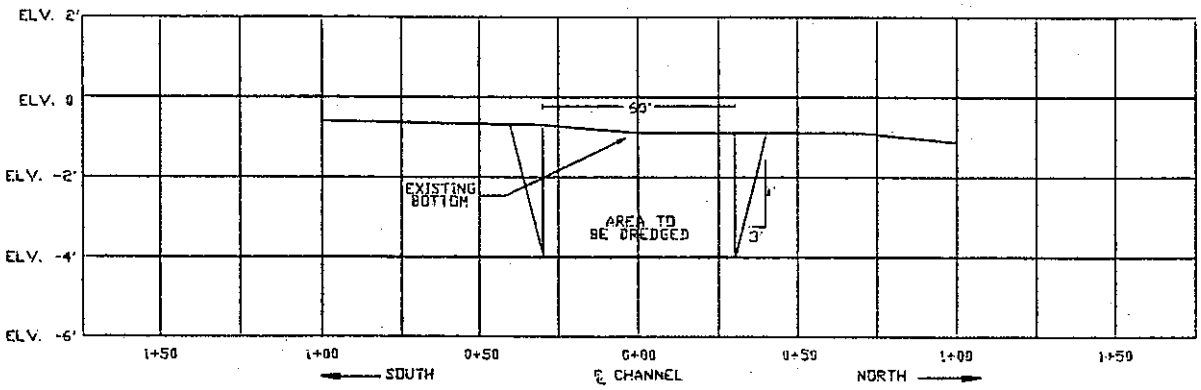
SCALE AS SHOWN



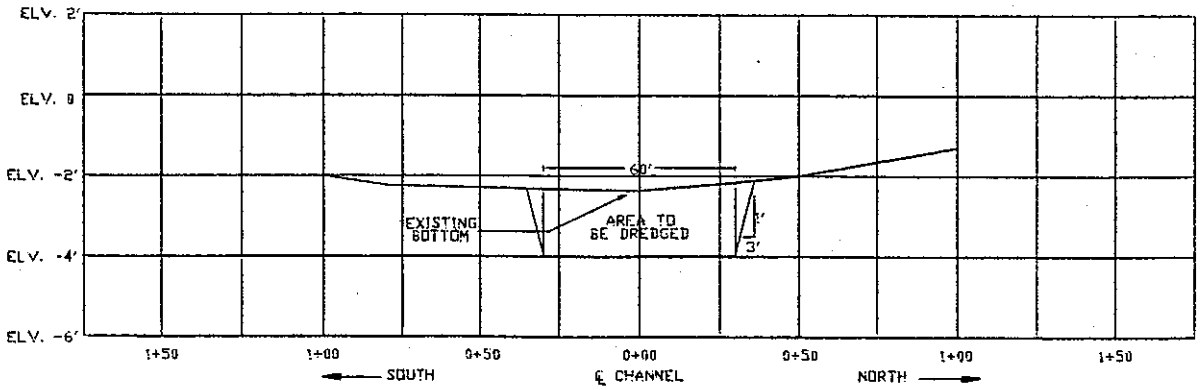
LOCATION MAP

TYPICAL CROSS-SECTIONS

CROSS-SECTION A-A

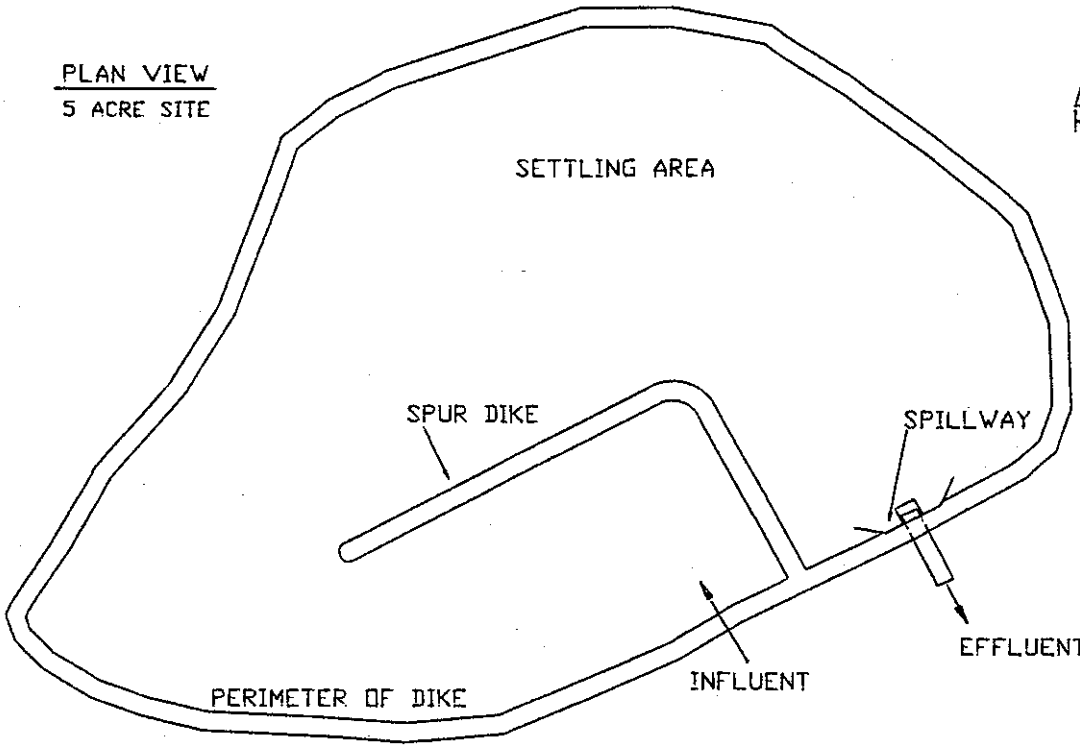


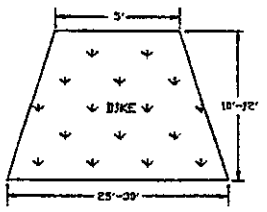
CROSS-SECTION B-B



SITE "A"/ UPLAND DISPOSAL SITE DESIGN

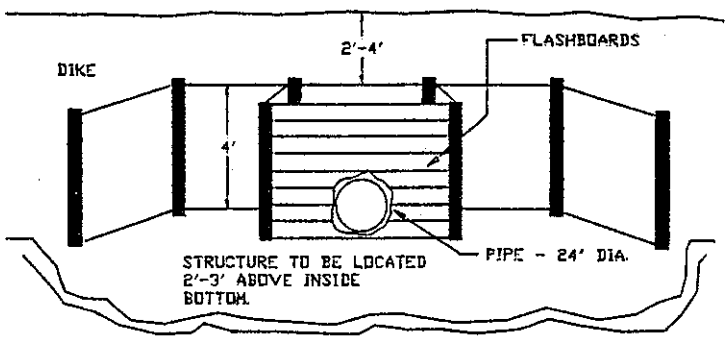
(NO SCALE)

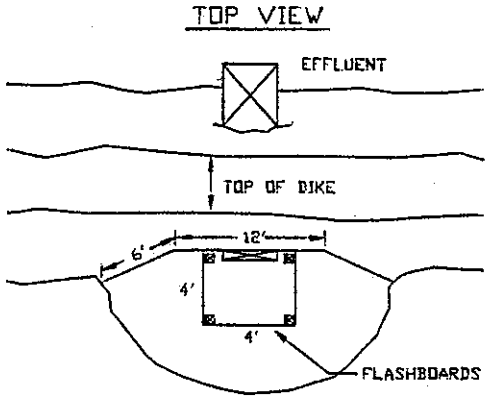




CROSS SECTION OF DIKE

SPILLWAY (WEIR) DESIGN





FLASHBOARDS WILL BE ADDED AS WATER LEVEL RISES.

PROPOSED MAINTENANCE DREDGING
OF FEDERAL CHANNEL
IN INDIAN RIVER

AT & EAST OF: MILLSBORO, SUSSEX CO., DELAWARE

APPLICATION BY: DEL. DEPT. OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIV. OF SOIL AND WATER CONSEVATION

DATE: MARCH 1, 1991 DATUM: MLW

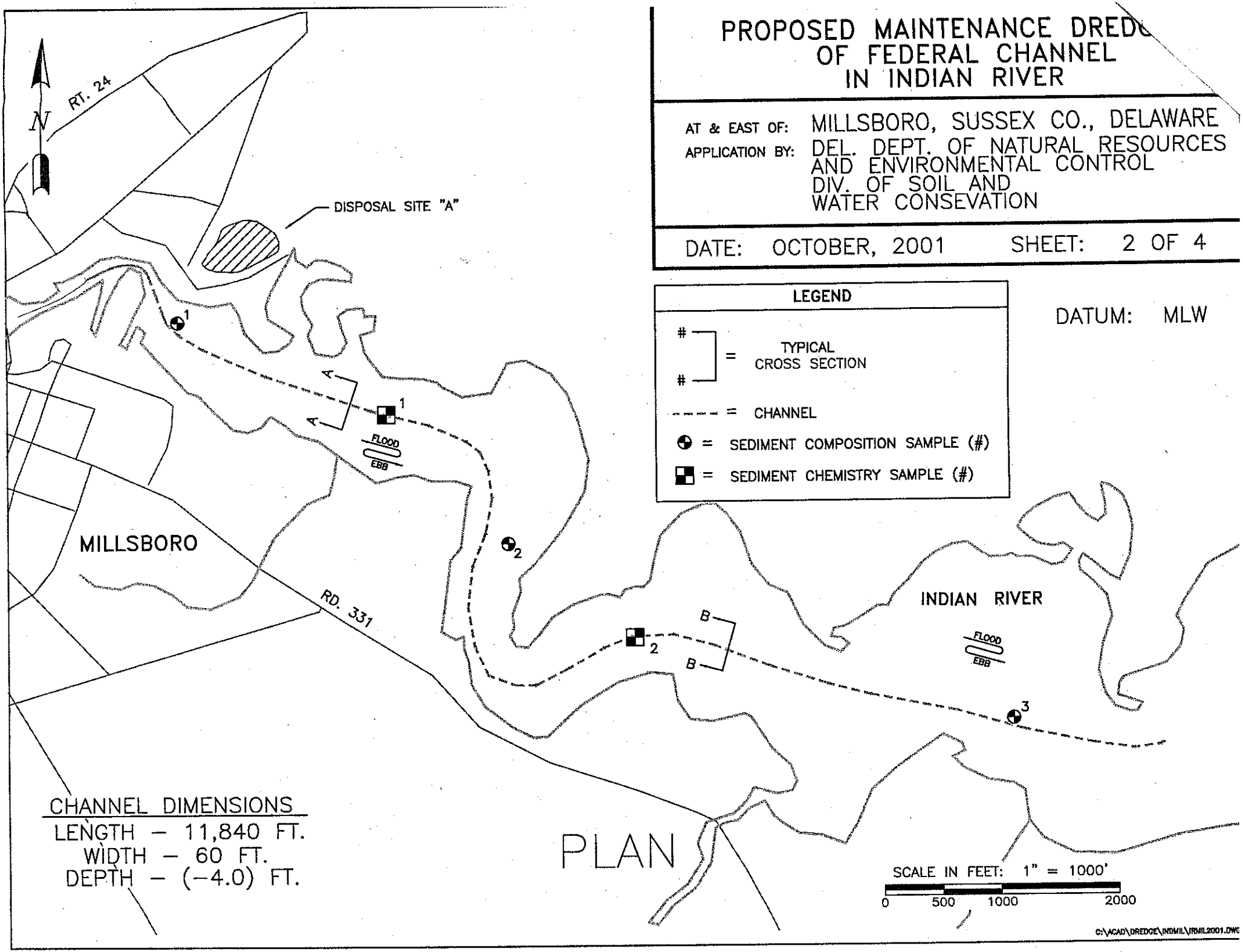
INDIAN RIVER 2001

PROPOSED MAINTENANCE DREDGE OF FEDERAL CHANNEL IN INDIAN RIVER

AT & EAST OF: MILLSBORO, SUSSEX CO., DELAWARE

APPLICATION BY: DEL. DEPT. OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL DIV. OF SOIL AND WATER CONSEVATION

DATE: OCTOBER, 2001 SHEET: 2 OF 4



LEGEND

- # / # = TYPICAL CROSS SECTION
- ---- = CHANNEL
- = SEDIMENT COMPOSITION SAMPLE (#)
- = SEDIMENT CHEMISTRY SAMPLE (#)

DATUM: MLW

CHANNEL DIMENSIONS

LENGTH – 11,840 FT.
WIDTH – 60 FT.
DEPTH – (–4.0) FT.

PLAN

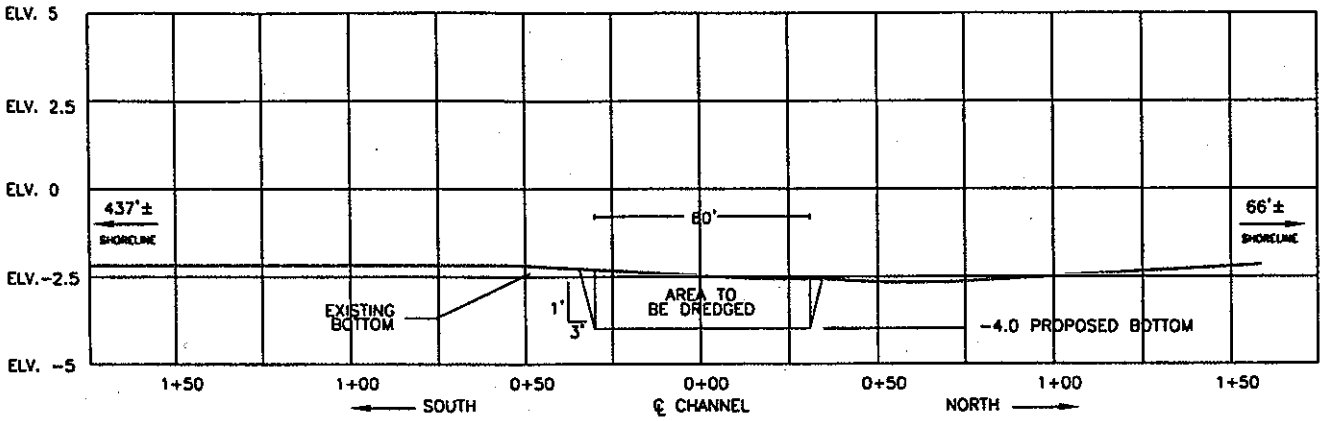
SCALE IN FEET: 1" = 1000'

0 500 1000 2000

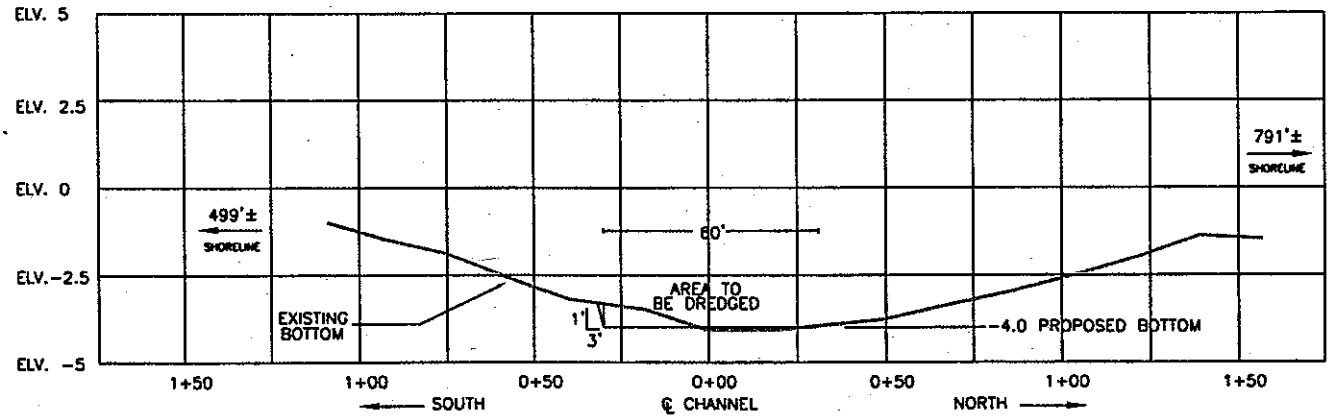
C:\ACAD\DREDGE\INDMIL\RMIL2001.DWG

TYPICAL CROSS-SECTIONS

CROSS-SECTION A-A



CROSS-SECTION B-B



PROPOSED MAINTENANCE DREDGING OF FEDERAL CHANNEL IN INDIAN RIVER, MILLSBORO	
AT & EAST OF: MILLSBORO, SUSSEX CO., DELAWARE APPLICATION BY: DELAWARE DEPT. OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL DIV. OF SOIL AND WATER CONSERVATION	
DATE: OCTOBER, 2001	SCALE AS SHOWN
DATUM: M.L.W.	SHEET: 3 OF 4

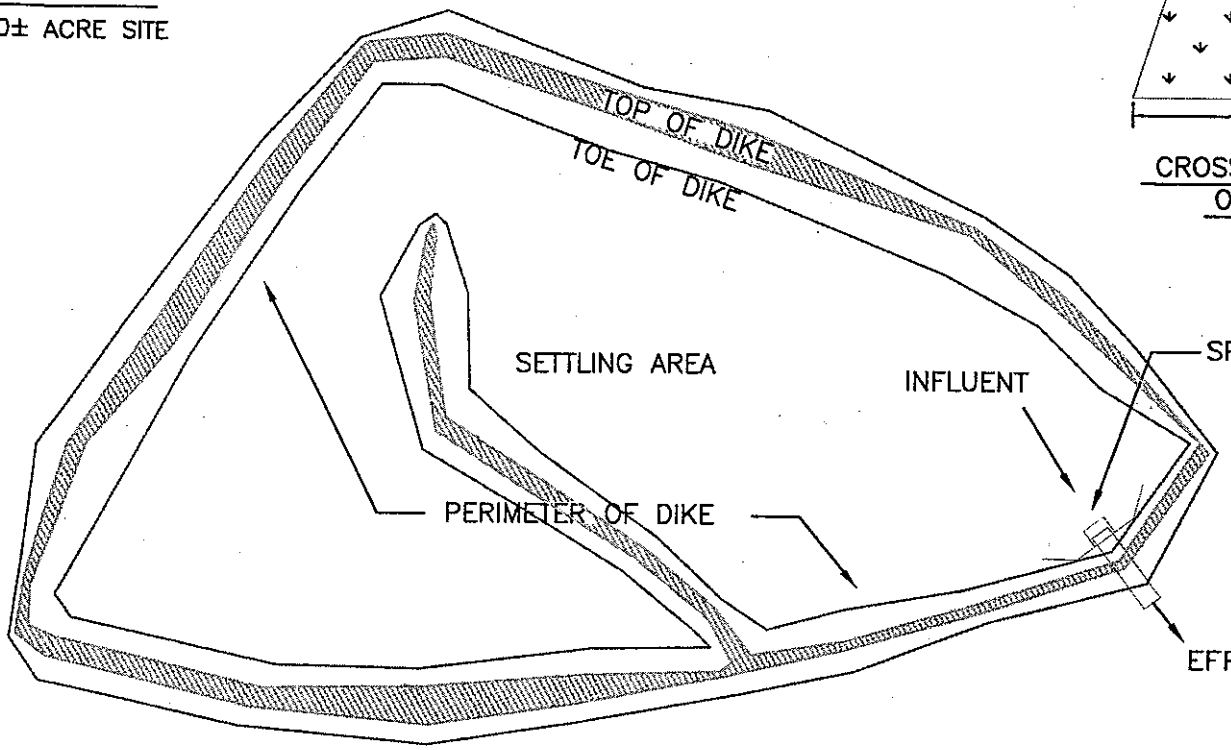
C:\ACAD\DREDGE\INDIAN\IRIVER2001.DWG

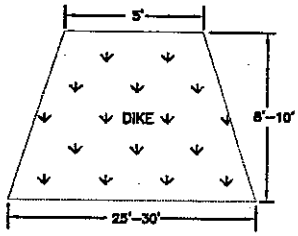
SITE "A"/ CONFINED UPLAND DISPOSAL SITE DESIGN

(NO SCALE)

PLAN VIEW

5.0± ACRE SITE

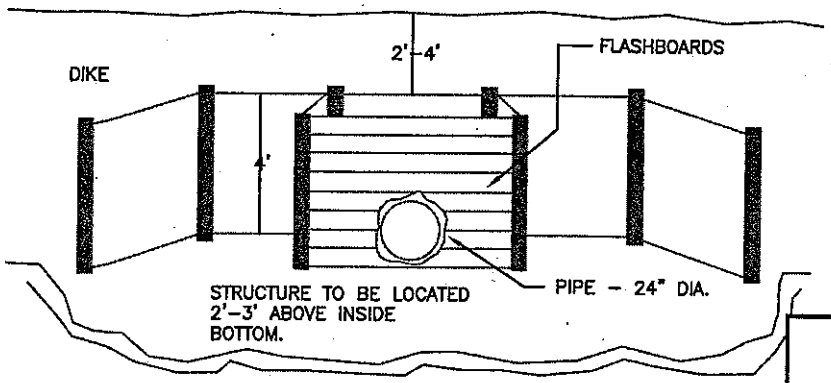




CROSS SECTION OF DIKE

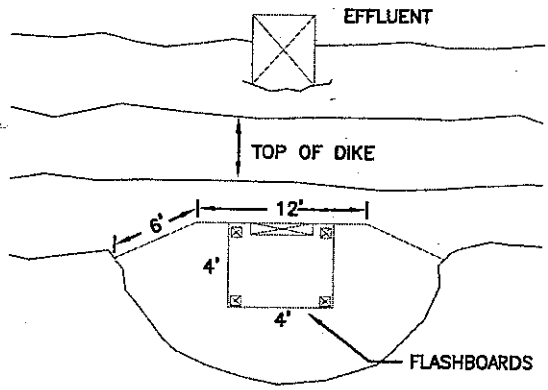
SPILLWAY (WEIR) DESIGN

PLAN VIEW



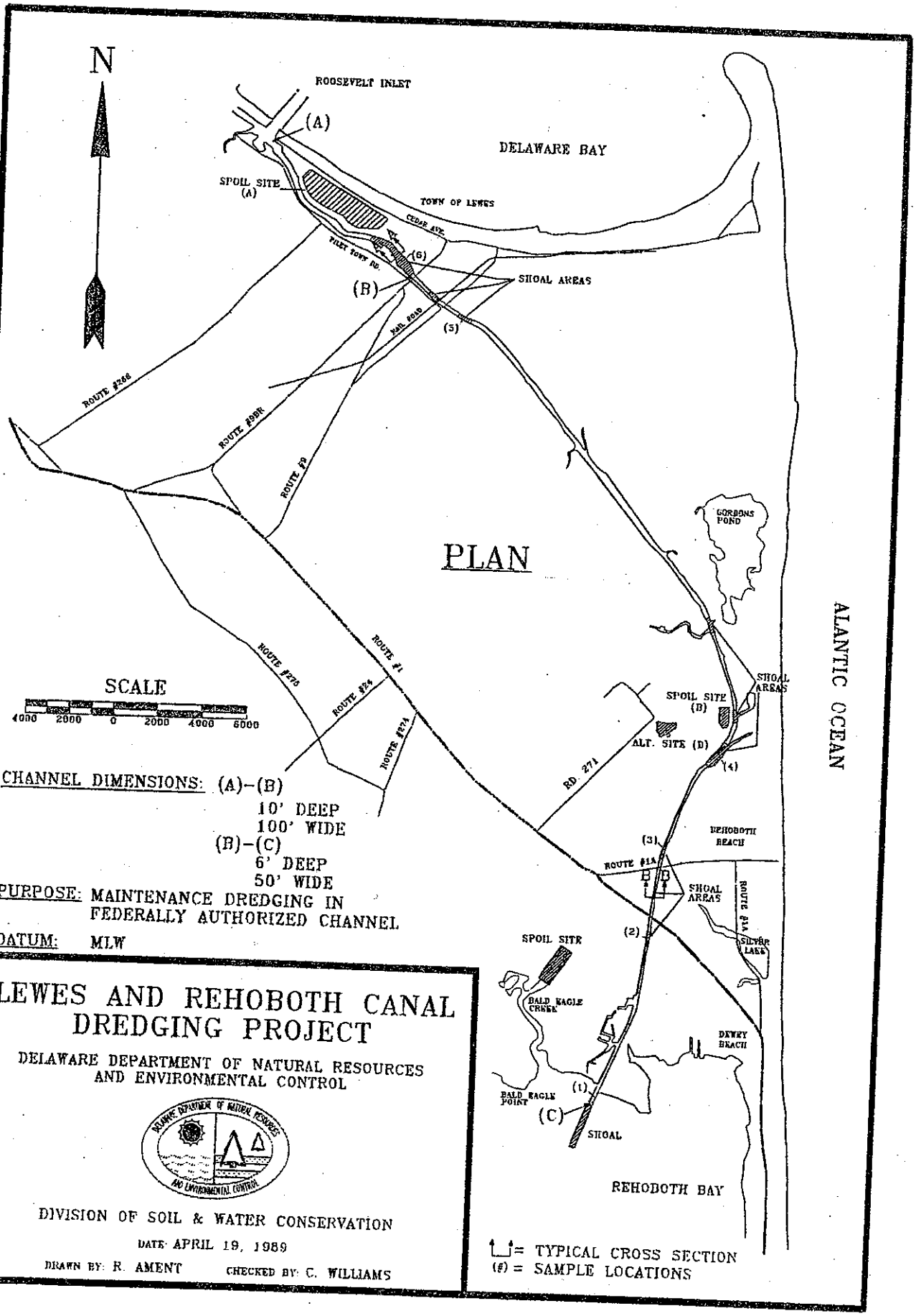
FLASHBOARDS WILL BE ADDED AS WATER LEVEL RISES.

TOP VIEW



PROPOSED MAINTENANCE DREDGING OF FEDERAL CHANNEL IN INDIAN RIVER, MILLSBORO	
AT & EAST OF: MILLSBORO, SUSSEX CO., DELAWARE APPLICATION BY: DELAWARE DEPT. OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL DIV. OF SOIL AND WATER CONSERVATION	
DATE: OCTOBER, 2001	SCALE AS SHOWN
DATUM: M.L.W.	SHEET: 4 OF 4

LEWES-REHOBOTH CANAL 1989



LEWES AND REHOBOTH CANAL DREDGING PROJECT

DELAWARE DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

DIVISION OF SOIL & WATER CONSERVATION

DATE: APRIL 19, 1989

DRAWN BY: R. AMENT CHECKED BY: C. WILLIAMS

DISPOSAL SITE "B"
& ALTERNATE SITE "D"

OWNER: MR. DANIEL ANDERSON

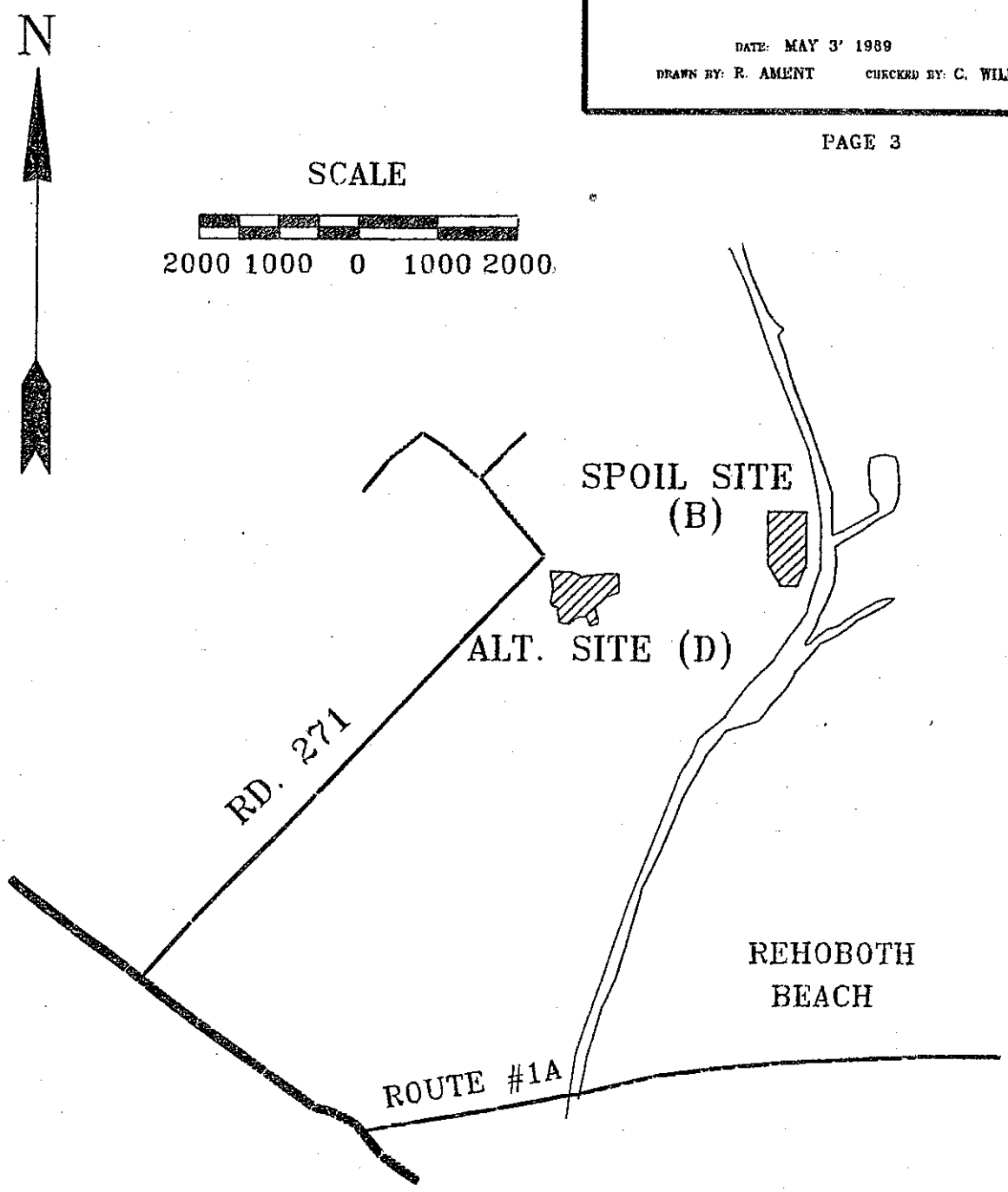
LEWES AND REHOBOTH CANAL DREDGING PROJECT

DELAWARE DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

DIVISION OF SOIL & WATER CONSERVATION

DATE: MAY 3' 1989

DRAWN BY: R. AMENT CHECKED BY: C. WILLIAMS



DISPOSAL SITE "A"

OWNER: COMMISSIONERS OF THE
CITY OF LEWES, DELAWARE

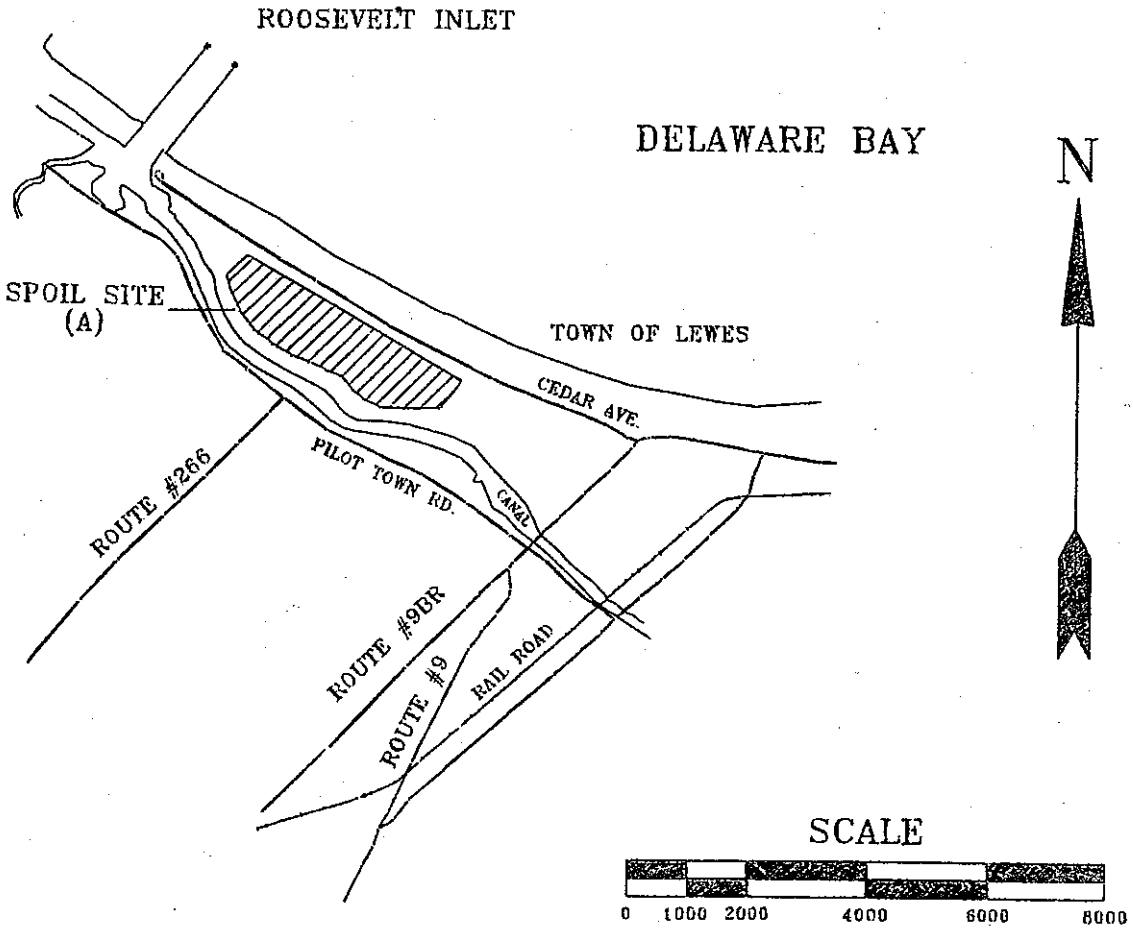
LEWES AND REHOBOTH CANAL DREDGING PROJECT

DELAWARE DEPARTMENT OF NATURAL RESOURCES
AND ENVIRONMENTAL CONTROL

DIVISION OF SOIL & WATER CONSERVATION

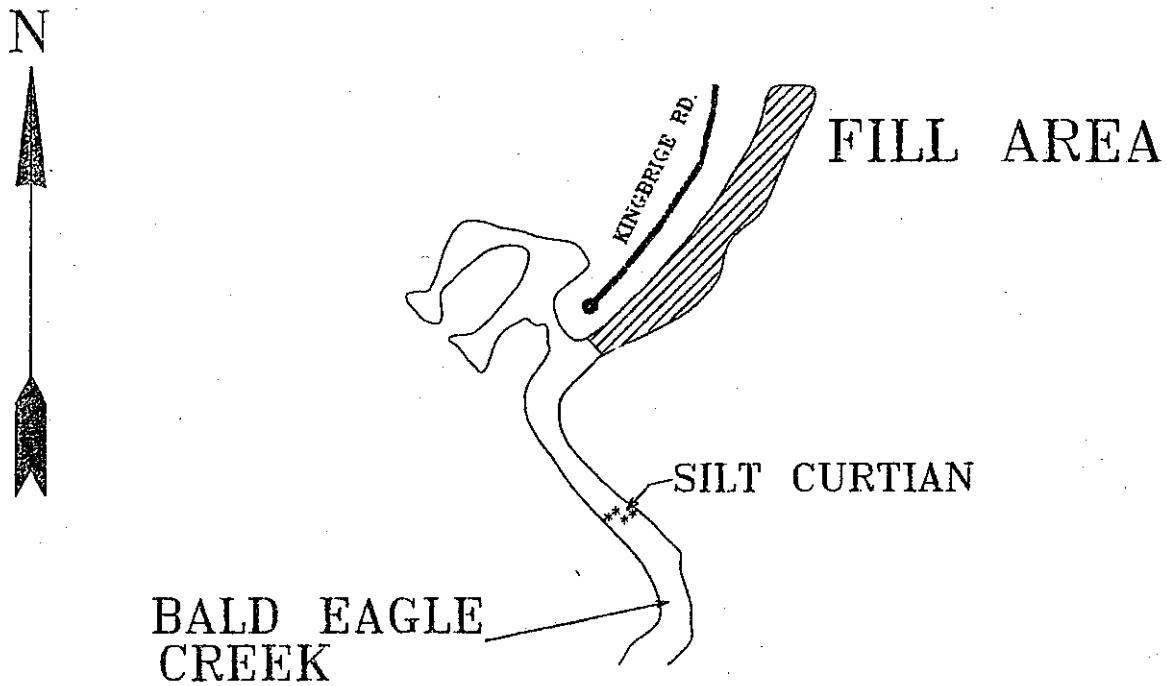
DATE: MAY 3' 1989

DRAWN BY: R. AMENT CHECKED BY: C. WILLIAMS



DISPOSAL SITE "C"

OWNER: LANDS OF THE GREAT SOUTH
BEACH IMPROVEMENT COMPANY



SCALE

2000 1000 0 1000 2000

NOTE: AVG. DEPTH OF
FILL AREA -20.0' MLW

AVG. DEPTH OF
CREEK -2.0' MLW

LEWES AND REHOBOTH CANAL
DREDGING PROJECT

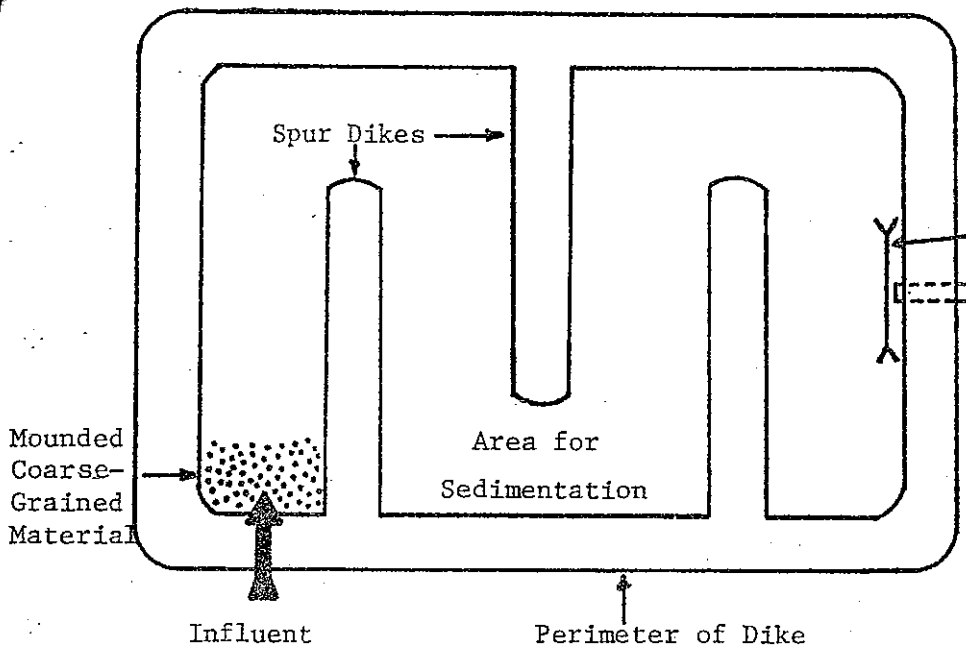
DELAWARE DEPARTMENT OF NATURAL RESOURCES
AND ENVIRONMENTAL CONTROL

DIVISION OF SOIL & WATER CONSERVATION

DATE: MAY 3, 1989

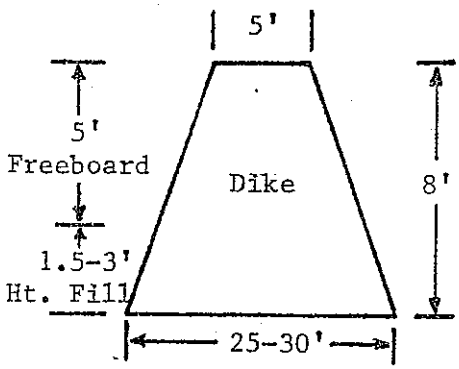
DRAWN BY: R. AMENT CHECKED BY: C. WILLIAMS

DISPOSAL SITE DESIGN, UPLAND

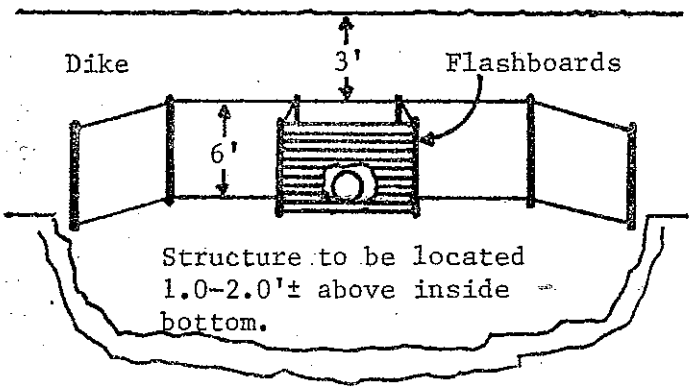


PLAN VIEW OF DISPOSAL AREA

6 Acre Site



CROSS-SECTION OF DIKE

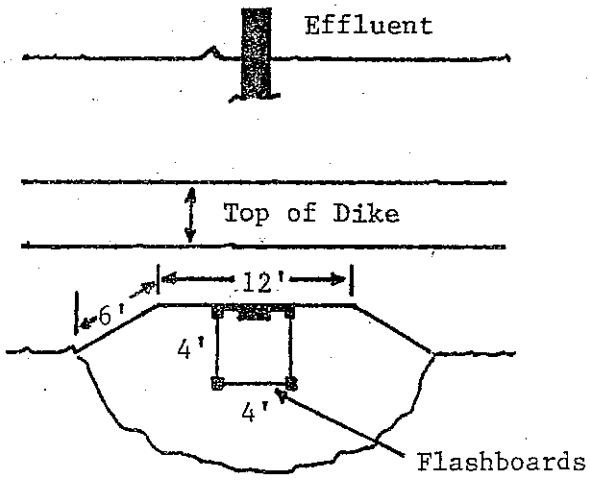


VIEW OF SPILLWAY

Outflow Pipe - 24" Diameter

Flashboards to be added as water level rises.

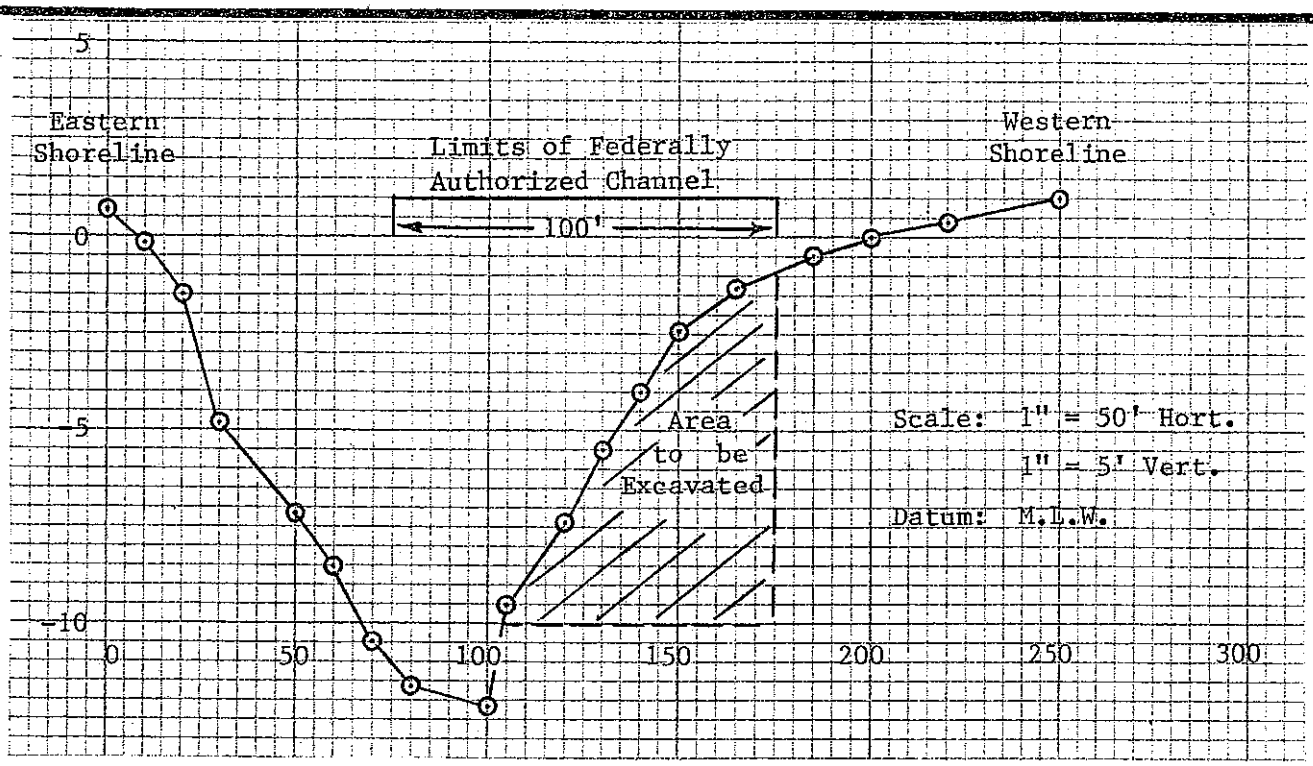
TOP VIEW OF SPILLWAY



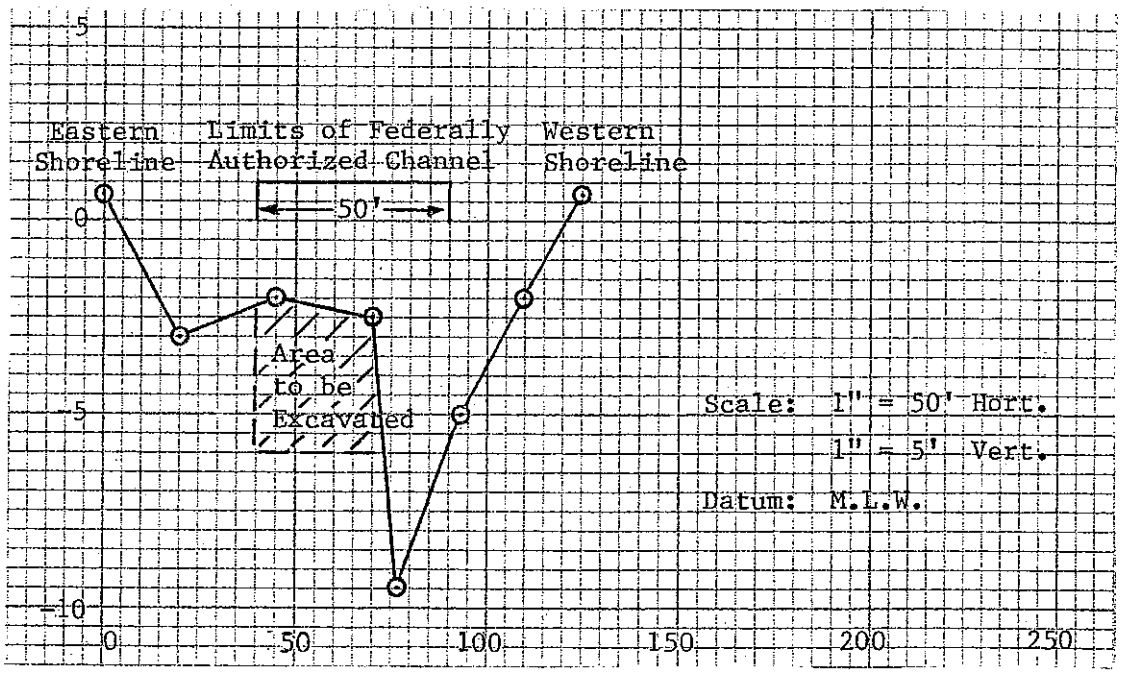
LEWES REHOBOTH CANAL DREDGING PROJECT

DELAWARE DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

DIVISION OF SOIL AND WATER CONSERVATION



TYPICAL CROSS SECTION "A-A"

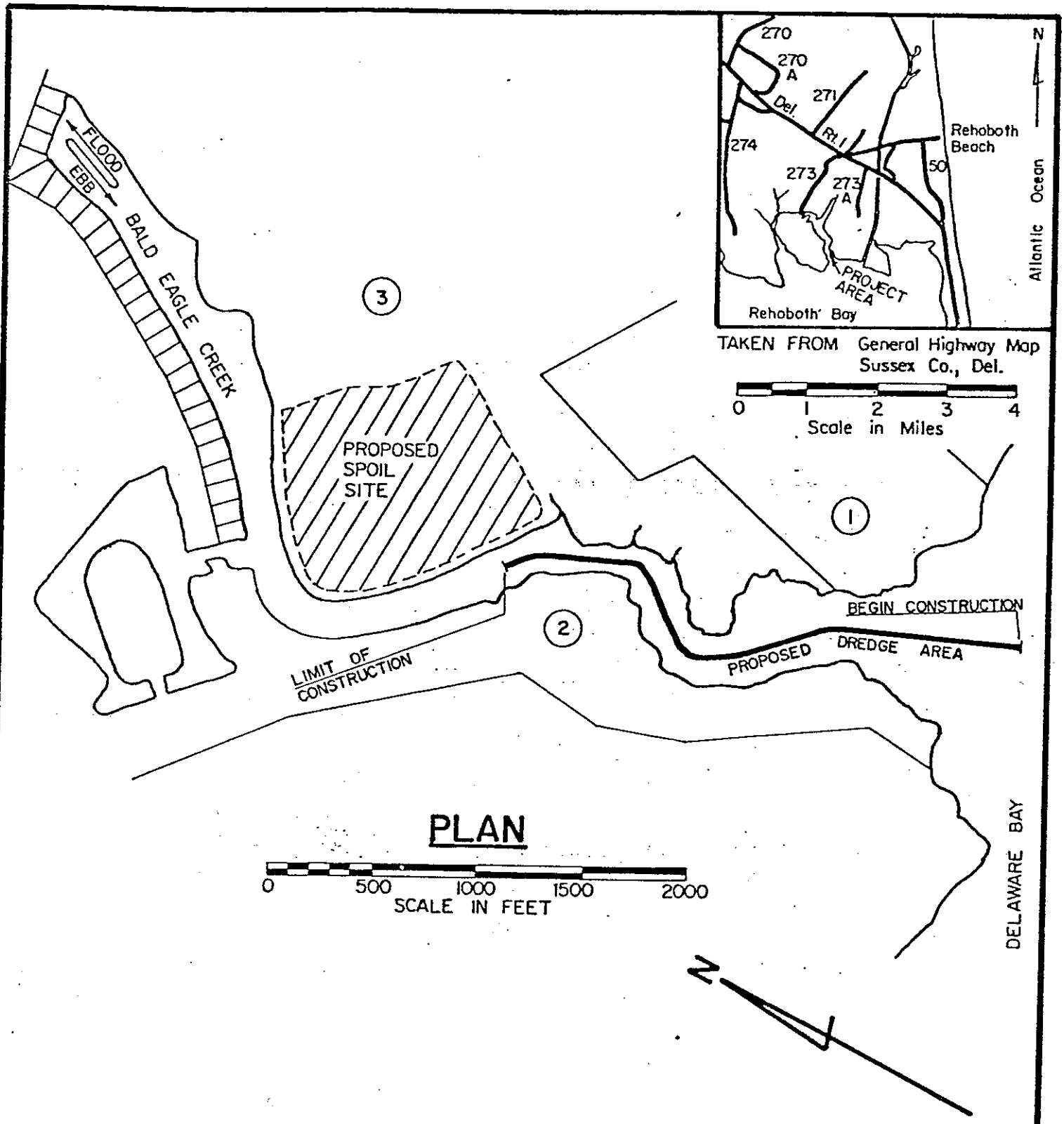


TYPICAL CROSS SECTION "B-B"

LEWES REHOBOTH CANAL
DREDGING PROJECT
TYPICAL CROSS SECTIONS

DELAWARE DEPARTMENT OF NATURAL RESOURCES
AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION

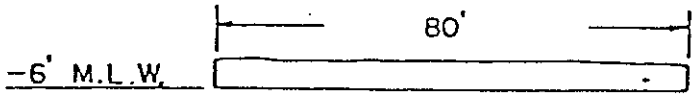
BALD EAGLE CREEK 1983

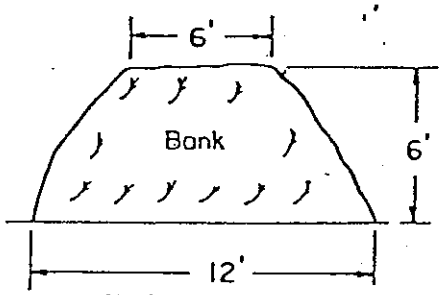


PURPOSE: NAVIGATION AND RECREATION CHANNEL
DATUM: MEAN LOW WATER
ADJACENT PROPERTY OWNERS:
See attached sheet

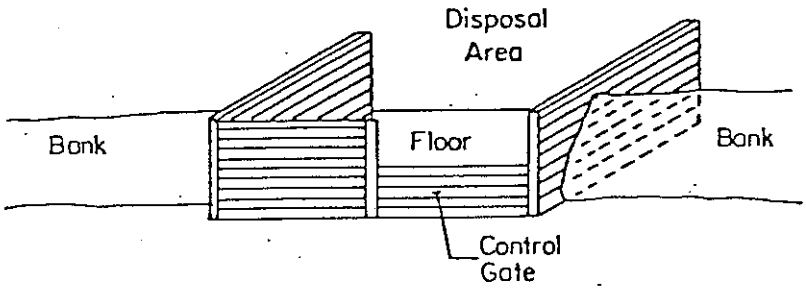
PROPOSED DREDGING
IN: Bald Eagle Creek
SOUTHWEST OF Rehoboth Beach, Sussex County, Delaware
APPLICATION BY Del. Dept. of Natural Resouces and Environmental Control
Div. of Soil and Water Conservation

Typical Section — Box Cut





Typical Bank



NOT TO SCALE

PROPOSED DREDGING

IN Bald Eagle Creek
SOUTHWEST OF Rehoboth Beach, Sussex Co., Del.
APPLICATION BY Del. Dept. of Natural
Resources and Environmental Control
Div. of Soil and Water Conservation

APPENDIX E – ANALYTICAL SEDIMENTATION MODEL

Most methods for predicting the rate of sedimentation in dredged channels assumes that the channel is aligned perpendicular to the flow direction. This assumption simplifies the situation but also restricts the applicability of these prediction methods.

In the past 5 to 10 years better formulae have been developed for conditions with flows crossing a dredged channel at an arbitrary angle taking into account local sediment transport, channel dimensions, natural water depth, settling velocity of sediment and wave conditions (Mayor-Mora et al., 1976 and Lean, 1980). These methods assume that the construction of the channel has disturbed a situation that was previously in equilibrium. Based on the relative change in hydraulic conditions and some other assumptions, the reduction in sediment transport capacity in the channel and the related sedimentation can be derived. These formulae yield fairly good predictions under conditions where the angle between channel and flow direction is 30° to 90°. Under such conditions, flow velocity in the channel satisfies the following equation of continuity:

$$u_2 = u_1 h_1 / h_2 \qquad (1)$$

Where:

- u_2 flow velocity in the channel
- u_1 flow velocity above the undisturbed bed just upstream of the channel
- h_1 undisturbed water depth
- h_2 (increased) water depth in the channel

Channels almost parallel with the flow, however, attract flow due to the artificially increased cross sectional area and the lower bottom shear stress coefficient relative to the original bed. Often the flow velocities in such channels even exceed the original flow velocity in the undisturbed situation. The referenced formulae then predict erosion in the channel that can be proven unrealistic. Hence, particularly in situations that are relevant for navigation channels, the referenced formulae become unreliable.

Erosion in Dredged Channels

As mentioned above, existing formulae for sedimentation can yield erosion instead of sedimentation for navigation channels which are oriented more or less in the direction of the dominant flows. This result is sometimes accepted as realistic although maintenance dredging figures for such situations prove the opposite. The reason for this misunderstanding is the two-dimensional interpretation of the sediment transport capacities per unit of width related to the local current velocities. If the sediment transport capacities to be compared are not related to the same rate of water discharge, the comparison is inappropriate. The question of whether erosion or deposition occurs amounts to a comparison of the sediment influx into the channel with the sediment outflux capacity. This can be illustrated for a dredged channel in a river or estuary (see Figure B-1). Erosion in the channel would occur in case:

$$fT_{le} < T_{2e} \qquad (2)$$

Where:

$$f = \frac{u_{2g}(\Delta F_1 + \Delta F)}{u_1(\Delta F_1)} = \frac{u_{2g} h_2}{u_1 h_1} \qquad (3)$$

The relation between the equilibrium transports T_{le} and T_{2e} generally can be written as:

$$T_{2e} = (u_{*2g} / u_{*1})^n T_{ie} = \left(\frac{u_{2g} R_c}{u_1 G} \right)^n T_{ie} \qquad (4)$$

with

$$R_C = C_1 / C_2 = 1 + \frac{18}{C_2} \log \frac{h_1}{h_2} \qquad \text{(relative Chézy-roughness effects)} \qquad (5)$$

and

$$G = \left\{ \frac{1 + 1/2(\xi_1 \frac{u_{01}}{u_1})^2}{1 + 1/2(\xi_2 \frac{u_{02}}{u_{02}})^2} \right\}^{1/2} \qquad \text{(relative wave influence)} \qquad (6)$$

Where:

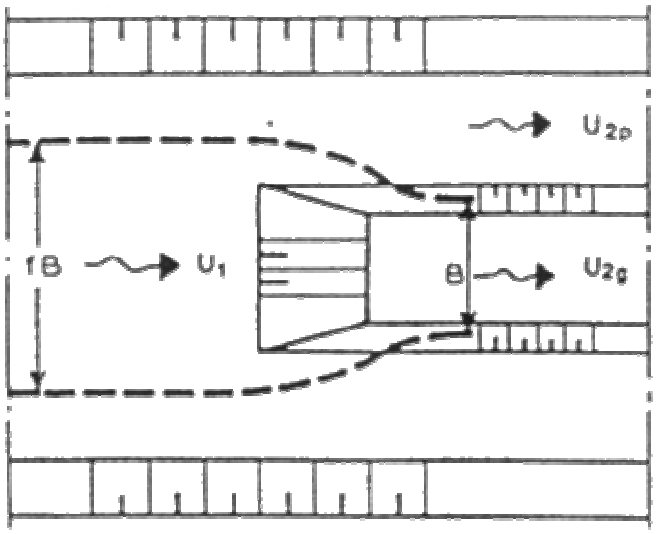
u_*	shear stress velocity
n	exponent varying between 3 and 5; in tidal areas 3 seems to be realistic
C	Roughness coefficient of Chézy
ξ	coefficient according to Bijker (1966)
u_o	orbital velocity of waves at the bottom

Substitution of (3) and (4) with n = 3 in (2) and applying the equation for conservation of water and the formula of Chézy to determine the ratio u_{2g}/u_{2p} ultimately yields:

$$\frac{G^3}{R_C} \left[1 + \frac{B}{B^t} \left\{ \left(\frac{h_2}{h_1} \right)^{3/2} \frac{1}{R_c} - 1 \right\} \right]^2 < 1 \qquad (7)$$

For an artificial deepening it holds that:
$h_2/h_1 > 1$, $R_C < 1$, and $G \geq 1$

Hence, the left-hand side of equation (7) equation is greater than one. This means that, in spite of the attraction of extra flow, the dredged channel always will suffer sedimentation and no erosion is expected.

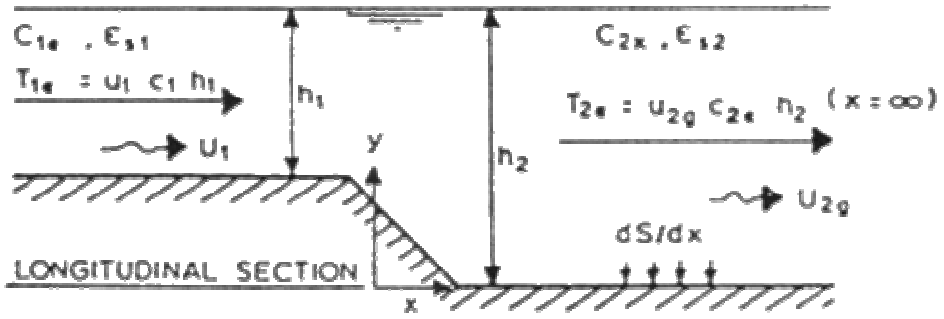


TOP VIEW

sediment influx into channel : (x = o) ; $T_{in} = f B T_{1e}$

minimum sediment flux out of channel : (x = ∞) $T_{out} = B T_{2e}$

if f = 1 than $U_{2g} = U_2$



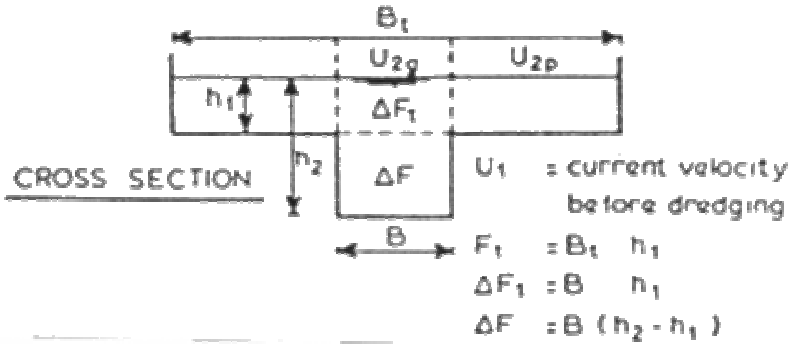


Figure E-1. Basic quantities of sedimentation in a dredged channel

Improved Method to Predict Sedimentation

The method starts with the assumptions regarding the adjustment of the sediment content profile at the upstream side of the channel (x = 0). The adaptation of the sediment content profile to the hydraulic conditions in the channel has been considered by means of the vertically two-dimensional mathematical model SUTRENCH (Van Rijn,1981). This model numerically solves the differential equation for the vertical (diffusive) sediment transport and has extensively been tested on both results from hydraulic models and nature. Based on many computations, it appears that the local sedimentation can be described by:

$$\frac{dS}{dX} = -h_2 u_{2g} \frac{d\bar{c}_{2x}}{dx} = A \frac{\bar{c}_{2x} - \bar{c}_{2e}}{\bar{c}_{2e}} \frac{T_{2e}}{h_2} \qquad (8)$$

Where:

A = dimensionless constant depending on sediment characteristics and the hydraulic conditions in the channel; f(w/u_*, k/h)

k = roughness of channel bottom

Integration of equation (8) and applying the proper boundary conditions yield

$$\bar{c}_{2x} = (\bar{c}_1 - \bar{c}_{2e}) \exp.(-A\frac{x}{h_2}) + \bar{c}_{2e} \qquad (9)$$

The total sedimentation per unit of width between x = 0 and x reads approximately:

$$S(x) = T_{in} - T_{2x} = \bar{c}_1 u_2 h_2 - \bar{c}_{2x} u_2 h_2 \qquad (10)$$

Substitution of (9) in (10) ultimately yields:

$$S(x) = (T_{in} - T_{2e})\{1 - \exp.(-A\frac{x}{h_2})\} \qquad (11)$$

The constant A has been derived based on the adjustment of over-saturated sediment-content profiles in access channels. Therefore, the constant A now only depends on the sediment characteristics and the hydraulic conditions in the channel and is always positive. Equation (11) is valid for suspended sediment transport where w/u_* is less than 0.3 to 0.4.

The flow velocity in the channel may be determined through simple consideration on the conservation of water with or without application of the Chézy formula, or even via model studies. However, the impression exists that simple computation methods often are satisfactory. An increased value of u_{2g} on one hand increases the influx of sediment, but, on the other hand, it also increases the outflux. This strongly reduces the sense of applying sophisticated methods to estimate u_{2g}.