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September 30, 1983

Mr. H. Hudson Barton
444 West Chestnut Hill Avenue
Philadelphia, Pennsylvania 19118

Dear Mr. Barton:

In accordance with your authorization of August 24, 1983, we have investigated the hydraulic and hydrologic requirements for maintenance of the ecological health of the marsh at Nonquitt. Our studies have included a review of the materials which you have provided to us, a field investigation on August 24, 1983 by Mr. Clifford W. Bowers and Dr. Robert J. Reimold, hydraulic calculations based upon our field observations, and the development and evaluation of alternative solutions to correct the deteriorating conditions in the Nonquitt marsh.

We recommend that the culvert and channel from the marsh side of the roadway to the existing headwall and slide gate structure be replaced by a piped system. We estimate the total cost of this work will be less than $20,000.

Our studies and basis for this recommendation and further detail are presented below.

## Review of Materials Provided

Our review of materials included the following items:

1. Letter to Mr. H.H. Barton from Mr. Alan W. DeCastro, Bristol County Mosquito Control Project, dated August 12, 1983.

2. Notes from the Nonquitt Marsh Committee, dated August 5, 1983.

3. Quotation to Incorporated Proprietors of Nonquitt from A. Rotundo & Sons, Inc., dated August 4, 1983.

4. A report entitled, "Marsh Grass Die-Back in the South Nonquitt, Massachuse Salt Marsh: A Preliminary Survey and Study", by Dr. James R. Sears and Dr. Henry S. Parker, dated January 10, 1981.

5. A report entitled, "Marsh Grass Die-Back in the South Nonquitt, Massachuse Salt Marsh: Second Year of Assessment 1981", by Dr. Henry S. Parker and Dr. James R. Sears, dated January 31, 1982.

6. A report entitled, "Marsh Grass Die-Back in the South Nonquitt, Massachuse Salt Marsh: Third Year of Assessment 1982", by Dr. James R. Sears and Dr. Henry S. Parker, dated April 7, 1983.

In addition to the above referenced materials, several conversations were held with residents of Nonquitt during the field investigation.

## Field Observations

Field observations began at 0945 hours EDT, 37 minutes after the time of predicted high water at Dumpling Rocks on August 24, 1983 and ended at 1600 hours, one-hour-twenty-one minutes after the predicted low tide on the same day.

## Environmental Observations

In order to assess the environmental conditions in the Nonquitt marsh, background information was obtained from the three reports prepared by Dr. James R. Sears and Dr. Henry S. Parker. These reports provided insight into conditions in the marsh during 1980, 1981, and 1982. Supplemental information from Metcalf & Eddy's extensive wetland library was utilized to gain additional comprehension of the nature and severity of the environmental problem, and to identify potential means for mitigation.

Measurements were made during our site visit of the interstitial salinity of the waters in the top five centimeters of the marsh soil at selected locations. Interstitial pore water was extracted with the aid of a 50cc syringe equipped with a glass microfiber filter, and salinities were measured with an American Optical Model 401 salinometer, to the nearest part per thousand. Samples of the adjacent intertidal water were also measured for comparison. Table 1 summarizes the results of salinities measured during the study period.

While the salinity of the adjacent waters was constant (31 parts per thousand, 0/00) during the period of investigation, there were considerable differences in the interstitial salinities. The excessiviely high interstitial salinities were well above the range of salinities in which Spartina alterniflora can survive. S. alterniflora seeds germinate most successfully in fresh or slightly brackish water. Full strength sea water (salinities near 35 0/00) inhibits germination even after soaking for one month. Studies of S. alterniflora growth conducted at North Carolina State University show that salinities in excess of 40 0/00 inhibit all growth. Consequently, it is not surprising that in areas where interstitial salinities exceeded 40 0/00 there was an absence of this ecologically important salt marsh emergent macrophyte. Due to the impounding nature of the water control structures (bridge, culvert and shoaled areas in the open channel between the two structures) the ebb and flood of the tide is impaired. This impairment of tidal exchange results in an evaporation of sea water in the marsh with resultant increase in interstitial salinity. Salt levels in excess of those which are tolerated by S. alterniflora not only inhibit the growth but also the reproduction of the species. Consequently, the barren areas are directly related to the increased salinities in the marsh soil caused by the severe impairment of the tidal exchanges.

TABLE 1. Interstitial Soil Salinity and Surface Water Salinity of Nonquitt Marsh, August 24, 1983.

| Location Description | Salinity |
|---|---|
| 1000 hours flood tide west of the bridge | 31 0/00 |
| 1445 hours ebb tide west of the bridge | 31 0/00 |
| Healthy Spartina alterniflora (interstitial salinity) | 48 0/00 |

Table 1, continued:

| Location Description | Salinity |
|---|---|
| Barren area with dead *Spartina alterniflora* roots (interstitial salinity) | 108 0/00 |
| *Salicornia* (interstitial salinity) | 55 0/00 |
| Barren area adjacent to transplant plot (interstitial salinity) | 90 0/00 |
| Healthy *Spartina patens* (interstitial salinity) | 20 0/00 |

## Summary of Environmental Findings

Based on our review of the reports from Dr. Sears and Dr. Parker, as well as our site inspection of the Nonquitt marsh, it is apparent that the die back in vegetation is due to increased salinity as result of insufficient tidal exchange. As a diagnostic aid, interstitial salinities were determined in the top 5 cm of marsh substrate in selected locations. While *Spartina alterniflora* can not easily tolerate interstitial salinities in excess of that of ordinary sea water, many barren areas had interstitial salinities over three times that of ocean water. With a normal tidal exchange of two-thirds to three-fourths of the normal intertidal volume of the marsh, the hypersaline conditions limiting plant growth would be minimized and abated. The physiological stress imposed by the increased salinities has impaired the ecological productivity of the overall marsh, and has in fact eliminated the very productive *Spartina alterniflora* from significant areas of the marsh.* Restoration of the tidal flow will reestablish the earlier pattern of vegetative production, and increase the overall ecological value of the existing wetland and its net contribution to the nearby coastal waters. These ecological improvements should serve as the foundation on which prerequisite permits may be approved.

## Hydraulic Observations

The existing water course through which ocean water floods and ebbs from Nonquitt marsh is a 30-inch diameter concrete pipe extending from the shoreward dune, seaward into the ocean a distance of about 100 feet from the entrance headwall. The pipe is held in place with wood piles with bolted wooden members across the top of the pipe to hold it down. Each pipe section has its own pile arrangement. Reinforced fiberglass panels have been installed across the top of the pipe joints and held in place with stainless steel bolts and spreaders to facilitate cleanout of the pipe and to restrict the entrance of sand. The pipe passes under the beach and terminates with a bell end in a headwall just landward of the seaward-most dune. A galvanized steel slide gate has been installed on the wall to control flow in the culvert. Incoming flooding tidal waters discharge from the pipe into a riprapped trapezoidal channel. There is a stoplog groove cast into the concrete and a one-foot return from the face of the headwall opening which is about 4.25 feet wide. Wingwalls open back at a wide angle for a distance of about 4.2 feet, then cut back at an even flatter angle to meet with the riprap. There was evidence of moderate erosion of sand and riprap at the northern end of the northern wingwall. The original slope of the riprap was

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* This is also a major reason why some earlier transplant efforts were unsuccessful.

about one foot rise ~ 1.5 feet back. The channel width at the water surface with a half-full pipe is approximately 8 feet. The water surface width varies from 8 to 9 feet with a one-foot water depth for the length of the riprap to about 14 feet which is the width at the east side of the roadway bridge. The effective width is about 9 feet. A buildup of organic material was observed in several places in this wider section. The organic material was readily disturbed with the survey rod. The roadway bridge is the next structure along the path of the marsh channel. The bridge is actually a stone culvert. The nominal dimensions of this culvert are 30 inches square. The entrance is somewhat irregular and there are numerous stones which are obstructing the channel entering the conduit. The stones in the flow line range in size from 8 to 12 inches in diameter. On the north side of the bridge, the width is also approximately 14 feet, There are several large boulders blocking the stream near the opening. One very large stone is present in the stream bed, approximately in the center line of the stream at about 8 feet away from the headwall. These obstructions add to the exit loss from the culvert. Thereafter, the channel is straight and appears relatively calm with essentially no losses observable on the surface.

Elevation measurements, using a transit and survey rod, were taken along the bottom and at the water surface along the entire stream bed of the marsh inlet/outlet. Measurements taken to the nearest 0.01 foot were also made to define and describe the bridge and headwall structures. Velocity measurements, taken with a Marsh McBirney Model 201 Portable Water Current Meter, were utilized to establish the rate of flow in the channel at several points and time periods.

The hydraulics of the present channel are unsatisfactory for optimal flow. There ar two major obstructions. The first of these occurs at the riprap section of the chan between the roadway bridge and the concrete headwall. In this area, the stream bott is elevated by approximately 0.64 feet (about 7-1/2 inches). The effect of this elevation of the bottom is very significant and any program to improve flow to the marsh or from the marsh must modify the elevations along this segment. The significance of this elevated area is most readily put into perspective when it is understoc that the elevation of this section, in essence, is a dam across the stream bed at a point one-half the maximum depth of water in the stone culvert under the roadway bri

The second major obstruction to flow is the 30-inch square culvert under the roadway There are several stones obstructing the inlet end and outlet end of this culvert. In addition, the interior of the culvert has begun to deteriorate with stones cluttering the invert and debris obstructing the crown.

Each of these two features results in a significant obstruction to free passage of water between the marsh and the ocean.

It was also observed that the ocean-end of the existing 30-inch pipe is in disrepai with the last several segments having open joints at the top and the last segment being tilted down at an angle and located at about the elevation of low tide. Thes openings at the top enhance the opportunity for sand and seaweed to enter the pipe. Closure of these openings would beneficially restrict the entrance of these substan Since seaweed tends to float, the openings in the top of the pipe joints tend to collect it as the tide rises. Ideally, the outlet should be located so that it wou always be below the low tide water surface and also be located above the ocean bott

If in the future this pipe is replaced, special care should be taken in its location both horizontally and vertically.

Solution Alternatives

We have reviewed or considered the following approaches to improving the hydraulic condition in the waterway from the marsh to the ocean:

1. The installation of a precast concrete box in lieu of the riprap section.

2. Removal and replacement of the existing riprap.

3. Replacement of the open channel with a piped system.

In any of the above alternatives the replacement of the culvert under the bridge at the roadway is essential for both hydraulic and safety reasons. Stones cluttering both the entrance and exit of the culvert should be removed. In addition, the outlet at the ocean should be repaired and/or extended so that it terminates below the elevation of low tide but is also elevated off the bottom of the sea bed to minimize the ingestion of sand and seaweed. This might be accomplished by means of a special precast section which would replace the presently deflected piece of 30-inch pipe at the end of the structure.

The installation of the precast concrete box described in the memorandum of the Nonquitt Marsh Committee, dated August 5, 1983, was the first alternative to be considered. We have several concerns regarding this alternative. The first observation is that the structure proposed would not extend for even the same distance as the present riprap. Since the present stream banks are eroded beyond the end of the existing riprap, it would seem reasonable that slope protection be placed at least that far and ideally as far as the bridge. Secondly, because the structure will not be buried and will be in approximately the same location as the presently heaved riprap, we have concern for potential movement of the box after placement. Since the elevations in this area are very important to the hydraulic capacity required to drain the marsh, slight changes in the attitude of the box could result in a repeat of the present condition with the different structure. We also believe that the box would collect deposits and debris and would tend to be difficult to clean. Cleaning with a clam shell could result in damage to the box. The cost of the box alternativ is relatively high.

The second alternative involves the removal and replacement of the existing riprap. This alternative would be accomplished by removing the existing riprap, excavating below the present stream bottom, and replacing the riprap in a V-shaped configuratic so that the two side slopes would intersect at a point substantially below the strea bottom. This would allow the two opposing slopes to provide mutual support. The stream bottom would be filled with soil to provide a smooth flow line in much the same way that the remainder of the channel has been deposited. The forces which caused movement of the present riprap could cause a similar failure in the repositic riprap. However, by eliminating the bottom riprap and filling that area with soil, to 2.5 feet of movement would have to occur before a serious effect on the hydraulic would result.

The third alternative consists of replacing the open channel system with a piped system. We envision a transition section consisting of a large precast manhole-type structure with a short section of 30-inch diameter concrete pipe extending from this structure to the headwall. The manhole would be specially designed with an extra wide base to engage sufficient soil to ensure stability. The cover for the manhole should be bolted down so that it would not provide an attractive nuisance. From this manhole, a 36-inch diameter pipe would be extended to the upstream face of the present bridge. The invert would be level and would be 0.5 feet below the elevation of the 30-inch pipe. During construction, the pipe could be extended to within a few feet of the present bridge, backfilled, and graded to provide a temporary roadway to South Nonquitt during the construction of the remainder of the system. A headwall would be constructed at the upstream face of the present bridge and would be fitted with a slide gate similar in design to the slide gate which is located on the present headwall at the beach. The present riprap and the stone bridge would be removed. We see the following advantages to such a pipe system:

1. the flow characteristics of the pipe system are excellent as compared with the rough channel bottom currently existing,

2. the pipe would be backfilled with soil, providing greater stability and a more integral beach,

3. it replaces and resolves the problem of the failing culvert under the roadway,

4. it is a low-cost alternative considering that the section which runs under the roadway and the headwall on at least one side of the roadway would be required in any event.

The lack of need for a headwall on the ocean side of the roadway would be traded off for a significant portion of the cost of the remaining pipe.

A disadvantage of the piped system, of course, is the potential for clogging. In ou review of the reports prepared by Dr. Sears and Dr. Parker, we noted that the fiber-glass covers over the pipe joints were effective in reducing the clogging action. With the location of the slide gate nearer the roadway and with further improvements on the ocean side to reduce the intake of seaweed and sand, the frequency and intensity of clogging should be greatly reduced. The velocities which will be prese in the pipe during operation will be sufficient to move sand and debris along the pi In the event that the pipeline is clogged, the manhole will provide one point of convenient access to the pipe. It would also be possible in a severe case of clogging to excavate to the pipe, break open a section, clear the blockage, and repair the damaged section.

We have made a rough estimate of the cost of each of these alternatives, including the replacement of the existing bridge. Although these costs have not been refined, the piped system alternative is clearly the lowest cost alternative, and is approximately two-thirds the cost of the next lowest cost alternative. We therefore recommend it based on engineering considerations, environmental effectiveness and economics.

Permit Requirements

The activities associated with the engineering activities described above may require a variety of applicable federal and state permits. The following summary details the applicable regulations and the processes that must be followed prior to the initiation of any work.

MEPA Review. Under the regulations implementing the Massachusetts Environmental Policy Act (301 CMR 10), the project is one that categorically requires the preparation of an Environmental Notification Form (ENF). The catagorical requirement is based on at least two threshold limits which apply in Nonquitt. One, the project is one requiring construction, replacement or expansion of a solid fill structure greater than 1,000 square feet base area in water (subject to Massachusetts General Law Chapter 91 - Waterways License, or Chapter 131 Section 40 - Wetlands Protection Regulations). Second, the project is within 100 feet of a coastal wetland as defined by Massachusetts Law.

The ENF provides basic environmental data on the project. It is distributed to the public and applicable federal, state and local agencies for comment. Following a specific comment period, the Secretary of the Executive Office of Environmental Affairs (EOEA) determines whether or not an Environmental Impact Report (EIR) is required and also determines what scope the EIR should have. This scoping process, part of the National Environmental Policy Act, ensures that only significant issues are addressed. If the project is determined by the Secretary to require an EIR, then the ENF and the comments received are utilized to establish the scope of the EIR.

It does not appear that the proposed project categorically requires the preparation o an EIR as no threshold values identified in the regulations are exceeded. While EIR's are required for projects requiring alteration of 10 or more acres of land subject to control under the Massachusetts Wetlands Protection Act, and while the total areal extent of the entire Nonquitt marsh exceeds this value, the area of the marsh expected to reasonably be affected by construction and the area of the marsh which is being improved due to improved circulation, constitute individually or in total less than 10 acres. However, if this reasoning is accepted by the State, the State still has the authority to require preparation of an EIR based on several other aspects including projects related to barrier beaches of the State. In the event that an EIR is required, it is likely that it would be limited in scope to the wetland issue, i.e., saltmarsh, barrier beach, and dunes. An EIR requires public and agency review and may include, at the option of the Secretary, a hearing. The EIR also requires the supporting documentation for permits, including those required by the U.S. Army Corps of Engineers, and the Order of Conditions under the Massachusetts Wetlands Protection Act.

Notice of Intent - Massachusetts Wetlands Protection Act. The project is clearly subject to regulation under the Coastal Wetlands Regulations (30 CMR 10). Wetlands protected under the Act that are or may be affected by the proposed project include: saltmarsh, beach, dune, and barrier beach. Anyone proposing to remove, dredge, fill or alter these areas must file a written Notice of Intent (NOI), including plans describing the activity and its effect on the environment, with the Conservation Commission of the city or town and also with the Massachusetts Departme of Environmental Quality Engineering (DEQE). A public hearing is scheduled after th submittal of the NOI. For the project to start, it must receive an Order of Conditions from the Conservation Commission specifying what actions must be taken either in the design or construction of the project to protect the interests of the Wetlands Act. Anyone who is agrieved by the Order may appeal to DEQE for a Superceding Order of Conditions. A variance under the regulations may also be granted by the Commissioner under certain conditions. The regulations generally prohibit the destruction of any saltmarsh. However, because this project is one which will restore and rehabilitate a marsh, it may be permissible under the regulations even if some saltmarsh is lost during construction (which if properly planned, will not happen). The filling, grading, and construction on beach, dune and barrier beach are likely to be conditioned in order to mitigate adverse impacts. The conditions may include restoration to original grade, use of suitable fill materials, measures to minimize erosion during construction, etc. The measures to mitigate adverse impacts on any of the resources in the areas of interest of the Act must be identified in the application. Massachusetts recently instituted a combined permit application with the U.S. Army Corps of Engineers so that the one application submitted will be concurrently circulated and reviewed.

Corps of Engineers. The project, due to its location in what the Corps defines as navigable waters of the United States, is under the jurisdiction of Section 10 of the Rivers and Harbors Act, and Section 404 of the Clean Water Act. Application must be made for an individual Department of the Army Dredge and Fill permit. A public notice is made of the application as it is circulated to various federal agencies (including U.S. Environmental Protection Agency; U.S. Fish and Wildlife Service; and U.S. Department of Commerce, National Marine Fisheries Service). A hearing may also be required if the project is controversial or raises significant objections. In Massachusetts, the action, as described above, is combined with the Notice of Intent for application for a State Wetlands permit. The Corps of Engineers will not issue their permit until it has received certificati under Section 401 of the Clean Water Act, from the Massachusetts Division of Water Pollution Control (see below).

Water Quality Certification. Projects involving dredge material disposal, or in the case of Nonquitt, filling in waters of the Commonwealth, require a permit from the Division of Water Pollution Control of DEQE. This also provides for certification under Section 401 of the Clean Water Act as described above. This certification indicates that Massachusetts has approved the project for which a federal permit is required and finds that the project will ensure the maintenance or attainment of Massachusetts Water Quality Standards in the effected waters of the Commonwealth, and will minimize the impact of the project on the environment. The application includes the submittal of project drawings and data. As no dredging or dredg material disposal is required other than to properly place the pipe, the application and supporting documentation are somewhat simplified. The State is required to make a decision on a complete application within 90 days of submittal.

Coastal Zone Management Consistency Review. Since this project is clearly within the boundary of the State's Coastal Zone Management Plan, the Massachusetts Office of Coastal Zone Management (MCZM) must conduct a review of the project to insure that it is consistent with its policies and to allow MCZM the opportunity to comment. All permit applications and other documentation should be submitted to MCZ concurrent with other submittals. The review by MCZM will be conducted before any federal permits can be issued.

Waterways License. Since the project falls under the jurisdiction of several Massachusetts Acts governing construction activities seaward of the high water mark (in this case the bottom of the tidal stream, landward of the headwall of the existing pipe), a license may be required from the Massachusetts Department of Environmental Quality Engineering, Division of Waterways. The application entails the submission of engineering plans for the activities, and copies of permit approvals from other agencies. The Commissioner must make certain findings regarding the nature and extent of the project before a license can be issued. As long as all the other permits and approvals are obtained, there is no factor that should not be satisfied, and thus nothing to preclude the granting of a license.

Although this permit process may seem insurmountable, we believe with preparation of the proper documentation for this project, you should not have extreme difficulties in obtaining the prerequisite permits for conduct of the work.

Very truly yours,

METCALF & EDDY, INC.

Clifford W. Bowers
Vice President

Registered Professional Engineer
Massachusetts License No. 23941

COMMONWEALTH OF MASSACHUSETTS
CLIFFORD W. BOWERS
No. 23941
REGISTERED PROFESSIONAL ENGINEER

cc: Mrs. Sheila Frothingham
Mr. Horace Jones