

**SAUGUS RIVER AND TRIBUTARIES
FLOOD DAMAGE REDUCTION PROJECT
LYNN, MALDEN, REVERE AND SAUGUS, MA**

This draft report is based on tide levels in 1990. Since then by 2021 tide levels have risen at least 1/2 foot from sea level rise and the openings in the Pines River bridges were widened. These changes have likely raised tides on both sides of the I-95 embankment, requiring reevaluation. The information and concepts presented remain useful in understanding the evaluation of restoring the marsh and mitigation of East Saugus flooding. *w/ the Regional Saugus River Floodgate Project*

**REVISED DRAFT # 2
FINAL IN-HOUSE REVIEW**

**DRAFT DOCUMENTATION
ENVIRONMENTAL RESTORATION**

US Army Corps of Engineers
New England Division
Waltham, Massachusetts, 02254-9149

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**SAUGUS RIVER AND TRIBUTARIES
FLOOD DAMAGE REDUCTION PROJECT**
AKA. REGIONAL SAUGUS RIVER FLOODGATE
ENVIRONMENTAL RESTORATION PROJECT

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INTRODUCTION

STUDY AUTHORITY

The Southeastern New England Study (SENE) was authorized on September 12, 1969, by a resolution that read:

"Resolved by the Committee on Public Works of the United States Senate, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the report on the Land and Water Resources of the New England-New York Region, transmitted to the President of the United States by the Secretary of the Army on April 27, 1956, and subsequently published as Senate Document Numbered 14, Eighty-fifth Congress, with a view to determining the feasibility of providing water resource improvements for flood control, navigation and related purposes in Southeastern New England for those watersheds, streams and estuaries which drain into the Atlantic Ocean and its bays and sounds in the reach of the coastline of Massachusetts, Rhode Island and Connecticut south-erly of, and not including the Merrimack River in Massachusetts, to, and including, the Pawcatuck River in Rhode Island and Connecticut, with due consideration for enhancing the economic growth and quality of the environment."

The Saugus River and Tributaries Study was authorized under the Southeastern New England authority. This authorized the Corps to investigate water resource improve-ments within the New England - New York Region "with due consideration for enhanc-ing the economic growth and quality of the environment". The Enviromental Restoration Study which includes breaching of the I-95 embankment is consistent with this consideration.

HISTORY OF INVESTIGATION

The Saugus River and Tributaries Final Feasibility Report dated April 1990 and its ac-companying Final Enviromental Impact Statement and Report dated December 1989 has undergone public review and has completed review by the Assistant Secretary of the Army for forwarding to the Congress for consideration as an authorized Federal Project. The project is currently undergoing Preconstruction Engineering and Design. The Environmental Restoration investigation , through breaching the I-95 embankment, was undertaken at the request of EPA and NMFS to the Corps' Chief of Engineers who agreed to consider their request early in design. The Saugus River and Tributaries Project report and appendices were used extensively for this investigation as no other re-ports have been written on breaching the I-95 embankment.

STUDY PURPOSE, GUIDANCE AND SCOPE

STUDY PURPOSE

The Saugus River and Tributaries Flood Damage Reduction Study was a feasibility inves-tigation carried out in partial response to the 1969 SENE study authority. This Environmental Restoration Report presents the Corps' reconnaissance investigation of potential solutions to restoring the natural flushing of salt marsh and restoration of con-verted wetlands. Restoration is an opportunity made significantly more feasible by the Saugus River and Tributaries Project, since it reduces tidal flooding which would other-wise be caused by breaching the I- 95 embankment, and it acquires the wetlands impact-ed by higher tide levels from breaching.

The Saugus River and Tributaries Project will provide flood reduction to areas surrounding the Saugus and Pines River Estuary. Because of the flood reduction provided by the project, the Corps is afforded the opportunity to restore marsh lands previously impacted by non-Corps projects. Consistent with the Corps' new mission of Environmental Protection established by Section 306 of the Water Resources Development Act of 1990, the Corps investigated the feasibility of restoring the previous hydrologic condition through breaching of the abandoned I-95 embankment as a means to restore the functioning of the salt marsh. The placement of a sand embankment across the Saugus marsh, which crossed major tidal creeks, resulted in the alteration of the normal marsh tidal regime; the depth and frequency of flooding was reduced which is causing deterioration of the marsh. Breaching the I-95 embankment **without** the flood protection project would induce flooding of the surrounding, developed uplands from both **storm** and **non-storm** related tides. **With** the flood reduction project there would **not** be any induced flooding associated with **storm** tides; although, induced flooding with **non-storm** tides would remain. The flood reduction project also acquires the estuary area which would be affected by higher tides if the embankment is breached. The Corps' project provides a significant opportunity to restore the hydrologic regime of this salt marsh with substantially less impact than if breaching were to occur without the project.

Local environmental organizations support restoration of the hydrologic connection to the restricted portion of the marsh because of the anticipated environmental benefits. Furthermore, letters from the Chief of Engineers to the National Marine Fisheries Service and the Environmental Protection Agency have committed the Corps to investigate alternative methods for breaching the I-95 embankment and restoring wetlands. Breaching would have potentially extensive and diverse environmental restoration benefits. The effects of the breaching have therefore been evaluated by the Corps at a reconnaissance level of detail and are described in this report.

WATER RESOURCES POLICIES AND AUTHORITIES

(1) Section 306 of the Water Resources Development Act of 1990 (Public Law 101-640, 28 Nov 90) established "environmental protection as one of the primary missions of the Corps of Engineers in planning, designing, constructing, operating, and maintaining water resource projects." Section 307 established an interim goal of no overall net loss of wetland acreage and function and a long term goal of increasing the quality and quantity of the Nation's wetlands by utilizing all appropriate authorities, including those to restore and create wetlands.

(2) ER 1165-2-28, 30 Apr. 80 "Water Resources Policies and Authorities - Corps of Engineers Participation in Improvements for Environmental Quality".

a) Balancing economic and environmental interests is a major requirement to be considered in the planning of all Corps projects.

b) Enhancement of the environment is an objective of Federal water resource programs to be considered in the planning, design, construction, and operation and maintenance of

projects. Opportunities for enhancement of the environment are sought through each of the above phases of project development. Specific considerations may include, but are not limited to, actions to preserve or enhance critical habitat for fish and wildlife; maintain or enhance water quality; improve streamflow; preservation and restoration of certain cultural resources, and the preservation or creation of wetlands.

c) If the selected plan or a portion thereof is not within existing Corps implementation authority, but is responsive to the planning objectives established for the study, the reporting officer may recommend Federal (Corps) participation.

d) Relationship of Environmental Quality (EQ) Measures to a Corps Water Resource Development Project. Measures proposed for EQ must enhance, preserve or restore the environment of the study area. EQ opportunities created as a result of meeting study authority purposes should be pursued and, as appropriate, included in plans for Corps implementation. In addition, the recommended plan may also include separable EQ measures to meet established planning objectives. Such separable EQ measures for Corps implementation must be related to, or take advantage of, opportunities created by a water resource development plan to be recommended for implementation by the Corps of Engineers.

Agency Agreement

The "Cooperative Agreement between the National Oceanic and Atmospheric Administration [National Marine Fisheries Service] and Department of the Army [Corps of Engineers] for a Program to Restore and Create Fish Habitat" (signed 31 January 1991), has the goal of increasing marine fish productivity and advancing habitat restoration technology in conjunction with Corps water resource projects. Example projects listed in the program guidance include restoration of tidal wetland areas by breaching dikes. According to draft guidance for implementing the program, "All Civil Works Federal projects (planning, construction, and operations and maintenance activities) should be examined to identify potential habitat restoration opportunities". The Corps and the NMFS will then select projects from lists generated by Corps divisions. The I-95 breaching may be proposed for inclusion on the Corps' New England Division (NED) list provided the Saugus River and Tributaries Flood Damage Reduction Project is authorized. That is, acceptability of the flood control project should be established first, but the two projects could be authorized concurrently or separately.

Under the program set up by this cooperative agreement, the goal is to produce a net increase of fish habitat, as opposed to mitigation of project impacts. The Corps proposal for I-95 breaching includes restoration of existing salt marsh and intertidal and subtidal habitat. If the restoration is done concurrent with the Saugus River and Tributaries project, there is sufficient subtidal and intertidal habitat being restored to eliminate the need for a separate project mitigation site. This would reduce the incremental cost of restoration, but the major emphasis of this effort is restoration of lost wetland values.

According to the Cooperative Agreement, "It is Corps policy to restore and create fish habitat at existing projects when it can be accomplished in an acceptable manner without added cost" and "If added costs are involved, the Corps will consider those op-

portunities using funds and authorities which may be available to them and with appropriate cost sharing by non-Federal interests". The Commonwealth of Massachusetts is the sponsor for cost sharing the Saugus River and Tributaries project. A discussion of available authorities and policies follows.

STUDY GUIDANCE

Fiscal Year 1993 guidance for Annual Program and Budget Request for Civil Works Activities of the Corps of Engineers (EC 11-8-2(FR), 31 March 91) indicated that "high priority is extended to the restoration of fish and wildlife habitat resources, including inland and coastal wetlands, aquatic habitat, and upland habitat", and "restoration of environmental resources will be an integral part of the priority ranking of new start candidates..."

The budget guidance provided the following definitions which are used in this report:

- 1) Mitigation - Measures undertaken to avoid and/or minimize the adverse environmental impacts of implementing Corps of Engineers water resource development projects and measures to compensate for unavoidable adverse impacts of these projects.
- 2) Restoration - Measures undertaken to return the existing fish and wildlife habitat resources to a modern historic condition. The goal of fish and wildlife habitat restoration is to reverse the adverse impacts of human activity and restore habitats to previous levels of productivity but not a higher level than would have existed under natural conditions in the absence of human activity or disturbance.
- 3) Enhancement - Measures which would bring the fish and wildlife habitat resources to a more productive or valuable condition than existed without a Corps of Engineers project in place. Such measures could extend the resources to a greater state of productivity than has existed in modern historic times or a higher state of productivity than would exist under natural conditions..

PRINCIPLES AND GUIDELINES

(1) ER 1105-2-100, 28 Dec 90, "Guidance for Conducting Civil Works Planning Studies", Section VIII, Fish and Wildlife Improvements.

"Federal Interest. Congress, in the Fish and Wildlife Coordination Act of 1958, as amended and the Federal Water Project Recreation Act of 1965, as amended, declare it national policy that in investigating and planning any Federal navigation, flood control, or multi-purpose water resource project, full consideration shall be given to the opportunities, if any, which the project affords for fish and wildlife conservation and improvement. The Corps may recommend fish and/or wildlife conservation and improvement as a project purpose in reports to Congress when certain conditions concerning resource significance, constraints on allocated costs, and requirements for non-Federal participation are met."

Fish and wildlife improvement shall include non-mitigation restoration activities, and includes wetland restoration and creation.

(2) Fish and Wildlife Coordination Act of 1958 (P.L. 85-624). This Act amended the Act of March 10, 1934, to provide that fish and wildlife conservation shall receive equal consideration with other project purposes and be coordinated with other features of water resource development programs.

Section 2(b) of the Act specifies that the project plan shall include such justifiable means and measures for wildlife purposes (mitigation or enhancement) as the reporting agency finds should be adopted to obtain maximum overall project benefits. The means or measures should be justified incrementally, and accordingly, when added to a plan would increase net benefits to provide for maximum overall project benefits.

Enhancement. Improvements for fish and wildlife enhancement shall be included in a project when the expected benefits, monetary and non-monetary, exceed the cost of bringing them into existence and cannot be provided more economically by other means. Acquisition of land for enhancement of the fish and wildlife resources requires specific legislative authorization.

(3) Executive Order 11990, Protection of Wetlands, directs the Corps to provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out its Civil Works activities... Provision for Corps planning guidance, as part of the specific and general environmental considerations required (ER 1105-2-50).

STUDY SCOPE

The scope of this study involves restoring tidal wetlands by dealing with a hydrologically and environmentally complex geographic area located in the city of Revere and the town of Saugus, Massachusetts. Federal and State agencies, interest groups, and the communities are also concerned for the environment in the study area. Initial study efforts concentrated on defining the problems and needs in the study area, developing objectives, and identifying constraints. Potential alternative solutions to the problems in the area have been evaluated. Information from previous water resource studies (see Supporting Appendices) of wetland restoration were used in the investigation; additional information was gathered and used where no existing information was available.

Interaction with the public progressed in tandem with technical data gathering, analysis and planning. The key steps included:

- gathering photographs; preparing topographic and aerial maps of the study area.
- conducting interviews in East Saugus to discuss past flooding problems, and problems with mosquitoes and review damage survey to buildings at varying flood heights in East Saugus.
- gathering tide data to calibrate a numerical model used to estimate future tide levels with breaching the embankment and conducting hydraulic evaluations to estimate the storage capacity of the

ponding areas.

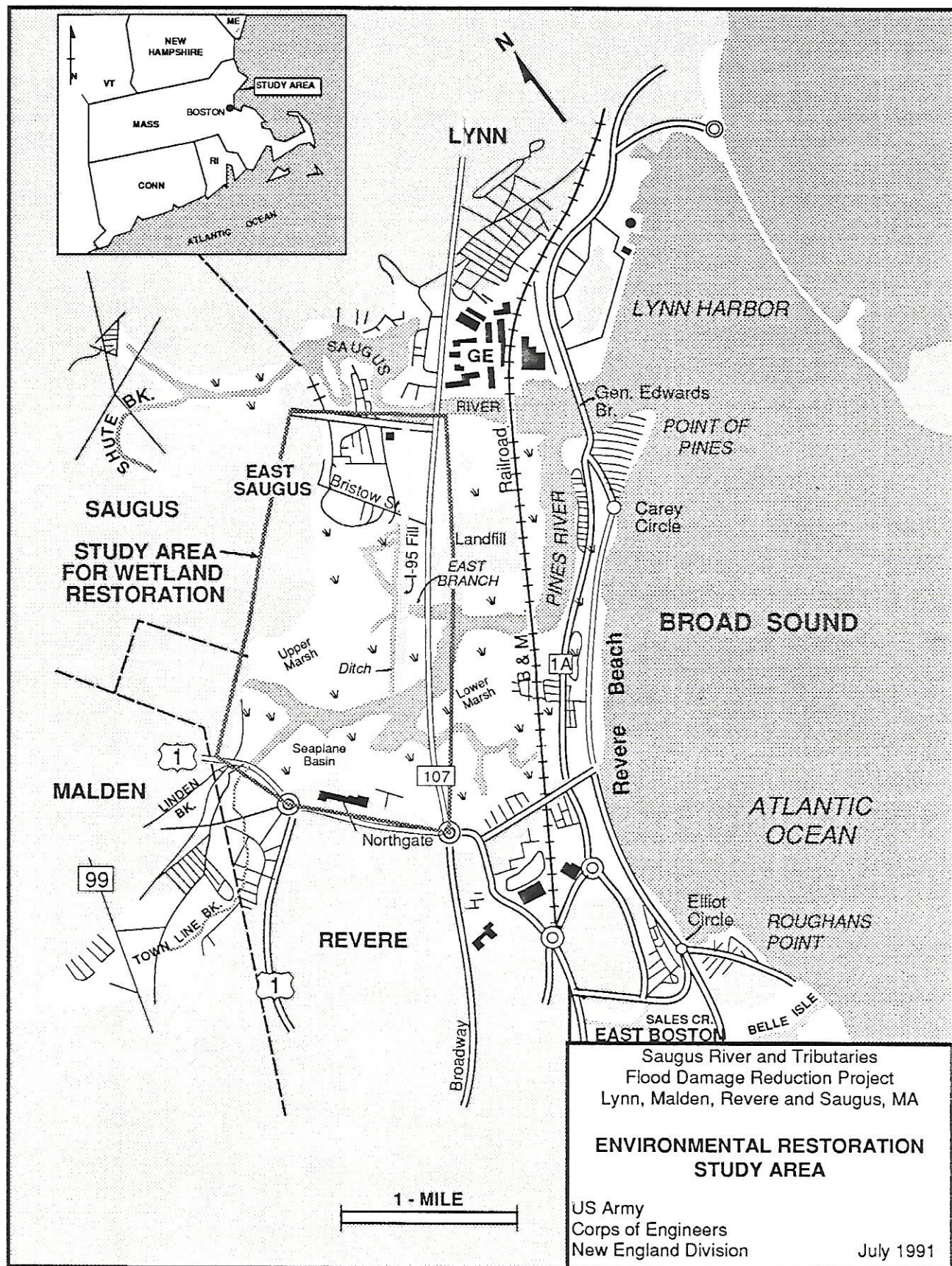
- surveying nearly a mile of existing shorefront to assess physical condition and estimate the potential for overtopping; surveying existing structures to determine current condition and vulnerability to damage from higher spring tide levels.
- preparing flood stage and frequencies of recurrence analyses for the East Saugus flood zone between the Pines Marsh and Bristow Street with 140 homes and 8 commercial buildings under both non-breaching and with breaching conditions.
- evaluating existing data and surveys of environmental resources for the study area.
- formulating structural and nonstructural solutions including preliminary design, costs and impacts to breach the I-95 embankment and to reduce flooding and overtopping along 3800 feet of shorefront.
- conducting recent meetings with the public to coordinate the formulation, evaluation and determination of support of various solutions.

DESCRIPTION OF THE STUDY AREA

THE STUDY AREA – The study area (see Plate 1) is comprised of the land within Saugus and Revere that is subject to increased inundation by breaching the I-95 embankment for the purpose of restoring the environment with tidal flushing to wetlands.

THE I-95 EMBANKMENT – The I-95 Embankment was under construction at about 1969 when construction was stopped for social and environmental reasons. The embankment is owned by the Commonwealth of Massachusetts. Much of the embankment has been removed to within four or five feet of the marsh during construction of the Revere Beach Erosion Control Project. The project is removing nearly 900,000 cubic yards of material and leaving a plateau several hundred feet wide. The embankment is a sandy material hauled from New Hampshire for road construction. When the embankment was constructed it left only a narrow opening for the Pines River to pass through to the upper marsh. The East Branch of the Pines River which fed tidal creeks and the marsh was cut off by the I-95 fill. A ditch was constructed along the entire length of the embankment from the Pines River opening to feed these creeks and the marsh; however, the embankment restricts the flow of water, and reduces tide levels in the upper marsh. The embankment covers over 60 acres of former wetlands and has affected the hydrology of nearly 475 acres of existing wetlands.

Total wetland area affected by I-95 : 60 + 475, or 535 acres.



UPPER PINES RIVER MARSH

The Saugus and Pines River estuary supports a great diversity of natural resources within an otherwise highly urbanized setting. Habitat resources include vegetated wetlands, mudflats and tidal creeks and rivers all linked together through a regular schedule of tidally induced flooding. Approximately 1,550 acres of the 1,660 acre estuary of the Saugus and Pines Rivers lie in the open estuary, the remaining acreage is partially land locked in ponding areas. The estuary acreage includes low (flooded twice daily) and high (flooded less than twice daily to monthly) salt marsh and tidal freshwater/brackish marsh. The wetland changes gradually from a salt water influenced habitat to one which is more strongly influenced by freshwater inflow. Collectively these wetlands today provide a number of values to the environment, including: fisheries and wildlife habitat, pollution attenuation, flood storage, erosion control, and recreational and aesthetic values. The Upper Pines River Marsh and adjacent ponding areas located west of the I-95 embankment includes 475 acres of wetlands. North of the Pines River is 338 acres in the Town of Saugus and south of the river is 137 acres in the city of Revere. The composition of the wetlands from the EIS in May 1987 include:

Wetland Acres - Upper Pines River, May 1987

	<u>Saugus</u>	<u>Revere</u>	<u>Total Acres</u>
Sub - Tidal Rivers	0	28	28
Mudflats	0	58	58
Low Salt Marsh Grasses	21	20	41
High Salt Marsh Grasses	245	28	273
Pannes	4	0	4
Phragmites Reeds			
in High Marsh	7(10-20)*	3	10 (13-23)*
in Ponding Areas	38	0	38
Marsh Elder Bush	14	0	14
Shrub/Wooded Swamps & Cattails	<u>9</u>	<u>0</u>	<u>9</u>
TOTAL	338	137	475

* Includes areas of phragmites not shown on the cover maps.

The center of the Pines River is the divide between Revere and Saugus, thus some of the tidal river would fall in Saugus. The sub-tidal river area is permanently flooded and serves as sub-tidal habitat for fish. The estuary in Revere is nearly half mud flats providing clam and benthic habitat which is a feeding source for shore birds and fish. The Seaplane Basin area is a productive clam flat.

The low marsh grasses are flooded twice daily. It is productive habitat of high value to fish and wildlife. The high marsh is less frequently flooded and makes up a major portion of the marsh in Saugus. It is valuable for fish and wildlife feeding, resting and nesting. Pannes are depressions in the high marsh, which when filled with salt water, may form a basin where small fish and other animals stay between tides.

Phragmites, or common reeds, and the marsh elder bush, a woody shrub, were found in areas irregularly flooded by salt water extending as low as El.4.9. They grow on areas of higher elevation, reduced salinity, or disturbed soils. The 7 acres of phragmites and 14 acres of marsh elder acreage found in Saugus in May 1987 may have resulted from a reduction in tide levels. State mosquito control officials reported the Phragmites and marsh elder have spread and grown in height nearly ten fold in the past decade in the northwestern area of the marsh. Field reconnaissance in May 1991 by the Corps found additional acreage of Phragmites in Saugus (which was omitted from the cover map prepared for the EIS) for a total of 10 to 20 acres, and new growth advancing ahead of last years reeds confirming the expansion of this reed, although the rate and ultimate extent have not yet been determined. This growth is attributed to the reduction of salinity in the soils of the high marsh. Also bordering the western edge of the marsh in Saugus is 9 acres, irregularly flooded by salt water, which are freshwater wetland habitats dominated by shrubs, or woody vegetation, and emergent vegetation. This area also may reflect the restriction in tide level since the areas range in elevation is similar to the rest of the Marsh. There are also two wetland areas used for interior ponding of runoff. Both areas are in East Saugus and are dominated by about 38 acres of phragmites where tidal flushing has been nearly eliminated by tide gates.

Approximately 40 species of finfish are recorded in the waters of the Saugus and Pines River Estuary, including anadromous species, species of commercial and recreational importance and forage fish. Anadromous species which pass into the estuary to spawn are shad, rainbow smelt, alewife, and blueback herring. Several commercially valuable species of flounder and other species use the estuary to spawn or as a nursery area. Bluefish, pollock and other species which feed in the study area waters provide important recreational fishing opportunities.

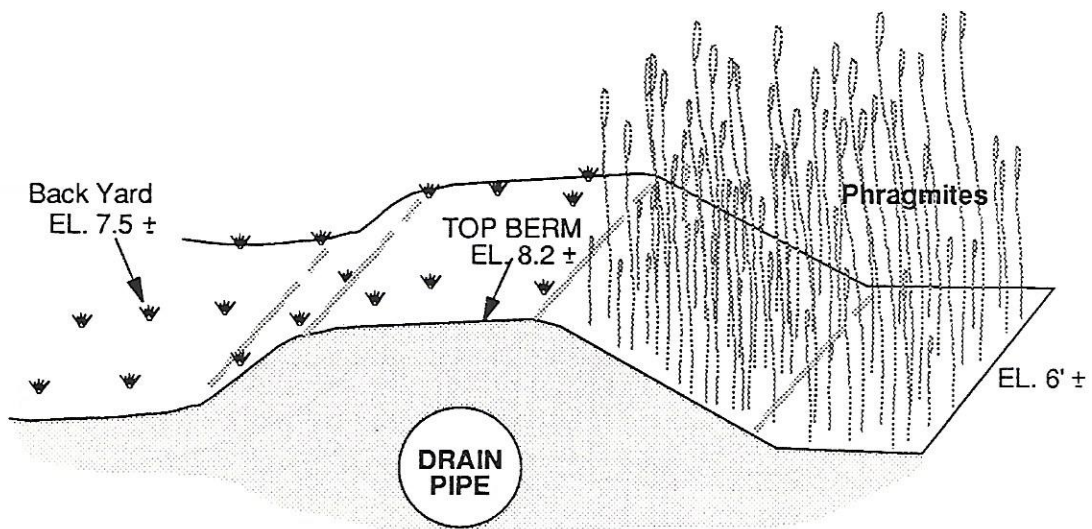
EAST SAUGUS – The East Saugus community borders on the Pines River Marsh as shown on Plate 2. The drainage area between Bristow Street to the marsh includes about 140 homes and 8 commercial buildings. Drainage problems would persist even with the Saugus River and Tributaries Project. The 3775 foot shoreline is generally bordered by a low earth berm one to two feet high along the edge of the marsh and back of property lines to reduce flooding from high tides. About 30 homes and three businesses border the shoreline. About 3000 feet of ditch are located along the marsh edge of the properties for drainage.

In 1988 land surveys developed profiles intermittently along the shoreline including the centerline of most streets. The 1600 foot shoreline from Bristow Street(near the I-95 embankment) to near Beachview Street is bordered by a berm generally at Elevation 7.5 feet, NGVD along the edge of the properties and ranges in elevation from 6.5 to 7.9 feet. See Plate 3. The parking lots for the three businesses and back yards were lower and ranged from El. 6 to 7. A drainage ditch borders about half the reach on the marsh side. The marsh surface varies from about El. 5.1 to 5.9.

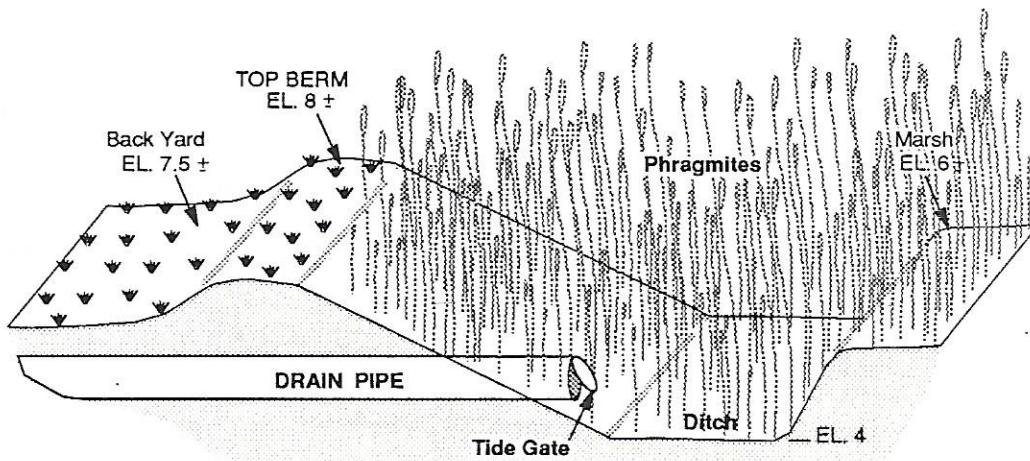
The longest reach, 1975 feet, from near Lindsell to Tuscan Avenue is lined with homes with yards bordered at the marsh with top of berms about El. 8, ranging from 6.7 to 9.5, while yards are from El. 7.0 to 8.5. The edge of the properties are nearly all lined with a

500 Ft.	Scale
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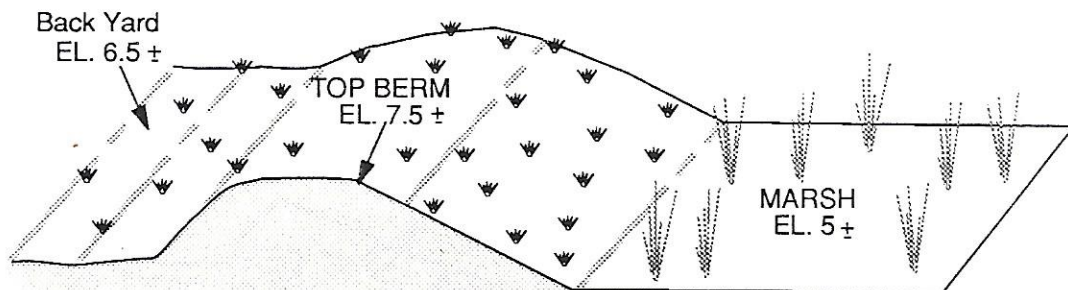




EXISTING BERM
Tuscan Ave. to Atlas Ave.



EXISTING BERM
Near Lindsell St. to Tuscan Ave.



EXISTING BERM
Bristow St. to near Beachview St.

ditch 10 to 20 feet wide and 2 to 3.5 feet deep, which carries runoff from six storm drains or pipes. All drainage outlets have flap gates except one near Tuscan Avenue. One pipe discharges water from the ponding area between Bristow Street and Seagrit Avenue. The drainage ditch discharges into a mosquito ditch in the marsh. The ditches are relatively flat at about El. 4 and border the marsh at El. 5 to 7. Some of the ditches are extensively over grown and plugged by the 8 foot tall phragmites reeds which return every year.

The last 200 foot reach runs from Tuscan Avenue to Atlas Avenue and borders residential properties. A pipe with an invert of El. 8.7 outlets into the ditch at the end of Tuscan and runs parallel to the shore buried beneath the berm. The properties are at El. 7 to 7.5 and marsh at El. 6.

The 3.7 acre ponding area located between Bristow Street and Seagrit Avenue store water for this area until it can drain through pipes to the marsh. The Bristow Avenue ponding area has about a 0.3 acre open water area surrounded by 3.4 acres of phragmite reeds.

Some runoff near Beachville Ave. also drains north to the ponding area near Eastern Ave. and the I-95 embankment. This Eastern Ave. ponding area is property owned by the state and several private interests and includes 18.5 acres of mostly phragmites on the west side of I-95. On the opposite side of the I-95 fill, a 20 acre ponding area of mostly phragmites is connected at the north end of the I-95 by a ditch to the Eastern Ave. side. The two ponding areas drain under Ballard Street by a culvert with a tide gate discharging to the Saugus River. The Eastern Ave ponding area also stores runoff for the area between Bristow and Ballard Streets.

ASTRONOMIC TIDE LEVELS IN THE UPPER AND LOWER PINES RIVER MARSH

The I-95 embankment has retarded the flow of tide waters into the upper Pines River Marsh. In the Revere end existing tides levels are only a few inches lower than levels east of the I-95 embankment. However, tide levels in the Saugus portion of the marsh are significantly different for tides above mean high water. The Corp's Waterways Experiment Station collected tidal data in the Fall of 1990 on both sides of the I-95 embankment. In the upper Pines River Marsh, gages were set at both the Town Line Brook opening to the Pines River at US Route 1 in Revere, and in Saugus at the end of a tidal creek near East Saugus. (See Plate 1). The following table compares high tide levels during non-storm conditions on opposite sides of the embankment.

Astronomic Elevation of High Tide Level	Existing Conditions-- Number of Times High Astronomic Tide Levels are Equaled or Exceeded in a year	
(Ft. NGVD)	Upper Marsh in Saugus (also Floodgates w/ existing I-95 fill)	Unrestricted Lower Marsh (also upper marsh if I-95 is breached w/ Floodgates)
5	220 times per year	365 per year
6	1 in 5 yr to 1 a year	110 per year
7	1 in 10 to 1 in 5 years	15 per year
7.3	1 in 200 to 1 in 100	3-4 per year

Elevation 5 feet NGVD is the mean high tide near Boston and in the unrestricted area of the Lower Pines River Marsh. The I-95 embankment is retarding the tide level for over half the time from reaching EL. 5. In the Upper Pines River Marsh EL. 5 is only reached about 220 times per year, when without restriction (or, if the I-95 is breached) it would be reached about 365 times per year, see [Figure 1](#). The difference in actual tide height however is small. The restricted elevation is about EL 4.7 ft NGVD when east of the embankment reaches EL.5. The reason for the small difference is that the tides are only filling the creeks and ditches which hold only a small volume of water. High tide is at or below EL.5 about 50 percent of the time.

The largest difference in tide levels occurs the other 50 percent of the time when the banks of the creeks are overtopped and flooding of the high marsh begins. A tremendous volume of water is needed to flood the marsh surface and the restricted opening cannot deliver the water needed. Consequently when the Mean Spring High Tide is reached at about EL 5.8 ([Figure 2](#)) in the lower Pines River, the Upper Pines River is one foot lower. Based on the frequency of inundation, the Mean Spring High Tide is reached about 100 times per year in the Lower Pines River, but only about once a year or less in the Upper Pines River in Saugus.

Finally High Spring Tide ([Figure 3](#)) which reaches EL. 7 feet in the Lower Pines River about 15 times per year, are restricted from reaching this level in the Upper Marsh to only once in 5 years or less. The tide height in the Upper Marsh is about 1.7 feet lower in the upper marsh which is restricted by I-95. Consequently, the restricted tide levels in the Upper Pines River Marsh have considerably reduced not only the flooding of the marsh, but the depth and volume of water reaching the marsh. The Maximum Predicted Astronomic High Water ([Figure 4](#)) which occurs about once a year is restricted to 1.8 feet lower in the upper marsh.

Project Mitigation

The Saugus River and Tributaries Project causes the loss of 2.0 acres of intertidal and 1.0 acre of subtidal habitat. For loss of this habitat, the plan includes creating 2.0 acres of intertidal clam flat and 1.0 acres of subtidal habitat. This would be accomplished by removing the west side of the abandoned I-95 fill near the Pines River to create a mostly intertidal basin ([Figure 5](#)). A 6.5 acre site would be used in total. Clams would be transplanted into two acres within the basin to form the clam flat ([Figure 6](#)). The created basin would be edged by a 0.5 acre fringe of marsh grass, a 2.3 acre buffer zone and protective dike and include an additional 0.7 acres of intertidal transition area. About 70,000 cy of sand would be excavated in total from the 850 foot long by 330 foot wide site. The sand would be used to create the protective berm; used elsewhere in the project to the extent practicable, or stockpiled on the embankment for later use by others.

This mitigation site is being considered for relocating to a site in Saugus for breaching the I-95 embankment, as discussed later in this report. The total cost to create the 3 acres of sandy intertidal/subtidal habitat is nearly \$450,000 which includes design and construction management costs and costs allocated to using the fill in project features. The cost per mitigated acre is about \$150,000 per acre to create the wetlands. The Roughans

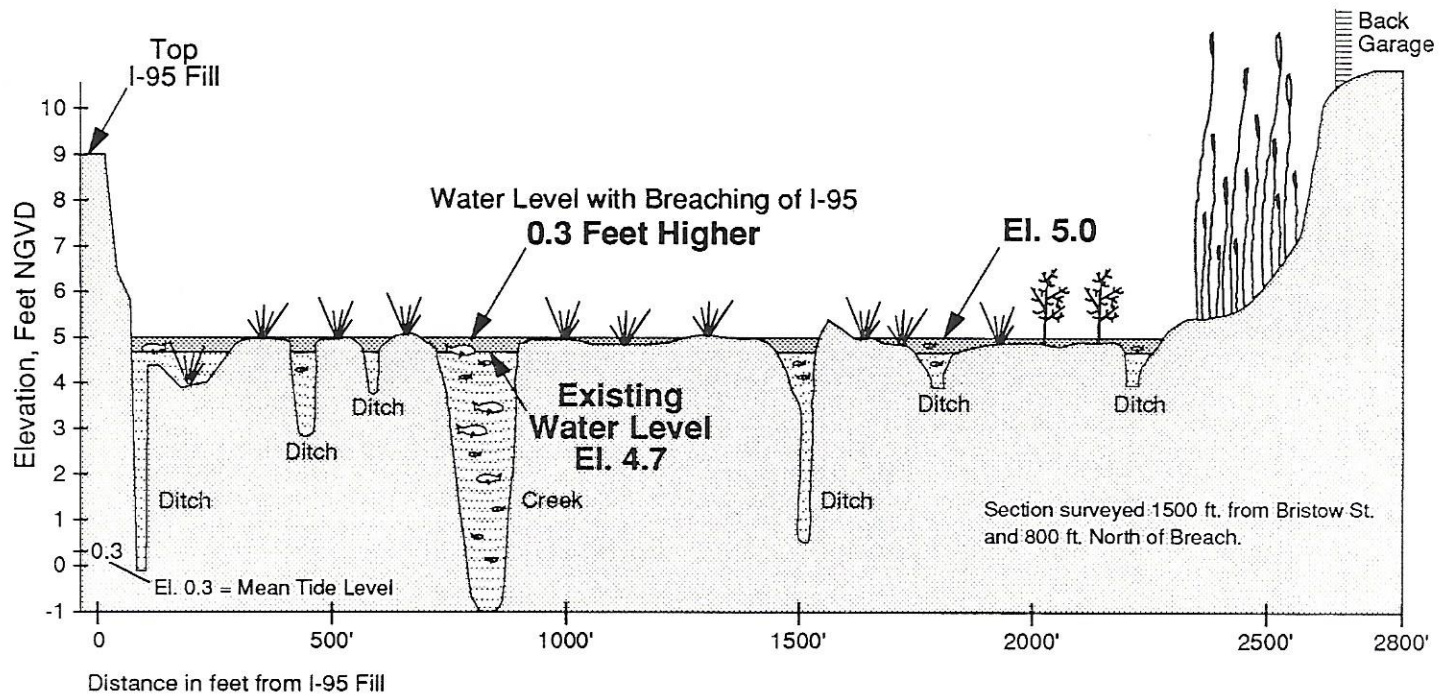


Figure 1 - Mean High Water
365 Times Per Year
 (Equaled or Exceeded)

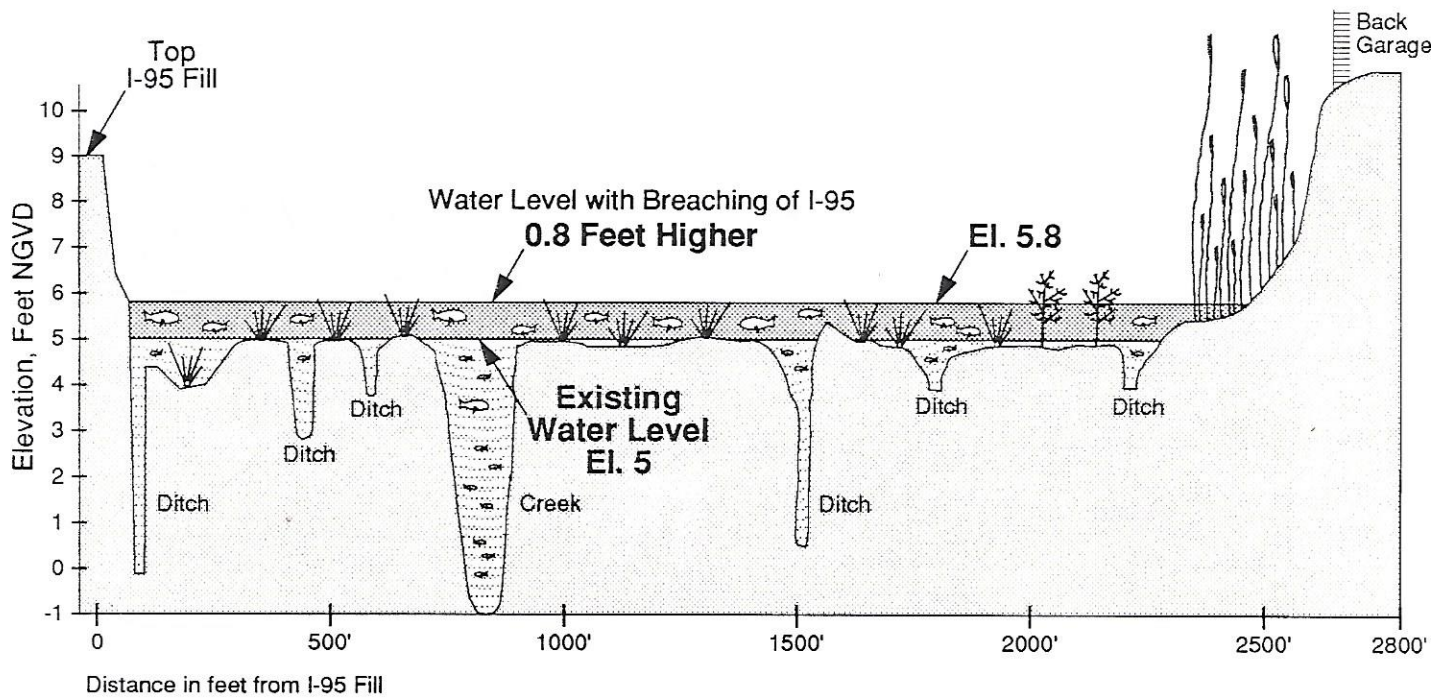


Figure 2 - Mean Spring High Water
Approx. 100 Times Per Year
 (Equaled or Exceeded)

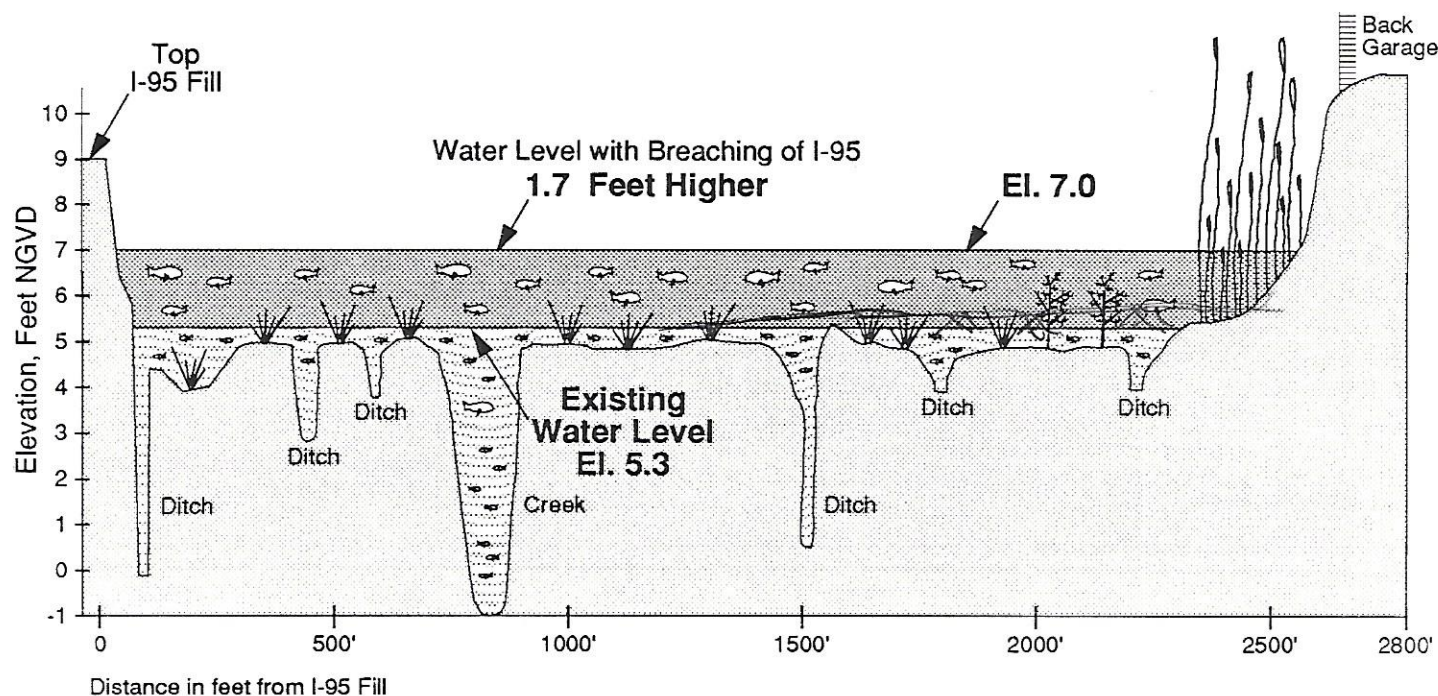


Figure 3 - High Spring Tide
Approx. 15 Times Per Year
 (Equaled or Exceeded)

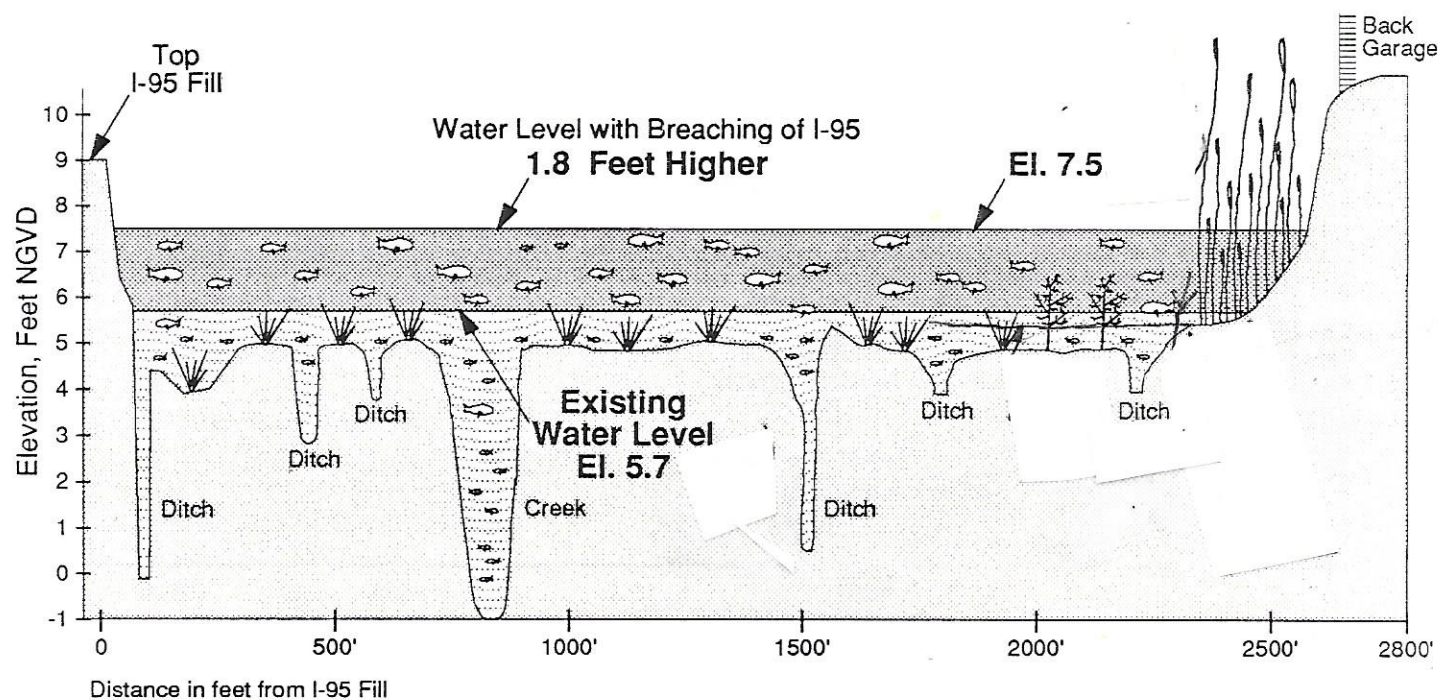
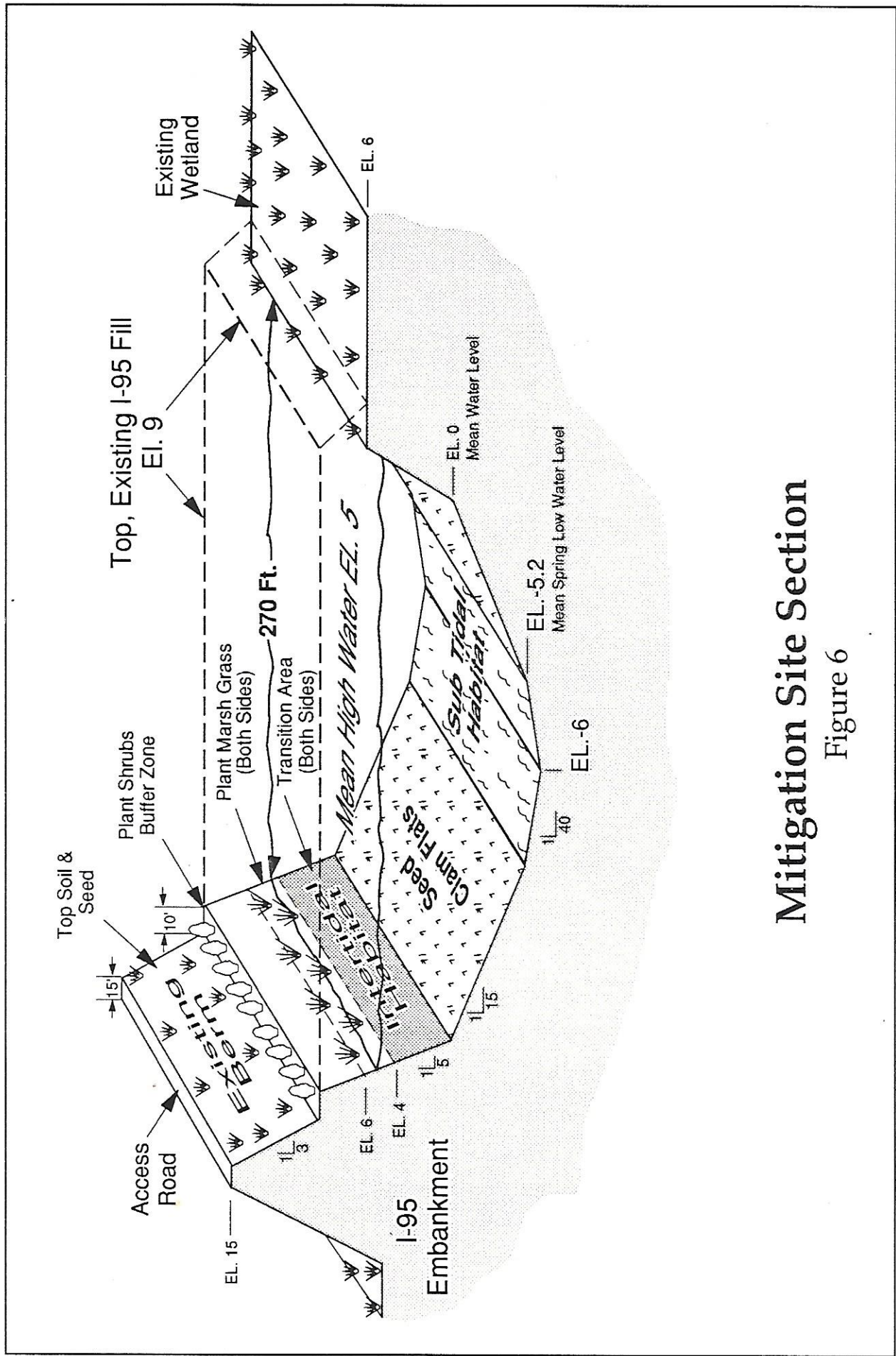


Figure 4 - Maximum Predicted Astronomic High Water
Approx. 1 Time Per Year
 (Equaled or Exceeded)



Mitigation Site Section

Figure 6

Point Flood Reduction Project plans to mitigate 2 acres of intertidal habitat at the I-95 embankment at a cost of about \$230,000, or \$ 115,000 per acre. These costs per acre - \$115,000 to \$150,000- reflect the value for creating wetlands which other projects have included for mitigation.

The Saugus River (107) Navigation Project was recently approved by the Office of the Chief of Engineers for preparation of Plans and Specifications . The project will include a 3 acre inter-tidal habitat mitigation site. The plan is to be designed and constructed (in about 2 years) west of the Saugus River and Tributaries Mitigation Site.

WATER QUALITY — The inland waters of the Saugus and Pines Rivers have been designated class B, and the coastal waters of these rivers have been designated class SB by the Massachusetts Division of Water Pollution Control (MDWPC). Class B waters are suitable for swimming, other recreation, and for protection and propagation of fish, other aquatic life and wildlife. Class SB waters, in addition to those uses approved for class B waters, are suitable for shellfish harvesting with depuration. Shellfishing is the most carefully controlled activity in the coastal area due to the stringent requirements established to prevent human consumption of contaminated clams and other bivalves. According to the "Saugus River Basin Water Quality Survey" prepared by the MDWPC in November 1982, the Saugus and Pines Rivers generally meet class B and SB standards during dry weather flows. During interior storm events, however, discharges from storm drains and overland flow have an adverse impact on the quality of the upper estuary (above the Route 107 bridge on the Saugus River). In the lower basin the impact is not as severe because of the large tidal interchange. However, coliform levels are high enough that the mudflats within the estuary have not been classified as open for shellfish harvesting in recent years, although a few areas have been classified as restricted. In these

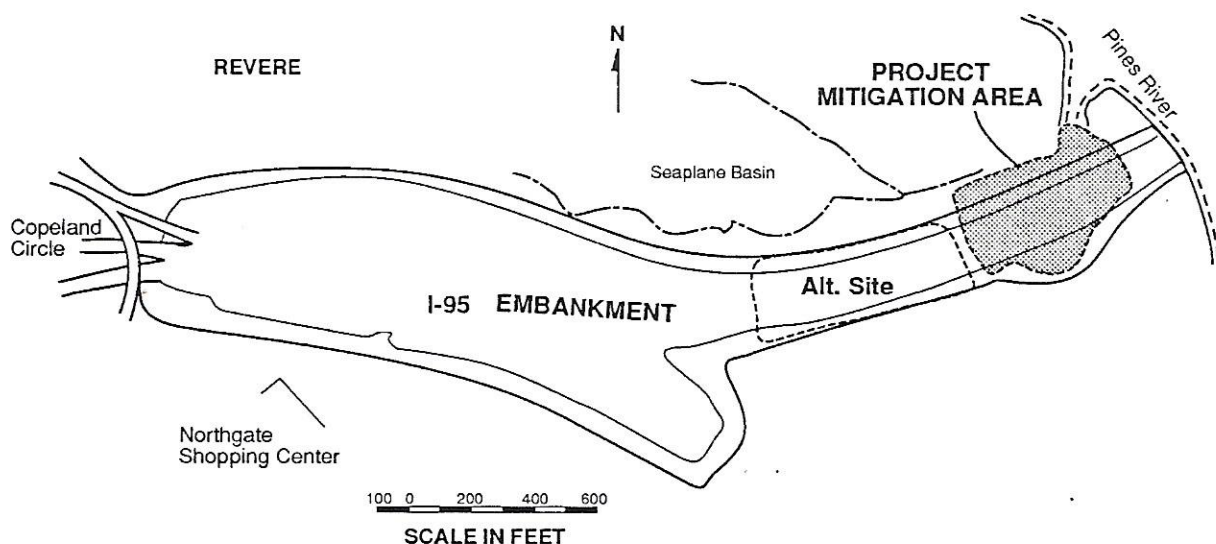


Figure 5

sections, licensed master diggers and their employees may harvest shellfish and then have them depurated. MDWPC testing for cadmium, chromium, mercury and zinc show that concentrations in the lower estuary generally met the latest Quality Criteria for Water (1986) published by EPA. Corps testing showed a number of metals exceeding chronic criteria to protect sensitive marine aquatic life, although the less stringent acute criteria were usually met.

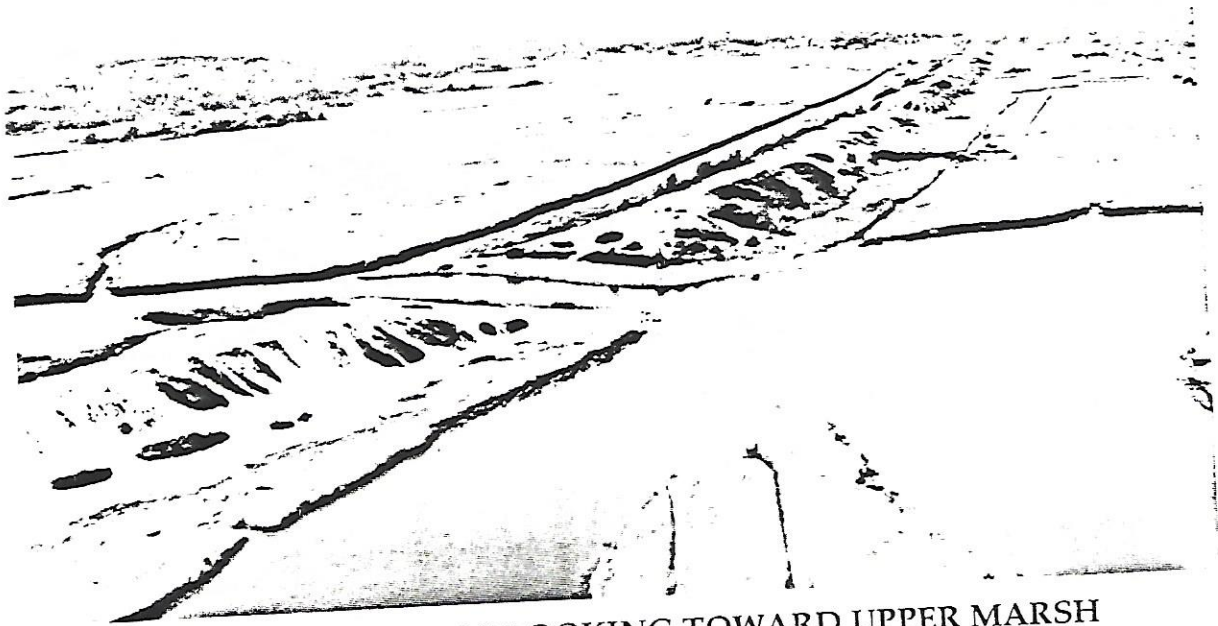
Current point and nonpoint sources of pollution within the estuary, but outside the Upper Pines River Marsh, include three thermal water discharges — the General Electric River Works Plant (31 discharge locations); the RESCO plant and the Eastern Tool Manufacturing Company (one pipe each); intermittent discharge from the combined sewer overflow (CSO) at Summer Street in Lynn, which occurs an estimated 40-50 times a year during periods of freshwater runoff; and leachate from the extensive landfill area located within the salt marsh near the junction of the Pines and Saugus Rivers. The landfill includes four major sites: the Saugus landfill which occupies almost 200 acres; the RESCO facility which covers approximately 100 acres; the RESCO ash landfill which covers approximately 11 acres, and the GE landfill, which covers approximately 10 acres.



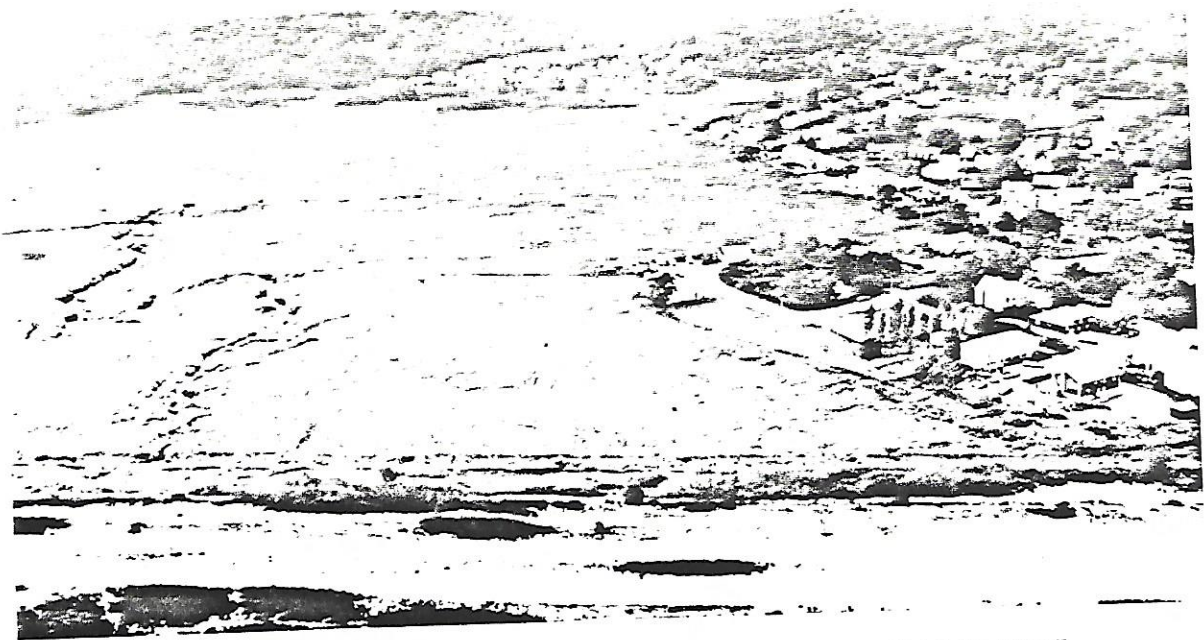
EAST BRANCH OF THE PINES RIVER LOOKING NORTH TOWARD UPPER MARSH AND EAST SAUGUS



EAST BRANCH LOOKING SOUTH TO PINES RIVER LOWER MARSH AND ROUTE 107



PINES RIVER OPENING LOOKING TOWARD UPPER MARSH



EAST SAUGUS BORDER ON UPPER PINES RIVER MARSH

PROBLEM IDENTIFICATION; THE WITHOUT PROJECT CONDITION

This section identifies the problems, needs and opportunities associated with the restricted tide levels in the study area: the tidal estuary of the Upper Pines River Marsh in Saugus and the East Saugus residential area. What is notable about the problems created by the reduction in tide levels caused by the I-95 embankment and by tide gates on ponding areas is not only their very substantial impacts on the environment of the marsh, but the adverse affect on the residents of East Saugus.

EXISTING CONDITIONS

REDUCTION OF TIDAL FLUSHING IN THE MARSH

Environmental Problems

General- Vegetation composition on salt marshes is dependent on a number of factors. These include: substrate composition, frequency and duration of flooding, salinity, nutrients, soil oxygen, microrelief, physical disturbance, and interspecific competition. The change in the marsh system which occurred following the placement of the I-95 embankment can be predicted based on an evaluation of these factors in relation to the change in tidal regime. The predictable change in the tidal regime will affect all of the factors listed above, but the focus of this analysis will be the depth, frequency, and duration of flooding without specific analysis of other factors.

The water regime of a wetland is determined by the depth, frequency, and duration of flooding. All of these parameters were affected by the I-95 embankment restriction. The most important of these factors is the frequency of flooding. The change in the depth and duration of flooding over the marsh surface is not expected to have affected the composition of salt marsh plants. Previous investigations for the EIS revealed that the entire marsh surface is flooded or saturated during a 6.4-7.0 feet, NGVD tide, measured at the mouth of the Saugus River. Under flooded conditions all of the marsh soil is presumably saturated through the root zone. Therefore, any increase in the depth or duration of flooding (and head) over the marsh surface would not increase the level of saturation or affect the parameter of soil saturation as it relates to vegetative composition. The depth and duration of flooding are also expected to remain within the tolerance limits of the salt marsh. The majority of the Upper Marsh surface at about El. 5 ft., NGVD originally flooded naturally about 100 to 365 times per year, and today is restricted to only about 15 times per year. This reduction in flooding frequency has reduced soil salinity and initiated a significant change in plant composition.

Plant Species- With restriction of the tidal regime, the vegetation of a salt marsh can change from the tidally influenced vegetation pattern to domination by less salt tolerant species as has already occurred in the extreme portions of the marsh. This change is considered to result in a degradation of the quality of the marsh. Extreme reduction of a tidal range (50%) which may be associated with the installation of a tide gate or other re-

striction results in a reduction in the marsh water table level and a reduction in soil water salinity. Initially, seaside golden rod, high tide or marsh elder bush, and fireweed invade salt meadow grass zones while *Phragmites* begins to encroach on the upland border. Once *Phragmites* establishes on the marsh periphery, it has the potential to overgrow the entire marsh system. *Phragmites* and marsh elder appears to have increased since the construction of the embankment. If this trend exists on the Saugus Marsh, the ecological benefits of elimination of the restriction would be tremendous. Preliminary evidence of this trend exists in the northwest corner of the Saugus Marsh with the high abundance of seaside arrow-grass and black grass over large areas of the marsh plain and *Phragmites* encroachment on the marsh periphery.

In order to evaluate changes in plant species composition that may have occurred due to the construction of the I-95 embankment, observations of aerial photography and a site visit were made. The pattern of marsh vegetation on the site was compared on 1957 (pre-embankment), 1969 (just following the embankment construction), 1986, and 1991 aerial photography. The purposes were to determine if changes in the amount of low marsh, high marsh or high marsh species composition have occurred.

Aerial Photography- *Phragmites* appears to have begun its colonization on disturbed portions of the marsh along the northern and western upland border behind the embankment. Portions of the northwestern corner of the marsh appear disturbed in monoscopic 1967 aerial photography (prior to the construction of the embankment), but *Phragmites* vegetation is not evident. *Phragmites* appears to be present on 1977 aerial photography in lesser quantities than on 1986 and 1991 photography. High quality, color-infrared aerial photography from November 1986 and April 1991 were examined to determine if *Phragmites* dominated areas in the northwest corner of the marsh near East Saugus or marsh elder growth along the border of East Saugus had expanded. Over this five year interval, no significant change in the aerial extent or pattern of *Phragmites* or marsh elder dominance is apparent on the aerial photography which only shows very dense stands.

Field Observations- A lag time in the response of the vegetation to the change in tidal regime may be occurring due to residual soil salinity. Field observations made on 31 May 1991 revealed that *Phragmites* in this area is expanding through subsurface shoots, or rhizomes. New plants from last year's growth were observed to have spread as much as 10 feet from the densely vegetated *Phragmites* area and this year's growth was already expanding on last year's growth. It is not possible to predict the ultimate extent or rate of growth with existing data, but if this reed were to ultimately replace the salt marsh in this area the environmental consequences would be significant. A detailed study involving monitoring of salinity and plant species composition over time would be required to document a trend toward less salt tolerant species. Salinity levels over one growing season could be collected to determine the existing marsh areas with salinity levels within the tolerance range of *Phragmites*. However, for preliminary decision-making purposes it may be supposed that as much as 80 acres of **high salt marsh** could be overtaken based on its apparent disturbed condition. A maximum of 270 acres could be affected in the Upper Marsh.

Based on the comparison of pre-breach and post-breach aerial photography, it is not anticipated that the quantity of **low marsh** will change with breaching.

Degraded Marsh, Phragmites-The most easily recognizable and significant change in marsh vegetation which could be expected with the restoration of tide levels would be the change of areas along the upland edge of the marsh from salt marsh vegetation to the common reed marsh, (*Phragmites australis*). Based on cover type mapping for the EIS, evaluation of aerial photography and field observations, the quantity of Phragmites marsh behind the embankment which could be reclaimed with additional tidal inundation includes about 10 to 20 acres. The benefits of these areas reverting to salt marsh are clear.

Phragmites is a relatively low value species ecologically compared to salt marsh grass which are generally recognized as having high ecological value. Phragmites tends to grow in dense stands which exclude other species of vegetation, thus decreasing the overall diversity of the marsh. Although the productivity of Phragmites is quite high, the value is limited. Whereas a portion of salt marsh production is exported to the aquatic and terrestrial food webs, Phragmites production is, to a large extent, unavailable to food webs. It has relatively low value as a food item because of the coarseness of its stems and leaves and its hairy seeds. In addition, Phragmites cover is a potential fire hazard, and stagnant Phragmites marshes are prime mosquito breeding areas.

Salt Marsh Elevations-Under normal conditions the elevation of a salt marsh is essentially self-regulating. The surface elevation increases through the accumulation of sediment and organic matter and decreases through the processes of subsidence. Under normal conditions, when a marsh subsides, it is inundated by the tides more frequently allowing greater sediment input. With more frequent inundation the anoxic conditions of inundation allow the marsh to store a greater quantity of peat. On the contrary, extreme decreases in the frequency of flooding of a tidal marsh have been shown to reduce the elevation of the marsh surface. It was found that marsh elevations were lower in restricted Phragmites dominated marshes than unrestricted salt marsh systems. Therefore, without the regulating influence of the pre-embankment tidal regime the marsh elevation may not have kept pace with sea level rise, or may have subsided. If the normal tidal regime is restored, especially if sediment input has been reduced, the marsh could revert to less productive high marsh. Survey information for the Saugus marsh west (restricted) and east of the embankment could be compared to estimate whether the restricted marsh surface has subsided.

Productivity Export-General

Salt marshes have been credited with having immense productivity, rivaling that of the most productive agricultural lands. Productivity, however, varies with the type and characteristics of the marsh. The marsh/estuarine ecosystem is immensely complex. It has, therefore, been necessary to make generalizations and estimations to develop preliminary evaluations of changes in the marsh system with increased tidal range. To measure the effects of the change in tidal regime within the scope of this effort these systems have been greatly simplified. These generalizations will allow a gross comparison of the positive and negative effects of the hydrology change.

The productivity change has been estimated based on the change in tidal regime as compared to work performed by others. The quantified change in productivity has been compared to typical productivity estimates for New England salt marshes to estimate the value of the productivity increase in terms of the number of acres of salt marsh it represents. This increase in an identifiable resource serves to represent what the increased productivity will mean in easily recognizable terms (i.e., numbers of acres of salt marsh).

Productivity Export -Salt marsh productivity or the production of food and nutrients is available to organisms in the estuarine and terrestrial food webs and, in some cases, a portion is believed to be exported to the coastal aquatic food web. Litter (dead plants) does not accumulate in the estuary because tidal action causes it to be removed as fast as it is produced. However, the export of productivity is dependent on the type of marsh (i.e., high marsh or low marsh) and the geomorphological characteristics of the estuary where the salt marsh occurs. Three reasons why the high marsh is not believed to play a major role in export of organic matter from the marsh are: 1) the high marsh is flooded much less frequently by tidal waters than the low marsh; 2) the grasses are farther from tidal creeks; and 3) high marsh grasses form a dense interwoven mat of vegetation which retains detritus (decaying vegetation which supplies food and nutrients to the food chain).

For this analysis, the Saugus Marsh has been classified as a system which consumes all its production within the marsh with little transported to the ocean. The greatest relative increase in benefits, in terms of productivity, is expected to be generated by the low marsh and remain within the Saugus estuarine system.

Most of the Saugus marsh affected by the anticipated change in tide regime, about 270 acres, is **high marsh**. An additional 20 acres is **low salt marsh** for a total of approximately 290 acres of marsh which could be affected by a change in tidal regime. These marsh types vary in their organic matter production and response to changes in tidal regime. Aboveground primary production of the **high marsh** in New England ranges from 425-1,100 gram dry weight per square meter per year and varies with vegetation type. The aboveground primary productivity of the **low marsh** in Massachusetts has been calculated at about 1,320 g dry weight/m²/yr. The increase in productivity associated with the tide range increase in the **low marsh** developed for study sites in Long Island Sound is 580 g/m²/year per meter increase in tidal range.

Low Marsh Productivity- The productivity of the low marsh behind the embankment could be expected to increase by 53 g/m²/year with a 0.3 foot increase in tidal range. Applying this increase to the total quantity of low salt marsh behind the embankment and north of the Pines River the potential increase in productivity could amount to 4,422,479 g/year.

High Marsh Productivity -The reduction caused by the I-95 restriction (or increase if the I-95 is breached) in the mean spring tide range at about 0.8 feet (El. 5.0 to 5.8) affected the productivity of the high marsh as well. Since information on the effects of increasing tidal range on high marsh productivity were not found, the rate of change in low marsh productivity will be applied to the high marsh, with modifications, to roughly predict its

potential maximum increase. This assumes that the high marsh is similarly affected by tidal range and is benefitted by the same tidal subsidy that benefits the low marsh.

Tides are believed to enhance the productivity of the marsh by increasing nutrient fluxes, recycling oxygen, and removing waste products. The height of high marsh grasses increases when soil drainage increases and also important are oxygen transport and root aeration to productivity. Although to a much lesser extent than the low marsh, the high marsh soils are affected by the tidal action which increases low marsh productivity when describing the irrigation force of the tides. Based on the theory that the increased tide range increases productivity through these mechanisms related to soil flow characteristics, the potential loss in productivity of the high marsh has been related to the potential low marsh changes. The potential loss in productivity of the high marsh with a 1 foot tide range reduction due to the I-95 restriction is about 3,600,000 g/yr.

Productivity Export Summary - Therefore, the total estimated loss in productivity for the high and low marsh is 8,020,900 g/yr. Related to the productivity of New England marshes, this loss in productivity would equate to 1.8-4.7 acres of lost high marsh or 1.5 acres of low marsh.

Fish and Wildlife, Aquatic Habitat- Salt marshes provide important transitional aquatic habitat. The increase in the depth and frequency of flooding with breaching will periodically provide increased feeding habitat for fish and other aquatic organisms. Menhaden, bluefish, fluke, sea trout and striped bass are among the more familiar wetland-dependent fish. Although not present in the study area, red drum and mullet are examples of fish which feed over the marsh surface. Fish are primarily benefitted by low salt marsh habitat, however the majority of marsh affected by the change in tidal flooding is high salt marsh. More specific benefits to aquatic organisms could be determined by evaluating the species present and their requirements against the expected change. However, the increased flooding will provide an increase in aquatic habitat which can be calculated in terms of permanent habitat as described below.

It is possible to estimate the average increase in the habitat available to aquatic organisms on a yearly basis. Assuming the high tide level remains for about 2 hours during each tide cycle above El. 5 for an El. 6 high tide, the increase in the number of tides at 2 hours each can be used to indicate the comparable quantity of permanent aquatic habitat. This estimation is based on the number of tides to elevation 6 feet NGVD which will increase by approximately 110 tides. Two hundred seventy (270) acres of marsh flooded by 110 tides equates to about 60,000 hours of flooding. There are 8,760 hours in a year; therefore, the increased flooding would be equal to 6.8 acres of new permanent aquatic habitat.

Fish and Wildlife, Nesting Birds- Bird censusing completed for the project EIS revealed that three species, from a list compiled by the U.S. Fish and Wildlife Service in Massachusetts, are present at the Saugus Marsh and one additional species has been recorded as present through other work. The species are: sharp-tailed sparrow, seaside sparrow, black duck, and meadowlark. Each of these species is present on the list, therefore, these species could be affected by an increase in tidal flooding frequency and depth. Effects on nesting would be evaluated through further study if this investigation proceeds.

FLOODING PROBLEMS

The Saugus River and Tributaries Project is assumed to be built in the future. Although the Project would substantially reduce coastal flooding in East Saugus, residual flooding would continue because of the poor drainage. The roads and properties in East Saugus between the Pines River Marsh and Bristow Street range from EL. 6 to 10 ft NGVD. When tide levels are high, say between EL. 5 and 8, runoff from interior rainfall and snow melt is slow to drain into the marsh. Consequently, heavy rainfall or snow melt ponds to depth of up to one foot on some roads and properties. Residents reported interior flooding currently occurs several times per year. The residual damages from this ponding is estimated at about \$11,600 per year. This includes damage to roads, utilities, lawns, basements and three first floors between EL. 6.9 to 7.8 ft NGVD. Although there are two ponding areas to store runoff, one has insufficient capacity to prevent these damages. The other appears to have ample capacity, but is not available to most of the area and was not investigated in detail.

PONDING AREAS

The two existing ponding areas in the study area are located near Bristow Street and Eastern Avenue. Both were formerly tidal wetlands. Tide gates however were placed on their culverts, retarding the flow of salt water into the area resulting in the over growth of phragmites. Cover typing in these two ponding areas showed that Bristow Street is 3.7 acres, including 3.36 acres of phragmites and 0.34 acres of ponding water. The Eastern Avenue ponding area has 38.50 acres of phragmites with 18.50 acres along the west side and 20.0 acres on the east of the I-95 embankment.

Bristow Street Ponding Area - The Bristow Street ponding area (3.7 acres) has the potential to be returned to salt water wetlands through the use of self-regulating tide gates. Returning salt water to the ponding area would destroy the phragmites and its problems with mosquitoes and fire threats, and provide the high ecological value of low and high wetland. However, currently tide levels in the Pines River Marsh are retarded to the point that salt water levels would rarely pond high enough to kill off the reeds. This is demonstrated by the perimeter of East Saugus where phragmites have overgrown the ditches at El. 4 to 6.

Detailed studies would need to determine whether there would be any impact on basements, the exact level of residential improved properties, the hydrologic and environmental conditions and the effectiveness of self-regulating tide gates. One concern with self-regulating tide gates is the high degree of maintenance they have required in the past. This investigation and public coordination would be needed before a decision is reached whether to return tidal flushing to the ponding area.

Eastern Avenue Ponding Area

The Eastern Avenue ponding area, includes 38.5 acres of phragmites most of which could be eliminated by returning salt water to the area's former low and high salt marsh. This ponding area could be investigated as a possible location to divert interior drainage and for restoration using self-regulating tide gates. This was not part of the current study effort and would need to be investigated during future studies.

MARSH RESTORATION BY REMOVING I-95 FILL

The I-95 embankment has a very wide base which replaced the marsh. Not all of the embankment is needed to provide the flood reduction its height affords to East Saugus. Some of the fill can be removed along its west side for the purpose of restoring or replanting vegetated wetlands. Breaching the embankment would improve flushing and tide levels to any wetland restored in the future by removing the I-95 embankment.

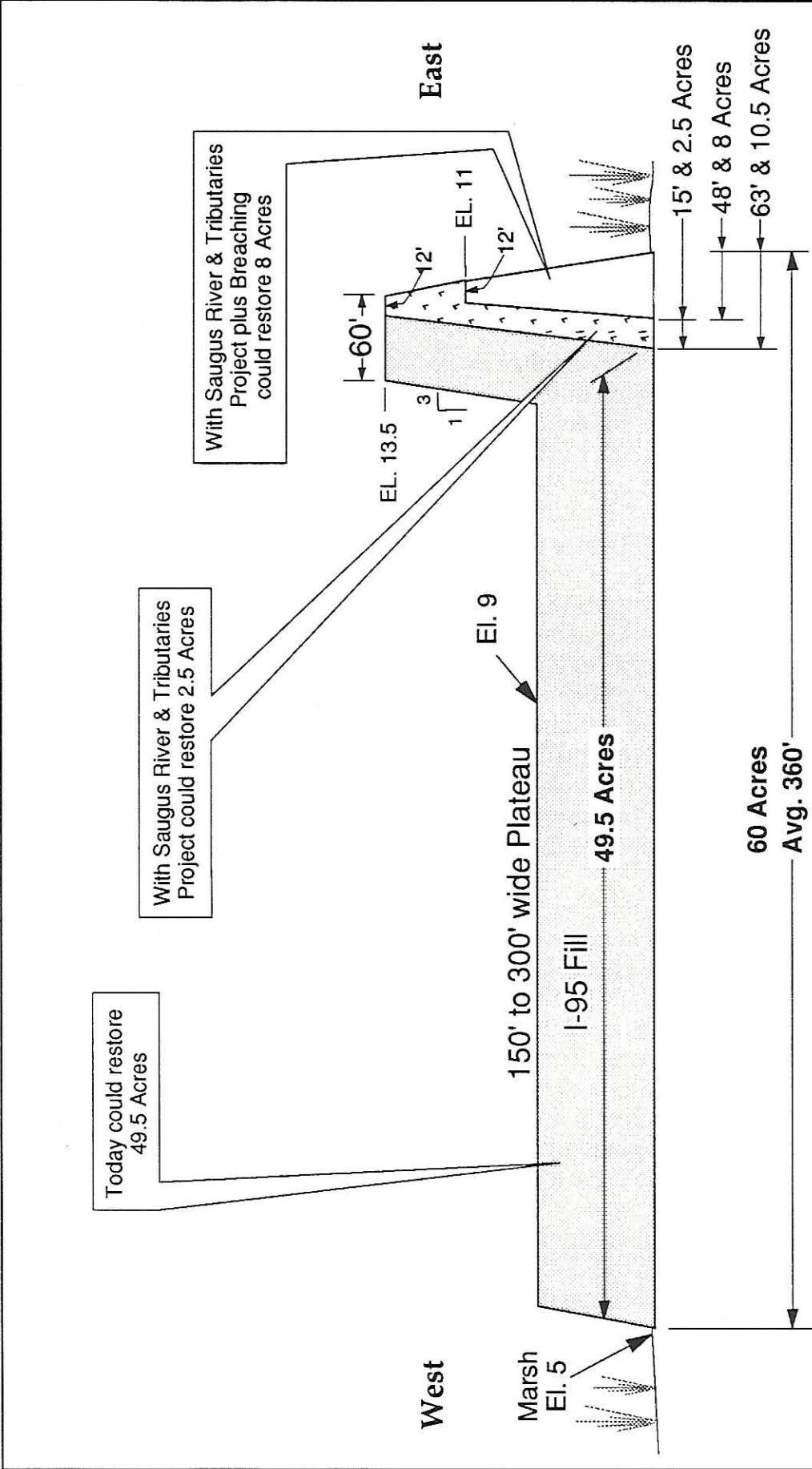
The embankment is about 7,300 feet long through the marsh, as measured from Bristow Street in East Saugus to near the east end of the Sea Plane Basin in Revere. The base of the fill at the level of the marsh (about EL. 5ft NGVD) ranges from about 250 to 600 feet wide (averaging 360 feet in width). It covers about 60 acres of former wetlands. The actual base of the embankment which is about EL. -10 is wider below the marsh surface.

The Revere Beach Erosion Control Project, currently under construction is removing about 900,000 cubic yards of the fill to restore the beach. The embankment is being lowered leaving a plateau 150 to 300 feet wide, generally to EL. 9 about four feet above the marsh along the west side of the embankment. See Figure 7. Along the east side of the embankment a higher berm elevation generally EL 13.5 is remaining to provide its flood reduction capability. The width of this higher plateau is generally 60 feet. The EL. 13.5 is based on a 100 year stillwater tide level of EL. 10.5 plus 3 feet for runup.

Currently for flood protection, the higher berm only needs to be 12 feet wide at EL. 13.5, as shown in the Project's Geotechnical Appendix. This would continue to provide the flood reduction it affords to East Saugus, and requires a width of only 63 feet at the base of the embankment covering an area of 10.5 acres. Therefore, today out of this total 60 acres, 10.5 acres should remain and 49.5 acres could be removed for restoring lost wetlands. The Saugus River and Tributaries Project will only allow non-storm tides to reach about EL.7.5. With three feet of freeboard, the height should remain at EL. 11, requiring a base width of 48 feet covering an area of 8 acres. Therefore, the Saugus River and Tributaries Project provides the opportunity for 2.5 acres (10.5 ac. less 8 ac.) of wetlands to be restored.

If the I-95 is breached to restore tide levels in the upper marsh to include protection along the shoreline of East Saugus, the remaining 8 acres of embankment could be removed to restore wetlands. The restoration opportunities however will only be realized to the extent the area is available after the Metropolitan District Commission establishes its plans for a linear park. The MDC master plan for the embankment park land is currently being prepared as part of Saugus' Order of Conditions for the Revere Beach project. The I-95 fill which will not be used for parkland has already been spoken for by various state projects, or planned to be used for mitigation of projects. The remaining sandy material however may have a high salt content and be difficult to reuse.

Breaching the I-95 embankment therefore provides the opportunities to not only restore 8 acres of new wetlands but also to improve the flushing of the total of up to 60 acres of additional wetlands which are likely to be restored in the future by others.



I-95 Section

After Sand is removed by the
Revere Beach Project

Figure 7

THE SALT MARSH MOSQUITO

Eleven residents bordering the marsh in East Saugus who's property would be directly affected by a plan to breach the I-95 embankment were interviewed. Seven commented on the severe and fierce mosquito problem which affects enjoyment of their yards. For example, a Boston Police officer commented on the "tremendous" mosquito problem explaining how they swarm his swimming pool especially in the evening. One woman would like to spend eight hours working in her garden during the day, but is forced indoors by the mosquitoes after only about two hours. Essex County Mosquito Control representatives reported that when the mosquitoes swarm from the marsh many calls are received from residents in this area and within 20 miles of the marsh--most significantly within one mile. The Saugus Board of Health agent reported that he knew Essex County formerly trenched and maintained the marsh because of the salt water / freshwater boundary which breeds mosquitoes. People have continuously complained to his office due to breeding grounds and adult populations. The county has a spraying program about once a week, however it is insufficient. Therefore the town has a daily program of spraying from 10 PM to 2AM. Corps representatives were also swarmed by mosquitoes when visiting the area in August 1991.

The following summarizes a brochure: "The Mosquito, The Salt Marsh, And You" , written by representatives of the Massachusetts Audubon Society and Essex County Mosquito Control Project.

The Salt Marsh Mosquito is an aggressive day and night biter and a prolific insect which aggravates residents within miles of the marsh. It is also different in other ways from the common fresh water variety, as it travels ten to twenty miles in search for a blood meal to produce a healthy batch of eggs. The aggressive appetite is satisfied by indiscriminate successive biting of both animals and humans, creating a health hazard by spreading disease--a hazard underestimated by the general public. It is a severe annoyance to residents along the coast. Millions of mosquitoes can hatch in as little as four to five days swarming nearby communities, forcing residents to stay indoors. The succession is repeated every few weeks from April through November.

Mosquito control has been an important part of public health efforts to prevent the transmission of diseases, such as Eastern Equine Encephalitis. In the 1930's marshes including marshes in the study area, were criss-crossed with a pattern of ditches every 100 to 200 feet to drain breeding pools and reduce mosquitoes. Ditches have not been maintained and are blocked by slumping sides or filled with debris creating, once again , breeding pools on the marsh surface. Perimeter ditches along the landward edge of the marsh were usually first to be filled with debris and closed off or partially blocked to tidal flows creating shallow channels--prime breeding grounds for mosquitoes. See Figure 8. Frequent flushing of marshes is required to keep predatory fish alive to control mosquitoes. Boggy areas and shallow pannes close to shore where mosquitoes breed do not contain predatory fish; and, consequently mosquitoes thrive in conditions surrounding the marsh. The study area is typical of the problem with pools of standing water created in the perimeter ditches and mosquito ditches across the marsh.

Figure 8

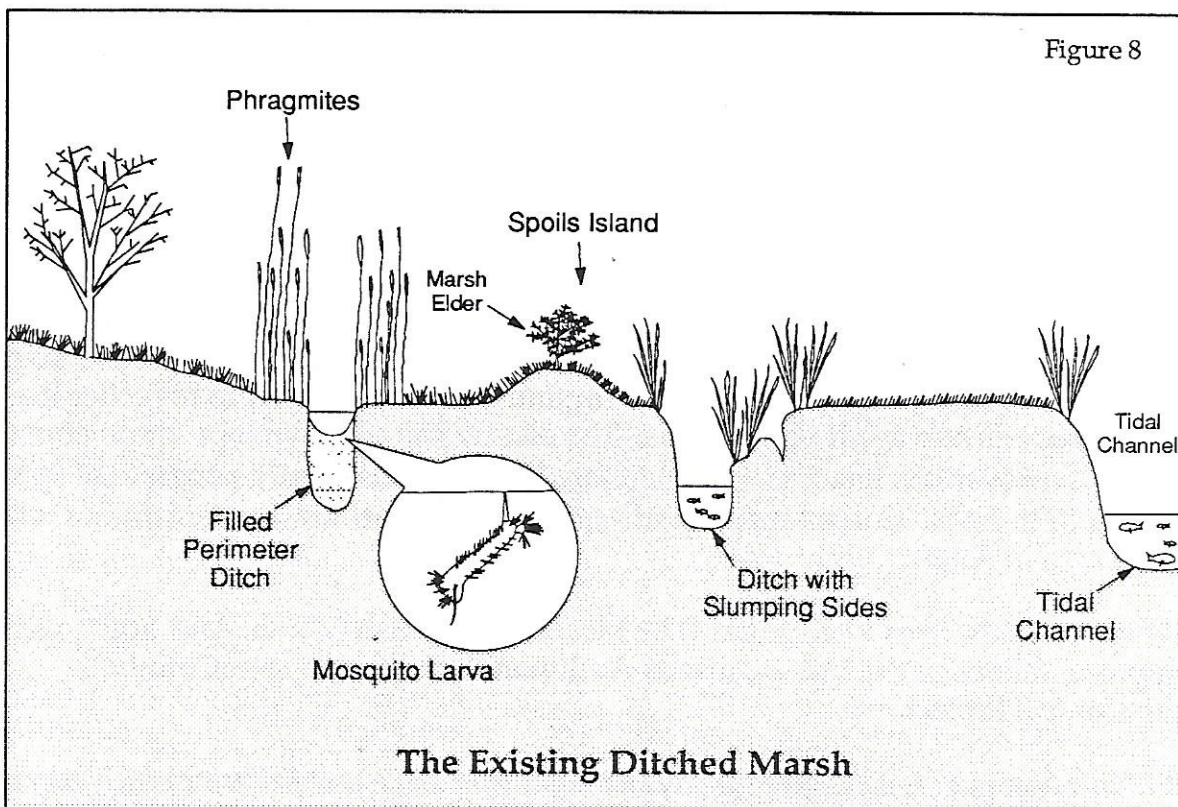
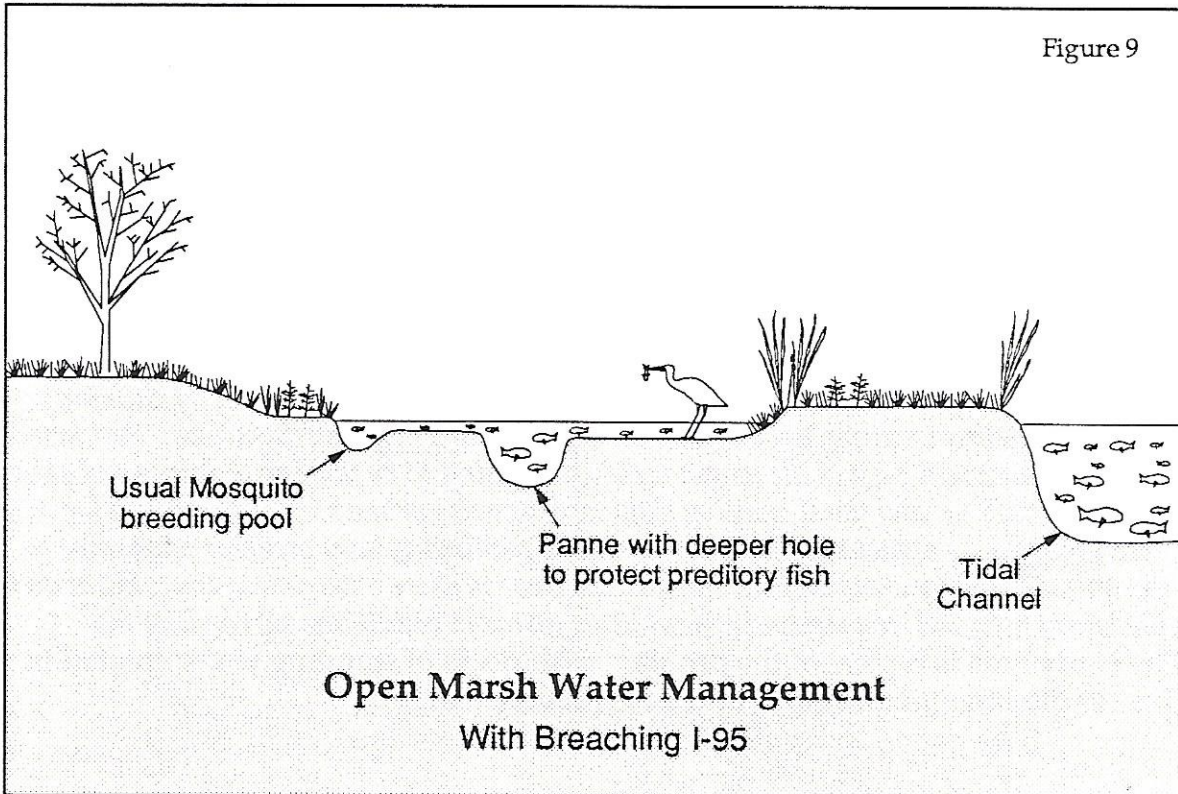


Figure 9



The Essex County Mosquito Control Project under the Massachusetts Department of Agriculture (participated in by Saugus, Lynn and Revere) was established to reduce insect numbers with minimum environmental damage. Open Marsh Water Management practices to reduce mosquitoes were investigated in cooperation with Massachusetts Audubon Society and the Manomet Bird Observatory. They found mosquito breeding reduced 95 to 100 percent. Not only is there no environmental damage to the marsh with the management practices, but shorebirds and wading birds returned to the ditched marsh. Open Marsh Water Management includes creating deep pools with shallow ditches connecting to mosquito breeding areas. Deep holes in the pools create refuge for fish between high spring tides. The interconnection of these pools and ditches supports the small predatory fish which are voracious eaters of the mosquito larvae. See Figure 9.

The salt marsh mosquitoes are more common on high marsh than marsh areas which are flooded more frequently. Mosquitoes require shallow pools of stagnant or still water to lay eggs. Mosquito "larvae did not appear in areas of a marsh in Delaware that were flooded more than 25 days each month, and that breeding was limited to areas where the frequency of flooding was less than 8 days per month." This suggests that the proposed breaching will reduce mosquito breeding on the marsh because the frequency of marsh flooding will increase, provided that newly flooded areas do not contain additional stagnant pools.

If the I-95 embankment is breached to return normal tidal flushing to the marsh and ditches, not only will the higher tide levels help to reduce mosquitoes by making the ditches accessible to predatory fish, but also provides the opportunity for implementing effective Open Marsh Water Management.

Representatives of the Essex County Mosquito Control Project estimated mosquito breeding can be reduced between 90 to 99 percent in the upper Pines River Marsh after breaching the embankment. There should be a substantial reduction in the mosquito problem reported by residents at least within one mile of the marsh. No economic impact has been estimated for this mosquito problem.

Fire Control

Residents in East Saugus bordering the Pines River Marsh reported fires are frequently started in the dry marsh grasses which spreads like wild fire to the phragmites bordering drainage ditches adjacent to their homes. Fires are a constant threat and have scorched their homes. The Saugus Fire Chief reported that he makes an average of 15 runs a year in the Pines Marsh to put out fires, and frequent flooding of the marsh would considerably reduce this problem. He estimated that each year about 2 homes are scorched or sheds are lost. Breaching the I-95 fill will change this high marsh from being inundated once or twice a year to 100 or more times a year, keeping the high marsh wet and considerably reducing the threat of fires. The estimated average annual increased cost including overtime to firemen, maintenance to equipment for fighting these fires, and related damages in the town is \$2,400.

Damages to Shorefront Structures

The East Saugus 3,775 foot long shorefront along the marsh is lined with primarily earth

berms. Every year residents maintain these berms by cutting the 8+ foot high phragmites growing on the face of the berms and building up the berms which are trampled down or erode. The berms reduce flooding and must be maintained. The cost of replacing and maintaining these berms would be reduced by the Saugus River and Tributaries (SR&T) project, since they would no longer be overtopped by severe coastal storms. However, the remaining average annual cost to maintain these berms with the Saugus River and Tributaries project is estimated at \$5,500 .

Wave action and river flows have eroded and damaged about 130 feet of shoreline near the Carter Broadcasting Co. Radio Tower on the East Branch of the Pines Rivers due to lack of maintenance or unstable banks. A severely deteriorated wall needs to be replaced since erosion of the river bank is threatening to undermine the tower's footing. The future average annual replacement, repair and maintenance cost is estimated at \$1,900.

Near the I-95 embankment opening at the Pines River a restriction reduces the flow of water into the marsh. This is due to a rock lined projection fronting the ditch which runs parallel to I-95. The entrance channel to the ditch along the west side of the I-95 is restricted from free flows to the marsh. About 530 feet of shoreline partially lined with stone, or eroding, would need to be removed to eliminate the restriction. Also the existing 120 feet of stone revetments along the shoreline at the Route 107 Bridge is in need of repair with stone protection. The estimated future replacement, repair and maintenance average annual cost for these shorefronts is \$1,000.

The estimated average annual maintenance cost along the total 4,555 feet of shorefront are \$8,400 as shown below.

Shorefront	Length (feet)	Shorefront Average Annual Cost (1991 P.L.)
East Saugus	3,775	\$5,500
Radio Tower	130	1,900
I-95 Restriction &	530	
Route 107 Bridge	<u>120</u>	<u>1,000</u>
TOTAL	4,555	\$8,400

Ditch Maintenance

There are about 3000 feet of ditches bordering the East Saugus shoreline. Residents, the town and others perform yearly maintenance to cut and remove the shrubs, phragmites, debris and siltation. The dry shrubs and phragmites in addition to being a fire hazards, also collects debris, slow the flow of water and causes siltation and ponding of water, and increased mosquito breeding. The estimated average annual cost of ditch maintenance is \$2,000. A plan to breach the I-95 embankment would significantly reduce the growth or eliminate weeds, phragmites, stagnant water and mosquitoes through frequent flushing of salt water in the ditches, or by filling in the ditches and restoring them to salt marsh.

ENVIRONMENTAL RESTORATION OPPORTUNITY CREATED BY SAUGUS RIVER AND TRIBUTARIES PROJECT

The Saugus River and Tributaries Project significantly improves, or provides the opportunity to breach or open up the I-95 embankment to restore tidal flushing and the wetland environment in the Upper Pines River Estuary. This is made possible since the project reduces, or eliminates storm related flood levels which would be increased by breaching. The project also acquires the estuary area which would be impacted by higher tides from breaching.

For example, **without** the Saugus River Project under today's conditions, breaching the I-95 embankment would raise the stillwater tide levels in the marsh bordering East Saugus by one to two feet for both non-storm related astronomic high tides, and for storm related flood tides up to about a 100 year coastal storm level (tide level EL. 10.5-11.0). To prevent this impact up to a 100 year event would require walls and dikes along East Saugus up to EL. 13.5 to 14.0, which includes runup. This would mean a structural barrier about six (6) to seven(7) feet high above the backyards (about EL.7 to 8) of residents bordering the marsh. This is a visual and aesthetic impact strongly objected to by residents and town officials during this study. It is highly unlikely breaching would occur under todays conditions.

The Saugus River and Tributaries Project would prevent flood stages from reaching or exceeding EL. 8 feet NGVD by closing the gates for coastal storms. The Floodgates would not be closed for high astronomic tides occuring without a storm which can reach EL. 7.5 ft., NGVD in Broad Sound. This level would also be maintained with the breaching of the I-95 embankment to prevent coastal flooding. As will be explained later, the shoreline along the marsh bordering East Saugus would still need to be raised with walls and dikes to prevent flooding from high astronomic tides when the Floodgates would not be closed; however, the height of dikes and walls would only be one (1) to (3) three feet above the backyards of residents bordering the marsh to prevent runup of higher tides from flooding residential property. Based on interviews with residents, this height and land area required is generally acceptable based on the benefits they would receive from restored flushing of the marsh, as explained later.

The Saugus River and Tributaries project would also acquire the estrary area which would be affected by higher tides with the breaching.

The Saugus River and Tributaries Project provides the opportunity to restore flushing with potentially significant environmental benefits and relatively little social impact.

PUBLIC CONCERNS ON BREACHING I-95

Federal Agencies

National Marine Fisheries Service, letter dated April 17, 1990.

"The project should include simple measures to enhance the estuary. This area is designated an Area of Critical Environmental Concern and should be treated as one. A major opportunity for habitat improvement exists with removal or reconfiguring the I-95 fill. The fill is currently a wasteland and nothing is growing in it. Motorcycles and other vehicles are constantly tearing up the embankment and causing continuous erosion into the estuary. The document does not present a convincing argument that the I-95 fill serves the only flood control measure to protect East Saugus. It may only prevent nuisance flooding. A mitigation plan should investigate removal of the I-95 fill. The fill could be used to build low berms along East Saugus to protect that community. At the very least, the I-95 fill on the Malden (Revere) side of the river could be removed. This would be more important for the estuary ecosystem as a whole than creating clam beds.

"The channel opening at the I-95 embankment is too narrow. The Corps states in their EIS (p45) that restrictive channel opening at the I-95 embankment reduces in the upper Pines River portion of the estuary. The opening at the I-95 embankment should be widened so the estuary can return to its natural state. If all the fill is not removed, at least a few breaks in the fill are needed to improve flushing/circulation in the estuary and to stop the use of this area by motorized vehicles. This will reduce the erosion and allow the area to regain some of its natural characteristics." Ref: Vol. 7, Sec. C, pg. A7.

U.S. Environmental Protection Agency, letter dated March 12, 1990.

"... EPA is concerned that the maintenance of the current hydrological restriction to 444 acres of marsh and former marsh land (1) will not coincide with the goal of the Clean Water Act to restore and maintain the integrity of the waters of the United States, (2) will not be compatible with the intent of the ACEC designation of Rumney Marsh, (3) and will not be consistent with EPA's longstanding environmental goal of restoring this area. The flood reduction plan's requirement for local assurance that all existing tidegates be maintained in operating order does not allow for the potential restoration of salt marsh through the use of self-regulating tidegates, which would automatically close when the tide reaches a pre-determined high elevation, or other means. We are also concerned that the Corps insists that the abandoned Interstate 95 fill can never be fully removed from the marsh, and that the hydrological restriction caused by the I-95 fill cannot be removed. The basis for the Corps insistence of retention of a minimum 15 foot high (NGVD) dike in place of the I-95 fill is that certain areas received unintended flood protection from the I-95 fill. According to the Final EIS, the complete removal of the I-95 fill would, even with the Regional Floodgate Project, cause flooding at normal high tides. We are not convinced that alternative means to protect these areas are not feasible, and environmentally preferable, to the retention of the I-95 hydrological restriction." Ref.: Vol. 7, Sec. C, pg A3.

U.S Fish and Wildlife Service

"The I-95 embankment acts as a barrier to incoming tides, reducing the historic high water mark by at least six inches. Restricted flows through the floodgate in combination with the I-95 embankment will further reduce the amount of water reaching the back of the marsh. It is our understanding that one of the arguments for not removing the I-95 embankment is that it acts as a barrier in reducing flood waters from adversely impacting the Town of East Saugus and Saugus, except during unusual severe storms. Since the material in the embankment is earmarked for various state and federal projects, we encourage the Corps to work with those agencies to remove the I-95 embankment.

"Removal of this impediment will enhance the quality and characteristics of the estuary by allowing an additional minimum of six inches of tidal water to circulate through the back portions of the marsh." Letter dated Nov 9, 1987, Ref.: Vol 5, pg C-15.

" Given the potential for widespread impacts to the Saugus-Pines River estuary from project-induced changes in tidal flushing, we believe that large scale mitigation/enhancement measures are justified. The Corps should seriously consider breaching and/or complete removal of the I-95 fill embankment to restore tidal flushing to degraded portions of the estuary. Breaching the fill embankment is mentioned throughout the Hydrology and Hydraulics Appendix as a way to mitigate estuary flushing impacts associated with the project. Providing measures to restore and enhance estuarine habitat is consistent with the stated plan formulation considerations, as well as the provisions of the Fish and Wildlife Coordination Act, the Cooperative Agreement on Waterfowl Conservation at Civil Works Projects, the "Estuary Protection Act" ,Executive Orders 11990 and 11988, and the Coastal Zone Management Act". Letter dated May 4, 1989.

Ref.: Vol. 5, pg C-25.

Office of Environmental Project Review, Dept. of Interior, letter dated August 4, 1989.

"Since the primary effect of floodgate operation would be on estuary flushing and water quality, breaching or removal of the Interstate-95 fill embankment to restore tidal flushing to the upper marsh may provide a suitable starting point for mitigation planning." Ref.: Vol.7, Sec.A, Pg. G.

State Agencies

Executive Office of Environmental Affairs, James S. Hoyte, Secretary,
letter dated August 22, 1988, ACEC Designation.

" The second exemption (from ACEC designation) is the removal of sand from the so-called "I-95 Embankment"... In general, I am, and have been, very concerned with the ultimate fate of this fill. To restate my position, our ultimate goal is to remove the fill and restore the marsh. Any activity which does not further this goal will be deemed inconsistent with the designation." Ref.: Vol. 5, pg. D-35.

MA DIVISION OF MARINE FISHERIES, letter dated Aug 3, 1989

" DMF supports the use of non-structural measures to reduce tidal flood damages... including floodplain land acquisition and enhancement of Pines River flushing by breaching the I-95 fill embankment." Ref.: Vol.7, Sec. A, pg. Q3

MA COASTAL ZONE MANAGEMENT ,letter dated Feb 12, 1990.

" In view of the evidence that the I-95 fill is severely retarding the circulation in the upper reaches of the estuary, it would seem far more valuable to consider removing a portion of the fill as a mitigation measure, considering the value of increased circulation and sustained flood control for areas landward of the fill" Ref.: Vol.7, Sec C, pg B2.

Town of Saugus

SAUGUS BOARD OF SELECTMEN, letter dated June 27, 1988.

"Please be advised that the Saugus Board of Selectmen has voted to request that the Army Corps of Engineers study the feasibility of breaching the I-95 sandpile in conjunction with the proposed floodgate construction... and are particularly interested in how such a proposal would enhance the viability of the existing marsh, what effect such a proposal would have on flood control, wildlife and mosquito control." Ref.: Vol. 6, pg. H-14.

SAUGUS ACTION VOLUNTEERS FOR THE ENVIRONMENT

Letter dated Jan 25, 1990.

" This project would also make it more politically palatable to study the complete removal of the remainder of the I-95 road embankment. The remains of this abandoned road bed are the real threat to the marsh wetland west of it. The erosion of the bank is filling in areas adjacent to it and the road bed retards flushing of the marsh behind it." Ref.: Vol. 7, Sec. C, Pg. B7.

INTERVIEWS WITH EAST SAUGUS RESIDENTS

East Saugus residents bordering the marsh are very interested in reducing the frequent flooding from tides and runoff, as well as eliminating the threat of fires caused by phragmites, and reduction of the mosquito problem. They are, for the most part, willing to have walls and berms built as part of a breaching plan.

FUTURE CONDITIONS

The Essex County Mosquito Control Unit has frequently observed the Marsh for over ten years. During that time they have observed a growth in the height of phragmites reeds from only a few feet to over eight feet high. They also commented that phragmites and the woody elder bush have spread out ten fold over the marsh along the perimeter. This is attributed to reduced salinity in the soil of the high marsh, from a reduction in tidal flushing and as fresh water infiltrates from the drainage areas. The Corps found 10 to 20 acres of phragmites in the marsh which are spreading and may cover another 80 acres or more in the future. This loss of about 100 acres, plus the 40 acres lost in ponding areas totals 140 acres. Essex County Mosquito representatives fully expect the Salt Water Mosquito problem to get worse with the growth of phragmites, plugging of ditches and standing water.

The continued deterioration of the soils' salinity with growth of phragmites and elder bush signals the deterioration of the high salt marsh and loss of fish and wildlife habitat in the future. It is difficult to quantify the likely future ecological loss of this resource; however, it's presence is very noticeable to those who live and work around the marsh.

The restoration of about 50 acres of wetland by removing the I-95 embankment is expected due to the demand for using the sandy material and the need for other state projects to develop mitigation sites. However, the flushing of the existing 440 acres of upper marsh wetlands, as well as the 50 acres of potentially restored wetlands in the footprint of the I-95 embankment will continue to experience retarded flushing, tide levels and circulation because of the I-95 embankment. Sea level may rise but the restriction to spring high tidal flushing and circulation will remain for decades to come in the upper marsh of East Saugus.

The existing ponding areas in East Saugus will continue to be overgrown by phragmites, and subject to development pressures because of less stringent state laws protecting areas with phragmites. East Saugus' problem with interior drainage will continue to worsen with a rise in sea level, and costs to maintain their shorefront will increase while they protect against rising high spring tides. With the growth of phragmites the cost and

threat of fires in the marsh will continue to plague the residents and get worse, as will the problem of maintaining their ditches. The future problems of the upper Pines River Marsh from restricted tidal flushing warrants formulation of solutions to restore the flushing and wetlands in the study area.

SUMMARY OF PROBLEMS AND OPPORTUNITIES

The Problems and Opportunities which could be alleviated or realized by considering breaching the I-95 and restoring wetlands are many. With the Saugus River and Tributaries Project constructed, breaching the embankment would provide the opportunities to restore marsh flushing and tide levels, fisheries and wildlife habitat, to 440 acres of existing wetland, including restoration of at least 10 to 20 acres of phragmites to wetlands in the high marsh and 40 acres more in ponding areas. It would provide the opportunity to prevent deterioration from the growth of phragmites over about 80 acres or more or less; also, to create 8 acres of new low or high marsh wetlands or other tidal habitat and improve flushing for up to 60 acres of future wetlands created by others removing the I-95 fill.

In East Saugus problems which would be addressed and possibly alleviated are fires in the marsh which threatened homes, flood reduction, mosquito control, and reduction in ditch and shoreline maintenance. There are also opportunities to restore almost 40 acres of fresh water ponding areas overgrown with phragmites back to salt water wetlands. However breaching the embankment would require additional shoreline and drainage improvements to East Saugus. The following table summarizes current costs and losses which might be reduced through plans to breach the I-95 and restore wetlands.

TABLE 1
FUTURE AVERAGE ANNUAL LOSSES
 (1991 PRICE LEVEL)

	<u>Average Annual Loss Damages/Costs</u>
Flood Damages to East Saugus	\$ 11,600
Fire Control Costs	2,400
Shoreline Maintenance Costs	8,400
Ditch Maintenance Costs	<u>2,000</u>
TOTAL	\$ 24,400

OTHER ENVIRONMENTAL LOSSES

Flushing retarded to existing wetlands	440 acres
Current Wetlands lost to Phragmites	10 to 20 acres
Future Loss to Phragmites, Prelim. potential	80 acres, more or less
Ponding areas formally saltwater wetlands, overgrown with Phragmites	40 acres
Retarded flushing to future restored wetlands under I-95	50 acres
Potential loss of wetlands remaining under I-95	8 acres more or less
Salt Marsh Mosquito Problem	Extends up to 20 miles

ALTERNATIVE PLANS

The analysis of alternative plans to restore coastal wetlands by breaching the I-95 embankment is based on a review of the existing and future situations and the problems, needs and opportunities of the study area. It is clear that substantial reductions in tidal flushing has reduced the fish and wildlife habitat of the Upper Pines River Marsh and created problems for East Saugus. The alternatives include solutions to restore wetlands, while also reducing mosquito populations, fires in the marsh, flood damages and maintenance for shorelines in East Saugus. The study has taken into consideration the strong state and local interests in restoring the natural values of these coastal wetlands. This section briefly describes the alternatives that were studied. The without project condition for comparing to alternative plans is the same as described in the Saugus River and Tributaries Project's Feasibility Report. The alternatives are compared to future non-project conditions. Since it is assumed breaching is not likely to occur in the absence of the project, some impacts, eg. flood reduction, are compared to the project first added, then the incremental affects with and without breaching are compared.

OBJECTIVES AND CONSTRAINTS

THE FEDERAL OBJECTIVE

The Federal objective of water and related land resources project planning is to contribute to National Economic Development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.

The objective of this reconnaissance study was to determine ways to restore wetlands by breaching the I-95 embankment with least possible disruption to East Saugus residents and determine potential feasibility. Future studies will also determine whether self-regulating tide gates can be used to restore existing ponding areas in the study area to coastal wetlands.

OBJECTIVES AND CONSTRAINTS

The limited resources of the Federal government and of cost-sharing partners emphasize the importance of carrying out investigations in the most efficient and effective way possible, while taking into full consideration all relevant Federal, state and local concerns. The geographic scope of the study was limited to the area affected by the breaching of the I-95 embankment in the Upper Pines River Marsh. The following constraints defined the precise nature of the study:

- Drainage problems from interior runoff, although also sources of periodic flooding

and aggravated by high tides, were not investigated unless adversely impacted by formulated plans. Most drainage problems are considered independent of the coastal flooding concern and will persist with or without coastal flood protection.

- Since much of the study area is comprised of saltwater wetlands, Federal and state wetland policies strongly influenced the study and the need to avoid adverse impacts on the wetland.

PLANNING OBJECTIVES

The planning objectives for the study were based on an assessment of the problems, needs and opportunities in the study area, as determined by Corps investigation and concerns and goals of the affected communities. The degree to which the alternative plans meet these objectives, while complying with required criteria, determines which alternative will ultimately be selected. The objectives of the study are to:

- Restore the wetlands in the Upper Pines River Marsh by opening up the I-95 embankment to restore flushing and tide levels to pre-I-95 conditions.
- Preserve the valuable resources in the estuary — its vegetated wetlands, mudflats, rivers and creeks, non-storm tide levels, flushing volume, water quality and navigation; and
- Support the objectives of other planning agencies and complement regional long range recreational, environmental protection, and development plans.

ALTERNATIVE PLANS

ALTERNATIVES AVAILABLE TO ADDRESS IDENTIFIED PROBLEMS AND OPPORTUNITIES

Measures through which the wetlands can be restored or the natural flushing and tide levels returned to the estuary include both structural and nonstructural solutions. One structural solution would be to breach the I-95 embankment and construct a stone lined channel through the embankment where the East Branch of the Pines River was cut off. Nonstructured solutions include removal of all or part of the I-95 fill to create widened unlined channels at the existing Pines River opening and where the East Branch can once again flow.

PLAN FORMULATION CRITERIA

FEDERAL CRITERIA

Federal water resource planning requires the formulation of a plan which reasonably maximizes net economic benefits, in other words, maximizes contributions to National Economic Development (NED). One plan, called the NED Plan, must be formulated, consistent with Federal objectives. Other plans may be formulated which have less net NED

benefits in order to further address other Federal, state, local and international concerns not fully addressed by the NED plan. All alternative plans, including the NED plan, are formulated in consideration of four criteria: completeness, effectiveness, efficiency and acceptability:

- Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. Each plan must be complete within itself to provide the benefits claimed for that plan.
- Effectiveness is the extent to which the alternative plan alleviates the specified problems and achieves the specified opportunities
- Efficiency is the extent to which an alternative plan is a cost effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment.
- Acceptability is the workability and viability of the alternative plan with respect to acceptance by State and local entities and the public, and compatibility with existing laws, regulations and public policies.

STATE REQUIREMENTS

The Massachusetts Environmental Policy Act (MEPA) process also requires the evaluation of alternatives and display of impacts.

ENVIRONMENTAL EVALUATION

The Water Resources Development Act of 1986, Public Law 99-662, Section 907 addressed the benefits and costs attributed to Environmental Measures. Corps of Engineers Engineering Circular (EC) 1165-2-146 provided guidance for implementing Section 907. Section 906 addresses cost sharing to be discussed later.

Section 907. Benefits and Costs Attributable to Environmental Measures -In the evaluation of benefits and costs of a water resources project, the benefits attributable to measures included in a project for the purpose of environmental quality, including improvement of the environment and fish and wildlife enhancement, shall be deemed to be at least equal to the costs of such measures.

(1) The purpose of Section 907 is to prevent the economic costs of measures included in a project for the purpose of environmental quality including improvement of the environment and fish and wildlife enhancement (including restoration), from depressing and distorting the benefit-cost ratio of a project, because benefits attributable to such measures are not easily ascertained in monetary terms.

Section 907 does not change the Principles and Guidelines requirement for incremental analysis and justification of such measures or separable increment thereof. That is, the monetary and non-monetary benefit values must equal or exceed the monetary and non-

monetary costs before a measure or separable increment thereof will be recommended. If enhancement measures are recommended, economic benefits will be added if required, so that the benefits attributed to such measures equal their economic costs.

(2) Section 907 does not apply to measures for the mitigation of project-caused fish and wildlife or other losses.

(3) This provision shall apply to cultural, aesthetic, and ecological resources and features which are enhanced in accordance with ER-1165-2-28.II. GENERAL

ECONOMIC EVALUATION (based upon the following terms and definitions:)

- Project First Costs include estimated costs for construction, contingencies, engineering, design, supervision and administration, real estate and mitigation , if any.
- Project Investment includes both the Project First Cost and interest during construction on project expenditures until features become operational or begin producing benefits.
- Operation, Maintenance and Replacement costs include all average annual costs estimated for the project after it is constructed to keep it operating and maintained in optimum condition in accordance with provisions prescribed by the Corps. Also included are the average annual costs of major replacements over the project life; these may include such items as operating mechanisms for gates, electrical equipment for the gates, etc.
- Average Annual Costs include the project investment amortized over a 100 year project life at a Federal interest rate of 8 and 3/4 percent plus the estimated project annual operation, maintenance and replacement cost.
- Average Annual Benefits include that portion of the Average Annual Flood Damages prevented by the plans plus any other related NED benefits;
- Benefit-to-Cost Ratio (BCR) is an indicator of the economic feasibility of the plan which is determined by dividing average annual benefits by average annual costs.
- Net Benefits are the difference between average annual benefits and average annual costs.

ENVIRONMENTAL CONSIDERATIONS

In order to enhance the physical and social environment of the study area or to avoid creating unacceptable impacts, the following were kept in mind:

- to avoid wherever possible the direct loss of wetlands;

- to avoid adversely affecting the dynamics and water quality of the estuary;
- to reduce or mitigate any significant adverse impacts which cannot easily be avoided; and in general
- to design and develop project features so as to provide opportunities which enhance the environment and recreation in the study area.

DESIGN ASTRONOMIC TIDE

The design of features for breaching the I-95 embankment is based generally on astronomic tides which reach a maximum of El. 7.5 feet, NGVD. However, the maximum stillwater tide level in the estuary for designing the breached area, mitigation site or shorefront structures is elevation 8 feet, NGVD. The floodgates would be closed for any storm tide which was forecasted to reach or exceed elevation 8. Under non-storm conditions, tides could exceed elevation 7.5 and approach elevation 8; however, the gates would be closed for storm tides expected to reach or exceed elevation 8 which is the estimated start of significant damages around the estuary.

DEVELOPMENT OF ALTERNATIVE PLANS TO MEET IDENTIFIED PROBLEMS AND OPPORTUNITIES

Two basic plans were prepared using combinations of management measures at a reconnaissance or preliminary level of detail. These include Alternative# 1: Breaching with a Stone Lined Channel; and Alternative# 2: Breaching with Unlined Channels and alternative measures to reduce restoration costs. These alternatives assume the Saugus River and Tributaries Project would be constructed prior to fully opening up the breach.

The only measure discarded without detailed evaluation was the complete removal of the I-95 embankment. If breaching is ultimately accomplished, total removal could follow by others in the course of using the sand on other projects, or as a means to mitigate impacts of other projects. It is fully expected with breaching that this would occur. Without breaching it is expected that all the embankment except the required berm to El. 11 would be removed. It would be extremely expensive for the Saugus River and Tributaries Project to undertake complete I-95 removal and marsh restoration. The estimated cost to acquire (\$2,000/acre), remove (\$12/cy) and plant marsh grass (\$5,500/ac) for the I-95 embankment would be about \$6.5 million assuming a storage area could be found for the excavated material nearby. This assumes 500,000 cubic yards of fill material would be removed to the level of the marsh over an area of about 60 acres. This excludes the cost to mitigate for higher flood tides in East Saugus and other affects.

ALTERNATIVE # 1: BREACHING WITH A STONE LINED CHANNEL

I-95 BREACH -There are two locations where Route 107 bridges allow the Pines River to pass under it to reach the upper marsh. One is the Pines River Bridge where the main Pines River flows up through the existing opening in the I-95 fill. The second is the East Branch Bridge where the flow was cut off by the I-95 fill after passing under the bridge. This alternative would restore a channel through the embankment connecting the East Branch with the largest tidal creek which was severed by the I-95 fill. The channel would also supply flows to the wide ditch which runs along the I-95 embankment, serving smaller creeks and ditches. The plan for Alternative # 1 is shown in Figure 10. Hydrologists determined the size of the channel needed to pass flows through the embankment which matched the flow area in the severed creek. Due to the high velocity of water flowing through the channel it would be lined with stone to prevent the sandy side slopes from scouring. The sand which would scour out could deposit in the creeks or ditches reducing the amount of flow they could carry. Stone protection is therefore used to prevent this from happening. The channel would run about 600 feet through the embankment.

Excavation for the proposed breach sections is shown on Figure 11. The end sections for the breach should have one vertical on four horizontal slopes and a ten foot wide toe. Boring samples should be taken along the centerline during the design of the breach to determine whether the sand bedding is needed and to what extent.

ROUTE 107 BRIDGE , STONE PROTECTION

The plan includes stone protection to protect the foundation of the Route 107 Bridge over the East Branch of the Pines River. The protection is required due to the additional volume of tide water and increased river velocities from breaching the I-95 embankment. The plan includes a stone apron along the river bottom from 30 feet upstream to 30 feet downstream. Also the existing stone revetment on either side of the bridge needs to be upgraded with additional stone.

RADIO TOWER, STONE PROTECTION

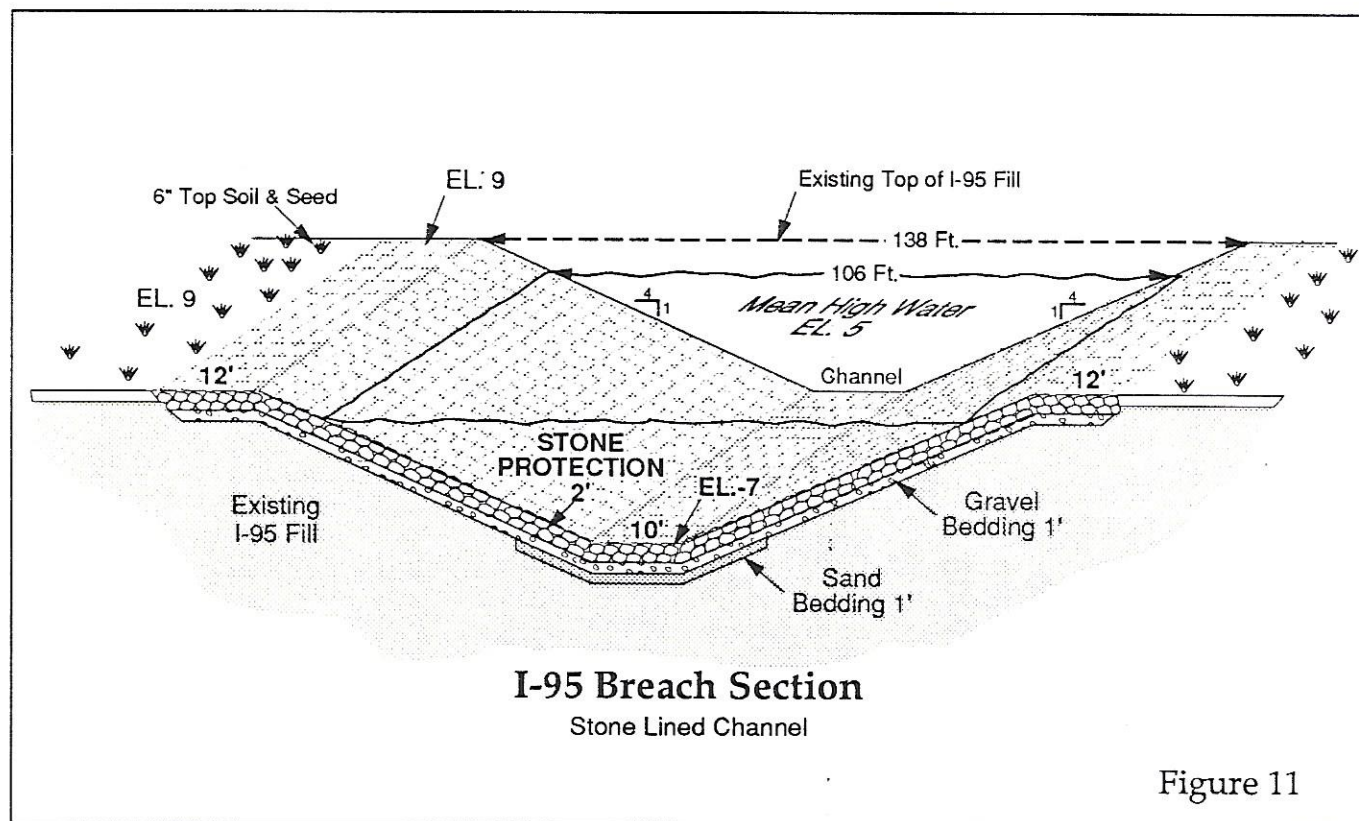
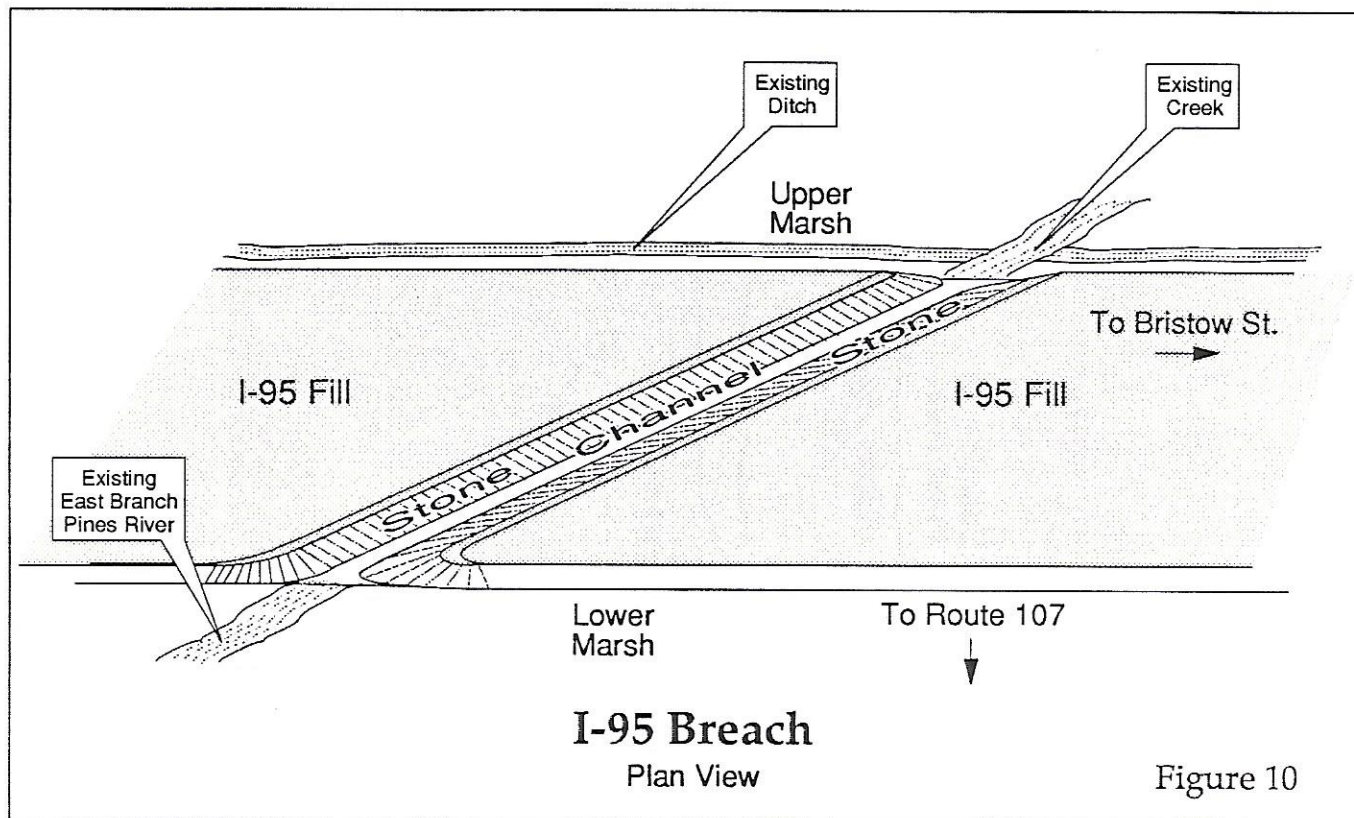
The plan includes stone protection along the East Branch riverbank to protect the footing of the WRYT radio tower, where the bank has eroded. Faster river currents and additional volume of tide water with the breaching could increase erosion and undermine the tower's footing (Figure 12).

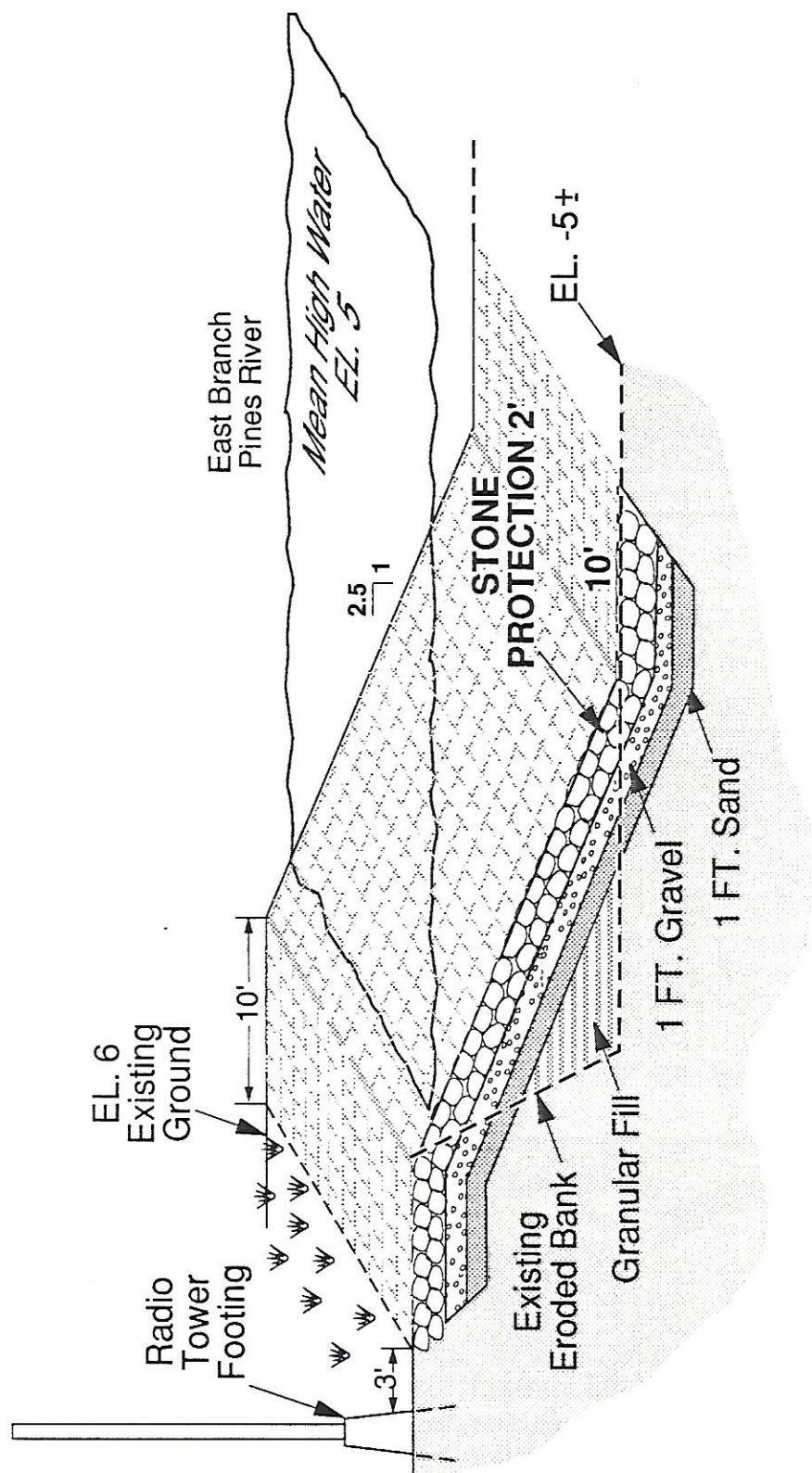
ENTRANCE CHANNEL TO I-95 DITCH

Hydrologists also found a poor restricted entrance condition exists where the present main Pines River cuts through the I-95 embankment and feeds the ditch which runs parallel to and west of the embankment. The plan includes removal of a berm to improve the entrance transition to this ditch and improve flows to the upper marsh in Saugus.

SAUGUS SHOREFRONT PROTECTION

With the new breach and improved ditch entrance, an increase in tide levels will occur





Tower Bank Section

Figure 12

within the upper Pines River marsh in Saugus; thereby, causing increased flooding at East Saugus. Tide levels would now reach higher elevations more frequently up to the level controlled by the Saugus River Floodgates. That controlled stillwater storm tide elevation is 8 feet NGVD, about a one year tide level in the lower Pines River. Since the shoreline in East Saugus is up to two feet lower in some areas than El.8, increased frequency of flooding would occur to properties and roads. This must be prevented. Therefore, the plan includes about 3,800 feet of walls and berms along the shoreline of East Saugus to prevent increased frequency of coastal flooding for high astronomic (non-storm) spring tides, when the floodgates would normally not be closed. A berm section is used where there is greater than 25 feet clearance between buildings and top edge of the berm. The I-wall section is used where the clearance is less than 35 feet clearance between buildings and the top edge of the ditch. See Figures 13 and 14.

SAUGUS DRAINAGE IMPROVEMENTS

The higher astronomic spring tides would also slow down or retard interior drainage from East Saugus to the marsh. The affected drainage area is located between Bristow Street and the Pines River Marsh. This would cause several inches of higher levels of water ponding in the streets and around properties in East Saugus. This also must be prevented. The plan therefore includes interior drainage improvements. Drainage pipes and catch basins would be installed along Seagrit and Venice Avenues to collect runoff along the streets and from the Bristow Street ponding area. A 20 cubic foot per second pumping station would be included to pump the water into an existing ditch bordering the marsh and reduce the interior ponding levels. The Bristow Street ponding area would be acquired (4.7 acres) to preserve its storage capacity for use with the pumping station. The small area near Beachview Street, which currently drains directly to the marsh, would be collected and conveyed through the berm by means of a flap-gated drain, or possibly could be diverted to the Eastern Avenue ponding area. These options would be explored during design studies.

This map illustrates the Venice area in San Diego, highlighting flood-prone regions and infrastructure. Key features include:

- Streets:** Venice Ave, Lincoln Ave, Ballard St, Eastern Ave, Route 107, Seagrit Ave, Bristow St, Pevwell Dr, Carr St, Wickford, Lindsell, Harlow St, Drain Pipe, Beachview, Winston, Belair, Hewlett, Naples, Milan, Genoa, Tuscan Ave, Atlas Ave, and Lewis Lane.
- Waterways and Marshes:** San Luis River, Pines River Marsh, and the 1951 Fill area.
- Flood-Prone Areas:** Aquire Ponding Area, Ponding Area, and Eastern Ave Ponding Area.
- Infrastructure:** Pump Station, Street Storm Drains, Berms, Culvert, and Fox Hill Draw Bridge.
- Scale and Orientation:** A scale bar indicates 500 Ft., and a north arrow is located in the upper left corner.

Figure 13

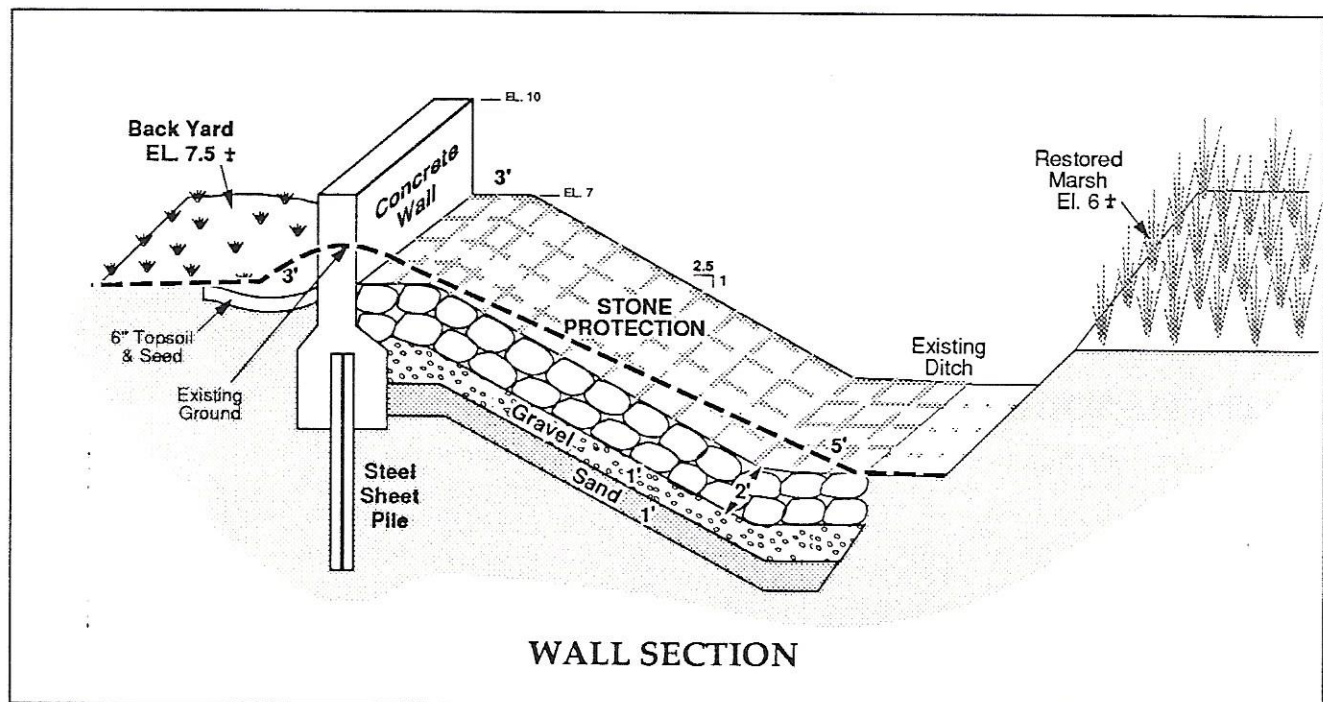
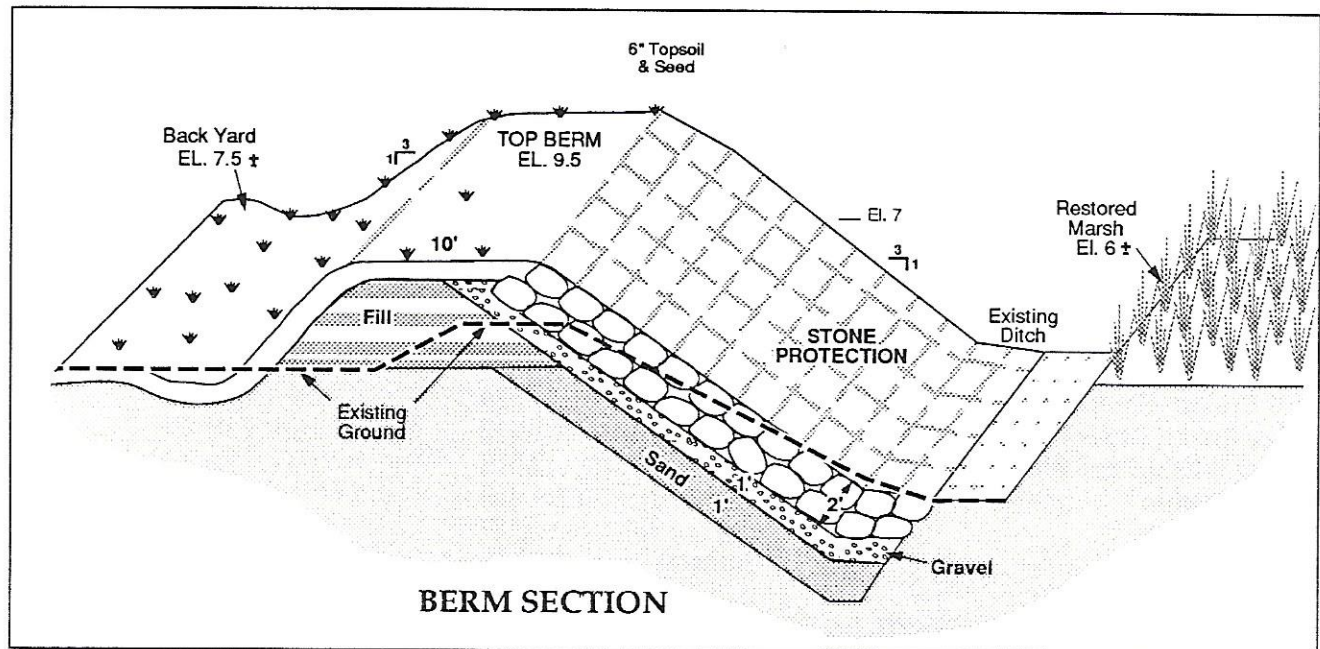


Figure 14

PROJECT COSTS- ALTERNATIVE #1 - The First Cost, Operation and Maintenance and Average Annual Costs are shown in Tables 2 to 4. Details of the cost estimates are included in supporting documentation.

TABLE 2

ALTERNATIVE 1 - DIRECT COSTS in \$1000
(1991 PRICE LEVEL)

FEATURE	DIRECT COST (includes contingencies)
Code 6-Fish & Wildlife	
Breach - Stoned lined Channel	\$ 786
Radio Tower - Stone Protection	39
RT 107 Bridge - Stone Protection	34
Entrance Channel to I-95 Ditch	222
East Saugus Dikes and Walls	2,013
Pumping Station	465
Drainage System	<u>87</u>
	Subtotal \$ 3,646
	SAY \$3,650
Lands, Easements and Rights of Way (L,E& R) (Code 1 - Lands & Damages)	
Breach at I-95	\$ 14.6
Radio Tower, Entrance Channel & Rt 107 Bridge	32.9
E. Saugus Berms, Walls & Pump Sta.	637.0
Bristow St. Ponding Area	69.5
Construction Storage Easement	<u>7.4</u>
Total L,E & R, Say	\$ 760
Planning, Engineering & Design (Code 30)	\$ 800
Construction Management (Code 31)	<u>\$240</u>
Alternative #1: TOTAL FIRST COST	\$5,450

TABLE 3
ALTERNATIVE # 1
ESTIMATED OPERATION, MAINTENANCE AND REPLACEMENT COST
(1991 Price Level)

FEATURE	AVERAGE ANNUAL COST
Breach - Stone lined Channel	\$ 400
Stone Protection Radio Tower and Entrance Channel	200
East Saugus Dikes, Walls, & Drainage	2,600
Pumping Station	4,100
Bristow St. Ponding area	<u>200</u>
Total O,M&R Cost	\$7,500

TABLE 4
ALTERNATIVE #1: TOTAL INVESTMENT AND ANNUAL COST

INVESTMENT	1991 PRICE LEVEL
Total First Cost	\$ 5,450,000
Interest During Construction (8 3/4%, 10 Mo.)	<u>\$ 180,000</u>
Factor: 0.03346	
Total Investment	\$ 5,630,000
ANNUAL COST	
Interest and Amortization on	\$ 492,500
Investment (8 3/4% , 100 yrs: fac. 0.087519)	
Operation, Maintenance and Major Replacement	<u>\$ 7,500</u>
Total Annual Cost	\$ 500,000

ALTERNATIVE# 1 - BENEFITS AND ACCOMPLISHMENTS SUMMARY

The plan would produce significant environmental benefits as shown in Table 5. It would restore up to 20 acres of lost wetlands, prevent 80 acres ,more or less, from being lost in the future and allow 8 acres under I-95 to be restored by others. Flushing and tide levels would be restored to 440 acres of existing wetlands and possibly 60 acres of future wetlands under the I-95. It would reduce the threat of fires from the marsh which is inundated more frequently, and due to the reduction of phragmites reeds bordering homes in East Saugus. With frequent inundation of the marsh, the Salt Marsh mosquito populations would be reduced. This would improve recreation of properties for 20 miles around with a substantial reduction within one mile. The berms and walls would replace the existing shoreline structures eliminating their cost of replacement and maintenance. The berms and wall's side slopes would line existing ditches with stone protection. Also when combined with increased salt water flushing, the ditches would not require the extensive maintenance of removing reeds, trash and sediment. Interior ponding flood levels would also be reduced with the improved drainage system, pumping station and maintained ponding area. Environmental and Total Benefits would be determined after an incremental analysis of restoration alternatives is performed during detailed studies. The Economic Analysis in Table 6 would be completed at that time.

TABLE 5

ALTERNATIVE # 1 - BENEFITS (1991 Price Level)

Economic Benefits	<u>Avg. Ann. Benefit</u>
Flood Reduction	\$ 1,200
Fire Control	2,200
Reduced Shoreline Maintenance	9,400
Reduced Ditch Maintenance	<u>1,200</u>
Sub Total Economic Benefits	\$14,000
Environmental Benefits	
Improved Tide Levels, Flushing & Water Quality to: Existing 440 Acres Future 60 acres under I-95	
Increased Productivity	
Restored Wetlands	
Current Phragmites, 10 to 20 Acres	
Future Phragmites, 80 or more acres	
Land under I-95 Fill, 8 Acres	
Mosquito Reduction	
Value assigned to remaining Environmental Benefits to offset economic costs	<u>To be determined*</u>
Total Benefits	To be determined*

* Environmental and Total Benefits would be determined after an incremental analysis is performed during detailed studies.

TABLE 6
ALTERNATIVE# 1: ECONOMIC ANALYSIS
 (1991 Price Level)

Average Annual Benefits	\$ To be determined
Average Annual Cost	\$ 500,000
Net Benefits	\$ To be determined
Benefit-to- Cost Ratio	To be determined

Alternative 1-Impacts

One adverse impact would be on the 32 residents and businesses bordering the shoreline. The walls and berms would border the back property lines. The structure would be about 0 to 2 feet higher than existing berms or generally 1 to 3 feet higher than their back yards. Shrubs could be planted 3 feet from walls to improve appearance. The berms would be planted with grass with a gradual slope for mowing. The visual and aesthetic impact is not considered significant (based on discussions with residents) due to the low height of these structures and blending them in with the yards.

One significant impact would be during the construction period. The total construction time would be about 10 months. The other impact would be the loss of about 10 feet of their yards where walls are used. The berms would cover about 29 feet, above the El. 7 guide taking line for the Project's Estuary storage acquisition.

There would be no significant impact on the marsh from the berms and walls since they are designed to be placed on upland with their slopes nearly corresponding to the existing banks. There would be however; a loss of about 0.1 acres of high marsh. This would occur along an estimated 800 foot reach where ditches were not dug along the shoreline. The toe of the stone protection would displace the high marsh in the vicinity of Beachview Street. In-kind mitigation for this loss would be off set by the vegetated marsh fringe in the existing mitigation site. The vegetated fringe was not required for mitigation of the Saugus River and Tributaries Project.

ALTERNATIVE # 2: BREACHING WITH UNLINED OPENINGS - SENSITIVITY ANALYSIS

This alternative includes combinations of Alternative # 1 and other opportunities which may possibly be realized after more detailed evaluation. Except for features which are similar to Alternative # 1, all other features were developed based on a very preliminary analysis not on detailed engineering studies, except as noted, and using criteria in part provided by the project team. Alternative #2 is intended to show features which may produce a plan at lower cost with higher environmental benefits. It is therefore considered a **sensitivity analysis**.

This alternative is similar to Alternative# 1, except that the breach would not be lined with stone. The breached opening for Alternative # 2 (Plate 4) would be instead widened with an unlined channel in combination with a widened unlined Pines River opening to include restoration of habitat along the unlined openings. Also, an excavated ponding area is used in lieu of the pumping station; berms replace walls at one location ; some walls and berms are moved into the existing ditch to reduce real estate and other costs; and, some steel sheet pile I-walls are assumed replaced by a concrete gravity wall.

I-95 Breach - One layout of the unlined channel for breaching the I-95 embankment was evaluated by the Corps' Waterways Experiment Station as part of designing the flood-gate structure. It includes the minimum flow area or cross section needed for a breach without being lined with stone, in combination with a maximum widening of the Pines River opening, shown in Figures 15 and 16.

Since the channel in the I-95 Breach would not be lined with stone, the currents must be reduced to at least 2 feet per second to prevent scouring the sandy side slopes. Some silt on the surface would however erode. To reduce the currents, the existing Pines River opening through the I-95 embankment and the flow area in the Breach below El. 6 equaled together a total area of about 6650 square feet.

The openings include a flow area of 1150 SF at the breach and 5500 SF at the Pines River opening. The criteria for establishing the minimum breach section is that the sides slopes should not be steeper than 1 verticle on 6 horizontal to avoid excessive scouring or erosion. The side slopes would be transplanted with clams between El. 2 to -5, and marsh grass from El. 4 to 6. Table 7 shows the wetlands created by the various alternatives. The 600 foot long breach requires an estimated excavation of 40,000 cy. The cost at \$ 6.03 per cy (used in Alternative #1) plus a \$ 15,000 cost for clam flats and grasses would total about \$ 255,000 for the breach.

Pines River Opening-The sensitivity analysis for Alternative #2 includes widening the Pines River Opening through the I-95 embankment. The initial layout includes a widened opening of 5500 SF below El. 6, the elevation of peak or maximum flow as determined by WES modeling, shown in Figure 16. The estimated quantity to be removed is about 69,000 cy. It is assumed that material above El. 0 or about 32,000 cy could be excavated from land at \$6.03 per cy., and below El. 0 excavated using a drag line at \$19.19 per cy for a total cost of about \$ 903,000.

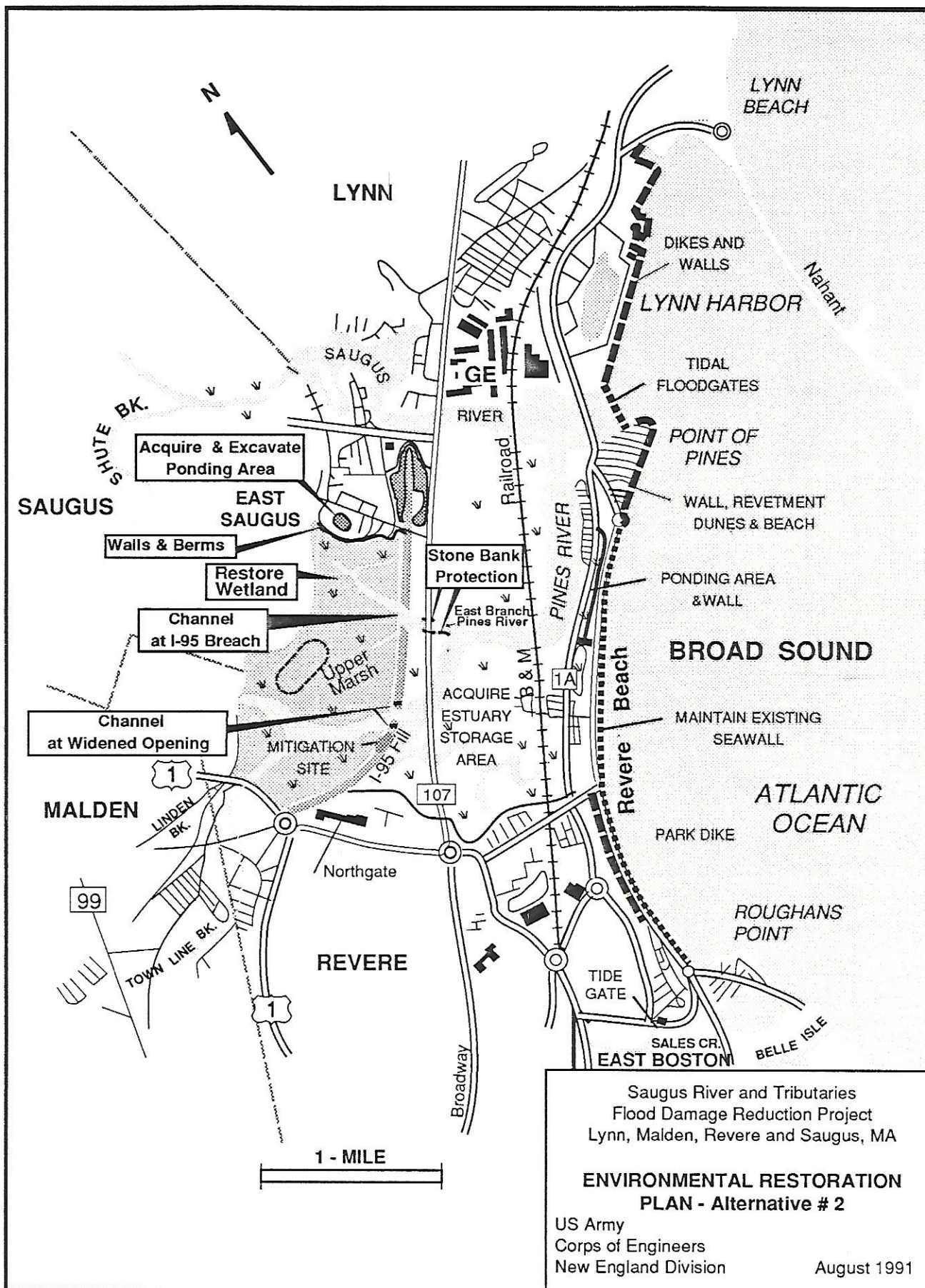


Figure 15

Minimum I-95 Breached Opening (1150 SF)
used with Maximum Pines River Opening (5500 SF)

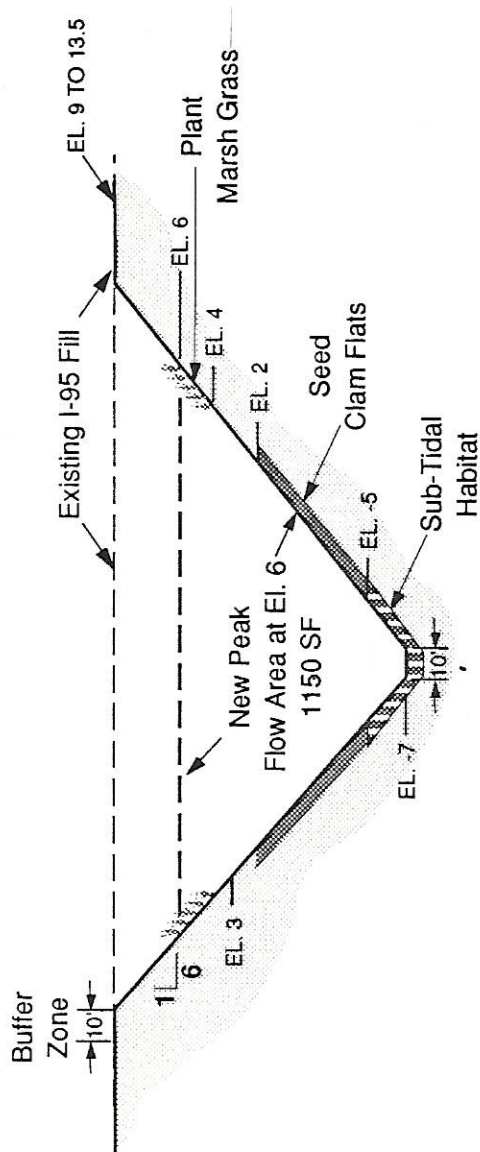
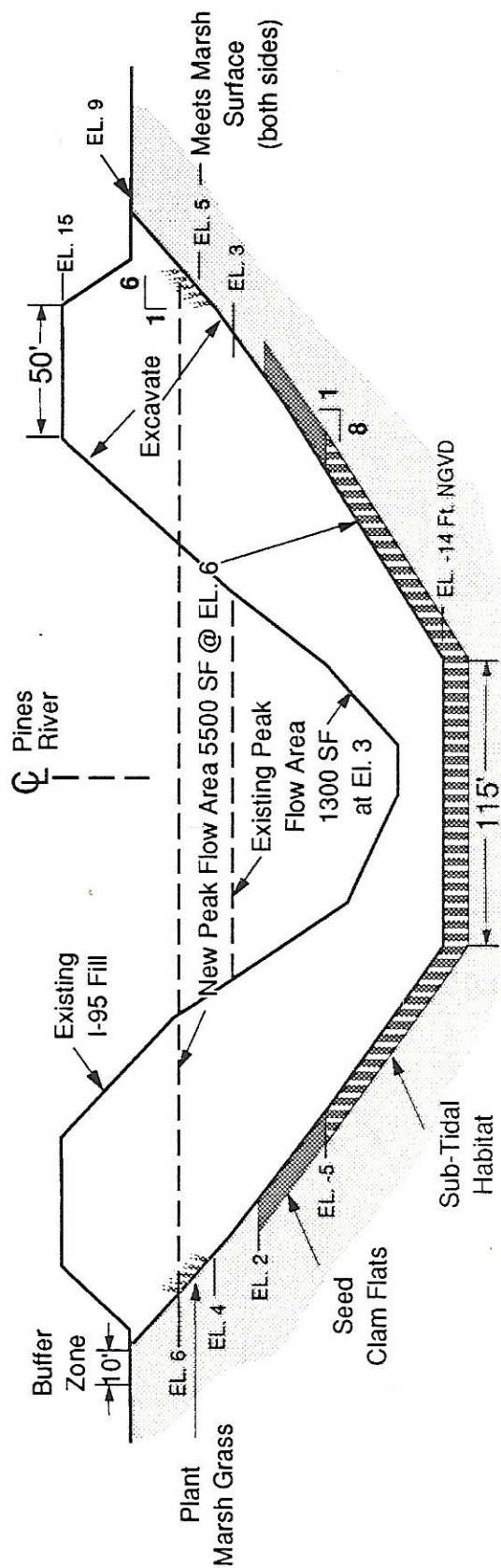


Figure 16

Maximum Pines River Opening (5500 SF)
used with Minimum I-95 Breached Opening (1150 SF)



WES Model Results- WES modeling of this alternative found that elevation 6 feet, NGVD was the point at which the peak flow occurred during an out-going high Spring tide through the unlined openings. The resulting peak flow rate through both openings was about 0.8 feet per second, well below the 2 fps criteria to prevent erosion of the unlined channel slopes. The low flow rate indicates that the openings with 6650 SF below El. 6 have nearly unrestricted flow, and the tide levels in the upper marsh have reached the highest level likely to be reached through breaching under the modeled conditions. The model evaluated an El. 7.1 tide near the mouth of the Pines River, and the Upper Pines River marsh reached about El. 6.7 near East Saugus with the two unlined openings, compared to about El. 6 without the breaching for the conditions evaluated. The high tide was reached about an hour earlier with unlined openings, than occurred without breaching. Without breaching the peak flow rate through the existing opening for the Pines River was about 6.3 fps which occurred at about El. 3 feet, NGVD with a flow area of about 1300 SF. There was also no measurable change in the peak flow rate at the mouth of the Saugus River (at the Floodgate alignment) when compared with and without the breaching of the I-95 embankment and widening the Pines River opening.

Shoreline Ditches-The existing ditches bordering the East Saugus shoreline are currently used for runoff from drain pipes. However, when the drainage pipes are connected to one system, thus closing off the ends of most of these pipes, then a ditch up to 20 feet wide is no longer needed. With one exception, the 24 inch diameter pipe at the end of Tuscan Ave. with an invert at El. 8.7 drains high ground above the study area. It would continue to flow along the ditch but not likely require as wide a ditch. Also the improved system would outlet into an existing ditch which drains to the marsh creeks.

The berm and wall alignment may be moved into the ditch significantly reducing the real estate cost and impact of acquiring the borders of residents' properties. Also the costly walls could possibly be replaced by the berms. See Figures 17 and 18. Following construction of the walls and berms, the estimated 3,000 foot ditch could possibly be filled level with the marsh and some high marsh would be created. The filling in of the ditch would also eliminate the maintenance cost of the ditches, and problems associated with mosquitoes from standing water. The realignment would significantly reduce the construction and real estate cost of the wall and berms.

Walls to Berms-Alternative # 2 includes 3,775 feet of both I-walls (2,140 ft) and berms (1,635 ft). About 3,000 feet of ditches could be used to possibly reduce project costs, social, aesthetic and real estate impacts of these structures. Alternative # 1's estimated unit price of I-walls is \$ 762 per foot compared to berms at \$ 206 per foot. It is assumed that the I-walls (1,220 feet) located between Tuscan Avenue to the end of Seagrit Avenue could be revised to berms located largely within the 20 foot wide ditch (Figures 17 and 18).

The savings in costs would exceed \$ 680,000. Some additional fill and possibly excavation of peat may be required in the ditch, however the cost would be minimal since it could be reused from excavating the I-95 fill for the breach. An environmental concern for filling in the ditch needs to be assessed. The total construction cost of the 2,855 feet of berms (1635 + 1220) at \$ 206 would be about \$ 590,000.

Other ideas which should be investigated to reduce these costs further are: the 1220 foot

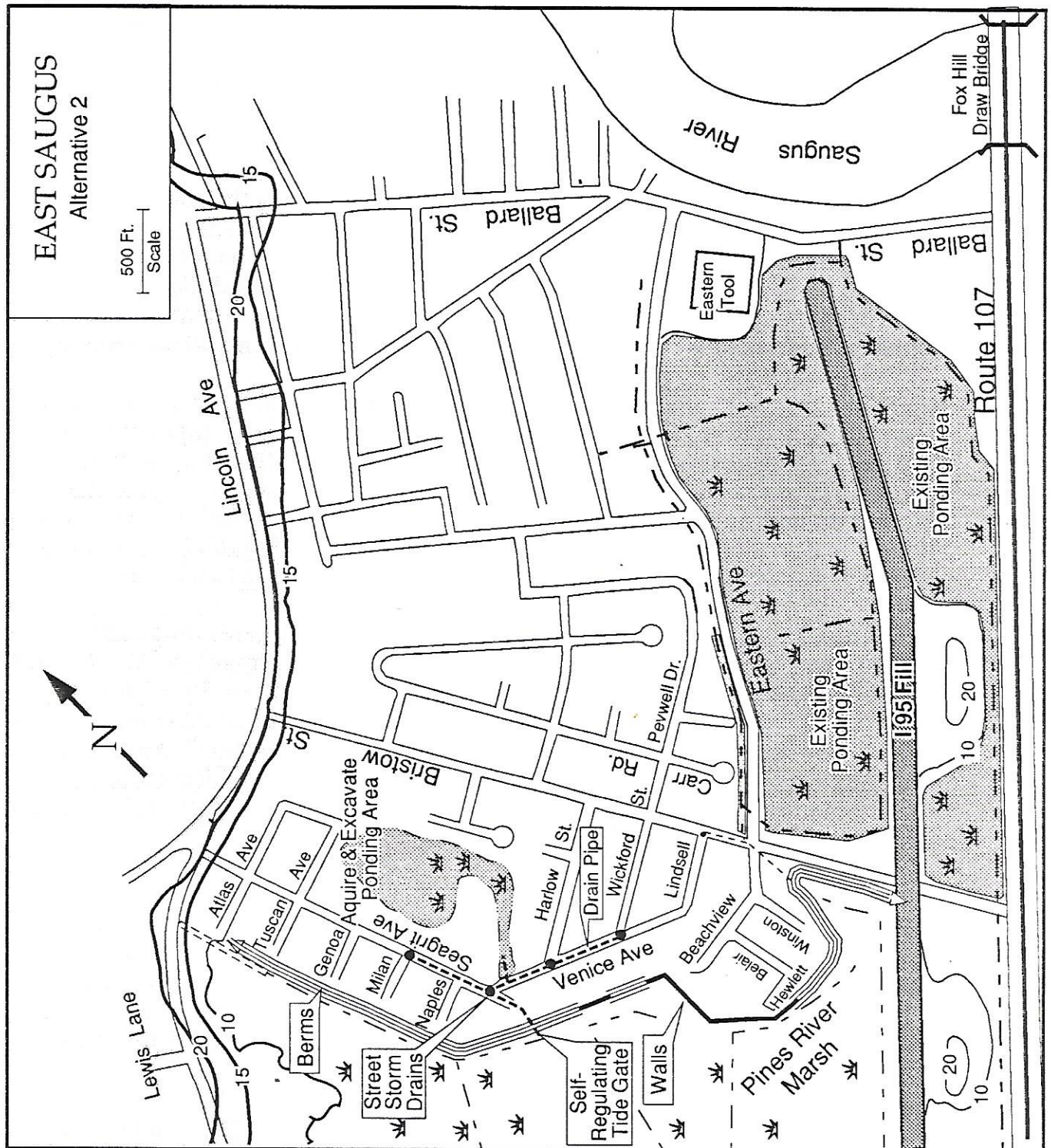


Figure 17

Alternative #2 East Saugus

Wall and Berm Sections

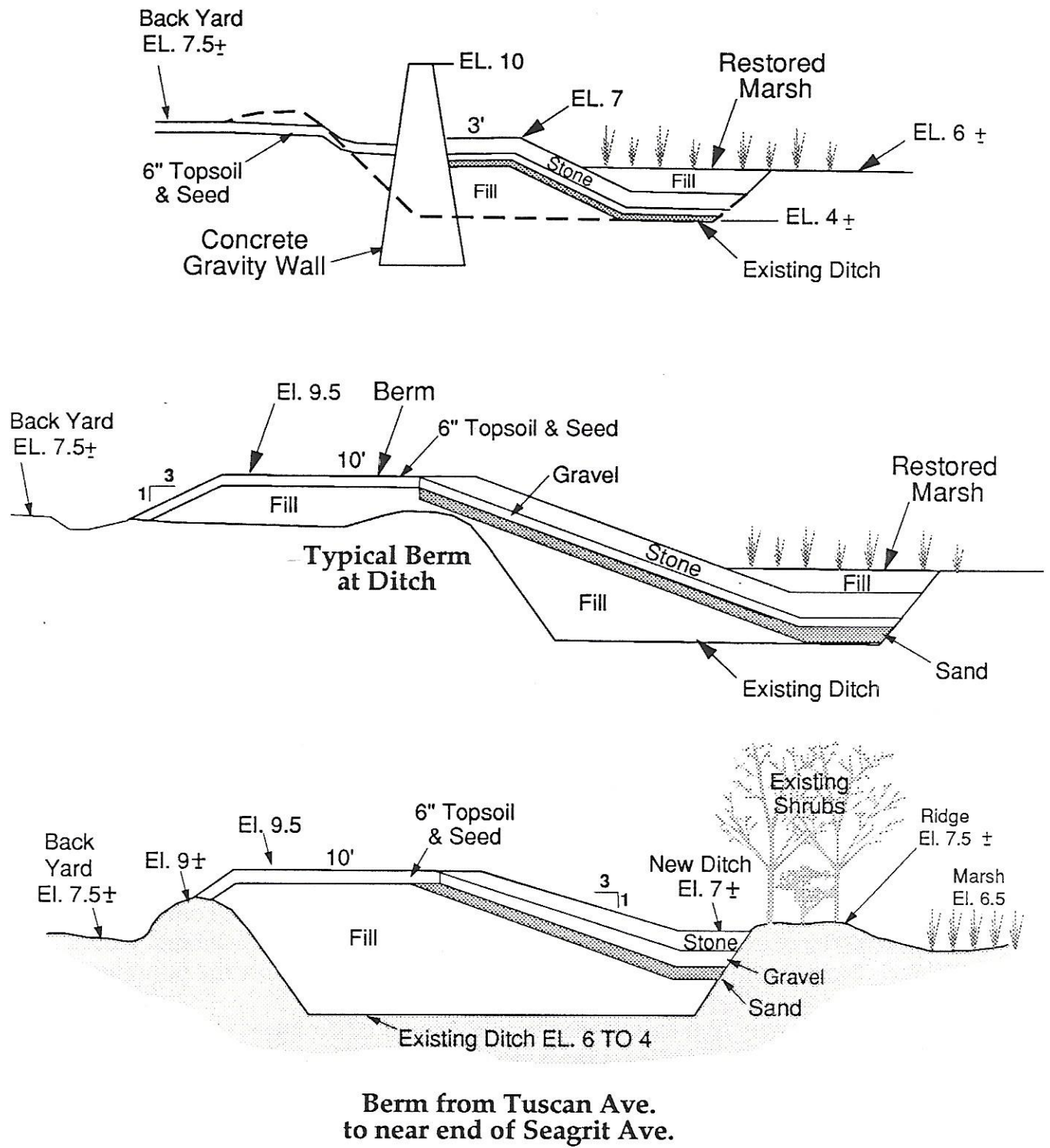


Figure 18

reach is located in an area partially sheltered from wave action due to a knoll bordering the marsh side of the ditch. The stone protection might be replaced with grass cover. Also part of the remaining 920 feet of walls may be revised to berms within the ditch. The reach near Bristow Street also is sheltered from direct waves by the I-95 fill and may not need stone protection.

I-Wall to Gravity Wall-Subsurface investigations will determine whether a Concrete gravity wall, shown in Figure 18, can be used in lieu of a steel sheet pile I-wall along the East Saugus shorefront. Assuming a gravity wall could be used (similar to the designs behind Revere Beach at the end of the ponding area in Reach M, and in Reach D in Lynn Harbor), the cost would be significantly reduced. With a wall located in the ditch, the height above the ground would be about 4 feet and 4 feet below ground. The 920 feet of walls would require about 850 cy of concrete at a cost of \$ 350/CY(or \$390 updated for price level). The revised cost , including 20% for contingency plus excavation and reuse of fill from the breach site, would equal about \$ 400,000. This would be a savings of \$ 300k. The total cost of berms (\$ 590k) and Gravity walls (\$400k) would be about \$ 990,000. If peat is found within this area, gravity walls may not be used.

Berms and Walls, Real Estate-The use of the drainage ditch which is located within the El. 7 guide taking line would significantly reduce the real estate cost. In alternative # 1 the real estate cost for berms and walls is \$549,000. The 1220 feet of berms located in the ditch would not require any additional real estate taking. Part of the remaining 920 feet of walls would be moved into the ditch without additional takings , while the rest would require a 10- foot permanent easement. Part of the 1635 feet of berms could also be moved into the ditch reducing their takings from about 29 to 17 feet. The revised real estate cost would be about \$ 331,000, for a savings of \$ 218,000.

Interior Drainage & Ponding Areas-Alternative # 1 includes the use of the Bristow Street ponding area, a 20 cfs pump station and a drainage system to reduce increased flood levels caused by higher tides levels bordering East Saugus. Alternative # 2 is revised to delete the 20 cfs pump station and use instead increased storage at the Bristow Avenue ponding area by excavating the acquired area. Hydraulic studies found that the ponding area at 3.5 acres could hold sufficient storage between El. 5 and 6 to reduce ponding levels lower than the 20 cfs pump, except at times of non-gravity drainage. At that time the resulting interior levels associated with the excavated ponding area are higher than those associated with the 20 cfs pumping station. That is , provided the storage area bounded by the El. 6 contour (3.5 acres) is excavated around the perimeter to El.5. This would increase storage between El. 5 and 6 from 1 Acre-Foot to 3.5 Ac-Ft with about 4,000 cy of excavation. At an excavation cost of \$ 6.00 /cy the cost would be about \$24,000. Note that about 4.3 acres of land would be acquired for the ponding area.

Further studies may find that the storage area could be designed to allow natural tide levels to flush into the area by using a self-regulating tide gate and reduce the problem of phragmites which has over grown the ponding area. This would allow tide levels to overflow the area on nearly each tide cycle restoring the marsh, and destroying phragmites and eliminating mosquitoes and the threat of fires.

Comments by the Saugus Steering Committee indicated a strong preference for use of existing ponding areas for storage rather than relying on a pumping station.

Radio Tower & Route 107 Bridge Stone Protection- The plan also includes stone protection at the Radio Tower and Route 107 Bridge on the East Branch of the Pines River, similar to Alternative # 1.

Eastern Avenue Ponding Area-The Eastern Avenue ponding area with about 40 acres of storage area to about El. 6, after further study, may be capable of being restored to salt water wetlands. No detailed analysis has been done on its storage requirements or area; however, much of the area is at El. 4.5. Further study would determine for Alternative #2, whether the area could be restored to salt marsh and continue to provide interior storage capacity using a self-regulating tide gate at Ballard Street. Acquisition of the ponding area would cost about \$100,000, based on real estate studies.

RESTORATION IF COMBINED WITH THE PROJECT

The restoration plan which uses unlined openings to breach the I-95 embankment and widen the Pines River opening also restores intertidal and subtidal habitat along the widened channels. If the restoration plan is accomplished concurrently with the project, a reduction in the cost of restoration could be realized. The unlined channels would create about the same or more subtidal and intertidal habitat as required for the project's mitigation site. By combining restoration and mitigation a separate mitigation site would not be required. The mitigation plan could be developed within the unlined channels. Also, there is a greater opportunity to reuse the existing stone protection and excavated materials from the Pines River opening and I-95 breached opening to further reduce the incremental increased cost of restoration.

The following tables show potential savings from a combined plan. By deleting the separate mitigation site about \$ 463,000 could be saved, and up to \$306,000 might be saved by reusing the excavated materials.

An additional savings would be in the administration costs of acquiring real estate from the same parcels. That is, the project requires acquisition of the estuary storage area, while the restoration plan requires acquisition of lands on 31 parcels in East Saugus which border and, in part, overlap the estuary perimeter. Acquisitions could affect many of the same parcels and significant savings could result from concurrent acquisition, however no estimate of savings will be available until further study is accomplished.

Reuse of Excavated Material- The excavation of the Pines River opening would include roughly about 6,500 cy of stone protection which could possibly be reused for the wet-land restoration features (3,500 cy) and for the park dike or Lynn Harbor (over 3,000 cy). In addition about 7,200 cy of the I-95's sand and gravel could possibly be reused for the restoration features. The cost savings are estimated below, subject to review of the quality of materials and whether the material is suitable for reuse and construction sequencing.

	Current Total Unit Cost/cy	Place Reused Material	Savings per cy	Needed Quantity, Available	Estimated Total Savings
Stone Protection	\$58.86	\$25/cy	\$33.86	6500 cy	\$220,000
Sand	24.14	9	15.14	2735 cy	41,000
Gravel(w/ screening)	16.79	7	9.79	3360 cy	33,000
Random Fill	15.99	6	9.99	1154 cy	<u>12,000</u>
				Total	\$ 306,000

TABLE 7
COMPARISON OF BREACHING ALTERNATIVES

	Alternative #1 Breach w/ Rock Lined Channel w/ Current Mitigation Site	Alternative # 2 Breach w/ Unlined Channel & Max. Pines R. Opening
<i>Peak</i> Flow Area <i>below EL 3</i>	<i>Below EL 3 ±</i>	<i>Below EL 6</i>
At Breach	500 SF	700 SF <i>1150</i>
At Pines River	1300 SF	4200 SF <i>5500</i>
Excavation Quantity		
At Breach	47,000 CY	40,000 CY
At Pines River	0	69,000 CY
At Current Mitig. Site	69,740 CY	n/a

Comparative Costs (\$ 1,000 - excludes markups & real estate costs)

At Breach	\$ 786	\$ 255
At Pines River	\$ 222	\$ 905
At Current Mitig. Site	\$ 400	n/a
TOTAL	\$ 1388**	\$ 1160**
<i>TOTAL COST OF RESTORATION</i>	<i>5450</i>	<i>3450</i>
<i>TOTAL COST OF REST W/ PROJECT</i>	<i>5450</i>	<i>2670</i>

** Excludes the cost to widen the culvert under the Route 107 Bridge over the East Branch, if necessary.

Created Wetlands at Excavated Sites (Acres)

Sub-tidal

At Current Mitig. Site	1.0	n/a
At Breach	0	0.5
At Pines River	0	2.9

Inter-tidal

At Current Mitig. Site	2.7	n/a
At Breach	0	1.7
At Pines River	0	1.4
TOTALS	3.7	6.5

Includes Clam Flats

At Current Mitig. Site	2.0	n/a
At Breach	0	1.2
At Pines River	0	1.0
TOTALS	2.0	2.2

ENVIRONMENTAL RESTORATION BREACH I-95 EMBANKMENT (UNLINED OPENINGS)

PROJECT COSTS

The First Cost of the Alternative # 2 is shown in Table 8. Operation, Maintenance and Replacement Costs are shown in Table 9. The cost includes maintaining the walls and berms, stone protection, ponding areas and drainage system . The investment and annual cost of the plan and benefits are shown in Tables 10 and 11.

TABLE 8
ALTERNATIVE 2, DIRECT COSTS in \$1000
(1991 PRICE LEVEL)

<u>FEATURE</u>	<u>DIRECT COST</u>
Code 6-Fish & Wildlife	
Breach -Minimum Mitigation Site	\$255
Maximum Pines River Opening	905
Radio Tower - Stone Protection	39
RT 107 Bridge - Stone Protection	34
East Saugus Berms and Gravity Walls	990
Drainage System (Relocations)	87
Excavate Bristow St. Ponding Area	<u>24</u>
Subtotal	\$ 2,334 Say \$2,300
Lands, Easements and Rights of Way (L,E& R)	
(Code 1 - Lands & Damages)	
Breach at I-95	\$ 16.0
Pines River Opening	8.8
Radio Tower &	
Rt 107 Bridge	25.9
East Saugus Berms & Walls	407.0
Bristow St. Ponding Area	69.5
Construction Easements	<u>7.4</u>
Total L, E & R	\$ 534.6, Say \$ 530
Planning, Engineering & Design (code 30), 20%	\$ 460
Construction Management (code 31)	<u>150</u>
Alternative # 2 RESTORATION TOTAL FIRST COST	\$ 3,440
SAVINGS WITH COMBINED PROJECT AND RESTORATION	
Delete Extra Mitigation Site	\$463
Reuse Excavated Material	<u>306</u>
Total Savings	\$769, Say <u>-\$ 770</u>
Incremental Increased Cost to Restoration	\$ 2,670

Table 9
Alternative # 2 ESTIMATED OPERATION, MAINTENANCE
AND REPLACEMENT COST (1991 PRICE LEVEL)

FEATURE	AVERAGE ANNUAL COST
I-95 Breach & Widened Pines River Opening	\$ 3,000
Stone Protection:	
Radio Tower	\$ 100
Pines River Opening	100
East Saugus Berms , Walls & Drainage	2,500
Ponding area	<u>200</u>
Total O,M&R Cost to Restoration	\$5,900
Savings with Mitigation Site & Material Reuse	<u>- 3,000</u>
Incremental Increased Cost to Restoration	\$2,900

TABLE 10
Alternative # 2 - Total Investment and Annual Cost

INVESTMENT	1991 PRICE LEVEL
Total First Cost to Restoration	\$ 3,440,000
Interest During Construction (8 3/4%, 10 Mo.)	<u>115,000</u>
Factor:0.03346	
Total Investment to Restoration	\$ 3,555,000
Savings with Mitigation Site & Material Reuse	<u>- 800,000</u>
Incremental Increased cost to Restoration	\$ 2,755,000

3,440K
- 800K
2,640K

ANNUAL COST

Interest and Amortization on	
Investment (8 3/4% , 100 yrs) Fac.: 0.087519	\$ 311,100
Operation, Maintenance and Major Replacement	<u>5,900</u>
Total Annual Cost to Restoration	\$ 317,000
Savings with Mitigation Site & Material Reuse	<u>- 73,000</u>
Incremental Increased Cost to Restoration	\$ 244,000

TABLE 11

**SENSITIVITY ANALYSIS ALTERNATIVE # 2
RESTORATION PLAN BENEFITS**

Economic Benefits (1991 Price Level)

Avg. Ann. Benefit

Flood Reduction	nil-not determined
Fire Control	2,200
Reduced Shoreline Maintenance	9,400
Reduced Ditch Maintenance (Delete Total Exist. Cost)	<u>2,000</u>
Sub Total Economic Benefits	\$13,600

Enviromental Benefits

Improved Tides Levels, Flushing & Water Quality to:

Existing 440 Acres

Future 60 acres under I-95

Increased Productivity

Restored Wetlands

Current Phragmites, 10 to 20 Acres

Future Phragmites, 80 or more acres

Pines River Opening, 4.3Ac.

I-95 Breached Opening, 2.2 Ac.

Ditch along East Saugus, 0.5 Ac.

Land under I-95, 8 acres

Mosquito Reduction

Value assigned to Environmental Benefits	<u>\$ *****</u>
to offset economic costs	

Total Benefits	\$ *****
-----------------------	-----------------

***** To be determined after an incremental analysis is performed during further study.

SENSITIVITY ANALYSIS ALTERNATIVE # 2
ECONOMIC ANALYSIS
(1991 Price Level)

	Total Restoration	Restoration Incremental Increase
Average Annual Benefits	\$ ND	\$ ND
Average Annual Cost	\$ 317,000	\$ 244,000
Net Benefits	ND	ND
Benefit-to- Cost Ratio	ND	ND

ALTERNATIVE# 2: BENEFITS AND ACCOMPLISHMENTS

The benefits and accomplishments of Alternative# 2 have been summarized in the benefit tables. The most significant benefits are the stopping of the deterioration of the marsh in the future and restoring lost wetlands as previously described. The unlined openings could be restored to inter & subtidal habitat. The benefits are similar to Alternative #1 except the ditches along the East Saugus shoreline and their maintenance would be nearly eliminated by filling. The economic benefit for flood reduction was not determined however based on a comparison of stage vs. frequency curves there would be no significant change from the with Project condition.

ALTERNATIVE# 2: IMPACTS

The impacts of Alternative# 2 would be similar to Alternative# 1. There would be less construction in Saugus without the pumping station. Breaching the I-95 fill and widening the Pines River opening with unlined channels provides additional habitat restoration. The alternative provides the opportunity to develop the mitigation plan within the unlined channels and reduce the incremental increased cost to restoration.

EVALUATION OF ALTERNATIVES

This section summarizes the major concerns that were considered in evaluating how Alternative #1 and #2 meet the Federal criteria of a plan that is complete, effective, efficient and acceptable. In addition, effects of sea level rise were considered. The findings are discussed in the Ecological Assessment that accompanies this Report.

SENSITIVITY OF ALTERNATIVES #1 AND # 2

The plans were formulated using various topographic maps. Along East Saugus' shoreline mapping with two foot contours were used from aerial topography dated 1974. Land surveys in 1988 supplemented the shoreline information. Mapping of the I-95 fill was developed from 1990 aerial topography. The tidal hydrology is based on gaging stations installed on both sides of the I-95 fill by the Corps' Waterways Experiment Station. Contingencies in the cost estimates have been included for uncertainties in the exact to-

pography of the area, unknown subsurface foundation conditions, costs of materials, refinements for design stability, realignment of structures, and value of real estate. The I-95 embankment currently owned by the Commonwealth is in the process of being turned over to the MDC, the project sponsor. Developing the mitigation plan within the breached channel and Pines River opening for Alternative #2, provides the same habitat as required for in-kind mitigation by for the project. Modeling has shown that Alternative #2's openings would produce restored tide levels and currents well below the 2 feet per second criteria. Therefore, the Pines River opening could be optimized by reducing the widened opening to approach the 2 fps criteria.

The modeling will also determine whether the Route 107 Bridge opening would restrict the flow of water up the East Branch. The modeling will identify the reduction in tides, if any, caused by the Route 107 Bridge culvert. If it is significant it may be necessary to make the enlarged bridge culvert part of the plan. This information will be provided to the Massachusetts DPW for designing the new bridge which is scheduled in five years.

EVALUATION OF ALTERNATIVES

Alternatives # 1 and 2 would comply with Federal and state laws, policies and goals for environmental restoration upon completing the study. Significant differences between the alternatives are with the methods used for breaching the I-95 fill, the higher environmental benefits of Alternative # 2 and lower cost. Using unlined openings for habitat restoration instead of the rock lined channel for breaching reduces the cost considerably with less construction impacts. With the unlined openings located at the breach, the rock-lined channel is eliminated from the cost and additional wetland restored at the openings. Alternative # 2 deletes the pumping station in favor of a non-structural solution of deepening the ponding area.

Alternatives #1 and 2 may be complete in accounting for all costs needed to realize the breaching of the I-95 and reducing adverse affects in East Saugus, however, more detailed studies are needed. Flushing, circulation and tide levels will return to the estuary. Any restriction imposed by the Route 107 Bridge culvert is not expected to significantly restrict returning the tide levels to their historical levels.

Alternative# 2 - Breaching with unlined openings should be the most effective means to restore the environment. The opening up of the East Branch is also the most effective location for breaching, since its the only channel flowing directly from the Pines River to the affected marsh. It should also be the most efficient alternative due to its lower cost. Based on comments received it should be acceptable to Federal and state agencies and residents bordering the marsh in East Saugus. Public review of a completed report will determine acceptability to the general public and the sponsor. The Plan would accomplish the objective of restoring flushing of the wetlands at the lowest cost.

Alternative# 2 - Breaching with the unlined openings appears to meet Federal criteria, should be consistent with local and state goals, is currently the preferred alternative, and therefore may become a selected plan - pending Federal, state and local review of a report. It may be the National Economic Development (NED) plan as it is expected to be the lowest cost alternative for realizing the benefits.

PLAN ACCOMPLISHMENTS

The Environmental Restoration Plan - Alternative # 2 offers significant environmental benefits to the region, State and Nation. It also offers potential benefits to flood reduction, fire reduction, and shorefront and ditch maintenance. The plan will be optimized during further detailed studies.

ENVIRONMENTAL BENEFITS

The Environmental Restoration Plan would restore tidal flushing and tide levels to 440 acres of existing coastal wetlands. In Saugus about 300 acres would receive significant benefits. The 279 acres of high marsh which today is flooded only a few inches by high spring tides about 15 times a year would be restored to flood one to two feet deep about 100 times a year. In addition the 10 to 20 acres of phragmites reeds which are unproductive land ecologically would return to productive high marsh. The future loss of marsh from phragmites, about 80 acres or up to 270 acres, in the Upper Pines River Marsh in Saugus, would be prevented.

The 21 acres of low marsh which floods today 220 times per year at mean high tide will experience a 0.3 foot rise in tide and flood about 365 times per year with the plan.

The 140 acres of tidal rivers, mud flats and marsh in Revere would benefit only slightly by about a 0.2 foot rise in high spring tides for a minor improvement in flushing.

The major benefits are to the increased productivity of the Saugus portion of the marsh amounting to an increase of 18,000 pounds of organic matter per year to feed the fish and wildlife which would return to this restored marsh. In other words, the productivity would increase in non-deteriorated areas by an equivalent 1.5 acres of low marsh or 1.8 to 4.7 acres of high marsh.

The periodic flooding of higher spring tides would restore the equivalent of 6 acres of permanent aquatic habitat which would enhance fishery and water bird use.

The restoration of marsh lost to phragmites, including 10 to 20 existing acres, and about 80 acres or up to 270 acres in the future, would provide a significant benefit to preserving the marsh and restoring productivity and habitat.

The Plan would restore flushing, tide levels and circulation and therefore, increased productivity and fish and wildlife habitat to 60 acres which are likely to be restored in the future by others from total removal of the I-95 embankment.

The Plan restores about 4.3 acres of intertidal and subtidal habitat by widening the Pines River opening and 2.2 acres in the I-95 breached channel, and provides others the opportunity to restore 8 additional acres from under the I-95 fill.

Following additional studies the Plan may be able to restore about 40 acres of former tidal wetlands in two existing ponding areas by using self-regulating tide gates.

The substantial reduction in phragmites would stop the deterioration of the high marsh, reduce the growing threat of mosquitoes and fires, and help restore the views, aesthetics, and most importantly the natural resources of this Area of Critical Environmental Concern.

The Salt Marsh Mosquito, which prevents residents within 20 miles of the marsh from enjoying outdoor activities day or night, could have its breeding reduced 90 to 99 percent with Open Marsh Water Management. Residents would experience substantial reductions of mosquitoes within one mile of the marsh.

The Plan mitigates for the project impacts in a flowing habitat more similar to the impacted habitat of the floodgate structure.

In summary, Alternative # 2 would restore **flushing** to the environment in **540 acres** of total wetlands, including: 440 acres of existing wetlands; 40 acres of ponding area; and, 60 acres under I-95. The total lost wetlands restored is **28 acres**, including: about 20 acres of phragmites in the high marsh and 8 acres at the Pines River and I-95 breached openings; and with further study about **40 acres** of phragmites in **ponding areas** may be restored. The plan would prevent about **80 acres or up to 270 acres** from being lost in the future from further deterioration.

ECONOMIC BENEFITS

The Environmental Restoration Plan would accomplish many positive economic objectives, including Flood Reduction, Shorefront Replacement, Fire Reduction and Ditch Maintenance benefits.

Flood Reduction

The Restoration Plan may help reduce the frequent interior flooding due to runoff aggravated by high tides for the East Saugus neighborhood bordering the Pines River Marsh by providing a more reliable drainage system. Table 12 reflects the estimated change in flood elevations in East Saugus between Bristow Street and the Pines River marsh. As shown, the Existing Conditions are reduced for the full range of flood events by the Saugus River and Tributaries (SR&T) Project without breaching. With breaching only (no improvements in East Saugus) and the SR&T project, flood levels increase above Existing Conditions at El. 6 with about a one foot higher stage to El. 6.8 for the 2 Year event. (Note: For Existing Conditions and during a 2 Year event El. 6 occurs about half the time and El. 7 the other half depending on low and high tide, respectively.) Also, breaching increases flood levels with the SR&T project in place versus without breaching for events up to 100 Year.

The impacts of higher flood levels from breaching, especially in the frequent ranges (2 to 5 Year), are nearly negated by the Restoration Plan using the excavated Bristow Street Ponding Area and Gravity Drainage improvements. The resulting flood levels are in-

creased about 0.2 feet above the SR&T project only levels, or the start of damage at 10.5 feet. The slightly higher (0.2 feet) ponding levels would cause slightly higher damages but are not likely economically significant. More detailed studies using detailed mapping and aerial photography / excavation of the larger ponding area (43 Acres) should be investigated to further reduce ponding levels. The improved drainage system including tide gates should operate more efficiently as opposed to several existing tide gates which are frequently blocked open by debris.

TABLE 12
FLOOD ELEVATIONS IN EAST SAUGUS RESIDENTIAL AREA
BETWEEN BRISTOW STREET AND MARSH

Flood Tide Event:	100 Year	10 Year	5 Year	2 Year
Existing Conditions	10.5	8.3-8.6*	7.4-8.0	6.0-7.0
Saugus River & Tribs. Project without Breaching				
Residual Flood Level	7.3	6.9-7.1	6.4-7.0	6.0-6.6
SR&T Prj. w// Breach Only	7.5-7.8	7.2-7.5	7.1-7.4	6.8-7.1
SR&T Prj.w/ Restoration Plan , incl. Breach	7.3-7.6	6.9-7.3	6.8-7.2	6.4-6.8

Shorefront Benefits

The Restoration Plan offers \$6,200 reduction in the estimated annual replacement and repair costs to the existing 3775 feet of shorefront structures bordering the East Saugus marsh (Table 13). Also, shorefront costs are reduced for : 530 feet at the Pines River opening in the I-95 embankment; 120 feet at the Rt. 107 Bridge; and 130 feet at the Radio Tower. These shoreline structures would no longer take the brunt of tidal action and the resulting damage from overtopping, undermining, deterioration, erosion or other activity. The reduced costs reflects the estimated remaining cost after the Saugus River and Tributaries Project is operating. The Wetland Restoration Plan would totally replace these structures and eliminate the remaining costs by others. The plan's First Cost and O&M picks ups the costs for maintaining these shorefronts.

TABLE 13
BENEFITS TO EXISTING SHOREFRONT STRUCTURES
REDUCTION IN AVERAGE ANNUAL REPLACEMENT & REPAIR COSTS
(1991 Price Level)

East Saugus Shorefronts	\$ 6,200
Other Shorefronts	<u>3,200</u>
Total	\$9,400

Fire Reduction

Fires in the marsh would be reduced about 90 percent from a reported 15 times a year due to frequent inundation and wetting of the marsh grasses and reduction in dry reeds. The benefits reflect only the estimated savings in damage to properties and depreciation on the fire engine and overtime paid to firemen and police. There would be no savings in the regular labor cost of firemen and police since they would be paid even without the fires. The estimated average annual benefit is : \$2,200.

Ditch Maintenance

The 3,000 feet of perimeter ditches which line the shoreline of East Saugus require annual maintenance to clean out debris, sediment and phragmites. These ditches would be eliminated by the Restoration Plan by being filled in with the berms and walls or restored to high marsh. The reduced cost of \$ 2,000 per year is a benefit to the Plan.

Economic Summary

The benefits from the Environmental Restoration Plan are shown in Table 14.

TABLE 14
Alternative #2-Restoration Plan Average Annual Benefits

Flood Reduction	\$ ND
Shorefront Replacement	9,400
Ditch Maintenance	2,000
Fire Reduction	<u>2,200</u>
Total Benefits	\$ 13,600

SUMMARY- Table 15 compares the impacts on the people, economy and natural and cultural resources of the study area from implementation of the Environmental Restoration Plan versus what could be expected to occur if no action is taken to restore the wetlands by breaching the I-95 embankment. As the information in the table indicates, the Restoration Plan provides opportunities to achieve significant environmental, economic, social and public safety objectives.

TABLE 15
COMPARATIVE IMPACTS

RESOURCE EVALUATED	RESTORATION PLAN Alternative #2	NO ACTION
Flood Protection	Possibly reduce flooding from interior runoff affecting properties and roads around 140 residents and 8 businesses.	Flood damages continue to increase with growth, affluence and sea level rise.
Hydrology	Restore tide levels and flushing to 440 acres in the Upper Estuary: high spring tides increase 1 to 2 ft. in high marsh; mean high tide is raised 0.3 ft. in low marsh & sea level rise.	Gradual rise (0.1 foot in 10 years) in tide levels with sea level rise.
Water Quality	Improved with significant increase in volume of flushing of Upper Marsh.	Some what improved with rise in sea level.
Wetlands	<p>279 acres of high marsh floods about 100 times more per year; and 21 acres of low marsh 145 more per year with improved productivity & habitat. Improved flushing for 50 acres of restored wetlands in future under I-95 & opportunity to restore 8 more.</p> <p>Restore 10 to 20 acres of phragmites in upper marsh back to high marsh and stop spread of phragmites about 80 acres or up to 270 acres which significantly degrades wetlands.</p> <p>Opportunity to restore 40 acres of phragmites ponding areas back to low & high Marsh environment.</p>	<p>High marsh continues to deteriorate with Phragmites and potential loss of 80 acres or more in the Upper Marsh also, with increase of fires, mosquitoes and loss of wetland resources.</p> <p>No change in retarded flushing of wetlands; however, sometime in the distant future sea level rise may restore this area.</p> <p>No change in 40 acres of ponding areas, remain in phragmites with problem of fires & mosquitoes.</p> <p>Phragmites area continues to grow deteriorating marsh.</p>

RESOURCE EVALUATED	WETLAND RESTORATION PLAN	NO ACTION
Benthic Habitats	Widen Pines River & I-95 Breach Openings to restore an additional 6.5 acres intertidal and subtidal habitat.	No significant impact.
Fish, Lobsters	Significant improvement in 300 acres of high and low marsh habitat with increased productivity and flooding of high marsh, and stops deterioration of marsh habitat.	Adverse impact from deterioration of marsh and reduced tide levels in wetlands.
Wildlife	Minor impact from loss of dry high marsh, but significant benefit with increased productivity of high marsh.	Deterioration of high marsh with phragmites reduces habitat.
Rare, Threatened and Endangered Species	No impact.	No change from the present.
Sandy Beaches, Artificial Shorelines	No significant impact.	No significant impact.
Historic and Archaeological Resources	No known impact.	No impact.
Economics	Average annual damages or losses reduced by \$13,600.	Average annual damages and losses exceed \$24,000.
Navigation	No significant impact.	No impact.
Recreation	Significant improvement within one mile and minor benefit for 20 miles from significant reduction of Salt Marsh Mosquito. Minor loss of yards due to walls & berms.	Growth of mosquito population deters recreation.
Visual Resources	Eliminate Phragmites, restores visibility and aesthetics to estuary.	Growing loss of visibility and aesthetics of estuary with growth in Phragmites.
Safety	Reduced mosquitoes result in reduced health hazard; Reduced fire threat with higher flushing of marsh and eliminating phragmites.	Growing health hazard and fire threat with increase in phragmites, mosquitoes and dry marsh.

SUMMARY OF PLAN ACCOMPLISHMENTS

The Environmental Restoration Plan would restore wetland resources in the Upper Estuary, reduce the threat of fires and mosquitoes, and possibly reduce flooding while providing opportunities for restoring additional lost wetlands. It would also help protect the recreation and aesthetics around the estuary. Benefits include significant improvements to the future well-being of the region, state and nation.

PROJECT JUSTIFICATION

The Benefit-to-Cost Ratio (BCR) indicates whether or not a project is economically justified. This comparison is done on an annual basis. The total estimated annual benefits and annual costs will be shown in Table 16. The BCR and net benefits for the NED plan are expected to show that the Benefits of restoration would offset the economic cost.

The average annual cost for Alternative # 2 was \$317,000. The economic benefits were \$13,600. The environmental benefits will be assigned a value to offset the residual cost after completing an incremental analysis during detailed studies. For an interm comparison, the estimated First Cost of Alternative #2 is \$ 5.4 million, or the incremental increased cost is \$2.76 million if added to the project. Restoration would restore or prevent the loss of about 100 acres: 20 acres currently lost, and about 80 acres currently deteriorating and a likely future loss. The range in first cost per acre would be \$27.6k to \$54k per acre. These costs compare to a cost of at least \$100k per acre to replace wetlands for mitigation by two Corps' projects in the area. The high Ecological Quality benefits, low comparable cost, public support and Federal interest appears to warrant further investigation of Environmental Restoration -- following coordination of these findings and receipt of sponsor support for completing detailed studies.

TABLE 16
Economic Analysis Summary (1991 Price Level)

Total Average Annual Cost	\$ 317,000
Average Annual Benefits	not determined
Benefit-to-Cost-Ratio (BCR)	not determined
Average Annual Net Benefits	not determined

Environmental Benefits

The major accomplishments of the Wetland Restoration Plan are:

- restore tidal flushing to 440 acres of existing wetlands;
- restore 10 to 20 acres of phragmites in upper marsh to high marsh wetlands;

- restore tidal flushing, productivity, and fish and wildlife habitat to 279 acres of high marsh and 21 acres of low marsh which are most significantly affected;
- restore about 4.3 acres to wetlands under I-95 by widening the Pines River opening and 2.2 acres at the I-95 breached opening;
- improve flushing and productivity to about 50 acres of potential wetlands to be restored by others in the future under I-95;
- after further study, possibly restore about 40 acres to wetlands in existing ponding areas, and provide the opportunity for others to restore about 8 acres under I-95;
- significantly reduce mosquitoes and the threat of disease, while improving recreation;

Other Benefits

- reduce flooding in East Saugus and/or provide a more reliable drainage system to offset the affects of higher astronomic tides;
- reduce the threat of fires and the number of fires about 15 per year;
- eliminate the existing replacement, repair and maintenance costs of 4,500 feet of shore-front structures, and maintenance costs to 3,000 feet of drainage ditches.

REGIONAL SIGNIFICANCE

The Environmental Restoration Plan would have both regional and state significance from restoring wetlands and in providing other opportunities. Due to the location of the study area near Boston, the plan protects significant environmental, natural and recreational resources serving the greater metropolitan area. The most important effect is the restoration of an Area of Critical Environmental Concern so close to Boston and only one of thirteen ACEC areas in Massachusetts. The estuary includes the largest area of wetlands near Boston and provides opportunities for education , research and enjoyment.

The construction of the project would also benefit the economy and labor force in the state. Construction of the project provides additional employment. The plan's cost would benefit the region by having a multiplier effect on the state's economy.

PLAN IMPLEMENTATION

This section describes the institutional requirements to implement the plan, including cost sharing and Federal and non-Federal responsibilities.

INSTITUTIONAL REQUIREMENTS

COST ALLOCATION

All measures of the Environmental Restoration Plan are required for environmental improvements; and their costs are allocated to Fish and Wildlife Enhancement.

COST APPORTIONMENT

EC 1165 -2-146, 15 March 88 "Fish and Wildlife Mitigation and Enhancement...", provides guidance for implementing Section 906(e) of PL 99-662, Water Resources Development Act of 1986.

"Section 906(e): Cost Sharing Associated with Fish and Wildlife Enhancement.

(1) When the Secretary recommends fish and wildlife enhancement in reports to Congress the following cost sharing applies.

a) First Costs. The first costs of fish and wildlife enhancement activities shall be a Federal cost when any of the following apply:

- (I) such enhancement provides benefits that are determined to be national. . .
- (II) such enhancement is designed to benefit species that have been listed as threatened or endangered. . . or
- (III) such activities are located on lands managed as a national wildlife refuge.

When fish and wildlife enhancement benefits do not qualify as stated above, 25 percent of such first costs of measures associated with those benefits shall be provided by non-federal interests during implementation."

b) OMRR Costs. The non-Federal share of OMRR of all activities to enhance fish and wildlife resources shall be 25 percent.

All of the requirements in the Water Resources Development Act of 1986, including those regarding cost-sharing have been reflected in this report.

For cost-sharing on Fish and Wildlife Enhancement the Federal share is limited to a maximum of 75 percent. Acquisition of necessary lands, easements, rights-of-way and all necessary relocations are all credited toward the minimum 25 percent non-Federal share for Fish and Wildlife Enhancement. The entire non-Federal share must be paid during the construction period. Operation, maintenance and major replacements of the project facilities are also cost shared at 75 percent Federal and 25 percent non-Federal. Table 17 summarizes the Cost Apportionment for the Restoration Plan (Alternative #2) assuming the plan is combined with the Saugus River and Tributaries Project.

TABLE 17
RESTORATION PLAN WITH PROJECT
INCREASED COST APPORTIONMENT
1991 Price Level

Cost Allocation: Fish and Wildlife Enhancement

Environmental Restoration *(99.47)* $\times \frac{2.3}{2.528} (2019p1)$
 $\frac{\$2,670,000}{2.528} = \$1,056,171 (2019p1)$ (INCREMENTAL INCREASED FIRST COST)

Cost Apportionment:	Federal Cost	Non-Federal Cost
Contributions:		
Environmental Restoration	\$ 2,000,000 (75.0%)	\$670,000 (25.0 %)
Lands, Easements, Rights of Way and Relocations (LERR)	_____	\$500,000
Remaining Cash	_____	<u>170,000</u>
TOTALS	\$2,000,000	\$670,000
TOTAL INCREMENTAL FIRST COST		\$2,670,000

Annual Operation, Maintenance and
Replacement:

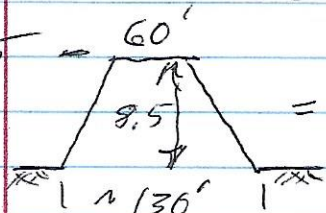
Wetland Restoration	\$2,200 (75%)	\$700 (25%)
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TOTAL INCREMENTAL O&M COST	\$ 2,900
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2020
Hunt

I-95 Fill Remaining to be Removed
Ref: EPA Map of Ramsey Marsh Restoration
+ Corps Draft Env. Restoration Rpt 9/91

EL 13.5 - 60'
FL 5 - 130'



$$= \frac{1}{2}(8.5)(60+130) = 800 \text{ SF}$$

Sites: @ 60' #13 @ 1800' #18 @ 1000' #23 @ 1000' #29 @ ~~1800'~~ 900'
Open Pines R. wider: 69,000 cy

Vol.: #13 @ 53000 cy

$$800 \text{ SF} \times 1800' \div 27 = 53,000 \text{ cy}$$

#18 30,000 cy

#23 30,000 cy

#29 17,000 cy

140,000 cy

+ Pines R. Wider 69,000 cy

209,000 cy

1800

1000

1000

900

214

4914

about a mile

Acres: #13 = $130' \times 1800' \div 43,560 \text{ SF} = 5.37 \text{ Ac}$

#18 $130 \times 1000 \div$ = 3.00

#23 1000 = 3.00

#29 900 = 2.69

14.1 Acres

Wider Pines R.

10 scale 0.7 = 50' 0.1 = 7.14' $\times 30(10') = 214 \text{ LF width of new marsh}$

$214 \times 530 \text{ ft wide} \div 43,560 = 2.6 \text{ Ac}$

Acres Restored = 16.7 Ac