Reconnaissance Report
Point Beach and
Bayview Beach
Milford, Connecticut

Local Flood Protection

November 1989

US Army Corps
of Engineers
New England Division

SECTION 205
LOCAL FLOOD PROTECTION
RECONNAISSANCE REPORT

POINT BEACH AND BAYVIEW BEACH
MILFORD, CONNECTICUT

NOVEMBER 1989

US ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

SYLLABUS

This study identifies and evaluates the feasibility of alternative tidal flood management measures along the Point Beach and Bayview Beach areas of Milford, Connecticut. This study was conducted under the authority contained in Section 205 of the 1948 Flood Control Act, as amended.

Reconnaissance studies were initiated during the West Central Connecticut Study which indicated there was economic feasibility for a project in these two areas. However, because of the scope of the West Central Connecticut Study, which included 8 communities and over 12,000 structures, many of the assumptions which were made effect the benefit analysis and project justification. Further analysis to confirm some of the more critical assumptions was required before proceeding into a cost shared feasibility study.

The West Central Connecticut Study identified feasible plans to raise 283 homes in both Point Beach and Bayview Beach, however, further analysis indicates it is only feasible to raise 52 homes in the Point Beach area. This report recommends the study be continued as a cost shared feasibility study under the Section 205 authority. Prelimimnary estimates indicate the feasibility study will cost about $100,000, $50,000 Federal and $50,000 non-Federal.

MILFORD, CONNECTICUT
BAYVIEW BEACH AND POINT BEACH
SECTION 205
RECONNAISSANCE REPORT

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INTRODUCTION

This Reconnaissance Report presents the results of investigations of the feasibility of providing local flood protection along the Point Beach and Bayview Beach areas of Milford, Connecticut. Raising homes as a flood control plan to reduce the damaging effects of future flooding was found to be economically justified.

This reconnaissance study phase is the first of a two-phase planning process and provides the basis for continuing into the feasibility or second phase. The feasibility phase includes a detailed investigation of alternative solutions, selection of a plan and results in a report which recommends a project for construction.

Reconnaissance studies were initiated after investigations performed under the West Central Connecticut Study determined in 1988 that an economically justified local protection project at Milford had sufficient local support to warrant further study. The West Central Connecticut Study recommended that further study be performed under the Section 205 authority.

STUDY AUTHORITY

This report was prepared under the special continuing authority of Section 205 of the 1948 Flood Control Act, as amended. This authority specifies that, not more than $5,000,000 shall be allowed for Federal participation in a project at any single locality. The work shall be complete in itself and not commit the United States to any additional improvement to insure its successful operation, except as may result from the normal procedure applying to projects authorized after submissions of preliminary examination and survey reports. Items of local cooperation, including cost sharing, shall be provided by a legally empowered and financially responsible local sponsor.

STUDY AREA

This investigation specifically addresses flooding problems over approximately 2 miles of shoreline along Point Beach and

Bayview Beach in Milford. The limits of study extend from Lawrence Avenue to Beachland Street in the Bayview Beach area, and from Virginia Street to Atwater Street in the Point Beach area (see Plate 1). The focus of the study is to provide flood protection for properties in the study area which have a potential to sustain major damage as a result of a 100 year frequency storm. There are 147 homes located in the 100 year flood plain in the Point Beach area and another 197 in the Bayview Beach area.

STUDY OBJECTIVE

The West Central Connecticut Study determined that justification exists for Federal participation in the implementation of flood control improvements in Milford, Connecticut. The primary objective of this reconnaissance investigation was to expand upon earlier study findings and develop, in sufficient detail, a viable justified plan for flood control that will reduce future flood losses. Because the West Central Connecticut Study made many assumptions which effect the justification of the project, further investigation was necessary to check the validity of the more critical assumptions. The other objective of this study was to negotiate a Feasibility Cost Sharing Agreement with the local sopnsor.

ONGOING STUDIES AND INVESTIGATIONS

Hurricane Evacuation Study - In November of 1986, the Corps of Engineers, at the request of the Federal Emergency Management Agency (FEMA) and the State of Connecticut, Office of Civil Preparedness, initiated a hurricane evacuation study for the coastal communities of Connecticut. The study is part of an ongoing National program to identify the portions of the coastal United States vulnerable to hurricane flooding. The Corps of Engineers participates in this program under the authority of the Flood Plain Management Services (FPMS) Program.

The purpose of the Connecticut Hurricane Evacuation Study is to identify the areas and population within the entire Connecticut coastal area vulnerable to the flooding effects of a potential landfall hurricane and to estimate the time and conditions required to safely evacuate the population at risk. The study

utilizes a mathematical hurricane storm surge model called SLOSH to determine the magnitude of the potential coastal flooding. The SLOSH model was developed by the National Weather Service and has been performed for the Connecticut study by the National Hurricane Center. The results of the model are used to develop evacuation maps for each of the coastal communities based on selected hypothetical hurricane scenarios. Detailed investigations will be performed for each scenario to determine the location of the population at risk, their probable evacuation destination, potential evacuation concerns and an estimate of the total time required to safely evacuate the vulnerable areas. The final results of the study will be documented in a technical data report. This report will provide the pertinent information required for the state and local communities to update or refine their hurricane response plans.

Shore Protection Studies - The New England Division of the Corps of Engineers has conducted several studies in West Central Connecticut under the authority granted in Section 103 of the 1962 River and Harbor Act as amended. The Authority provides for the Chief of Engineers to construct small shore protection projects. There is one project currently under study in Milford.

> Woodmont Beach, Milford, CT - A feasibility study was recently completed to determine the feasibility of controlling erosion and reducing damages to an approximately 1,500-foot reach of Woodmont Beach between Clinton Avenue and Bonsilene Avenue. Improvement plans under consideration are beachfill, revetments and a combination of fill and revetment.

REPORT AND STUDY PROCESS

The two phase planning process provides a mechanism to accommodate significant non-Federal participation in Corps feasibility studies, thereby, contributing to an efficient and effective planning process. The reconnaissance (first) phase provides a preliminary indication of the potential of the study to yield solutions which could be recommended as Federal projects. The results of the reconnaissance phase provide the basis for decision-making within and outside the Corps and the Administration to evaluate the merits of continuing the study and allocating feasibility (second) phase funds.

BACKGROUND INFORMATION

GENERAL

Milford is located in south central Connecticut adjacent to Long Island Sound, approximately 75 miles northeast of New York City and 10 miles southwest of New Haven, Connecticut. The first pioneers of Milford were among the earliest settlers of the United States and developed the area industrially. Today Milford has evolved into a center of economic and industrial activity serving several surrounding cities.

STUDY AREA DESCRIPTION

Area Profile - Connecticut is a popular vacation and tourist area and is aptly termed the gateway to New England. The State is approximately 100 miles long in an east-west direction, and 50 miles wide in a north-south, inland, direction. The entire southern boundary of the State is the shore of Long Island Sound, a rather narrow, sheltered arm of the Atlantic Ocean. The fact that Connecticut is located in a temperate latitude and that the waters of Long Island Sound are generally calmer and warmer than along the exposed ocean shores of the neighboring states has induced intensive development of the water front. A further attribute of the State is that the flat plain which extends generally a mile or more inland is well suited to resort development. The Connecticut shore is also very irregular, about 165 miles long, dotted with bays, coves, promontories and near-lying islands, all of which add variety to the area and to its value for resort and residential development.

The study area is located along the north shore of Long Island Sound in the west-central portion of Connecticut. The area extends westerly from Atwater Street at Point Beach to Lawrence Avenue at Bayview Beach. There are 147 houses in the 500 year flood plain at El. 12.0 feet NGVD in the Point Beach area. The Bayview Beach area was seperated into two areas, Melba Street with 61 structures and Bayview with 136 structures.

CLIMATOLOGY

Milford has a variable climate characterized by frequent but short periods of heavy precipitation. The area is influenced by prevailing "westerlies" that travel across the country in an easterly and northeasterly direction, and of larger weather systems of tropical and extra-tropical origin that travel up the eastern seaboard. The severe winters normally experienced in New England are moderated somewhat by the presence of Long Island Sound, leaving the area with less snowfall on average than the rest of the region. Temperatures average about 50 degrees Fahrenheit year round, with extremes ranging from lows in the minus 20's to highs in the low 100's. Precipitation averages about 44 inches annually distributed uniformly throughout the year. Maximum and minimum precipitation, recorded over 89 years through 1982 at Bridgeport, Connecticut, are 73.9 and 23.0 inches, respectively.

SOCIO-ECONOMIC SETTING

Land Use - Milford has an area approximately 23.6 square miles. Almost 60 percent of the land is developed in residential uses, and 10 percent is devoted to commercial and industrial development. The study area in Point Beach and Bayview Beach is exclusively residential

Economy and Population - Over the last 50 years, Milford saw its greatest period of growth between 1940 and 1950 when its population increased 63.5 percent. Census figures for 1980 show a population of 50,898 for Milford. Milford's population increased a mere tenth of one percent between 1970 and 1980. This is generally comparable to the statewide trend of little change for that decade. Current projections predict the population of Milford to increase by about 5.2 percent by the year 2000.

Milford is in the Bridgeport Labor Market Area (LMA). In 1981, Milford's labor force totalled 24,611 with an unemployment rate of 5.6 percent, which is below that of its respective LMA as well as that of the State of Connecticut and the nation for the same year. Total employment in the Bridgeport LMA is forecasted to increase to 6.2 percent.

TIDAL FLOOD HISTORY

Tidal flooding within the study area is caused primarily by hurricanes or extratropical storms. Hurricanes have been the most damaging, because their intensity has had a greater affect on tide levels and wave heights.

Hurricanes can be defined as tropical cyclones with a central barometric pressure of 29.0 inches or less and a maximum wind speed in excess of 75 miles per hour. In the northern hemisphere they consist of winds revolving in a counter-clockwise direction around a calm center or "eye". Their diameter can vary considerably, from as small as 50-75 miles across to over 500 miles wide. Winds at the outer edge are usually light and increase in intensity as they approach the center. Hurricanes that have had the most severe affect on the study area usually approach from the south after curving east of Florida and skirting the Middle Atlantic States.

The two most damaging hurricances experienced along Long Island Sound occurred during September 1938 and August 1954. Flood levels experienced during these events were used to prepare tidal flood profiles for areas along the shoreline. A detailed description of these and other recent hurricanes is given in the following paragraphs.

Hurricane of September 21, 1938 - Tidal flooding from this hurricane was the greatest ever experienced in Long Island Sound. The center of the hurricane entered Connecticut perpendicular to the coast about 15 miles east of New Haven during mid-afternoon on September 21, 1938 and proceeded northwesterly at a forward speed of 50 to 60 miles per hour. The eye was clearly observed at New Haven. The lowest barometric pressure recorded during the storm was 28.04 inches at Hartford, Connecticut, with minimum pressures of 28.30 inches reported in Bridgeport and 28.11 in New Haven. The maximum wind velocity in New England was a gust of 186 miles per hour (mph) at the Blue Hills Observatory in Milton, Massachusetts, where a sustained five minute wind of 121 mph was also recorded. At locations long the southern coast, sustained five-minute velocities of 38 to 82 mph were experienced. Hurricane tide occurred one to two hours before the predicted high tide. The hurricane caused extreme high tides throughout most of the Sound, with a tidal surge of about seven feet above the normal predicted tide at Bridgeport. Wave action accompanying the

storm produced a devastating effect upon the shoreline, resulting in widespread damage. Wave heights ranged from ten feet at New London to 15 feet at New Haven and Bridgeport.

Hurricane of September 14, 1944 - In this event, the eye of the storm passed inland just west of Pt. Judith, Rhode Island and continued in a northeasterly direction at a forward speed of 30 to 35 mph veering out to sea at Boston, Massachusetts. The hurricane tide arrived in the Sound at about mean tide at the eastern end and about two hours after predicted high tide at the western end, which resulted in moderately high ocean levels.

The maximum gust was an estimated 104 mph at Hartford, Connecticut. A one-minute wind of 99 mph and a five-minute velocity of 81 mph were recorded at New York City. The lowest pressure of 28.30 inches was recorded at Westerly, Rhode Island.

Hurricane of August 31, 1954 (Carol) - The second most damaging hurricane to strike southern New England occurred just 16 years after the record 1938 event. The center of this storm crossed the shoreline of Connecticut near New London with a forward speed of about 45 mph and then followed a general northerly path across New England. As the hurricane surge occurred at or near predicted normal high tide within the Sound, tide levels rose to near record heights. Tidal surges ranged from five to eight feet higher than normal tides.

The wind attained a maximum gust of 135 mph and a five minute sustained velocity of 98 mph at Block Island, Rhode Island. Minimum pressures of 28.2 and 28.3 inches were recorded at Storrs and New London.

Damages from flooding of low shore areas occurred throughout Connecticut as a result of extremely high tides. Waves were particularly damaging east of the Connecticut River. Statewide damages occurred as a result of inundation of commercial and residential properties and coastal losses ranged from damage to fishing and pleasure craft, harbor facilities, shorefront residences and bathing beach establishments.

Hurricane of September 27, 1985 (Gloria) - Hurricane Gloria made landfall in Westport, after crossing Long Island, at 1215 EST. The "eye" of the hurricane, then continued on its north-northeastward track, passing near Hartford before exiting the

state at Suffield at about 1313 EST. Wind gusts of hurricane force ripped through the southern and central, as well as the eastern portion of the state, with the peak gust for the entire state recorded to 92 mph at Bridgeport. The lowest sea level pressure was 28.50 inches, recorded at Bridgeport. Other peak wind gusts included 82 mph at Hartford, 75 mph at New Haven, and 66 mph at Windsor Locks. Along the coast, up to 20,000 people were evacuated from their homes from Greenwich to Stonington and hundreds of small craft were torn from their moorings and damaged or sunk. Five docks were ripped up in Milford Harbor and about one hundred pleasure craft were torn from their moorings. However, the coastal flooding was at a minimum despite tides of 2 to 4 feet above normal, since Gloria reached the coast near low tide.

Tidal Flood Problem - Throughout history tidal floods produced by hurricanes and extratropical storms have caused loss of life, massive damage to public and private property and in some instances significant ecological destruction along the Connecticut shoreline. As described in the previous paragraphs, several severe hurricanes have struck the Connecticut coastline in the past 50 years with the most severe occurring on 21 September 1938. This storm caused tidal flooding along the Connecticut shore to elevations ranging from about 9.2 to 11.7 feet above mean sea level. In the next most severe hurricane, on 31 August 1954, flood stages approximated the 1938 level from the west limit of Stratford to the east limit of Madison. At other locations along the Sound, the 1954 stage was zero to 1.6 feet below the 1938 level.

In addition to high water levels, waves generated by wind, associated with severe storms, can, and have, caused serious damage to the coastline. Although wave measurements or statistical wave data is very limited in the study area, waves generated by southwesterly to southeasterly winds pose the greatest threat to the study area. Since wave height is dependent upon wind speed and fetch distance, winds from southerly directions result in a much greater threat due to the relatively long fetch available in Long Island Sound.

In addition to the threat posed by coastal storms, the New England coastline is experiencing a phenomenon known as sea level rise. In the study area, this rise has been about one foot in the last century. Although there are many projections regarding

future sea level changes, the Corps policy is one of concern rather than alarm. However, if the historic rate of rise were to continue, future flood levels would increase along with sea levels.

Storm Impacts - Tidal floods produced by hurricanes and extratropical storms have been responsible for badly damaging or completely destroying residential, commercial, and industrial structures, roadways and recreational beaches and park areas in developed coastal areas. From a social standpoint this destruction has caused a number of problems which include: the relocation of entire families and in some instances, neighborhoods; unemployment due to the destruction or severe damage to industrial and commercial establishments; the loss of recreational facilities such as beaches and parks as well as boats and marina facilities; the disruption to the flow of traffic due to road damage; and public health problems due to water supply contamination or destruction of sewerage disposal systems.

PROBLEM IDENTIFICATION

EXPECTED FUTURE CONDITIONS

Existing and future activities on coastal floodplain land in the study area is regulated and/or controlled by numerous laws, ordinances and policies. The National Flood Insurance Program, administered by the Federal Emergency Management Agency (FEMA) is currently in force in Milford. Under this program flood insurance zones and base flood elevation lines are established for each community. Subsidized flood insurance is then made available based on the Flood Hazard Factors of areas subject to flooding. To be eligible for Federal flood insurance, a community must adopt floodplain regulations to protect life and property from flooding, and control development in areas that are subject to flooding. Milford has adopted such regulations.

The State of Connecticut has also been very active in establishing regulations and programs to control development of floodplain lands. Floodplain management is presently being pursued in Connecticut under the following Acts:

- Stream Channel Encroachment Act
- The Inland Wetlands and Water Courses Act
- The Tidal Wetlands Act
- Flood Management for State Agencies Act
- Structures and Dredging Act
- The Diversion Act
- Coastal Area Management Act

These Acts form the basis for the Connecticut Department of Environmental Protection policy on floodplain management. This policy involves both the careful regulation and control of development in floodplain areas, and the promotion of floodplain uses such as recreation and open space which are compatible with the flood threat.

Refinement of existing state and community preparedness plans is also expected to continue. With completion of the Corps' hurricane evacuation study in the early 1990's, a large amount of technical data concerning flooding will be available. This information, which will include data on population centers at risk, evacuation routes and other concerns, will allow state

and local officials to update their emergency response plans.

The impact of the above programs, regulations and policies will be to limit and control future development of floodplain lands, and to promote the wise use of the low-lying coastal environment. Even with these regulations, the pressure for coastal development has not subsided. The recent and on-going development and redevelopment of what is considered "prime" coastal areas is expected to contiue. However, inasmuch as new construction or major reconstruction must have the first floor elevated above the 100 year flood height, future inundation damages are not expected to increase substantially due to new construction.

PLANNING OBJECTIVES

Water resources planning undertaken by Federal agencies is directed by the Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. These principles provide the basis for Federal participation with river basin commissions, State agencies and other concerned groups in developing plans for the use of water and related land resources to meet short and long term needs. The Federal objective of such studies is to contribute to national economic development (NED), consistent with protecting the Nation's environment, pursuant to environmental statues and applicable executive orders and Federal planning requirements. Plans will, therefore, be developed in the interest of achieving the general objectives of enhancing national economic development and protecting environmental quality. National economic development is enhanced by increasing the value of the output of goods and services, and by improving national economic efficiency.

Based on an assessment of the problems and needs of the study area, and the goals of the non-Federal sponsor, the study has concentrated on the following planning objectives:

1) Reduce potential tidal flood damage in Milford.

2) Preserve or enhance the environmental resources of coastal floodplain areas.

STUDY AND PLANNING CRITERIA

Recommendations to proceed to the next study stage (feasibility phase) were guided by two general constraints:

1) information be sufficiently detailed to determine that at least one potential solution will likely have Federal interest and be in accord with current policies and budgetary priorities; and

2) the potential solution be supported by the non-Federal sponsor, and consistent with their policies and statutes on coastal zone management, flood plain management and flood control. Since this study focused on flood damage reduction, Federal interest was established if a potential solution was economically justified and the non-Federal sponsor demonstrated support for futher study.

PLAN FORMULATION

MEASURES AVAILABLE TO ADDRESS THE FLOOD PROBLEM

To prevent or reduce flooding and associated damage, there are two basic types of protection available; structural and nonstructural. Structural and nonstructural measures differ in that structural measures affect the flood waters while nonstructural measures affect activities in the floodplain. Nonstructural solutions to flood problems are normally applied directly to each flood plain property or activity, in contrast to structural measures which normally affect the floodplain. Both types of flood control measures, or possible combinations, are evaluated to address the flood problem.

Structural Measures - Structural measures are characterized as those measures that prevent or reduce inundation of the floodplain. The following structural measures, either singularly or in combination with others, represent potential solutions to coastal flooding.

- Seawalls
- Dikes (to including the following)
  (1) Dune restoration and beach nourishment
  (2) road raising
- Bulkheads
- Tide gates or navigation gates
- Pumping facilities (used in conjunction with walls or dikes)

Nonstructural Measures - Nonstructural flood control measures are those measures which prevent or mitigate losses experienced by existing flood prone properties and activities, while allowing continued inundation of the floodplain. Applicable nonstructural measures are presented below:

Floodproofing techniques - Floodproofing, by definition, is a body of techniques for preventing damages due to floods; requiring adjustments both to structures and to building contents. It involves keeping water out as well as reducing the effects of water entry. Such adjustments can be applied by an individual or as part of a collective action either when buildings are under construction or during remodeling or expansion of existing struc-

tures. They may be permanent or temporary.

Floodproofing, like other methods of preventing flood damages, has its limitations. It can generate a false sense of security and discourage the development of needed flood control and other actions. Indiscriminately used, it can tend to increase the uneconomical use of flood plains resulting from unregulated flood plain development.

Although numerous measures exist, the following techniques apply to the study area:

(1) Temporary or permanent closures for openings in existing structures

(2) Raising existing structures

(3) Rearranging or protecting damageable property within an existing structure

(4) Relocation of existing structures and/or contents from a flood prone area

Flood forecast, warning and evacuation - This is a strategy to reduce flood losses by charting out a plan of action to respond to a flood threat. The strategy includes:

- A system for early recognition and evaluation of potential floods.

- Procedures for issuance and dissemination of a flood warning.

- Arrangements for temporary evacuation of people and property.

- Provisions for installation of temporary protective measures.

- A means to maintain vital services.

- A plan for postflood reoccupation and economic recovery of the flooded area.

NOT TO SCALE SHEET NO. 2

Floodplain regulations - Through proper land use regulation, floodplains can be managed to insure that their use is compatible with the severity of a flood hazard. Several means of regulation are available, including zoning ordinances, subdivision regulations, and building and housing codes. Their purpose is to reduce losses by controlling the future use and changing the existing use of floodplain lands.

Some regulations covering the use of the flood plains are already in effect in the communities within the study area. Regulations may be relatively prohibitive or may allow construction, provided the new structures are floodproofed and/or elevated above a designated flood elevation.

Flood insurance - Flood insurance is not really a flood damage prevention measure as it doesn't reduce damages, rather it provides protection from financial loss suffered during a flood. The National Flood Insurance Program was created by Congress in an attempt to reduce, through more careful planning, the annual flood losses and to make flood insurance protection available to property owners. Prior to this program, the response to flood disasters was limited to the building of flood control works and providing disaster relief to flood victims.

Utilization of nonstructural measures usually requires a combination of measures to adequately protect activities in a flood plain. For example, raising existing structures above projected flood heights would not completely solve the flood problem. Residents or other occupants must be warned of expected flooding so that the area can be evacuated. In addition, further development of the floodplain should be regulated to prevent future flood damages.

PRELIMINARY SCREENING OF MEASURES

The preliminary screening of alternatives was accomplished in the West Central Connecticut Study and summarized over the next few pages. During the course of the West Central Connecticut reconnaissance study, numerous meetings were held with State of Connecticut officials and representatives of Milford. The purpose of these meetings was to identify potentially high damage areas and possible alternative flood damage reduction measures.

In conducting the initial evaluation of these sites, all methods of reducing or eliminating potential flood damage were given consideration.

To determine which sites and alternatives warranted further study, an initial screening process was conducted. Factors considered during this process included the potential for flood damage, the possible environmental and social impacts, engineering feasibility, and public acceptability of identified alternatives. This preliminary screening process, which considered the views and desires of local interests, was conducted in conjunction with the Connecticut Department of Environmental Protection, Coastal Area Management (DEP/CAM) staff.

Costs and benefits for these plans were developed based on providing protection from a 100-year tidal flood event. Annual costs were developed using a project economic life of 50 years and the current Federal interest rate of 8 7/8 percent.

Information contained in Federal Emergency Management Agency publications and cost figures obtained from local contractors were used to develop costs to raise structures. Based on this information, the average cost to elevate an existing structure was determined to be about $28.00 per square foot of first floor area. This includes contingency costs and costs for engineering and design, and supervision and administration of construction.

Benefits attributable to protective works considered in this study were developed by conducting damage surveys. Damage evaluation teams visited each site, noted the physical characteristics and location of properties and conducted random interviews with local residents. This information, along with that obtained at local assessors' offices, formed the basis for calculating damages. To obtain expected damage figures, this information was then correlated with data concerning the frequency and depth of flooding. The annual flood reduction benefits attributable to a plan are then measured by subtracting annual damages remaining with a plan from total annual damages expected under current conditions.

Costs for structural plans considered in this report were based on actual costs for similar work which were adjusted to reflect current costs in the Connecticut area. Of particular note is the cost of sand necessary for dune and beach nourishment

projects. An analysis conducted by this office in conjunction with our evaluation of an erosion problem at Savin Rock Beach, West Haven determined that sand must be brought in from other areas as local suppliers are unable to supply the large quantities of sand required. Considering the purchase cost, and costs of transportation and placement, the final cost per cubic yard of sand was in the $20.00 to $25.00 range. An average cost of $22.00 per cubic yard was used to develop costs in this report. Costs for engineering and design, and supervision and administration of construction must be added to develop total project cost.

Sites and Alternatives Studied - Eight sites covering most of the coastline of Milford were identified for study. These eight sites were: Burwells Beach, Point Beach, Bayview Beach, Gulf Pond/Indian River/Rt. 162, Milford Harbor/Factory Lane, Fort Trumbull/Silver Beaches, Seaview Ave./Broadway, and Cedar Beach.

Two sites, Gulf Pond/Indian River/Rt. 162 and Milford/Factory Lane, were determined to have insignificant Federal interest due to a lack of potential benefits. These are only a few homes and commercial buildings subject to minor flooding in the two areas.

Alternatives originally considered for the six remaining sites included dune restoration/construction and beach nourishment, raising structures, flood warning and evacuation, and in the case of Cedar Beach, road raising and relocation. Road raising was determined to have no significant impact on flood damage reduction, and relocation was considered impractical and too expensive, as well as politically unacceptable. Sand dune restoration and beach nourishment at Cedar Beach was also not feasible because of high costs and the potentially severe adverse environmental impacts. Dune restoration/construction and beach nourishment plans were developed in some detail for the other five sites. Further study of raising structures and flood warning and evacuation was conducted for all six sites. Dune construction plans for all five sites would have the same height and basic configuration. The top elevation of the dune would be at elevation 17.0 feet NGVD. The dune would be stabilized by planting dune grass. A 50 feet wide berm would be located on the seaside of the dune at elevation 11.0 feet NGVD to protect the dune against excessive wave action. This berm would be fronted by a sloped beach face of essentially the same slope as the existing beach.

The approximate length and limits of these dune projects are shown on Plate 2 and presented as follows:

Point Beach - A dune approximately 3,000 feet long, tying to high ground at each end, would protect this area.

Bayview Beach - Protecting this area would require a dune about 4,400 feet long and tide gate at Calf River. The dune would extend to high ground at each end.

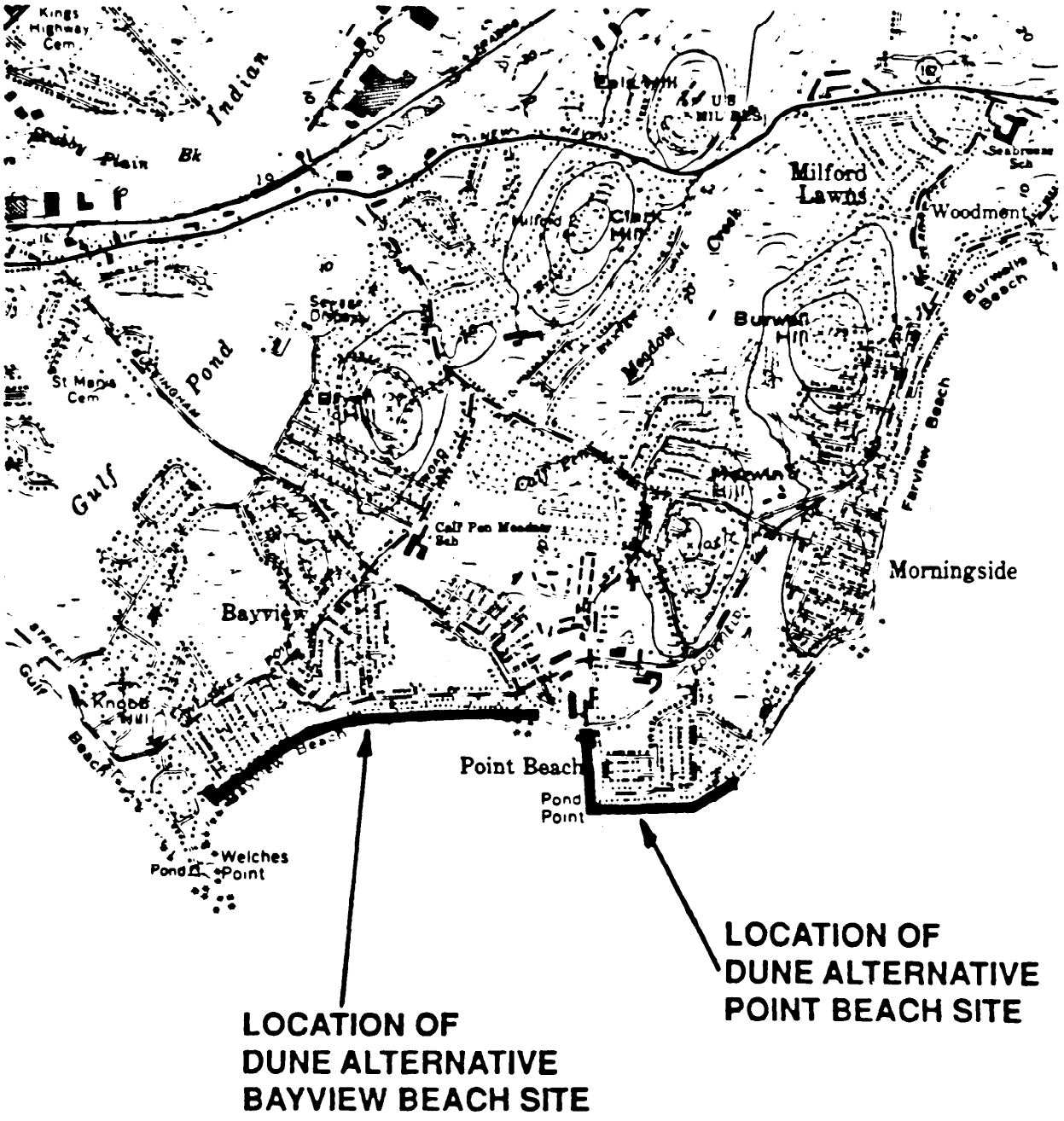
Economic Anlaysis - Although dune and beach nourishment projects are not economically justified at any of the five sites investigated, raising structures was justified at Point Beach and Bayview Beach. Costs of raising structures at these two locations were evaluated further by estimating the average size of first floor area for homes in the 100 year flood plain. This size was developed based on contour mapping provided by the City of Milford. This size was multiplied by the estimated cost of $28.00 per square foot to raise a wood-frame structure. The average first floor area of homes at these sites is about 1,050 square feet, resulting in an average raising cost of $29,400. Bsaed on these costs the following table presents the results of the West Central Connecticut Study:

Table 1
West Central Connecticut Study Results

Area	Structures	First Cost	Annual Cost	Annual Benefit
Point Beach	147	$4,320,000	$379,000	$572,000
Bayview Beach	136	$4,000,000	$351,000	$375,000

SUMMARY OF PRELIMINARY SCREENING

As a result of the initial screening of available flood control alternatives accomplished by the West Central Connecticut study, two areas were recommended for further evaluation. Preliminary analysis indicated there were economically justified plans to raise homes in the Point Beach and Bayview Beach areas. However, because of the scope of the West Central Connecticut Study, which included 8 communities and over 12,000 structures, many assumptions were made which effect the benefit analysis and project justification. Further analysis to confirm some of the more critical assumptions was required before proceeding into a cost shared feasibility study.



Milford, Connecticut
Section 205
Local Flood Protection

Dune Projects

Plate 2

SECOND STAGE SCREENING

The second stage screening was necessary and conducted under the Section 205 authority. The screening involved obtaining more detailed site specific information in each of the 2 damage areas including estimates of first floor elevations, types of homes and more detailed estimates of costs to raise homes.

There are 147 houses in the 100 year flood plain at El. 10.0 feet NGVD (see Plate 3) in the Point Beach area. The Bayview Beach area was seperated into two areas, Melba Street (see Plate 4) with 61 structures and Bayview with 136 structures as shown on Plate 5. The ground elevation at each structure was estimated using 1 inch equals 100 foot, 2 foot contour mapping provided by the city. The first floor elevations of the structures were determined by estimating the height of the first floor above the ground for each structure during a field visit.

The first floor elevations for the structures were then compared with the appropriate flood elevations. Flood frequencies and elevations were provided as part of the West Central Connecticut Study and represents the ocean stillwater elevation in the Milford area. The following table summarizes the flood elevations, frequencies and the number of structures with first floors in each flood zone.

Table 2
Structures in the Flood Plain

1st Floor Elevation	Frequency	No. of Structures Point Beach	Melba St.	Bayview
Total ~~over 12 ft~~		147	61	136
below 12 ft	~~500 year~~	105	35	34
below 10.5 ft	~~100 year~~	52	16	7
below 9.7 ft	~~50 year~~	13	4	3

The Structure Inventory for Damage Analysis (SID) computer program was used to calculate the total annual damage for each structure. The assessed value of the structure and the elevation of the first floor were the major input parameters for this analysis. The total annual damage for all the structures in each

area were calculated using the Recurring Losses for each event as summarized in Table 2b. The total annual damages for each area are shown below in Table 3:

Table 2b
Recurring Losses by Event

	50 year Losses	100 year Losses	500 year Losses
Point Beach	$3,018,000	$5,601,000	$11,342,000
Melba Street	$ 950,000	$1,774,000	$ 3,878,000
Bayview Beach	$ 392,000	$ 858,000	$ 3,711,000

Table 3
Total Annual Damage

Point Beach	Melba St.	Bayview
$331,000	$69,000	$37,000

The annual benefit for each structure was determined by raising the 1st floor level to the 50-year, 100-year and 500-year flood elevation and eliminating the damages below that point. The annual damage to each structure was recalculated and subtracted from the total annual damage to determine the annual benefit. The benefits are summarized in Table 4 with annual residual losses in Table 4a below:

Table 4
Total Annual Benefit

1st Floor Elev	Point Beach	Melba St.	Bayview
12.0 ft	$305,620	$59,980	$28,610
10.5 ft	$229,000	$36,220	$ 3,190
9.7 ft	$183,780	$19,880	$ 5,920

Table 4a
Annual Residual Losses

1st Floor Elev	Point Beach	Melba St.	Bayview
12.0 ft	$ 25,400	$ 9,000	$ 8,400
10.5 ft	$102,000	$32,800	$23,800
9.7 ft	$147,200	$49,100	$31,100

To determine if a project is economically justified and eligible for Federal participation, the annual benefit of the project must exceed the annual cost. The costs estimated for the original study were based on curves developed by the Federal Emergency Management Agency which are general in nature and adequate for use in a preliminary analysis. However, for this investigation it was necessary to update these costs. Raising homes in these areas would involve the following actions:

1) Raising the structure
2) Replacing or rebuilding the existing foundation; piles or foundation walls would be used.
3) Placing the structure on the elevated foundation
4) Extending utilities and rebuilding/extending access.
5) Relocating or protecting any utilities (heating system) that may have been located in a basement and subject to flooding.
6) Temporary relocation of building occupants during the construction period.

Costs were estimated for each of these actions based on other studies at New England Division and adjusted for this specific area. The costs were based on the type of structure, the height it needed to be raised and whether or not it had a basement. The following table summarizes the results of the cost analysis for each area.

Table 5
Total Raising Costs

1st Floor Elev	Point Beach	Melba St.	Bayview
12.0 ft	$4,604,000	$1,494,000	$1,320,000
10.5 ft	$2,061,000	$ 612,000	$ 272,000
9.7 ft	$ 527,000	$ 150,000	$ 108,000

Benefit Cost Ratio's (BCR) were calculated to determine if any of the areas have justified projects. For 100-year flood condition, Point Beach area has a 1.3 BCR and for 50-year, Point Beach and Melba Street have a 3.88 and 1.47 BCR, respectively. See Tables 6a, 6b and 6c below:

Table 6a
50 Year Raising Plan

	Point Beach	Melba St.	Bayview
Annual Benefits	$183,780	$19,880	$5,920
Annual Costs	$ 47,400	$13,500	$9,700
B/C Ratio	3.88	1.47	0.61
Net Benefit	$136,380	$ 6,380	-$3,780

Table 6b
100 Year Raising Plan

	Point Beach	Melba St.	Bayview
Annual Benefits	$229,000	$36,220	$13,190
Annual Costs	$185,600	$55,100	$24,500
B/C Ratio	1.27	0.66	0.54
Net Benefit	$ 43,400	-$18,900	-$11,300

Table 6c
500 Year Raising Plan

	Point Beach	Melba St.	Bayview
Annual Benefits	$305,620	$59,980	$28,610
Annual Costs	$414,500	$134,500	$118,800
B/C Ratio	0.74	0.45	0.24
Net Benefit	-$108,900	-$74,500	-$90.200

Rationale for Selected Plan

The plan selected for further study is based on the final analysis provided in Tables 5 & 6. As shown in those tables, 3 seperate proposals are economically justified (BCR greater than one). The 50 year plan for Point Beach suggests raising 13 homes to the 50 year flood elevation. The 50 year plan for Melba Street suggests raising only 4 homes. Because of the scope and the number of structures involved, it is not in the Federal interest to participate in these plans. However, the plan to raise 52 homes in the Point Beach area to the 100 year elevation does appear feasible for Federal participation.

FEASIBLE PLAN

PROJECT DESCRIPTION

A feasible plan for local flood protection in the Point Beach area of Milford consists of raising the first floor elevation of all the homes within the 100 year floodplain to the 100 year flood level plus 2 feet. There are 52 homes with first floors located below elevation 10.5 feet, which is the 100 year flood level.

PROJECT COSTS

The costs to raise the homes involved are based on the square foot area of the first floors and the height the structure has to be raised. The following costs were estimated for each structure based on previous studies and revised for this specific area:

Jacking structure off foundation
Raising the foundation
Adjusting or protecting utilities
Adjusting entrances
Temoporary relocation of family
Landscaping

Added to these costs were a contingency factor, engineering and design costs and supervision and administration costs. The average cost per structure was estimated at just under $40,000. The total cost of the plan is $2,061,000. The annual cost was based on the total cost amortized over a 50 year project life at 8 7/8% interest rate. The annual cost of the plan is $185,600.

PLAN ACCOMPLISHMENTS

The plan of improvement would provide protection against a one percent (100 year) frequency design flood. The proposed project would reduce the average annual flood losses by over 95 percent from $239,000 to $10,000 providing an average flood damage reduction benefit of $229,000. With an annual cost of $185,600, the proposed plan would have a benefit to cost ratio of 1.27 to 1.

COST ALLOCATION

The sole purpose of the justified plan is flood damage reduction, and all costs have been allocated as such. Under current cost sharing requirements for Section 205 local protection projects, the local sponsor of the project must provide 25 percent of the project costs including the necessary lands, easements, rights-of-way and utility relocations required for the project and assume responsibility for operation and maintenance of the project after it is constructed. Table 7, below, presents a division of project costs between the Federal government and non-Federal sponsor, based on current cost sharing policies.

TABLE 7
Cost Sharing for the Selected Plan

	Total Project Costs	Percent of Total
Federal	$1,546,000	75
Non-Federal	$515,000	25
Total	$2,061,000	100

CONCLUSIONS

This study was accomplished under authority contained in Section 205 of the 1948 Flood Control Act, as amended. This plan would provide the properties in the Point Beach area with much needed protection from future flood losses. The plan involves raising the first floors of the homes in the area to the 100 year flood level plus 2 feet. The best indication of the protection offered by the this project would be it's effectiveness in reducing expected annual flood losses. It is estimated that this project would reduce annual flood losses in the project area by over 95 percent.

RECOMMENDATIONS

I recommend that further study on this project be continued under Section 205 of the 1948 Flood Control Act in the Detailed Project Phase. The total Detailed Project Phase is expected to cost $100,000.

Date

DANIEL M. WILSON
Colonel, Corps of Engineer
Division Engineer