TIDEWATER GOBY MANAGEMENT PLAN

LOWER MISSION CREEK FLOOD CONTROL PROJECT

April 2005

Prepared for:

City of Santa Barbara
County of Santa Barbara
Corps of Engineers

Prepared by:

URS Corporation
Goleta, California

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LOWER MISSION CREEK FLOOD CONTROL PROJECT

Corps of Engineers, Los Angeles District, County of Santa Barbara, and City of Santa Barbara

April 2005

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1.1 BACKGROUND INFORMATION

The Lower Mission Creek Flood Control Project (Project) consists of various channel and bridge improvements along Mission Creek from Canon Perdido Street to Cabrillo Boulevard. The Corps of Engineers (Corps) is funding most of the design and construction. The local sponsors are the City and County of Santa Barbara. The objective of the Project is to reduce flooding by increasing the channel capacity from its current capacity of 1,500 cfs to 3,400 cfs (a 20-year event). The improvements described in the Lower Mission Creek Flood Control Feasibility Study (Corps, 2000) include the following elements: widening the existing channel; replacing and widening of four bridges; constructing vertical wall channels with the upper slope and adjacent buffer zone to be planted with riparian trees and understory plants; constructing a by-pass weir and parallel culvert to convey high flows under Highway 101; and constructing various channel features to improve habitat conditions for fish.

In 2001, the California Coastal Commission (CCC) approved a preliminary Federal Coastal Zone Consistency Determination to the Corps for the Project. In November 2001, the CCC issued an Addendum to the Consistency Determination Findings. The Addendum included a condition that addressed impacts of the Project on the endangered tidewater goby, which occurs in the estuarine reach of the creek. The condition requires that the Corps and local sponsors consult with tidewater goby experts to develop a plan to minimize project-specific and cumulative impacts to the goby through design elements and protective measures to be implemented during construction, and feasible short-term and long-term recommendations identified in this plan. The plan must be approved by the CCC prior to issuance of a final consistency determination for the project design. The condition reads as follows:

> "*Tidewater Goby Studies, Management Plan and Recommendations: The Corps of Engineers with input from interested biological experts shall conduct Tidewater Goby studies and develop a Management Plan for Tidewater Gobies in the Mission Creek Estuary that evaluates project specific impacts and includes recommendations to minimize those effects. The Corps shall implement all feasible short- and long-term recommendations in the plan to mitigate impacts associated with the project or intended to lessen project-specific or cumulative impacts to Tidewater Gobies. The Corps shall also make recommendations regarding whether or not to proceed with a Tidewater Goby genetic study to help assess project impacts related to potential extirpation and recolonization. In addition, the Corps shall make recommendations regarding allowing the Mission Creek and Laguna Creek estuaries to merge under natural conditions (or as recommended by the team of biologists) in order to benefit Tidewater Gobies. The results of the tidewater goby management studies and recommendations shall be submitted to the Commission as part of the consistency determination for the design phase review of the Lower Mission Creek Flood Control Project.*"

As noted above the City of Santa Barbara (City) and County Flood Control District (County) are local sponsors of the Project. In 2002, the City initiated efforts to develop the Tidewater Goby Management Plan (Plan) on behalf of the Corps and County. The City convened the Tidewater Goby Working Group in March 2002. The City conducted four meetings of the group to assist in developing the Plan. The meetings occurred in March, May, and October 2002; and in February 2005. The Working Group consisted of the following parties:

John Moeur and Gail Campos – Corps of Engineers
Bridget Fahey and Chris Dellith – US Fish and Wildlife Service
Pat Kelly – City of Santa Barbara, City Engineer
Tom Fayram – County Flood Control District, Deputy Director
Jan Hubbell and Mike Berman – City of Santa Barbara, Community Development
Brian Trautwein – Environmental Defense Center
Drew Bohan and Jessie Alstatt – Santa Barbara Channelkeeper
Camm Swift – Los Angeles County Museum of Natural History
David Jacobs – University of California, Los Angeles
Kevin Lafferty – University of California, Santa Barbara
Mark Holmgren – UCSB, Vertebrate Museum
Scott Cooper – UCSB, Biological Sciences Department
John Gray – URS Corporation

1.2 OBJECTIVE AND SCOPE OF THE PLAN

The objective of the Plan is to present design features and management measures that will reduce adverse impacts of the Project on the tidewater goby. The Plan will be jointly implemented by the City, County, and Corps. The Plan will be implemented in the following three phases:

- Design Phase – channel design features to enhance habitat conditions for the goby will be included in engineering plans prepared by the Corps.

- Construction Phase – fish protection and relocation procedures will be implemented by the Corps, City, and County during construction.

- Post-Construction Phase – fish monitoring will be implemented by the City and County to ensure that the goby population remains stable or increases, and to implement any necessary corrective measures if adverse impacts are observed.

The Plan has been prepared as a concise document with specific management actions and guidance that will become a part of the Project, and that will be approved by the CCC in their final Federal Coastal Zone Consistency Determination for the Project. The Plan will be implemented and funded by the Corps, City, and County. The division of responsibility and funding for implementing the Plan amongst the Corps, City, and County will be determined in the near future.

2.0 SUMMARY OF THE PROJECT IN THE ESTUARY

Lower Mission Creek is subject to tidal influence up to Yanonali Street (Figure 1, Appendix A). The extent of tidal influence is dependent upon conditions at the beach. In the summer and fall, a lagoon forms on the beach at the mouth of the creek. In the winter, the mouth of the creek is open to the ocean because runoff breaches the sandbar that forms the lagoon. When the creek is open to the ocean, high tides flow into the creek and can reach the concrete sill at Chapala Street Bridge near Yanonali Street. Hence, the entire reach is considered Mission Creek estuary, although the extent of tidal influence is highly limited. The waterbody downstream of Cabrillo Boulevard is called the Mission Creek Lagoon. Hence, the term estuary or estuarine reach refers to all tidally influenced portions of the creek, while the lagoon only refers to the waterbody south of Cabrillo Boulevard.

In the estuarine reach of Lower Mission Creek, the channel will be widened to 50 - 60 feet, which is approximately twice its current width (see Figures 2a,b). Based on the design in the Corps' September 2000 feasibility study, the new channel will have vertical concrete walls for most of the estuary length, except for two short reaches with a combination of vertical wall and rip-rap upper slope, and riparian habitat above the slope (see Figure 3). Mason Street Bridge will be replaced with a wider bridge. The Project does not include replacement of the State Street or Cabrillo Boulevard bridges.

The County conducts routine maintenance of the improved portions of Mission Creek, including the creek channel in the urbanized areas of Santa Barbara. Maintenance primarily involves the removal of sediment and woody debris that have accumulated in the channel, reducing channel capacity. In some instances, obstructive vegetation is removed. The County has not conducted maintenance along the estuarine reach for several decades. It appears that the high winter flows that occur in the lower reaches of the creek have been sufficient to convey sediments and debris to the beach and ocean. No obstructive vegetation forms in the estuarine reach because of the cobbly substrate and the presence of year-round water.

As described in the Corps' Revised Biological Assessment (June 2000) for the Project, the Corps has determined that maintenance of the estuarine reach to remove sediments, obstructive vegetation, and debris will not be required after the Project is constructed. However, the County will inspect the new channel walls and repair them as necessary. If it is determined that channel maintenance is required along the estuarine reach after completion of the Project improvements, the City and County will reconvene the Goby Working Group to develop maintenance procedures and goby protection measures that are acceptable to all parties.

3.0 OCCURRENCE OF TIDEWATER GOBIES

A permanent population of tidewater gobies occurs in the estuary. There are few data on the relative abundance of the species and its distribution in the estuary. Surveys of limited extent have been conducted throughout the 1990s, and in 2000 and 2002 by various investigators. A report on the occurrence of the gobies was prepared in 2000 by Camm Swift (Swift, 2000). In 2004, the City Parks and Recreation Department, Creeks Division, initiated a two-year creek monitoring study on the estuarine reach of Mission Creek, including the lagoon, that included goby surveys (ECORP, 2005).

A summary of the current state of knowledge about the occurrence of gobies and the condition of their habitat in the estuarine reach is presented below:

- Water temperatures, salinity, and depth are suitable for gobies throughout the estuarine reach
- The substrate upstream of State Street bridge appears to be comprised of cobbles, which would preclude or limit spawning
- The substrate downstream of State Street bridge is comprised of fine to coarse sands, which is suitable for goby spawning
- Observations and sampling data collected to date indicate that most of the gobies are located in the portion of the estuary immediately above and below Cabrillo Boulevard Bridge
- Emergent vegetation is sparse in most of the estuary and absent from the lagoon, which would limit overall goby abundance

Knowledge of the following issues is limited: (1) most favorable locations for spawning and foraging; (2) primary habitat factors (temperature, cover, salinity, etc) that affect goby abundance and distribution; (3) means by which gobies avoid being washed to the ocean during storm events; and (4) year to year and seasonal population fluctuations.

Quantitative sampling of gobies in Mission Creek estuary was conducted by the Creeks Division in 2004; results are reported in ECORP (2005). Fish seining was conducted at three locations in the estuary during the months of June, September, and November 2004. The locations included the following:

- Lower Estuary – about middle of the lagoon on the beach
- Middle Estuary – between Cabrillo Boulevard and State Street
- Upper Estuary – immediately below the Mason Street Bridge

During each sampling event, a beach seine (33 feet in length, 1/8 inch mesh) was deployed about 25 feet from shore and pulled onto the adjacent shore. All fish were collected and identified into species and size classes. The results of the survey for gobies are summarized below:

TABLE 1
RESULTS OF GOBY SAMPLING, 2004

Sample Event	Number of Gobies in Sample		
	Lower Estuary (Lagoon)	Middle Estuary	Upper Estuary
June	43	183	38
September	17	8	0
November	0	0	0

Data from ECORP (2005)

The surveys show that gobies occur in low abundance in the upper estuary and in the lagoon. Gobies were most abundant between the lagoon and State Street Bridge. Goby were also more abundant in the spring compared to the late summer. At this time, there is insufficient information to explain these observations or to identify trends or patterns.

The results from the 2004 surveys also indicate that gobies appear to occur in low numbers in Mission Creek Estuary compared to Arroyo Burro Estuary where a similar sampling was conducted. Arroyo Burro Estuary is located about three miles west of Mission Creek in another watershed.

4.1 INTRODUCTION

A genetic study was conducted of the tidewater goby population in Mission Creek estuary by Dr. David Jacobs of the Department of Ecology & Evolution, University of California, Los Angeles on behalf of the Corps of Engineers. The objective of the study was to characterize the genetic variation in the Mission Creek estuary population and compare it to other regional populations. Specific questions that were addressed included: (1) is the genetic make up of the population distinct from others in the region? (2) Does the Mission Creek population have greater genetic variation? (3) Does the Mission Creek population exhibit unique genetic traits? and (4) Does the genetic data indicate that the Mission Creek population serves as a source population to recolonize other smaller estuaries in the region? Answers to these questions provide a context for determining the level of concern regarding the potential impacts to the tidewater goby due to the Lower Mission Creek Flood Control Project. A summary of the study results is provided below. Copies of the full report are available from the Corps of Engineers.

4.2 BACKGROUND

The Mission Creek tidewater goby population occurs in the "CO3 subunit of the Conception Unit," identified in U.S. Fish and Wildlife Service's Draft Tidewater Goby Recovery Plan as the populations in coastal estuaries from Point Conception to Rincon Creek. Tidewater gobies have been reported in 28 localities in the CO3 Subunit. Not all these localities currently support tidewater goby populations and others are thought to be intermittent rather than continuously inhabited localities. Four large populations appear to be extirpated - Devereaux Slough, Campus Lagoon, Goleta Slough and Carpinteria Salt Marsh. Fifteen sites are considered intermittently occupied. There are nine sites in the CO3 Subunit where tidewater gobies are thought to occur regularly. The Corps' genetic study examined 10 populations from Gaviota Creek, approximately 33 miles to the west of Mission Creek, to Arroyo Paredon, approximately eight miles east of Mission Creek.

The individual populations in the CO3 Subunit are part of a "metapopulation," which is defined as a set of populations in a region within which local extirpation, migration, and recolonization occur. Genetic variation is affected by these population processes. Hence, habitat factors at the individual population sites that affect the rate of extirpation, migration, and recolonization will influence the genetic variation of the metapopulation. Maintaining the habitat quality and number of occupied estuaries will maintain genetic variation of the metapopulation.

The metapopulation will vary greatly over time due to floods, droughts and human influences. Some individual populations may have occurred in estuaries that persist through this variation. Such populations may then serve as sources for other less persistent "sink" populations. Persistence greatly increases the potential that a site will be a source of recruits rather than a sink in a metapopulation. Persistent source populations have a more continuous history of larger population size critical to sustaining the genetic variation in the regional metapopulation as they are

less subject to population "bottlenecks." Large systems are likely to be more persistent source populations. Smaller sites, perhaps even some that only very irregularly contain gobies, are likely to provide stepping stones permitting dispersal and recolonization along the coast.

The Mission Creek population is expected to be a source population in contributing to the regional metapopulation because of it's large size and long history of goby occurrence. Available data indicates that the size of lagoons is correlated with the persistence of tidewater gobies. Mission Creek is the largest lagoon that is regularly inhabited by tidewater gobies in the C03 Subunit. It also has a more extensive upstream reach accessible to tidewater gobies than other streams, a habitat type known to be extensively used by tidewater gobies.

The major issues addressed in the Corps' genetic study are whether the Mission Creek and the associated Laguna Channel Lagoon are source populations critical to the maintenance of the local metapopulation, and whether, as more persistent source populations, they contain genetic variation not found elsewhere. If so, the possible extirpation of the population from human activities, such as the Lower Mission Creek Flood Control Project would have genetic consequences.

4.3 STUDY METHODS

The localities examined in the study include Gaviota Creek, Refugio Creek, Tecolote Canyon, Winchester Canyon, Arroyo Burro, Mission Creek, Laguna Channel, Sycamore Creek Andre Clark Bird Refuge and Arroyo Paredon. The 10 sampling sites investigated in the study vary in size, proximity to one another, and in whether they are considered "regular" or "intermittent."

Tidewater gobies were collected from the 10 study sites between 1999 and 2002 under the auspices of California Department of Fish and Game Permit No. 801120-02, including associated Memorandum of Understanding and U.S. Fish and Wildlife Service Permit No. 801120-02 (issued to C.C. Swift). DNA was extracted from 30 individual fish from each of the 10 sites, with the exception of Laguna Channel, which only had 25 fish collected from it.

4.4 RESULTS

The results of the genetic analysis indicate the populations in the CO3 Subunit are significantly subdivided, as summarized below:

- The genetic variation at Gaviota Creek is unique, perhaps due to its isolation on the end of the study area. It may be engaged in intermittent longer distance gene flow with sites on the eastern end of the range.

- Winchester Canyon, Tecolote Canyon and Refugio Creek exhibit with limited mitochondrial variation and distinct microsatellite alleles. Tecolote Canyon and Refugio Creek are inferred to have recolonized from Winchester Canyon. Refugio Creek is substantially reduced in genetic variation.

- Arroyo Burro, Mission Creek and Laguna Channel are significant sources inferred to have recolonized Sycamore Creek, Andre Clark Bird Refuge and Arroyo Paredon. They

contain substantial numbers of unique mitochondrial alleles, but only a few unique microsatellite alleles.

4.5 CONCLUSIONS AND RECOMMENDATIONS

The study concluded that tidewater goby population in Mission Creek Estuary and Laguna Channel Lagoon contains a small fraction of unique alleles. This population may be critically important in the recolonization of intermittent populations in Sycamore Creek, Andre Clark and Arroyo Paredon. Extirpation of the Mission Creek population during construction, if it were to occur, would adversely affect genetic variation in the region. This impact would not be significant if the estuary was rapidly recolonized from another site in the CO3 Subunit.

The following recommendations to avoid extirpation of the Mission Creek Estuary population, and its indirect genetic effects, were presented in the study:

- ✓ Arroyo Burro is the most similar source population to Mission Creek and Laguna Channel Lagoon. Hence, the City and County should avoid any major construction or maintenance work at Arroyo Burro estuary that could affect the goby at the same time as the work on Mission Creek Estuary is occurring.

- ✓ The Mission Creek Lagoon on the beach should be maintained separate from the Laguna Channel Lagoon during and immediately after the construction in Mission Creek to preclude any adverse impacts of construction on the Mission Creek Lagoon from also affecting the Laguna Channel Lagoon.

- ✓ A small number of gobies should be maintained outside of the Mission Creek Estuary during construction as a possible contingency source population in the unlikely event of significant mortality during construction.

The impacts to the tidewater goby from the proposed project were evaluated in the September 2000 Final EIR/EIS, the Corps' Biological Assessment, and the Biological Opinion (dated June 2001) prepared by the US Fish and Wildlife Service. Impacts of concern are listed below:

- Possible reduction in fine and sandy sediments in the estuarine reach due to a change in hydraulic conditions that could adversely affect suitability of the channel bottom for foraging and spawning.

- Possible loss of individual gobies during construction dewatering procedures due to handling; entrainment in dewatering pumps; noise/vibration effects from construction; sedimentation due to upstream construction; and contamination from construction related spills.

- Potential disturbance of population and habitat due to future channel wall repair.

An assessment of these impacts is presented below, supplementing the analyses in the Final EIR/EIS and Biological Assessment.

5.1 IMPACTS OF MODIFIED HYDRAULIC CONDITIONS

5.1.1 Increased Flow Velocities

The proposed channel widening will alter hydraulic conditions in the estuary because a greater percentage of flows will be contained in the channel compared to current conditions when the same flows would overtop the banks and be conveyed overland. The Corps has predicted that the flow velocities in the estuarine reach would increase as a consequence of a wider channel with greater conveyance capacity, as shown in Table 2. The magnitude of the increase would be minor. For the 20-year event, the flow velocities would actually decrease.

TABLE 2
PREDICTED CHANGE IN FLOW VELOCITIES IN THE ESTUARY

Storm Event	Flow Velocities in the Center of the Channel (feet per second)*	
	Existing Conditions	Proposed Conditions
2-yr (640 cfs)	4.13	5.22
5-yr (1,470 cfs)	5.85	6.64
20-yr (3,400 cfs)	7.91	7.02

* Average flow velocities for channel from Cabrillo Blvd to Yanonali St. Data from the Corps' Final EIR/EIS Volume II, Hydraulic Report.

Tidewater gobies are poor swimmers in fast moving water. During storm events, they find refuge in backwater areas where flow velocities are reduced. No backwater areas occur in the estuary

upstream of Cabrillo Boulevard under current conditions, nor would any be created with the Project. However, the Corps has included the following design elements to provide area for gobies to find refuge during high flow events (see Figures 2 and 3):

- Fish refugia, which will consist of 8-foot tall "ribs" constructed on the concrete walls. They will protrude about 3 inches from the walls, providing a barrier to high flows. The ribs will be spaced at two foot intervals. They would extend from the ordinary high water mark to the channel bottom. Flow velocities would be lowered behind the ribs, providing a refuge for small gobies during high flow events.

- Fish ledges, which consist of concrete structures about two feet high and 50 feet long. The would be placed about 10-20 inches above the creek bottom, and would be under water most of the time. The ledges will provide shade and protection from predators in the new channel, and may provide limited backwater effects.

- Fish baffles, which consist of two rows of 1.5 - 2 foot high rock placed on the creek bottom adjacent to the walls. The rocks will create backwater effects where gobies can rest.

It should also be noted that velocities in the channel are greatly reduced along the perimeter due to the effects of friction on the channel bottom and walls. Hence, gobies would find slower moving water along the channel walls and bottom. It is likely that these areas are currently used by gobies during storm events, as there are no distinct backwater areas in the estuary upstream of Cabrillo Boulevard.

As fast-moving water enters the lagoon and beach area, it spreads out and velocities are reduced. The Corps' hydraulic modeling for the Project included the lagoon. The data from the modeling indicates that velocities would decrease on the beach, as shown in Table 3. The current and future velocities are relatively low. Gobies would be capable of withstanding the velocities of the 2- and 5-year events, and would likely find backwater refugia in the lagoon during the high flow event.

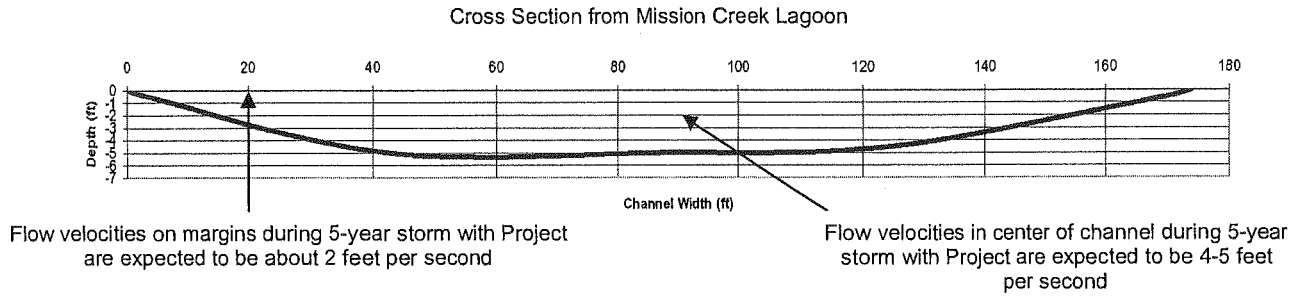
TABLE 3
PREDICTED CHANGE IN FLOW VELOCITIES IN THE LAGOON

Storm Event	Flow Velocities (feet per second)*	
	Existing Conditions	Proposed Conditions
2-yr (640 cfs)	4.13	2.04
5-yr (1,470 cfs)	6.13	4.07
20-yr (3,400 cfs)	8.48	6.64

* Average flow velocities for channel downstream of Cabrillo Blvd. Data from the Corps' Final EIR/EIS Volume II, Hydraulic Report.

As noted above, the velocities along the perimeter of the flowing water in a channel, or in the lagoon, will be less than the average velocities across the entire cross section. The width of Mission Creek lagoon ranges from 50 to 200 feet (see Figure 4). Velocities along the perimeter of earthen channel, such as at the lagoon, are typically 30-50% lower than in the center of the

channel. In the case of Mission Creek lagoon, the wide channel would create low velocities along the margins that would reduce impacts of fast moving water on gobies during storm events, as shown below:



5.1.2 Changes in Channel Substrate

In the Final EIR/EIS and the Biological Assessment, the Corps concluded that the Project could reduce fine sediment in the bed load reaching the estuary, which could convert any sandy substrate that is present in the estuary to rocky substrate. The Corps indicated that fine sediments would be removed from the estuary during high flow events because the water from the upstream by-pass weir would have a low sediment load, and therefore, would scour and transport fine sediments from the estuary. The Corps also stated that fine sediments would be re-deposited during low flow conditions.

The USFWS reviewed the Corps's analysis and concluded that the potential reduction in fine sediments would not adversely affect goby spawning because: (1) the substrate in the estuary upstream of State Street Bridge is mostly cobble; (2) goby spawning appears to be restricted to the lagoon or between State Street and Cabrillo Boulevard where a sandy substrate is present; and (3) the sandy substrates observed in the lagoon are derived from the beach and tidal inflows, not from upstream deposition (Swift, 2000). Photographs of the substrate are presented in Appendix B.

The effect of a potential reduction in fine sediments on goby foraging is unknown, but believed to be minor to negligible because the existing channel substrate upstream of State Street appears to be comprised of cobbles. Hence, any increase in scouring and sediment transport in the estuary would not remove sediments and convert a sandy substrate to a rocky substrate.

5.2 CONSTRUCTION IMPACTS

Construction of the channel improvements would directly affect any gobies in the estuary, and possibly indirectly affect any gobies in the lagoon. Construction of the channel improvements and the wider Mason Street bridge will require dewatering of a portion of the channel to provide construction access. Gobies will need to be temporarily relocated during construction.

Potential impacts to gobies include the following:

- Possible loss of individual gobies during construction dewatering procedures due to entrainment in dewatering pumps

- Potential loss of gobies due to fish capture and relocation efforts
- Possible disturbance due to noise and vibration from nearby construction
- Possible disturbance to downstream fish due to increased turbidity and sedimentation from construction
- Possible harm from contamination from accidental construction-related spills

The Corps has incorporated the following measures in the Project to minimize construction related impacts:

- Construction work in the estuary will only occur from June 15th to December 15th to avoid the peak spawning period

- The construction areas will be separated from the estuary and dewatered using temporary cofferdams. No more than one half of the estuary (upstream of Cabrillo Boulevard) will be dewatered at any time.

- Gobies will be removed from the construction areas prior to dewatering by seine netting under the direction of a qualified biologist with federal permits to handle gobies. Captured gobies would be placed in the unaffected portions of the estuary and lagoon.

USFWS included the following terms and conditions in their 2001 Biological Opinion for the Project to protect gobies during construction. The incidental take statement in the Biological Opinion included unavoidable harm, harassment, and mortality of gobies during construction from capturing and relocating fish.

1. The Corps shall submit to the Service in writing, at least four weeks prior to the onset of work, the qualifications of a biologist familiar with tidewater goby biology. This biologist will be responsible for implementing measures that involve handling and relocating tidewater gobies. The Service will provide written authorization of the individual, if qualified, or denial, if unqualified.

2. The qualified biologist shall conduct a training session for all personnel associated with construction in the estuary prior to the onset of work. At a minimum, the training shall include a description of the tidewater goby and its habitat; the general provisions of the Act; the necessity for adhering to the provisions of the Act; the penalties associated with violating the provisions of the Act; the specific measures that are being implemented to conserve the tidewater goby as they relate to the project; and the boundaries of the project within which it may be accomplished.

3. The authorized biologist shall complete initial surveys for tidewater gobies in Mission Creek one week prior to the onset of work. After the construction phase of the project has been completed and then annually for a period of five years, a qualified biologist shall conduct surveys for tidewater gobies to determine their status. Surveys shall be conducted as follows:

a) Monitoring surveys shall be conducted at the same time each year, the time of which will have been determined by surveys conducted prior to the onset of work, as described above.

b) Five survey locations shall be identified for the initial survey and shall be used for the duration of the monitoring, regardless of condition of the estuary each year. The locations shall be spread within the estuary from the lagoon up to the sill at Yanonali Street.

c) The qualified biologist shall note the conditions of the substrate in the estuary, such as its depth, relative suitability for spawning and foraging, and any other factors deemed relevant to tidewater goby habitat.

d) The qualified biologist shall note water conditions in the estuary, including temperature, a subjective estimate of turbidity, level at the sampling locations, and subjective water quality (odor, color, litter).

e) Individuals shall be captured using standard techniques such as beach seining or dip-netting. The specimens shall be released immediately at the point of capture once they have been identified, measured, and their sex determined.

4. Because tidewater gobies are most often on the bottom of the estuary, the intake on the pumps used for water diversion shall be floated as long as possible to prevent tidewater gobies from being entrained and killed.

5. The mesh size on the pump intake shall be 1/8-inch or less. The mesh shall be checked by the qualified biologist prior to use each day and twice daily during operation to determine that it is intact. If the mesh develops holes or other conditions that impair its functioning, it shall be replaced, or repaired immediately.

In addition to the information gathered pursuant to the terms and conditions above, the Corps must provide an annual report to the USFWS on activities conducted during the year related to the project. The report must contain a brief discussion of the activities completed in the previous year or planned for the next year; approximate acreage habitat within the estuary affected; occurrences of incidental take, if any; problems encountered in implementing avoidance and minimization measures and terms and conditions; recommendations for modifying the terms and conditions to enhance the protection of the tidewater goby and to simplify compliance with them; and any other pertinent information. The report must be submitted to the USFWS by January 31 each year.

The management actions included as enforceable terms and conditions of the Biological Opinion are considered sufficient to protect the goby during construction. The monitoring program included in Term 3 will provide information about the response of the goby population after construction has ended, and provide information to the Corps, City, and County if unexpected adverse impacts are occurring after construction.

5.3 IMPACTS OF CHANNEL REPAIR

As noted earlier, the only anticipated channel maintenance in the estuary would be the repair of channel walls that may deteriorate over time. Channel repairs would likely be localized. They

would require separating the work area from the estuary through the use of temporary cofferdams and dewatering pumps. The potential impacts to gobies would be the same as for the original construction of the Project, described above. Measures to minimize impacts would also be the same as those described above.

6.1 MANAGEMENT OBJECTIVES

The primary management objective is to incorporate tidewater goby protection measures and design features into the Project and implement management actions to improve habitat conditions for this species throughout the estuary compared to current conditions. The management plan includes the tidewater goby protection and habitat enhancement measures described in the Corps' Biological Assessment and USFWS's Biological Opinion (see Section 5.2). These measures are described in Section 5 of this Plan and included below as specific management actions. However, the management plan also includes several other elements that represent new measures or actions, or an enhancement of previously committed measures, as described below.

6.2 MANAGEMENT ACTIONS

Design Phase

Management Action 1 – Fish Features. The Corps will incorporate the proposed fish ledges, fish refugia, and fish baffles, as described in the Final EIR/EIS and Biological Assessment for the Project. A qualified biologist will participate in the development of the preliminary and final engineering plans for these features to ensure that these features are suitable for gobies, taking into account factors such as materials, size and scale, channel location, and depth. The preliminary and final plans for these features will be submitted to the Goby Working Group for review and concurrence.

Management Action 2 – Substrate Modification. The Corps will remove existing cobble substrate from the channel to the extent feasible, and replace with sandy substrate to provide a more natural channel bottom that may be used by gobies for spawning. Prior to developing preliminary plans, the Corps will conduct a survey of the substrate from Cabrillo Boulevard to Chapala Street, mapping the extent and type of substrate. The engineering plans will clearly indicate the nature of the material and compaction of the final substrate to be established in the estuary, taking into account recommendations by a qualified biologist that has reviewed the results of the pre-construction substrate survey.

Management Action 3 – Dewatering and Fish Rescue Plans. The preliminary and final engineering plans will include plans, details, and specifications on the placement/removal of cofferdams, dewatering operations, and fish capture and relocation procedures. A qualified biologist will assist in the preparation of these drawings and specifications. The fish rescue and relocation will follow the procedures included in the Biological Assessment and Biological Opinion. These are standard field procedures to reduce risk of stranding or entraining fish during dewatering, and for protecting fish when relocating them to protected habitat areas. For this Project, fish will be relocated to adjacent channel areas in the estuary that are not dewatered or subject to construction disturbance. The dewatering and fish rescue plans will be submitted to USFWS for review and

approval to ensure that the proper procedures and safe guard are included to avoid unnecessary take of gobies.

Construction Phase

Management Action 4 – Avoid Spawning Period. Construction work in the estuary will only occur from June 15th to December 15th to avoid the peak spawning period.

Management Action 5 – Dewatering and Fish Rescue Operations. The Corps, City, and County shall implement the fish capture, relocation, and protection measures contained in the Biological Assessment and Biological Opinion, and as approved by USFWS as presented in the final Project plans. A qualified biologist with a goby handling permit shall be on site at all times during the installation of the cofferdam, dewatering operations, and fish capture and relocation procedures.

Management Action 6 – Limit on Dewatered Areas. No more than one half of the estuary from Cabrillo Boulevard to Chapala Street will be dewatered at any time. The lagoon will not be dewatered, sequestered, or otherwise affected by any construction actions. Prior to moving fish to the new, re-watered channel, a biologist shall assess the water quality in the re-watered channel reach to ensure that it is suitable for re-introduction of gobies.

Management Action 7 – Onsite Monitor. A qualified biologist shall conduct daily inspections of the construction work areas to ensure that the cofferdams remain intact, and that no gobies have entered the work areas. The biologist shall also monitor and inspect erosion control measures to be implemented as part of the Project. Finally, the biologist shall conduct periodic visual surveys of the unaffected portions of the estuary to monitor the abundance and condition of fish during construction. Weekly reports shall be provided to USFWS to apprise them of the status of the goby and the effectiveness of the protection measures during construction.

Management Action 8 – Worker Training. A qualified biologist will conduct a training session for all construction personnel prior to the onset of work to inform them of goby protection measures, work limits, legal prohibitions on take, and procedures to report problems and observations to the biologist.

Management Action 9 – Consider Arroyo Burro Impacts. The City of Santa Barbara and the County of Santa Barbara, Parks Department, should coordinate to prevent scheduling any major construction or maintenance work at Arroyo Burro estuary that could affect the goby at the same time as the work on Mission Creek Estuary is occurring.

Management Action 10 – Separate Two Lagoons. The Mission Creek Lagoon on the beach will be maintained separate from the Laguna Channel Lagoon during and immediately after the construction in Mission Creek to preclude any adverse impacts of construction on the Mission Creek Lagoon from also affecting the Laguna Channel Lagoon. The separation can be accomplished by placing sand barriers on the beach, and shall be established under the direction of a qualified biologist.

Management Action 11 – Contingency Population. The City will consider maintaining a small number of gobies outside of the Mission Creek Estuary during construction as a possible contingency source population in the unlikely event of significant mortality during construction. One possible approach is to create a small impoundment on the beach that is separate from the larger lagoon, and is maintained by inflows from Mission Creek or potable water, and protected from impacts due to people or predators. Another approach is to create a segregated portion of the estuary in the channel upstream of the beach, but outside the construction zone. The City would coordinate with US Fish and Wildlife Service to seek assistance on the design and maintenance of the physical facilities for the fish.

Post-Construction Phase

Management Action 12 - Maintenance Procedures. The County shall implement the approved fish capture, relocation, and protection measures contained in the Biological Assessment and Biological Opinion when conducting any channel wall repairs.

Other Actions

Management Action 13 – Lagoon Management. The lagoon downstream of Cabrillo Boulevard is an important part of the Lower Mission Creek Estuary. Although it provides habitat for gobies, it also provides foraging and wading opportunities for many shorebirds and seabirds, as described in detail in the 2003 summary of the biological resources of the lagoon (URS, 2003). The lagoon is very dynamic - the size, depth, and alignment varies from year to year and from season to season. In recent years, the lagoon has exhibited an east-west alignment across the beach, facilitated in part by the beach sand management by the City Waterfront Department. In this alignment, the lagoon often merges with the waterbody at the mouth of Laguna Channel, when it is present.

The Lower Mission Creek Project does not include the lagoon. However, the City recognizes that the lagoon is a part of the estuary, and that management of the estuary to improve habitat conditions for the tidewater goby as a result of the Project must include a consideration of the lagoon. Hence, the City will implement the following management actions for the lagoon:

A. The City shall prohibit breaching of the lagoon at the beach to dewater the lagoon or reduce water levels except when there is an imminent threat to public health and safety. The City ended its practice of breaching the lagoon in 1999.

B. The City Waterfront Department will continue its beach sand management program at East Beach, as approved by the Corps of Engineers and Coastal Commission in 2000, which allows the artificial build up of sand on each side of the lagoon to keep the Mission Creek alignment away from Stearns Wharf. However, the City Waterfront Department will no longer build up sand between Mission Creek Lagoon and the lagoon at Laguna Channel. Instead, the City Waterfront Department will allow the two waterbodies to merge due to natural forces (e.g., runoff, tidal action, condition of the beach, etc), and will take no action to purposely merge or separate the two waterbodies. The City conducted a study on the merging of the two waterbodies and determined that merging would have a beneficial impact on the goby

populations at the mouth of both Mission Creek and Laguna Channel. The report is included in Appendix D of this Plan.

C. The City will establish a 10-foot wide zone of native shrubs on the top of the concrete wing walls immediately below the bike path bridge. In addition, the City will establish a 20-50 foot wide zone along one or both sides of the lagoon that extends 150-200 feet downstream of the ends of the existing wing walls at the downstream side of the Cabrillo Boulevard bridge (Figure 5). Coastal sage scrub, back dune, and brackish marsh vegetation would be established along this zone to stabilize the banks and provide food and cover for gobies and birds. Vegetation in these areas would be partially protected from flood flows due to the effects of the wing walls, and also because the velocities of flood flows would be the lowest along the margins of the lagoon. These areas could be further stabilized by placing a widely spaced "paver" material (e.g., articulated concrete blocks with large spaces for planting) under the ground surface that would prevent the sand from being washed away. Alternatively, several rows of small boulders buried below the ground surface and parallel to the lagoon alignment would also provide some bank stabilization. Once a stabilization method has been selected, the areas should be planted with native species that would typically occur in and around coastal lagoons.

D. The City will install signs (English and Spanish wording) on each side of the lagoon informing the public of the ecological importance of the lagoon for tidewater gobies, seabirds, shorebirds, and invertebrates. The signs will also include a prohibition on wading or swimming.

Management Action 14 – Recolonization Procedures. In the event that the goby population in the Mission Creek Estuary were to become extirpated at any time in the future, as documented by a qualified biologist and/or USFWS, the City and County would implement a recolonization program to re-establish the goby population in the Mission Creek Estuary. The recolonization procedures would be developed in consultation with USFWS, and include fish capture and relocation from another South Coast population; re-introduction to Mission Creek Estuary, and post-colonization monitoring. Prior to recolonization, the City and County will conduct a survey of the source population to determine if the removal of fish can occur without long-term impacts to the source population. In addition, the City and County would conduct a field survey of Mission Creek Estuary to ensure that suitable habitat is present, or determine when it would be present, and to identify any risk factors that may cause the relocation to be unsuccessful. Finally, the City and County will evaluate the conditions and circumstances that resulted in the extirpation, and whether it was caused by a natural event, a human disaster that could not have been foresee or avoided, or conditions created by the Lower Mission Creek Project. In the event that the extirpation is linked directly to the physical and biological conditions in the estuary created by the Project, the City and County will consult with USFWS to identify feasible Project modifications or additional management actions to prevent future extirpations.

Monitoring and Adaptive Management Program (Management Action 15)

The City will initiate a comprehensive study of tidewater gobies in the Mission Creek Estuary two years prior to the initiation of construction. The study will include a two years of pre-construction surveys, and five years of post-construction surveys. The objectives of the study are to: (1) fully characterize the distribution and abundance of gobies in the estuary, including the lagoon; (2) address the uncertainties about goby habitat and the population identified in Section 3; (3) determine if the Project is adversely affecting gobies; and (4) provide more information to refine and improve the management actions in the Plan over time.

The study will expand upon the goby survey requirement in the USFWS Biological Opinion by increasing the number of years of the study (from 5 to 7 years), including seasonal surveys during each year, and seeking answers to specific questions or areas of uncertainty (see Section 3).

The study will include the following elements:

- A qualified biologist with permits to survey and handle gobies will conduct the field surveys. Field surveys will be conducted in June, September, and November of each year, using the same fish sampling methodologies as those used in the Creek Division's surveys of Mission Creek Estuary in 2004. Three sampling locations will be used – lower, middle, and upper estuary. Seine nets will be pulled across the channel at each location to capture fish. All fish will be identified to species and counted. Gobies will be measured for length and then immediately returned to the estuary. The sampling locations are located at sufficient distance to prevent fish from moving from location to location during the course of the survey.

- The surveys shall also include an inventory of physical conditions at six locations in the estuary (including the three fish sampling locations), including water temperature, salinity, depth, turbidity, flow, presence of algae, substrate, emergent vegetation, bank conditions, and in-stream debris. Water samples will be collected at the six sampling sites and measured for pH, total suspended solids, and total dissolved solids.

- The data from the pre-construction surveys will be compiled in a report that is submitted to the USFWS and CCC six months prior to the start of construction in the estuary. The report shall include an interpretation of the study results, particularly to the areas of uncertainty noted in Section 3. The report will incorporate the results of the Creek Division's goby surveys from 2004 and 2005. Finally, the report will include recommendations, if any, to modify any of the construction goby protection measures or Project design features to enhance goby habitat based on additional information from the field study. The City, County, and Corps will reconvene the Goby Working Group to elicit input on these recommendations before submitting them to the USFWS and CCC. Input from the Working Group will be summarized in the report.

- The goby study will resume when construction in the estuary has ended. Results of the monitoring program shall be provided to the USFWS each year. In the event that there is a documented decrease in the goby population that cannot be readily explained by natural

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APPENDIX A

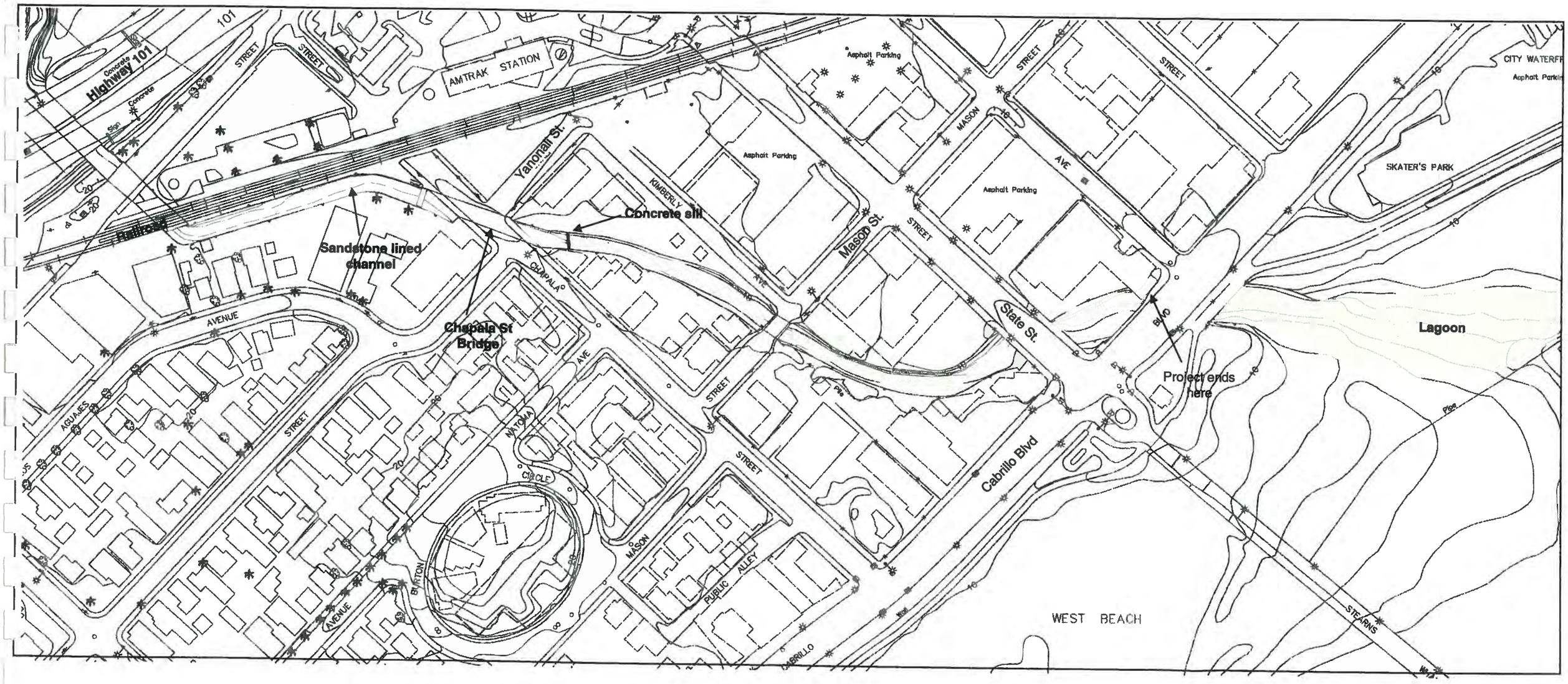
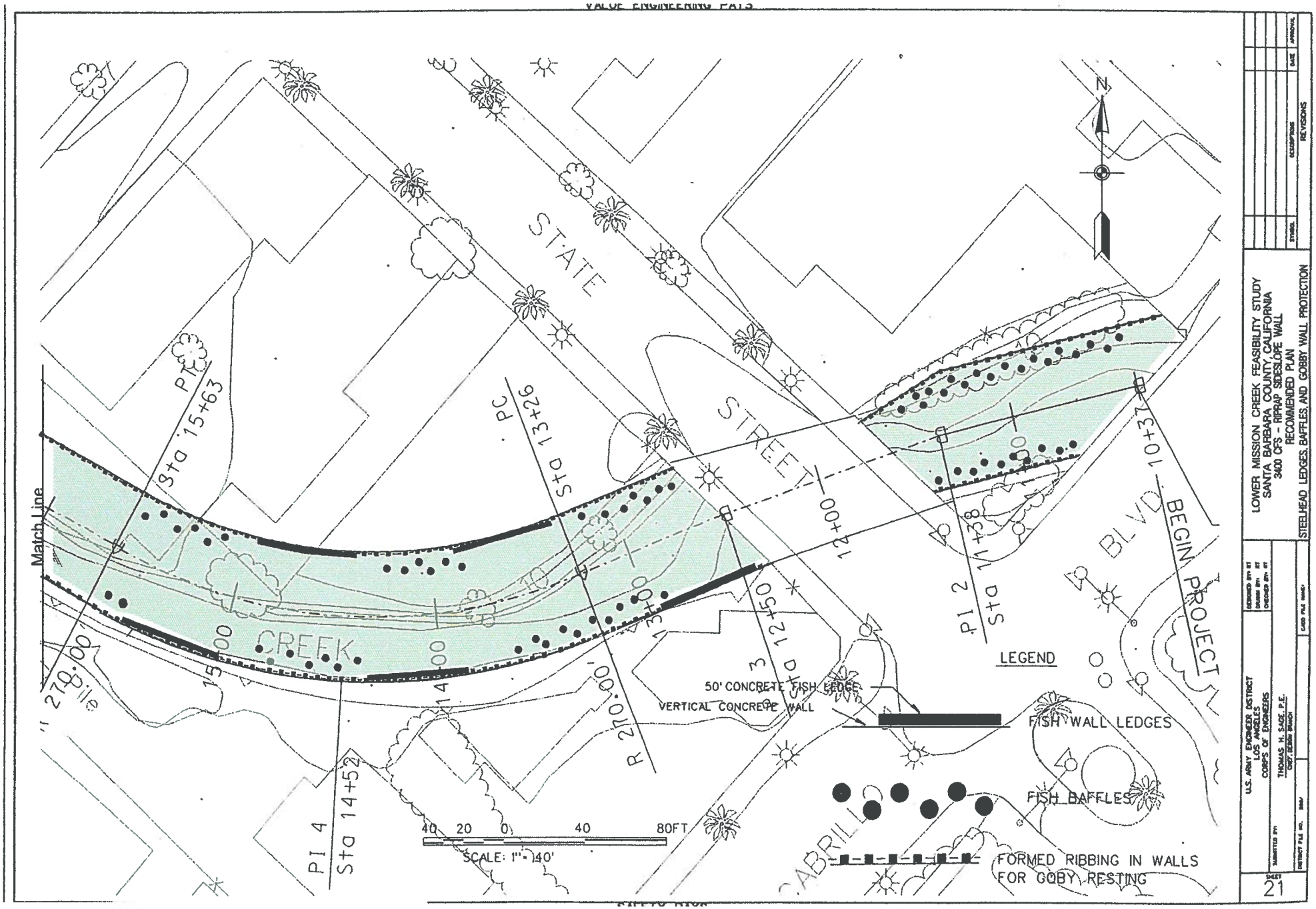
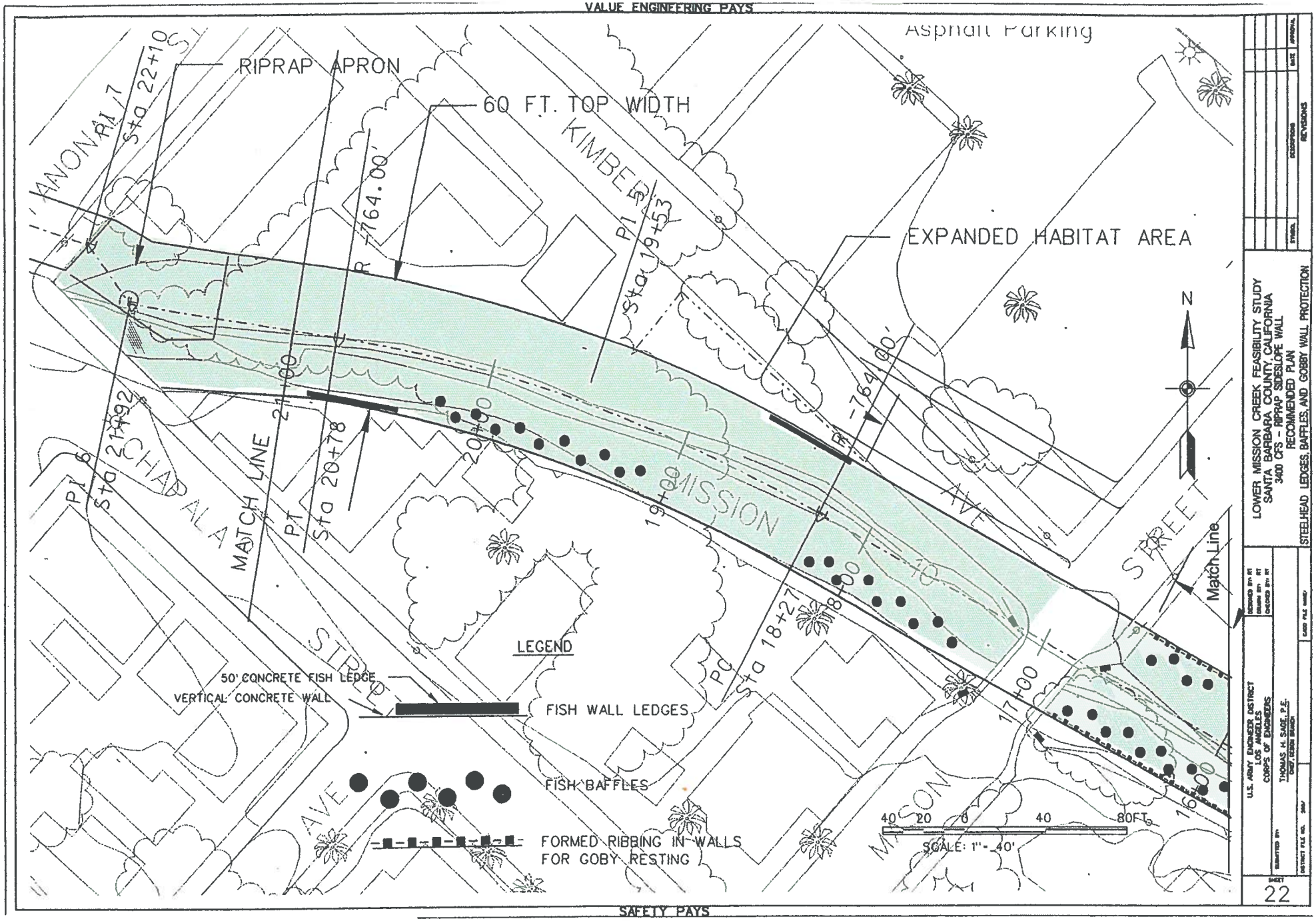


Figure 1. Mission Creek Estuary



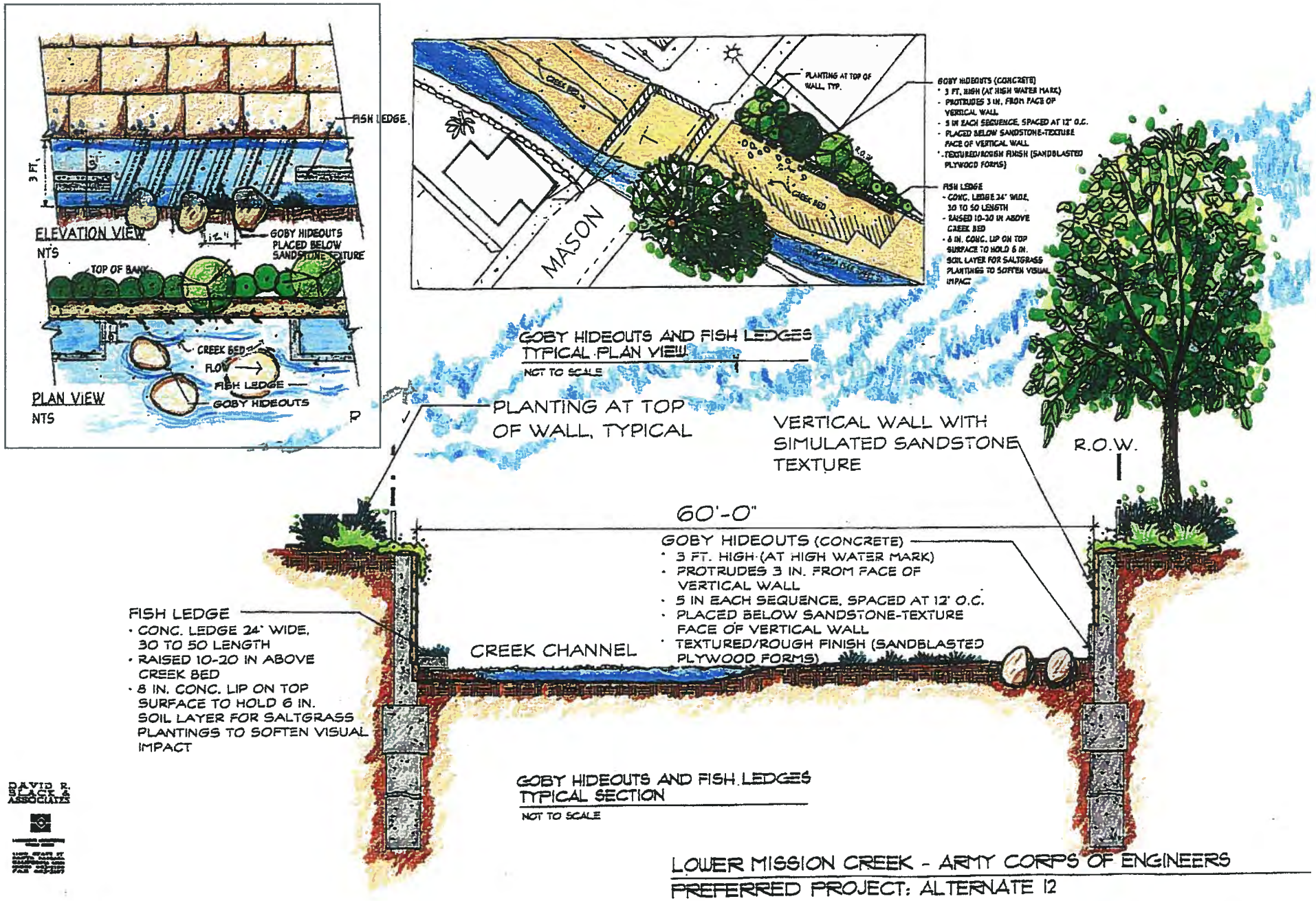
Source: Corps of Engineers, Lower Mission Creek Flood Control Feasibility Study, Sept. 2000

Figure 2a. Channel Improvements in Mission Creek Estuary



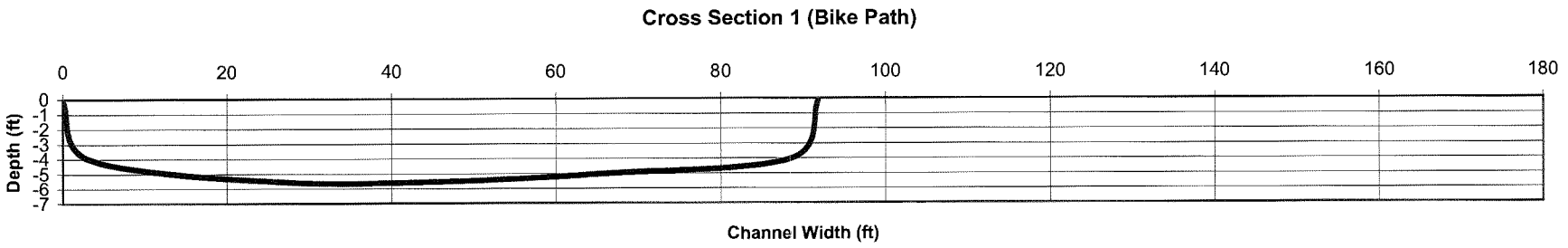
Source: Corps of Engineers, Lower Mission Creek Flood Control Feasibility Study, Sept. 2000

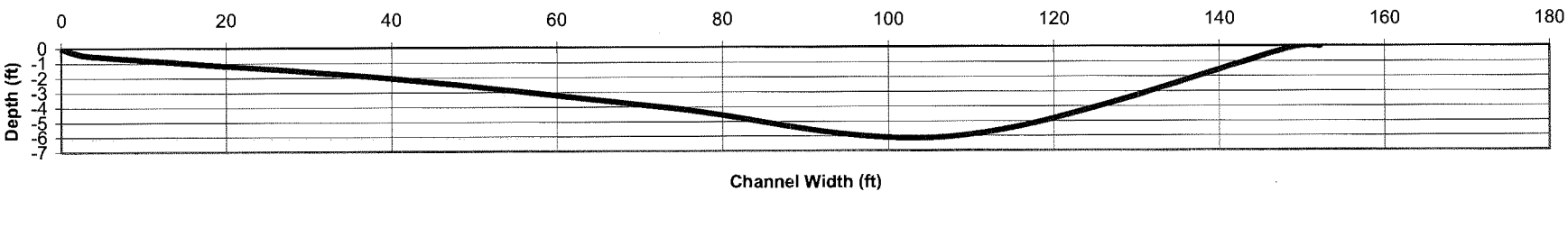
Figure 2b. Channel Improvements in Mission Creek Estuary

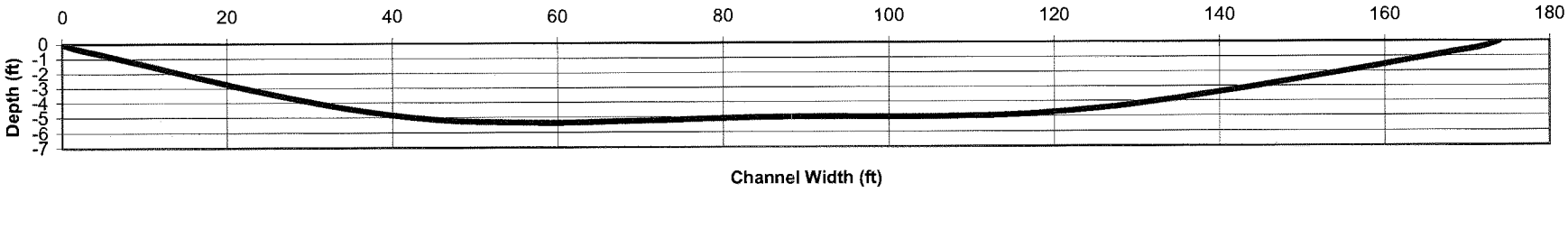


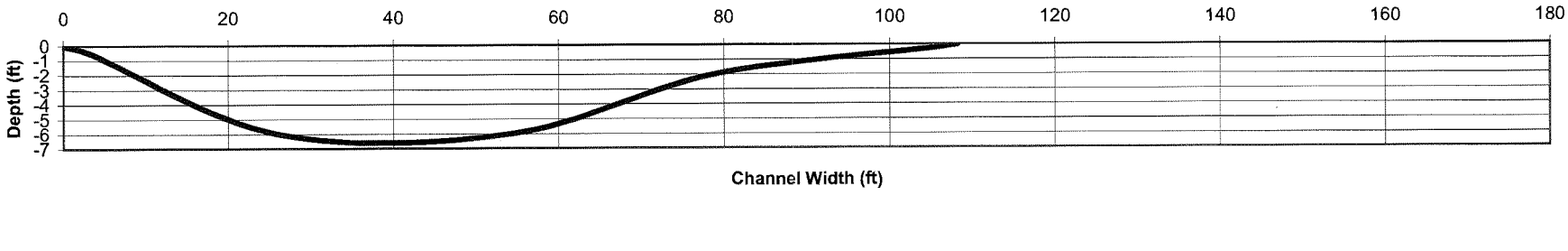
Source: Corps of Engineers, Lower Mission Creek Flood Control Feasibility Study, Sept. 2000

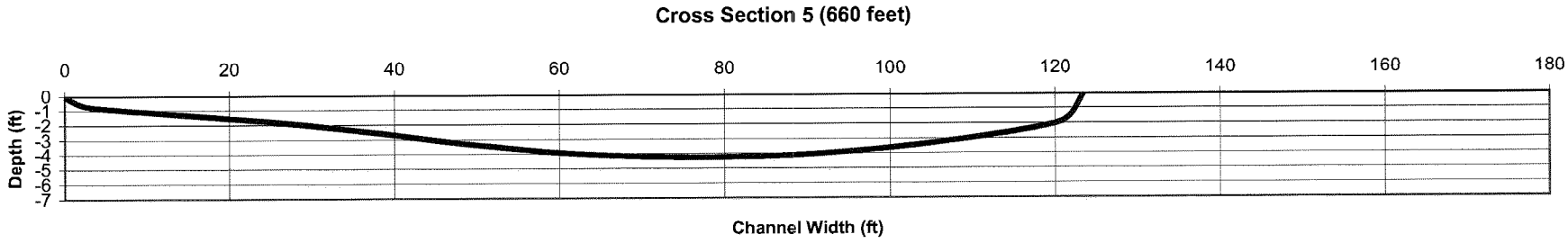
Figure 3. Fish Enhancement Features

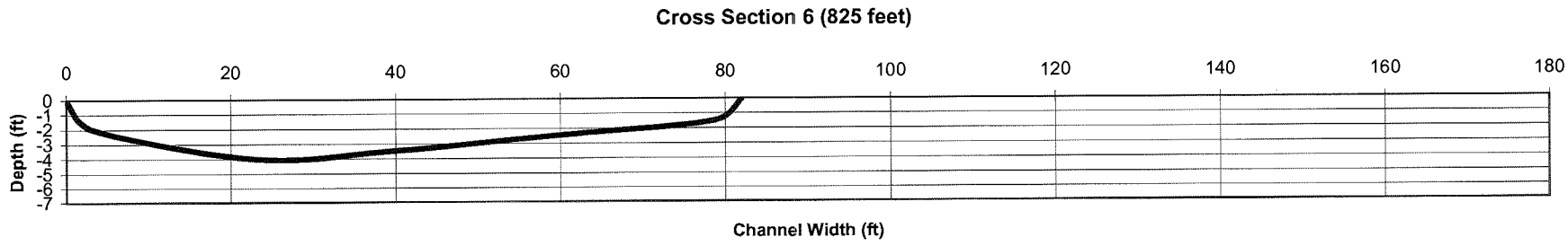


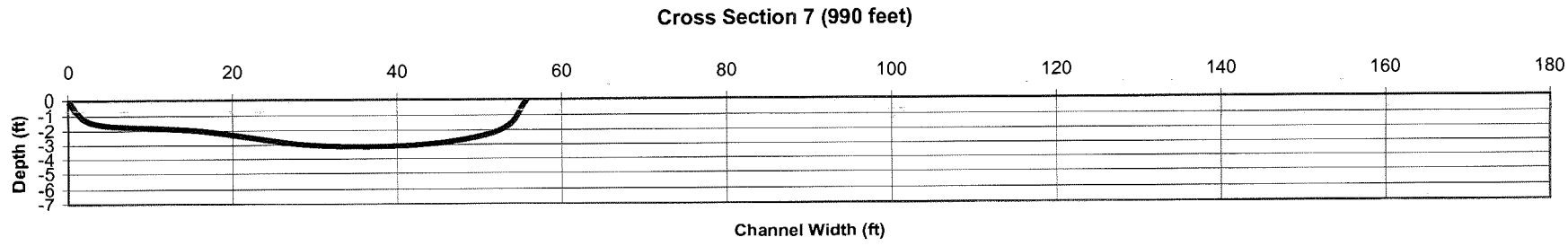


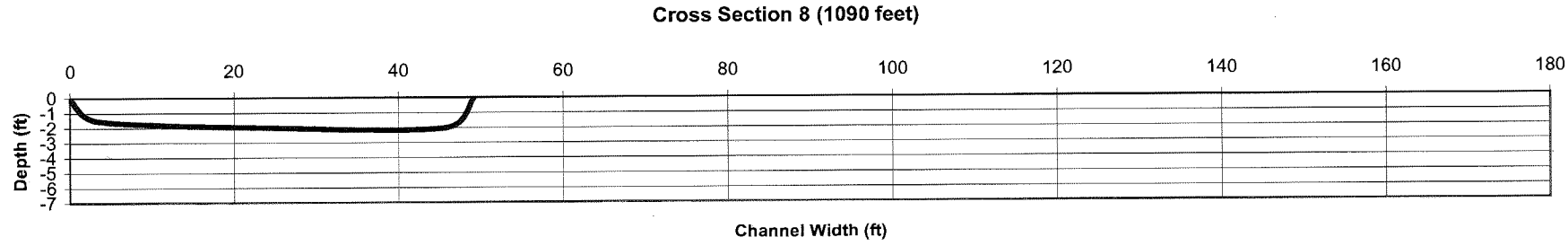












Cross sections were measured in April 2002 when the lagoon was closed. Cross section locations shown on Figure 2.

Figure 4. Cross Sections of the Mission Creek Lagoon

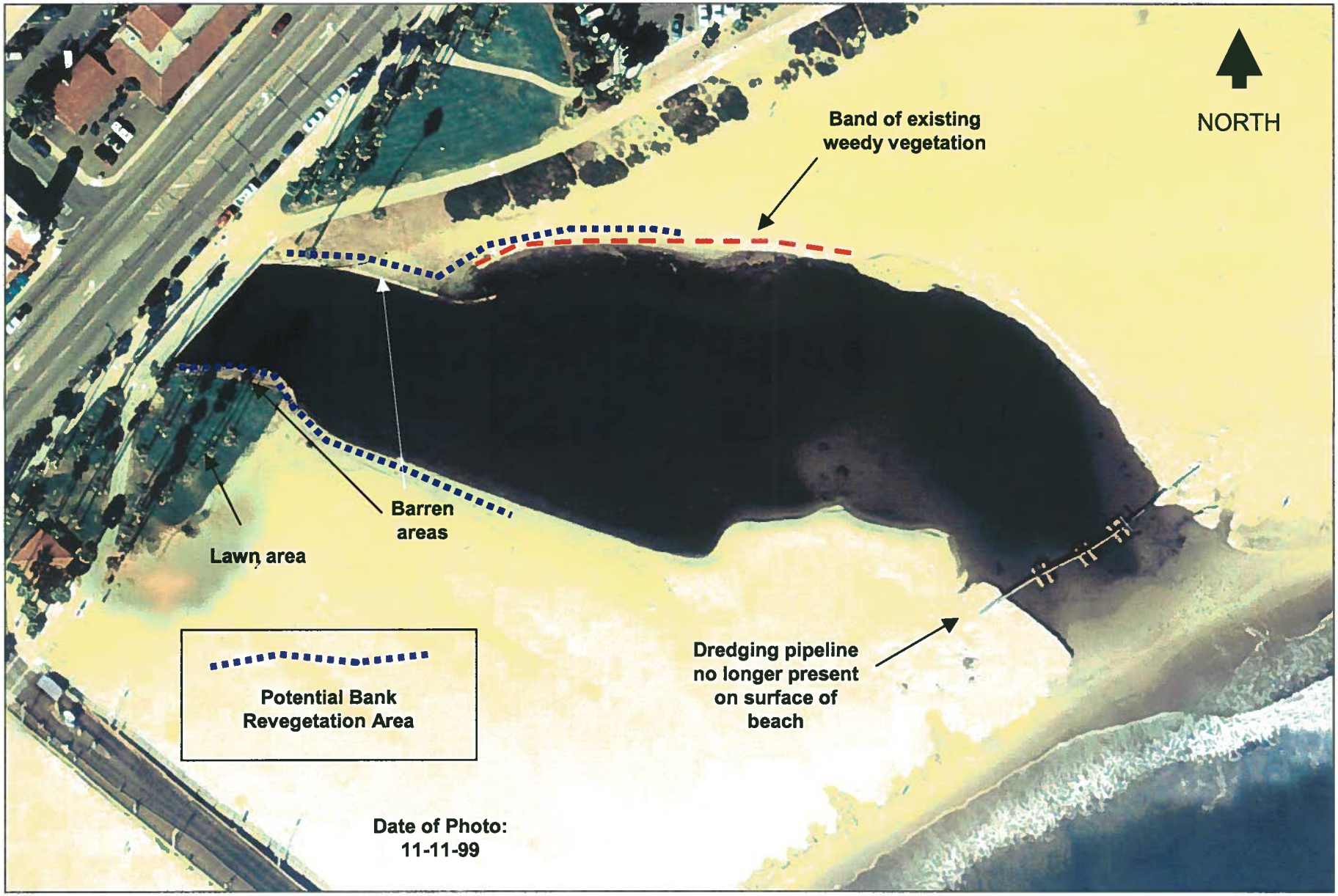
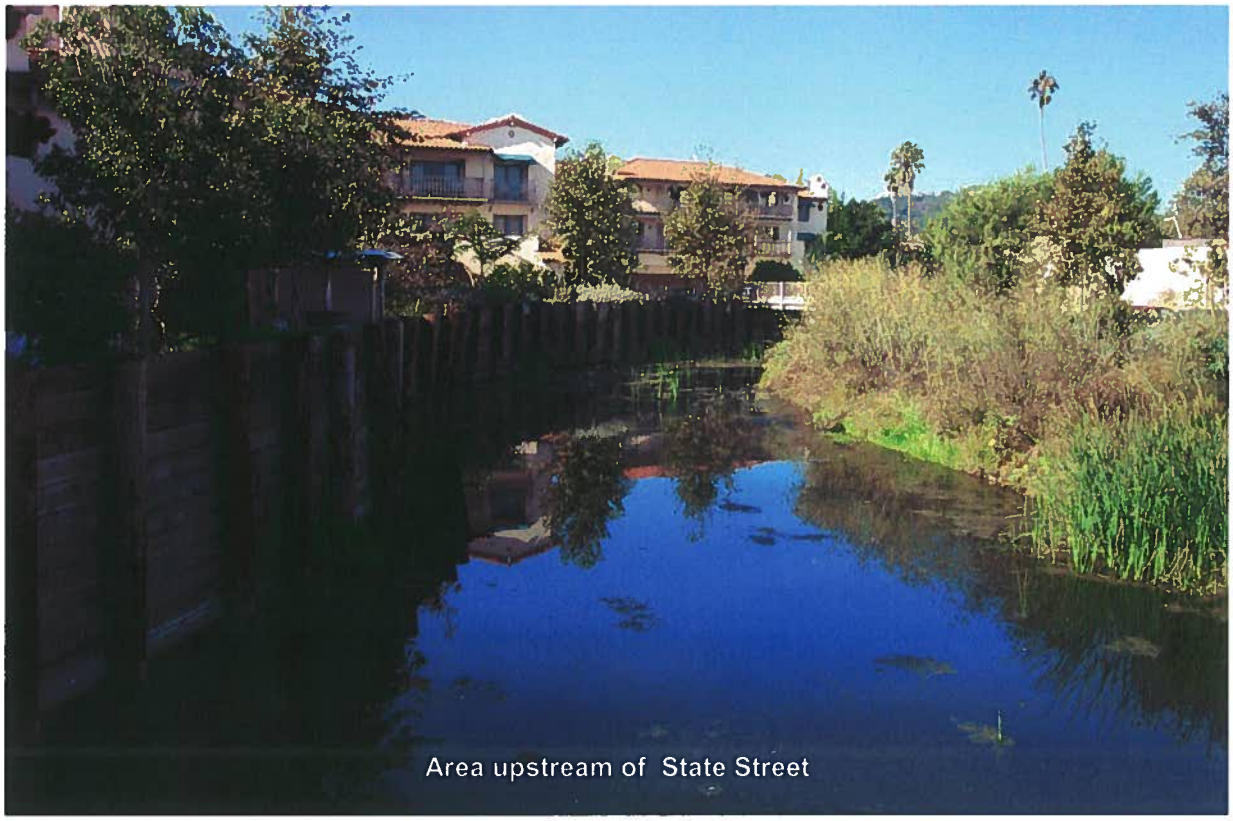


Figure 5. Lagoon Bank Restoration Areas

APPENDIX B

Lower Mission Creek Estuary - September 2002



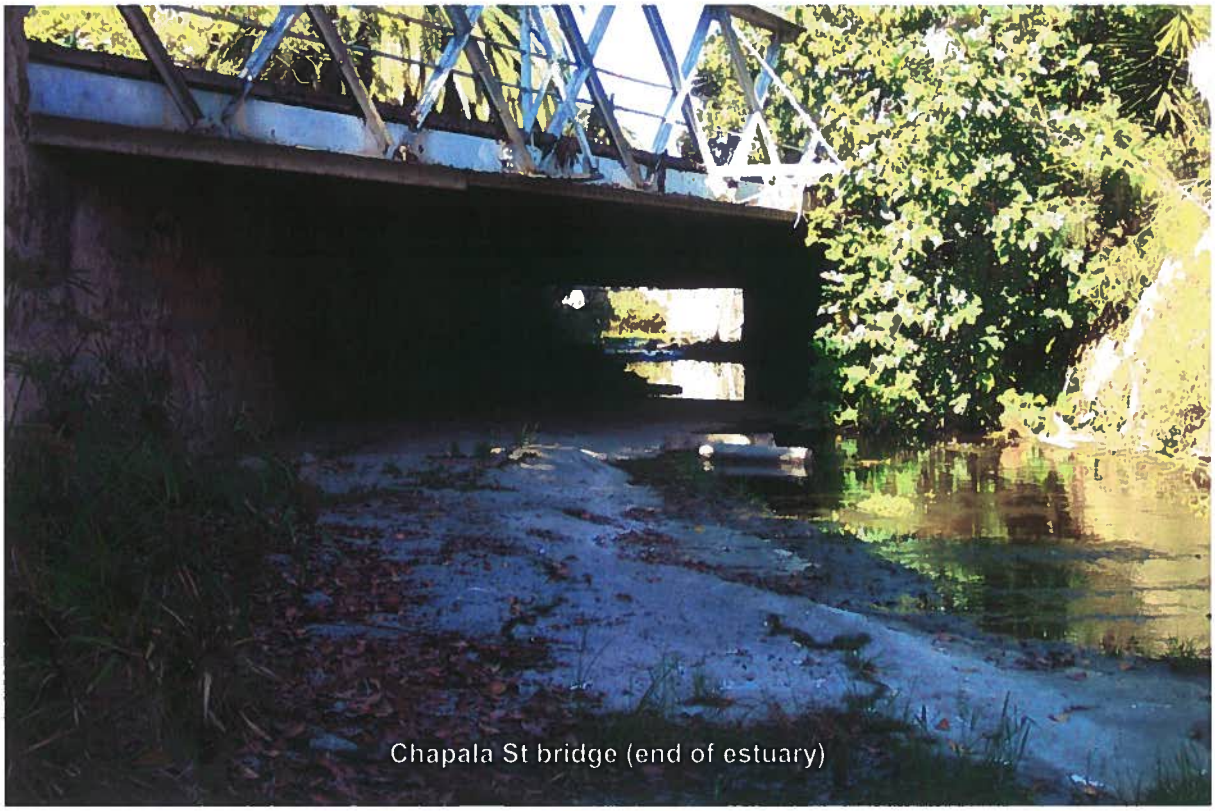
Area upstream of State Street

Area upstream of State Street

Area downstream of Mason St

Area upstream of Mason St

Area downstream of Chapala and Yanonali Streets



Chapala St bridge (end of estuary)

Concrete sill downstream of Chapala St bridge (end of estuary)

Chapala St bridge and beginning of sandstone channel

Examples of exposed substrate.

APPENDIX C

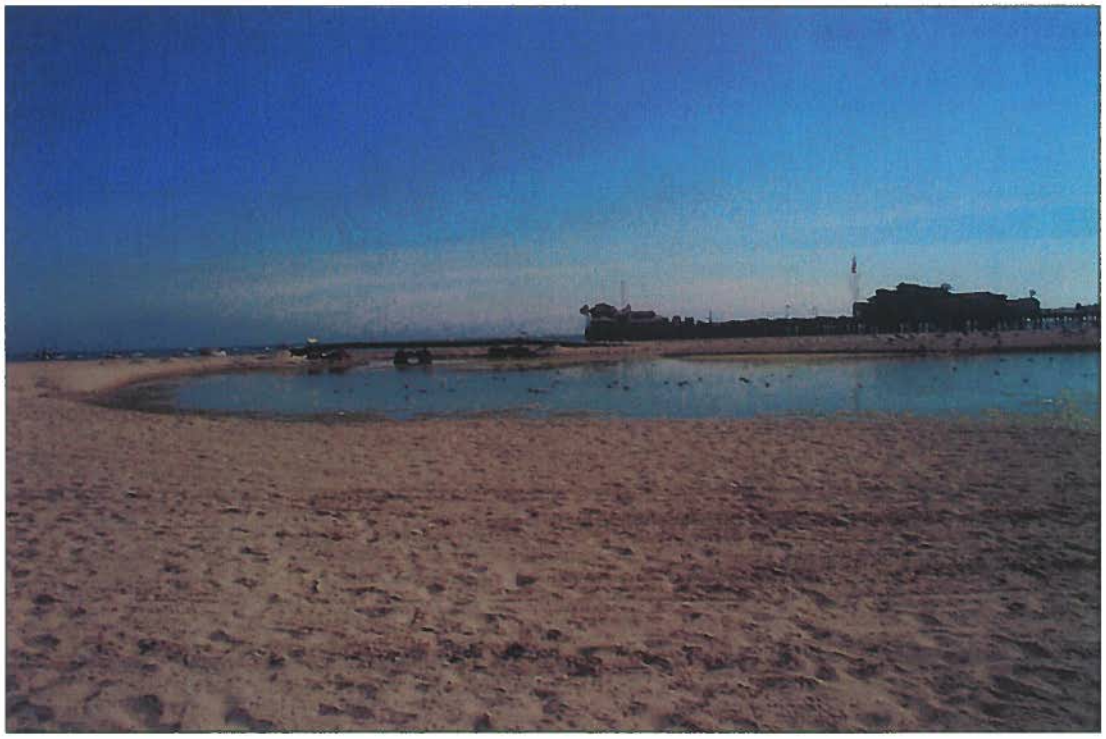
Photograph No. 1. View of bike path and Cabrillo Blvd bridge over Mission Creek estuary. The bridge is used to define the upper end of the lagoon.

Photograph No. 2. Closer View of bike path and Cabrillo Blvd bridge over Mission Creek estuary.

Photograph No. 3. View of eastern banks of lagoon near the bike path. Note concrete sandbag walls and eroded slopes.

Photograph No. 4. View of eastern banks of lagoon on sandy beach, downstream of concrete sandbag wall. Note dead non-native weeds in foreground.

Photograph No. 5. View of lagoon from the beach, view to the northwest. Note heavy foot and bike traffic on the sand, and algae mats on margins.



Photograph No. 6. View of eastern banks of lagoon on sandy beach, downstream of concrete sandbag wall. View to towards the wharf.

APPENDIX D

FREQUENCY OF MERGING OF THE LAGOONS AT THE ENDS OF MISSION CREEK AND LAGUNA CHANNEL

EAST BEACH, SANTA BARBARA

May 2004

Prepared for:

City of Santa Barbara
Public Works Department

Prepared by:

URS Corporation
Goleta, California

FREQUENCY OF MERGING OF THE LAGOONS AT THE END OF MISSION CREEK AND LAGUNA CHANNEL

EAST BEACH
SANTA BARBARA, CALIFORNIA

May 2004

Prepared for:

City of Santa Barbara
Public Works Department
630 Garden Street
Santa Barbara, California 93101
Contact: Mr. Pat Kelly, City Engineer

Prepared by:

URS Corporation
130 Robin Hill Road, Suite 100
Goleta, California 93117
Contact: Dr. John Gray

1. INTRODUCTION

The Lower Mission Creek Project is a Corps of Engineers project to reduce flooding along the lower reaches of this creek by widening the channel and certain bridges. The City of Santa Barbara and County Flood Control District are local sponsors of the project. In late 2001, the California Coastal Commission (CCC) issued a Federal Coastal Zone Consistency Determination to the Corps of Engineers for the project. This approval is required because portions of the project occur in the Coastal Zone.

In a November 2001 Addendum to the Consistency Determination Findings, the CCC issued several revised conditions including one that addresses concerns about impacts of the project on the endangered tidewater goby which resides in the Mission Creek and Laguna Channel lagoons. The condition requires that the Corps and local sponsors consult with tidewater goby experts to develop a plan to minimize impacts to the goby through design elements and protective measures to be implemented during construction. The condition also included the following requirement:

> *"In addition, the Corps shall make recommendations regarding allowing the Mission Creek and Laguna Creek estuaries to merge under natural conditions (or as recommended by the team of biologists) in order to benefit Tidewater Gobies."*

This report provides an analysis of the frequency with which the lagoons at the mouths of the nearby Mission Creek and Laguna Channel merge (Figure 1). It also identifies the natural and man-made factors that affect the merging of these two water bodies on East Beach, and provides an assessment of the ecological benefits of merging the two lagoons for the tidewater goby. The City and Corps will consider the results of this report when making a recommendation to the CCC pursuant to the above condition.

2.1 MISSION CREEK

Mission Creek discharges to East Beach at Cabrillo Boulevard (Figure 2). A lagoon is typically present year-round at the beach. The size and configuration of the lagoon vary considerably due to runoff, waves, and beach sand management. In most winters, there is sufficient runoff after large rain events to breach the sandbar formed at the crest of the beach and create a continuous flow into the ocean. The creek then forms a lagoon in the summer and fall when runoff is very low or absent. Until several years ago, the City periodically breached the lagoon in the summer and fall with a bulldozer in order to maintain the water depths and lagoon size to desirable levels. In 2000, the Corps of Engineers informed the City that a permit was required for this action. In response, the City terminated the breaching of the lagoon and evaluated options to address the problems noted above.

The size of the lagoon varies considerably from season to season. In all but drought years, winter runoff is sufficient to enlarge the lagoon such that it breaks through the sandbar formed on the beach and discharges to the ocean. If there are large or frequent runoff events, the a static waterbody is absent and the creek flows across the beach. As the flows diminish, sand builds up from wave action. A berm is formed when the hydrostatic pressure and water levels in the creek decline and become insufficient to displace the sandbar. As the berm is forming, the water depth and surface area of the lagoon increase until it reaches an equilibrium in which inflow from the creek is equal to seepage to the ocean, and the hydrostatic pressure in the lagoon is less than the force required to displace the sandbar.

The process of forming of the lagoon each winter is very dynamic. The lagoon may form and breach several times each winter. In addition, the beach sand management actions in the winter under the City Waterfront Department's Sediment Management Program (see below) affect the size and timing of lagoon formation. Mission Creek flows year-round; hence, there is a base flow to the lagoon in the summer months that maintains the lagoon at a relatively constant size.

The maximum depth of the lagoon in the summer typically ranges from 5 to 6 feet. The water surface elevation in the lagoon is generally determined by the height of the sandbar, which is usually about 6 to 8 feet (NAVD 88). If water surface elevations increase above these levels, the lagoon will breach the sandbar.

2.2 LAGUNA CHANNEL

Laguna Channel is a man-made drainage that discharges to the beach about 800 feet east of Mission Creek (Figure 2). A natural drainage was always present at this location, connected to a low-lying salt marsh called El Estero that was located along Yanonali Street between Cabrillo Boulevard and Gutierrez Street (see historic maps of the marsh in Appendix B). Due to the low elevation of the area, a pump system and tide gate was installed in 1939. It was replaced in 1961 with the current pump and tide gate facility. During most of the year, a small pump periodically is operated to

remove water accumulating in the channel upstream due to winter runoff, nuisance flows, or groundwater seepage. This water is discharged to a concrete flume that passes under the bike path and discharges to the beach (Figure 2). When the pumps are unable to keep up with the inflow during moderate to high storm flow conditions, the water level in the channel rises to flood stage, and the tide gates are opened when the water level in the channel is above the lagoon level, allowing water to discharge directly to the beach. Once these flows have subsided, the tide gates are closed to prevent tides from entering the channel.

A water body, that is called the Laguna Channel lagoon, often forms on the beach at the pump station due to the periodic pumping of water to the beach throughout the year. The water body is typically 2 to 3 feet in depth; its size can vary considerably, but it is always substantially smaller than the lagoon at Mission Creek.

2.3 CURRENTS AND BEACH SAND DEPOSITION

There is a year-round longshore current along the South Coast that moves in a west-to-east direction. Although the predominant littoral transport is west-to-east, westerly transport occurs periodically on a small scale. The longshore current is responsible for transporting sand along the coast. The majority of sand transport occurs in the winter months, and is associated with storm events. The longshore current contributes to the overall northwest-southeast alignment of the lagoon. However, the effect of this current is dampened by the presence of the Harbor. Sand that is transported down the coast encounters the Santa Barbara Harbor Breakwater where it accumulates along Leadbetter Beach and the breakwater sandspit. Much of the sand accumulates at the entrance to the Harbor and must be dredged annually. Although the Harbor has created a shadow effect on sand transport to East Beach, dampening the west-to-east longshore currents along East Beach. Hence, the altered currents has allowed sand to accumulate immediately downcoast of Stearns Wharf. The width of the beach near Mission Creek and Laguna Channel has increased substantially since the Harbor was constructed.

There are two primary wave exposures along the Santa Barbara coast. The predominant waves are swales from the west that enter the Santa Barbara Channel between Point Conception and San Miguel Island. In addition, the coast is exposed to southeasterly waves generated from winds preceding extratropical storms. The greatest wave action for both exposures occurs in the winter months. As a consequence of these two wave exposures, the lagoon outlets may migrate either east or west depending upon individual storm and wave events.

2.4 BEACH SAND MANAGEMENT

In 2000, the City approved a Waterfront Area Sediment Management Program which is implemented by the Waterfront Department. The program includes a comprehensive sediment dredging and beach sand management plan for the Harbor, West Beach, East Beach, and Leadbetter Beach. The program includes creation of a small boat area off West Beach, which was completed in spring 2002.

The sediment management program allows the City Waterfront Department to maintain certain beach configurations at Leadbetter Beach, West Beach, and East Beach. The City Waterfront Department will grade these beaches to create target (ideal) profiles that balance the needs for recreation and shore protection. In general, on-site sand is moved on the beach to reach desired contours. However, sand may be imported from other locations in the Waterfront area to achieve the designed elevations.

The approximate limits of grading on East Beach near the Mission Creek and Laguna Channel lagoons are shown on Figure 3. The City Waterfront Department may grade up to 500 feet of the beach west of the Mission Creek Lagoon to maintain a 10-foot elevation. Up to 400 feet of the beach may be graded east of the lagoon. No grading may occur within 200 feet of the centerline of the lagoon during the winter and spring to prevent impacts to steelhead that might pass through the lagoon. The sediment management program allows for the City Waterfront Department to maintain a beach with 10-foot elevation between the Mission Creek lagoon and the outlet from Laguna Channel (see Figure 3). Beach grading may occur year round, subject to certain seasonal restrictions if the California least tern is present and in April when grunion runs occur.

The City Waterfront Department is currently applying for renewal of the Corps of Engineers permit for the sediment management program, which expires in September 2004. The ideal beach condition sought under the renewed permit will be almost identical to the condition allowed under the current permit. Existing and proposed ideal beach conditions are presented in Appendix C.

3. STUDY METHODS

To determine the frequency with which the lagoons merged in the past, URS investigators, Dr. John Gray and Ms. Shruti Chandra, acquired representative aerial photographs of East Beach from the following sources: (1) Waterfront Department files; (2) Pacific Western Aerial Survey; and (3) the Map and Imagery Laboratory at University of California, Santa Barbara. Aerial photographs were selected that contained sufficient resolution to identify the conditions of the lagoons, and that provided a range of years from the earliest photograph (in 1928) to 2003. Each photograph was examined and the following data were collected:

- Are the lagoons connected to the ocean, independent of one another?
- Are the lagoons merged?
- If the lagoons are merged, is the combined water body connected to the ocean?
- What is the angle of the water body across the beach (see Figure 4 for basis of measuring the angle for each creek)?

The observations were recorded and summarized in a spreadsheet. Copies of most aerial photographs were available and are presented in Appendix B.

4. STUDY RESULTS AND RECOMMENDATIONS

The results of the aerial photograph analyses are presented in Table 1. A total of 36 photographs were examined and analyzed; additional photographs were reviewed but were not analyzed due to the poor quality or inadequate cover of the image. The photographs included 30 separate years over the period 1928 to 2003 (75 years). Most of the photographs were from the fall months (August through November), followed by the winter months (December through March). Only a few photographs were available from the spring and early summer.

Mission Creek and Laguna Channel were typically connected to the ocean, as shown by the following data derived from Table 1:

	Number of Photos Examined	Number of Times Connected to the Ocean
Mission Creek	36	27
Laguna Channel	36	27

The angles of the lagoon alignments at Mission Creek and Laguna Channel varied from year to year. The average angle observed for each water body in the aerial photograph is shown on Figure 3 and summarized below. The typical alignment of the creeks results in their intersection on the beach.

	Angle (degrees)	Compass Direction
Mission Creek	66	Northwest to southeast
Laguna Channel	80	Northeast to southwest

The creek lagoons were merged seven times in the 36 aerial photographs. In two additional aerial photographs, it appears that the lagoons were recently merged, or about to become merged. Of the seven instances of merged water bodies, four of them included a connection to the ocean. A summary of the merged conditions is provided below. Photographs of these events are shown on Figures 5a-c.

Date	Connected to the Ocean?	General Runoff Conditions at that Time
September 9, 1978	Yes	Fall of the year with a 3-year drought ended.
February 3, 1982	Yes	Normal winter; 2.5 inch rain events in Dec. 1981 and Jan. 1982
November 16, 1994	No	Normal early winter conditions with little rainfall to date
December 4, 1995	Yes	Very large combined lagoon at the end of a record-setting rainfall year
October 24, 1996	No	Normal dry fall; 2.6 inch rain event in October

Date	Connected to the Ocean?	General Runoff Conditions at that Time
November 18, 2002	Yes	Normal dry fall; 6.5 inch rain event in November; beach berm constructed west of Mission Creek
November 22, 2003	No	Normal dry fall; no winter rainfall yet; beach berm constructed west of Mission Creek

A summary of the types of combined water body that forms at East Beach is shown on Figure 6.

The general range of hydraulic conditions at East Beach that affect the formation of a combined lagoon are shown on Figure 7 and summarized below:

Condition A. A combined lagoon often forms in low runoff years if the lagoon alignments across the beach, formed during the previous winter storm events, intercept one another. Under low flow conditions, hydraulic forces are insufficient to breach the beach sand berm, and a lagoon can persist for most of the year.

Condition B. The construction of a sand berm on the west side of the Mission Creek lagoon directs the alignment of the lagoon to the east, where it readily merges with the Laguna Channel lagoon. The presence of a merged lagoon from 2002 to present time appears to be largely due to the maintenance of high sand berms west of the Mission Creek lagoon and relatively low runoff winters.

Condition C. No lagoon is formed if the creek alignments across the beach do not intercept. The determination of the alignments are based on a combination of hydraulic forces in the creek during winter events, presence or absence of man-made sand berms on the beach, wave action that intercept creek flows in the surf zone, and the configuration and height the beach sand along East Beach.

Condition D. No lagoon is present at either creek during high winter flow events. The hydraulic forces during these events, and for several weeks after them, create a channel across the beach to the ocean. A lagoon eventually forms as flows recede and the wave action creates a beach sand barrier.

Based on the aerial photographs and general observations of the lagoons at the beach, the following factors contribute to the merging of the lagoons (not in priority order):

- Low runoff years allow for the formation of water bodies at each creek mouth. A combined water body will be present even with low runoff conditions if the lagoon alignments across the beach intercept one another.

- Maintenance of a sand berm along the west side of Mission Creek lagoon facilitates the merging of the lagoons by directing the Mission Creek lagoon towards Laguna Channel.

- High runoff years with prolonged spring base flows create a larger water body at Laguna Channel, which in turn, increases the probability of merging of the lagoons.

The following factors discourage the formation of a combined lagoon:

- Artificial breaching of either lagoon at the beach, which directs hydraulic forces towards the ocean and away from any lateral movement along the beach which could form a merged lagoon

- A narrow beach created by high wave action that scours sand and reduces the width of the beach.

As noted earlier, the endangered tidewater goby resides year-round in the Mission Creek lagoon. When a lagoon is present at Laguna Channel, the tidewater goby has been observed if the lagoon has been connected to Mission Creek recently to allow fish to migrate. The habitat conditions for the tidewater goby in Laguna Channel are less favorable than in Mission Creek lagoon for the following reasons: (1) the Laguna Channel lagoon is smaller and shallower, which leads to increased water temperatures and predation by birds; (2) the Laguna Channel lagoon is ephemeral, and is absent in some years which precludes the development of a favorable substrate for the goby, a bottom dwelling species; and (3) the Laguna Channel lagoon does not have any shade or vegetation.

Allowing the two water bodies to merge, either by natural events or facilitated by beach sand management, would result in the following beneficial impacts to the goby population at East Beach:

- The goby population in the Mission Creek lagoon is continually present, but is subject to year to year variation due to runoff conditions, the depth and size of the lagoon, and the natural fluctuations in goby population which can vary by several orders of magnitude due to changes in reproduction and natural mortality. A combined lagoon increases the available habitat for this population to forage and breed. During years with a combined lagoon, the fall population may be higher than with a separate lagoon at Mission Creek, which provides a buffer from the expected population loss in the winter months. In addition, a higher population may allow for dispersal of fish in the winter to other downcoast lagoons.

- The habitat for tidewater goby in the Laguna Channel lagoon is highly variable and unreliable due to its small size and poor habitat conditions (i.e., shallow water, lack of cover on shore, small waterbody subject to high water temperatures). Gobies are likely extirpated from the lagoon during many winters. They recolonize the lagoon either from a connection with Mission Creek, or from fish moving along the nearshore waters from Mission Creek. A combined lagoon provides a source of fish to colonize the Laguna Channel lagoon during those years that it has favorable conditions to support gobies.

In conclusion, allowing the two lagoons to merge would enhance conditions for the tidewater goby in the Lower Mission Creek Estuary, and should be considered as a management action for the Tidewater Goby Management Plan for the Lower Mission Creek Project.

APPENDIX A

Figures 1 – 7

Figure 1. Location of Mission Creek and Laguna Channel Outlets

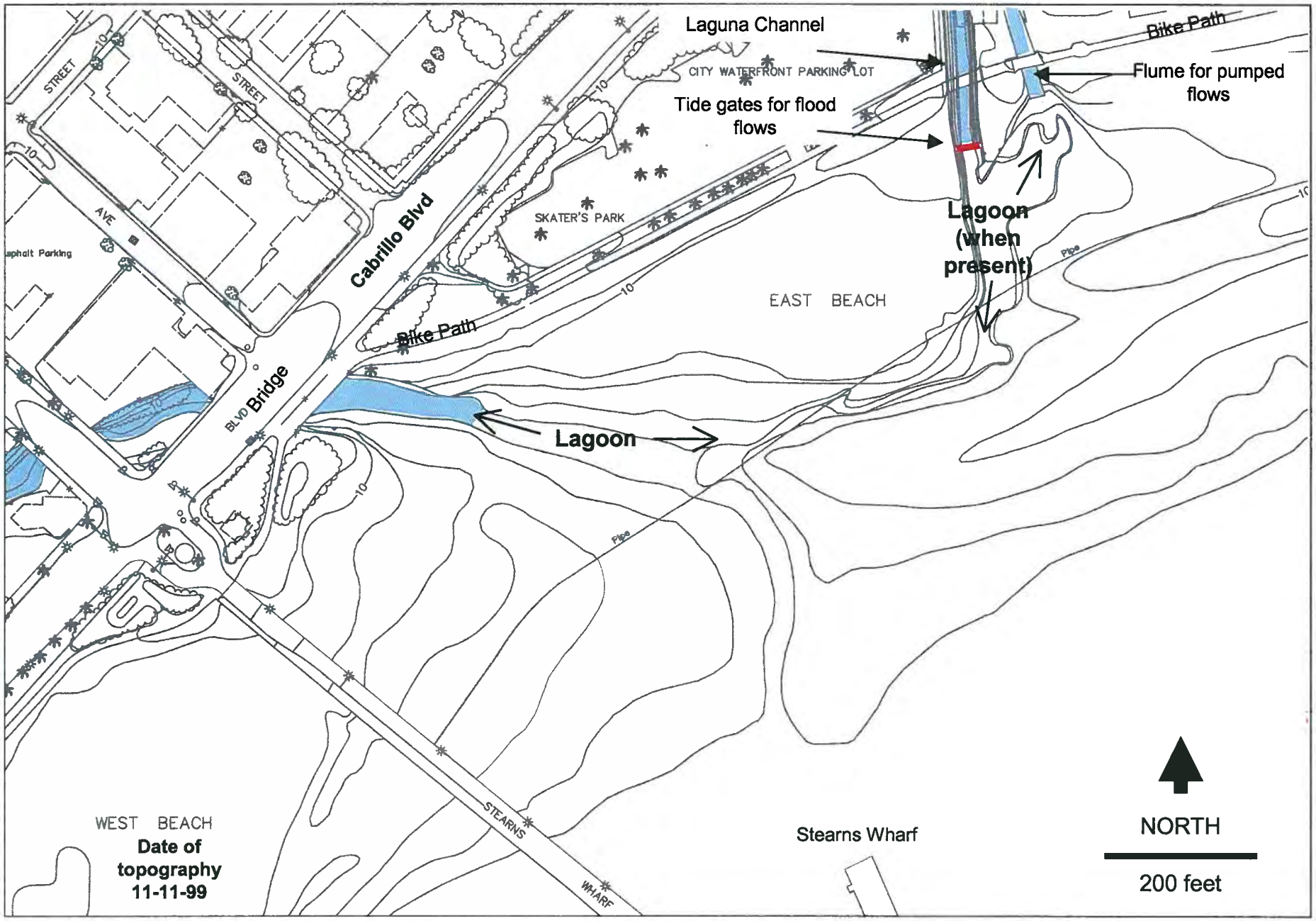


Figure 2. Key Features at the Study Area

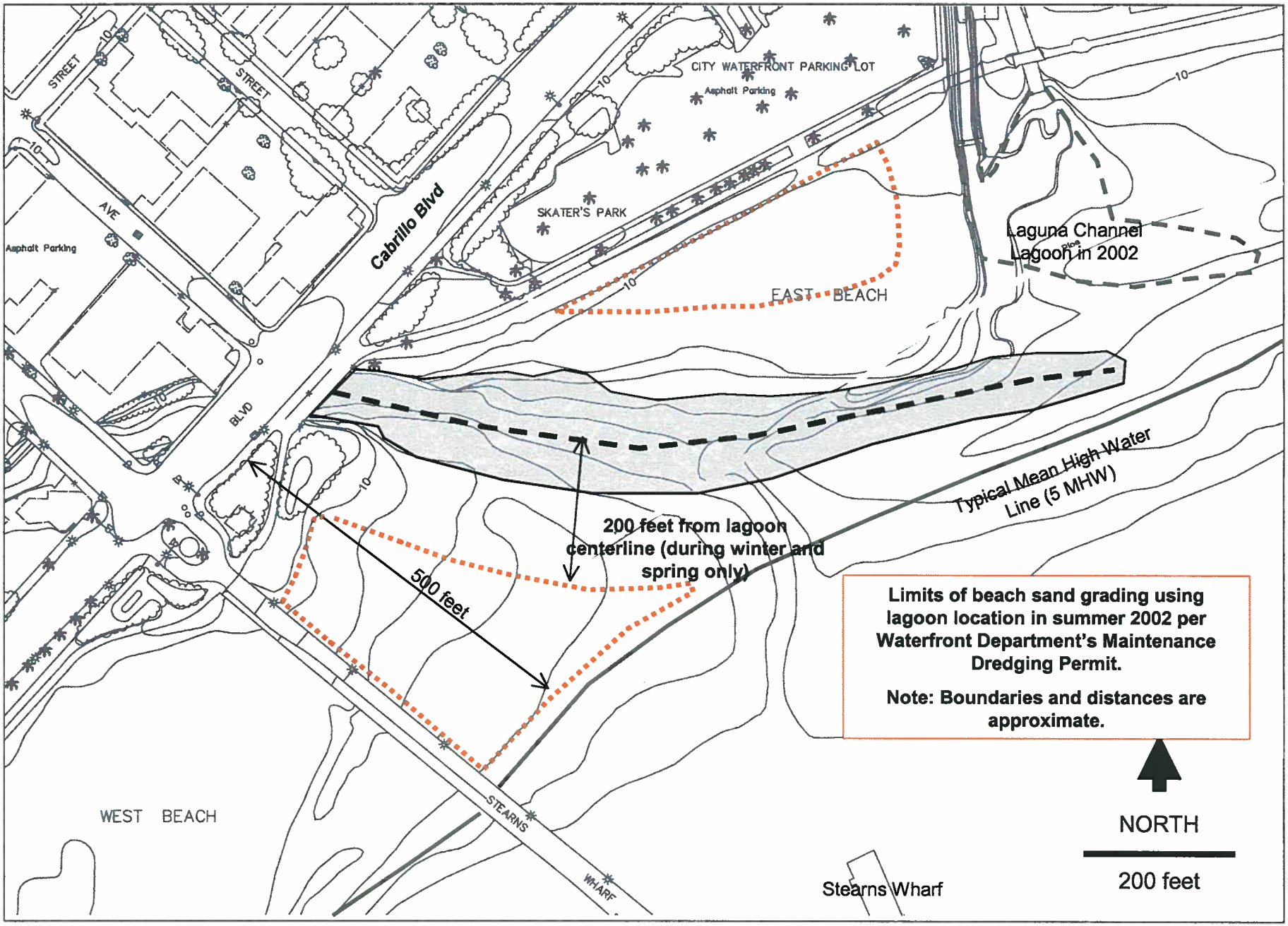


Figure 3. Permitted Beach Sand Management Areas

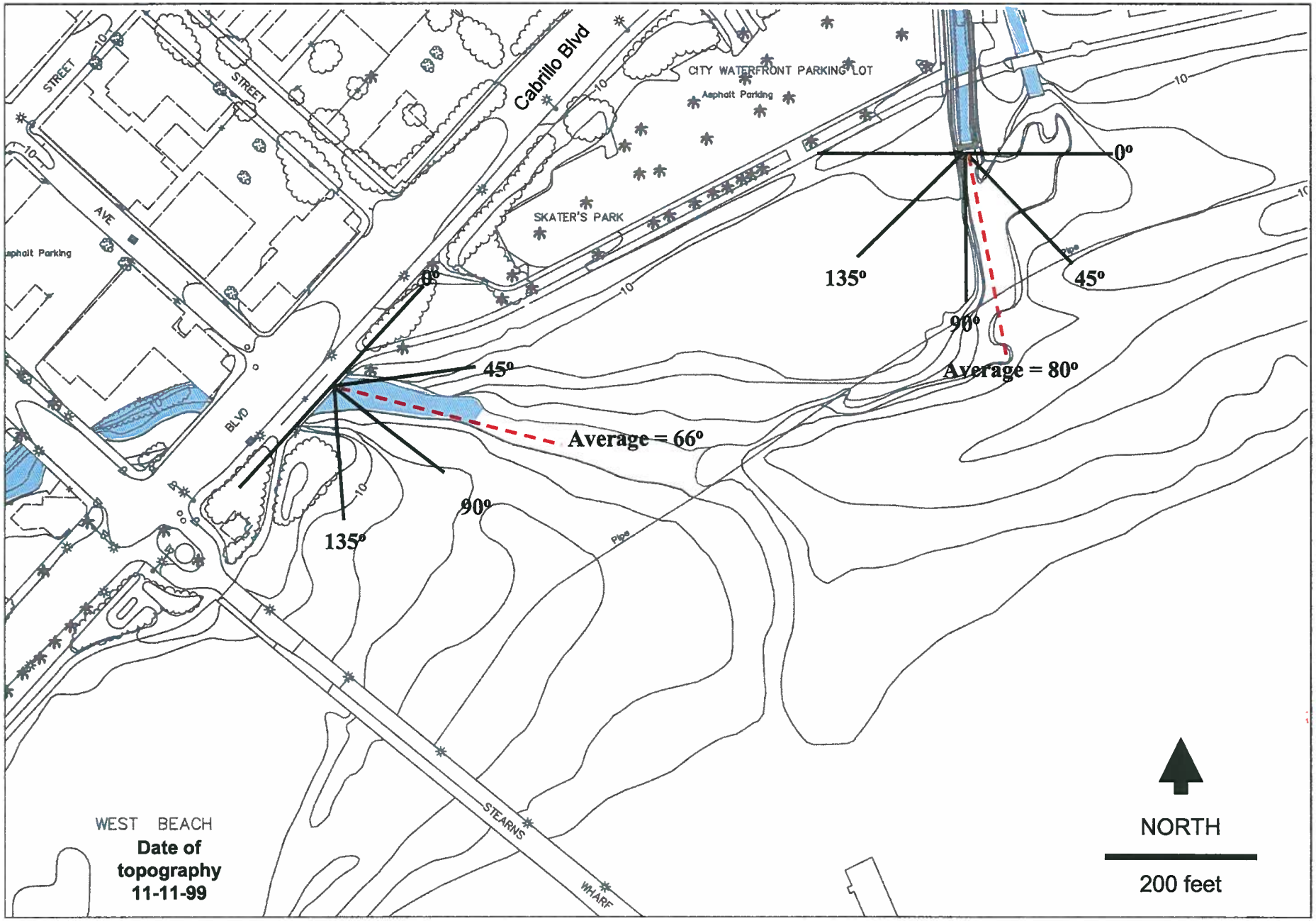


Figure 4. Basis for Measuring Angle of Lagoon

Figure 5a. Photographs of Merged Creeks

Figure 5b. Photographs of Merged Creeks

Figure 5c. Photographs of Merged Creeks

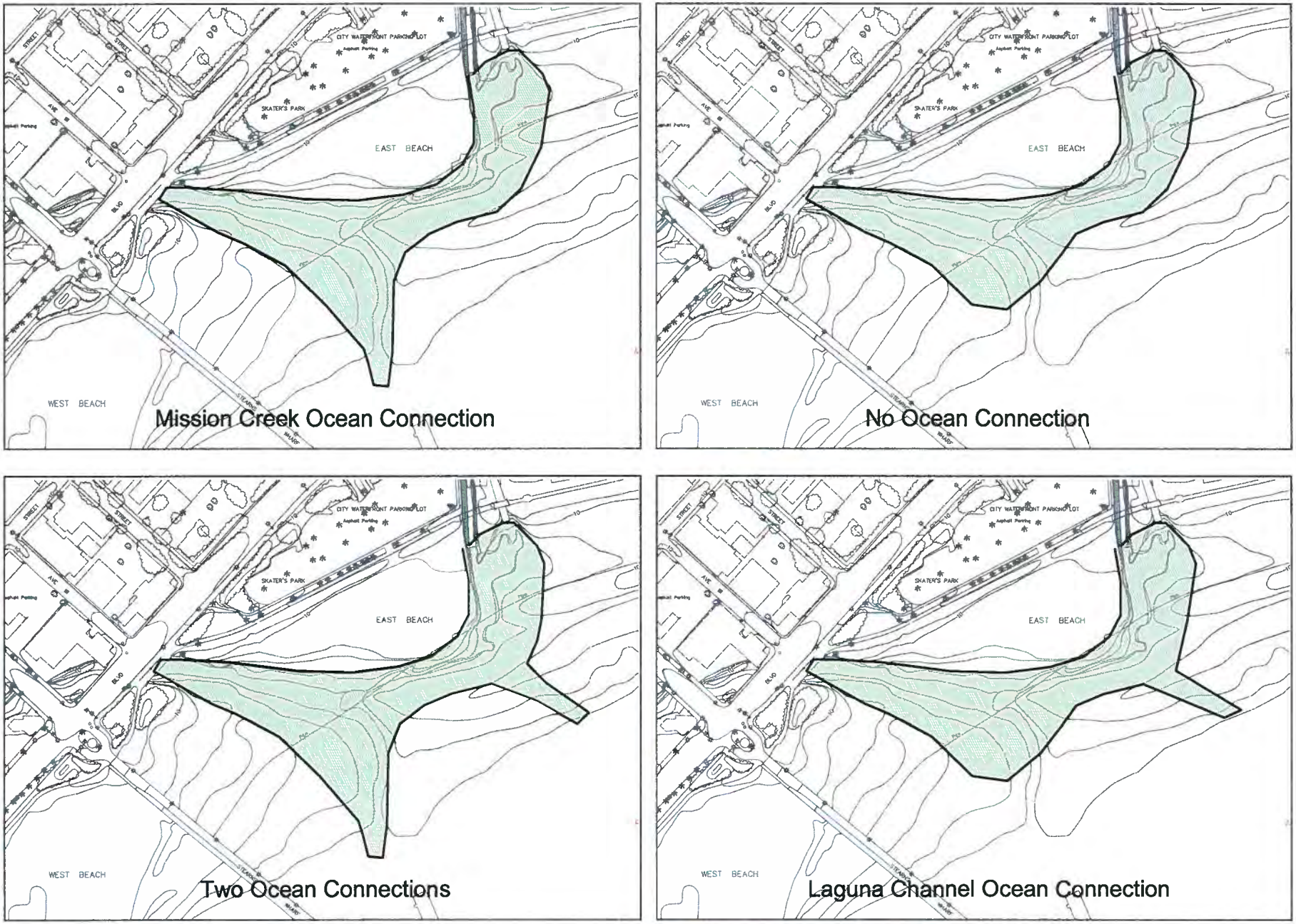
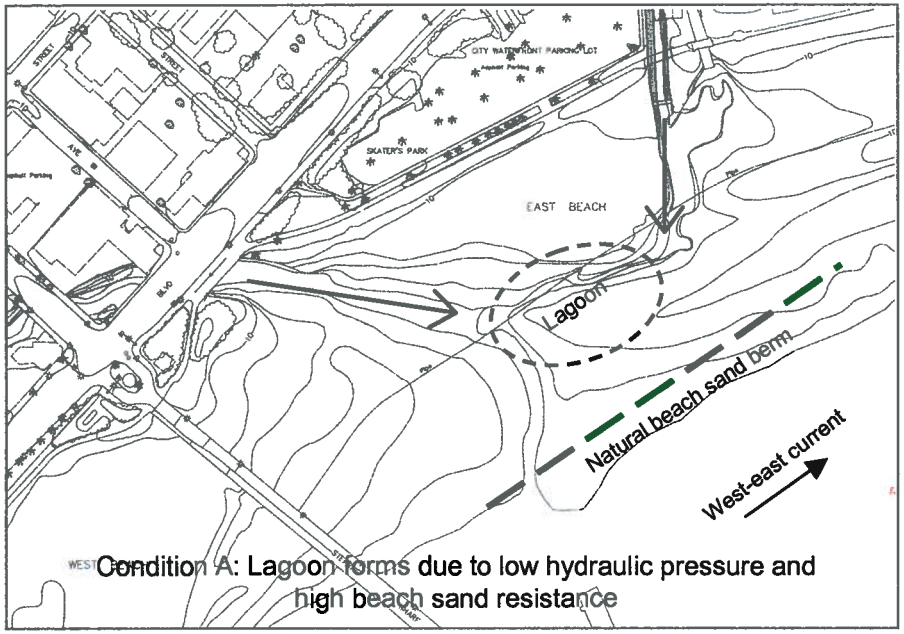
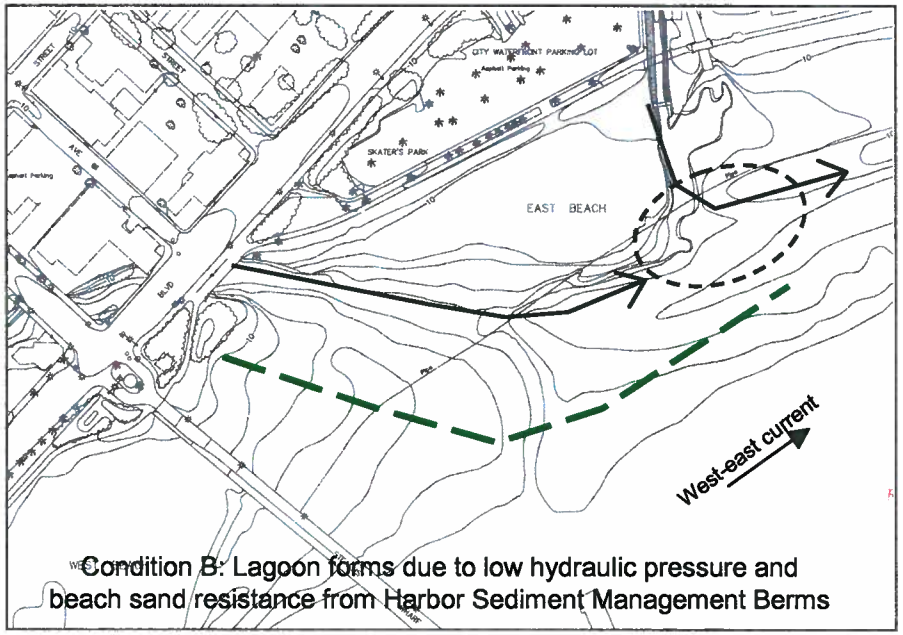


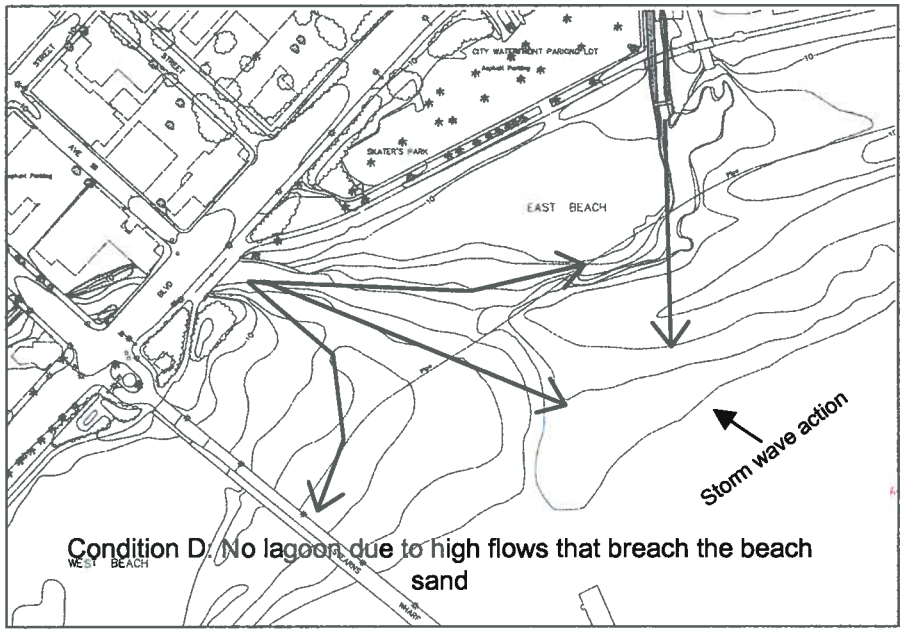
Figure 6. Types of Lagoon Merging Configurations



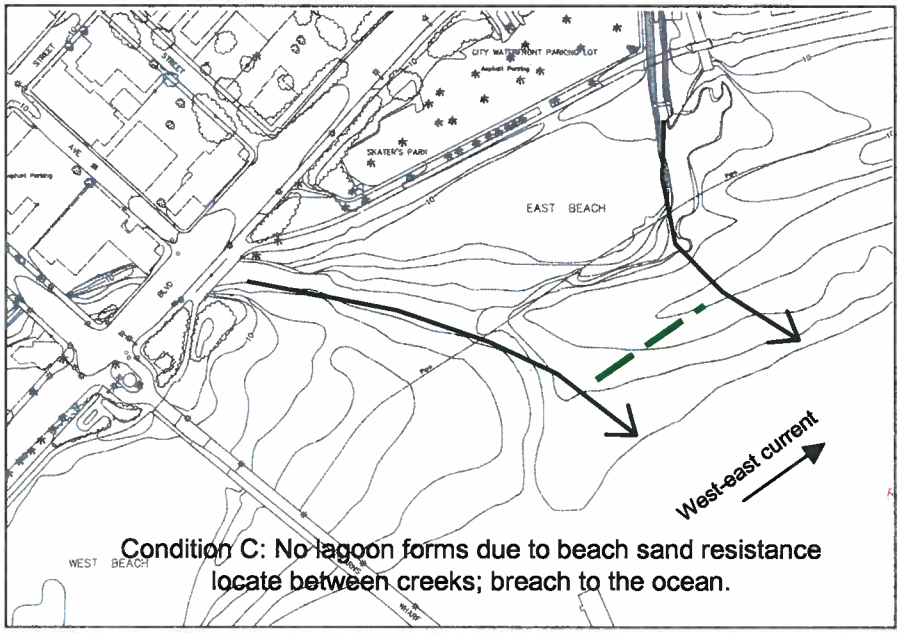
Condition A: Lagoon forms due to low hydraulic pressure and high beach sand resistance



Condition B: Lagoon forms due to low hydraulic pressure and beach sand resistance from Harbor Sediment Management Berms



Condition D: No lagoon due to high flows that breach the beach sand

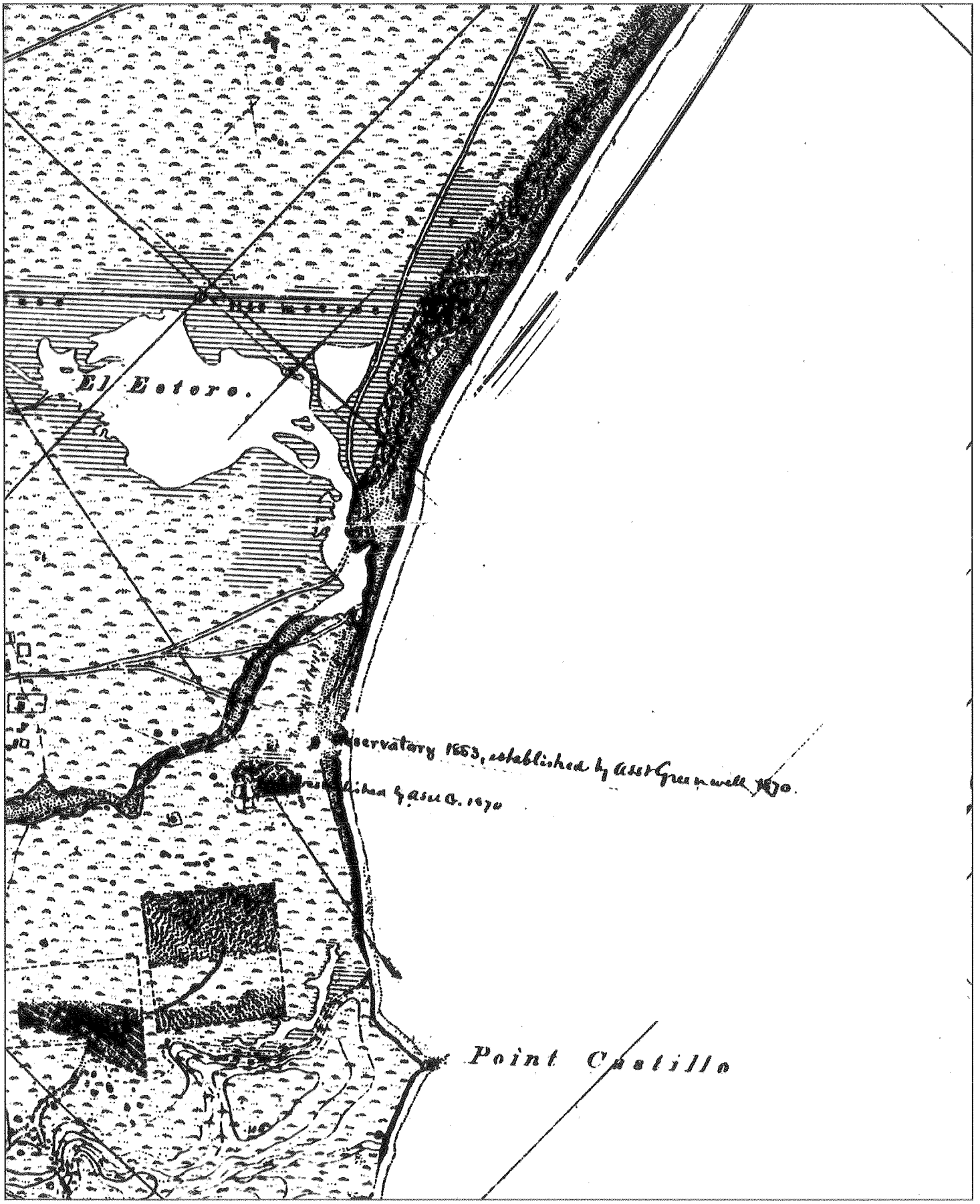


Condition C: No lagoon forms due to beach sand resistance locate between creeks; breach to the ocean.

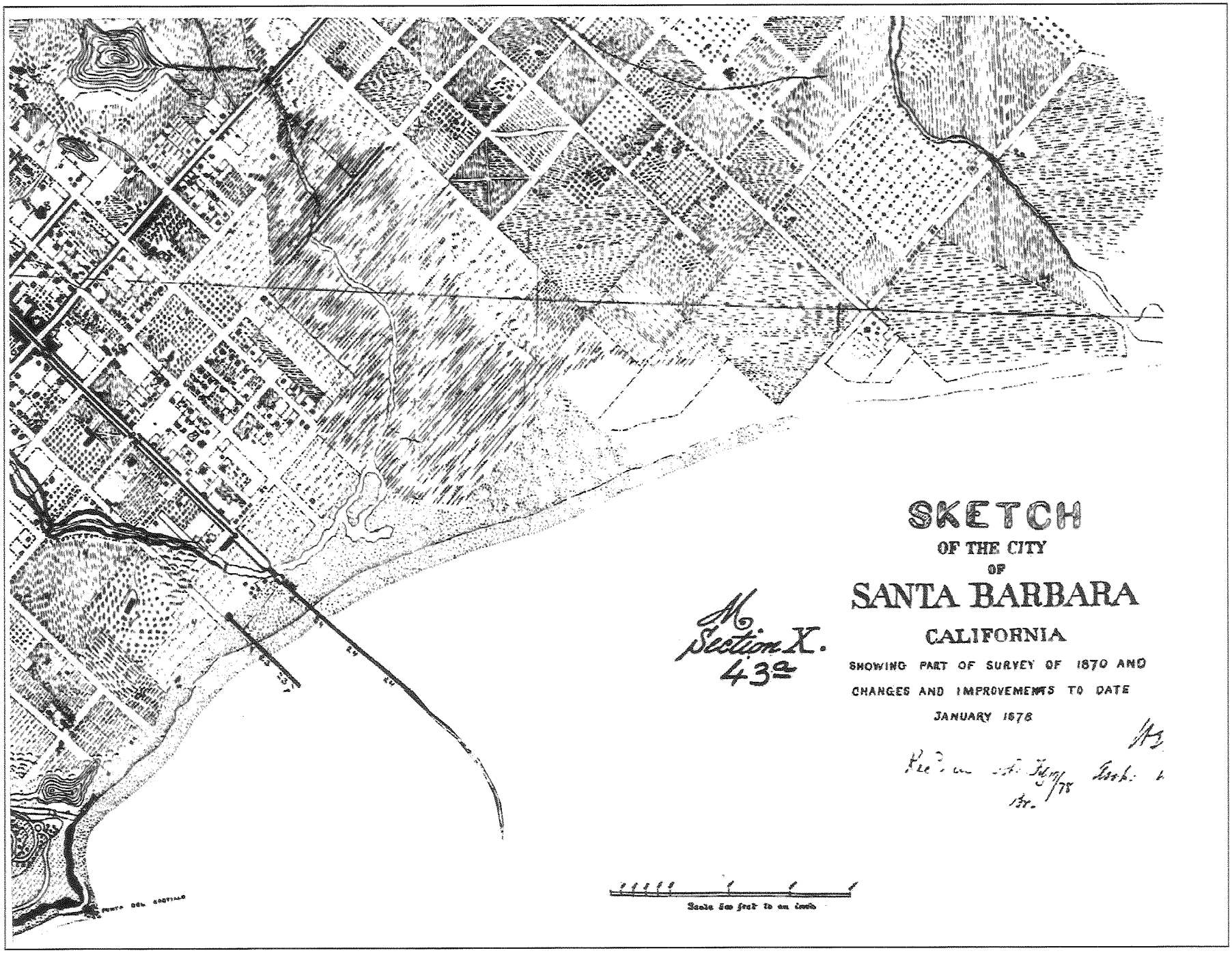
Figure 7. Types of Hydraulic Conditions at the Lagoons

APPENDIX B

Historic Maps and Aerial Photographs, 1852 – 2004 (30 plates)



Historic Map from 1852



Historic Map from 1878

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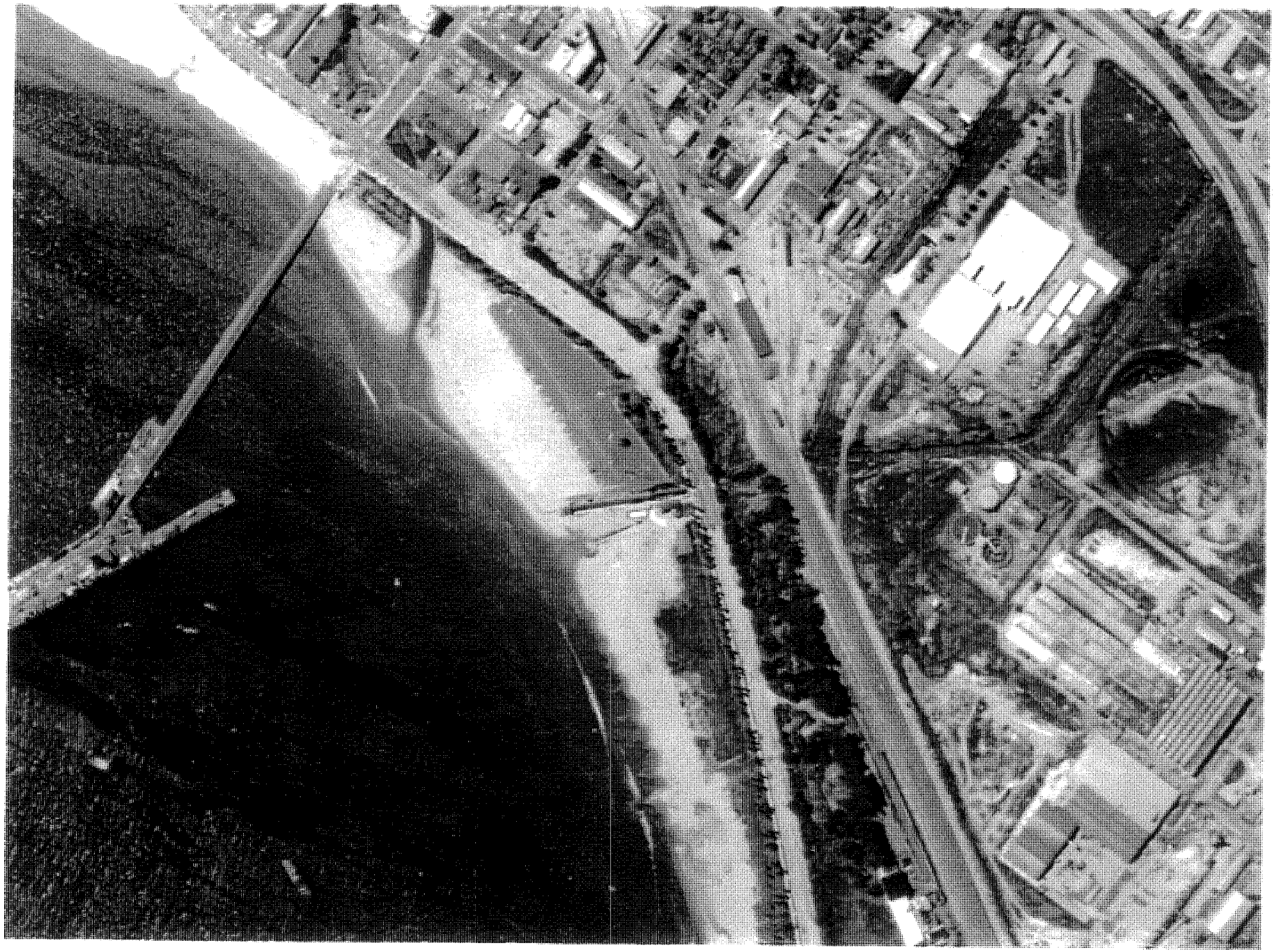
8-16-47

2-25-54

1954

11-23-59



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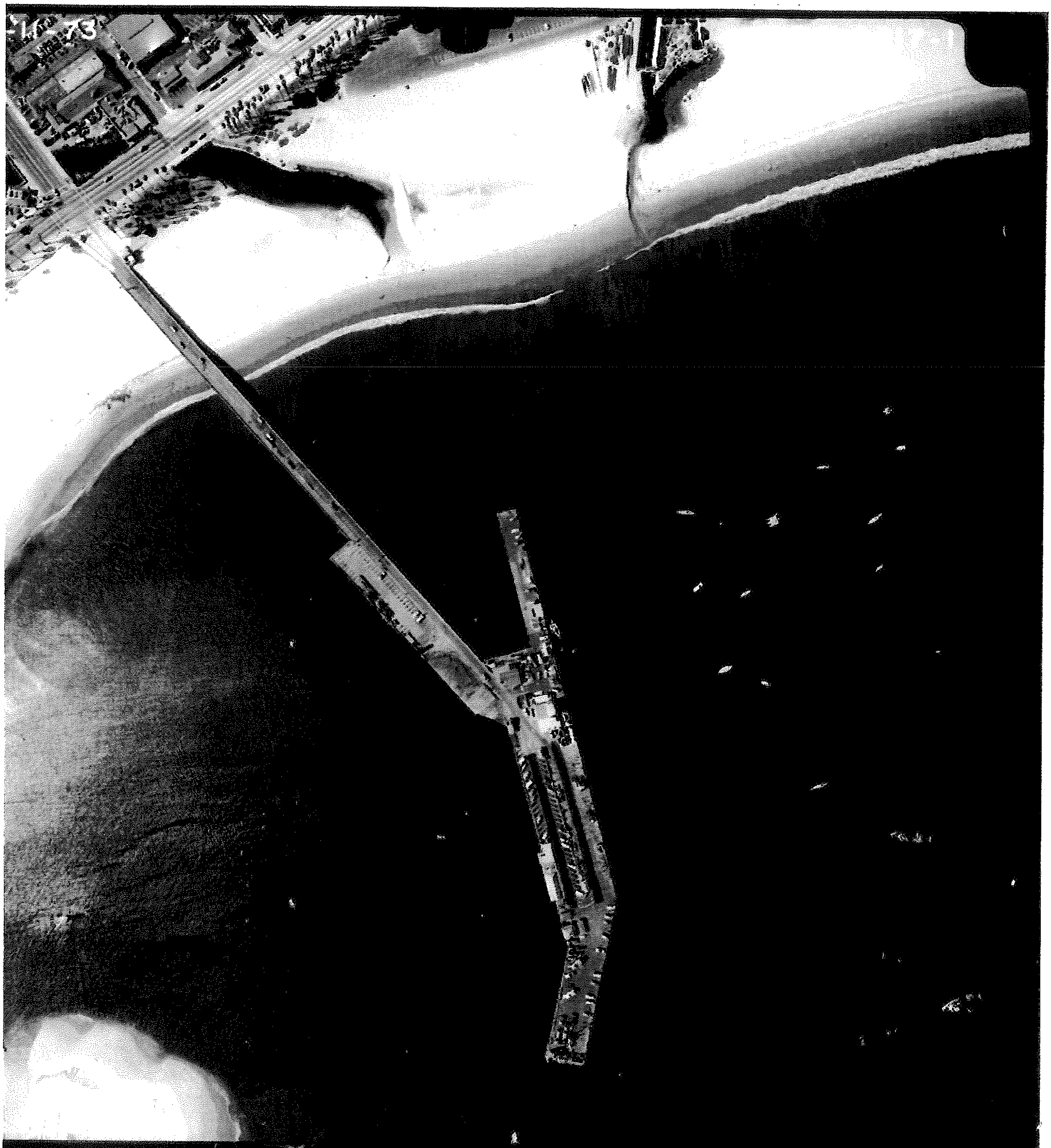
2-26-69



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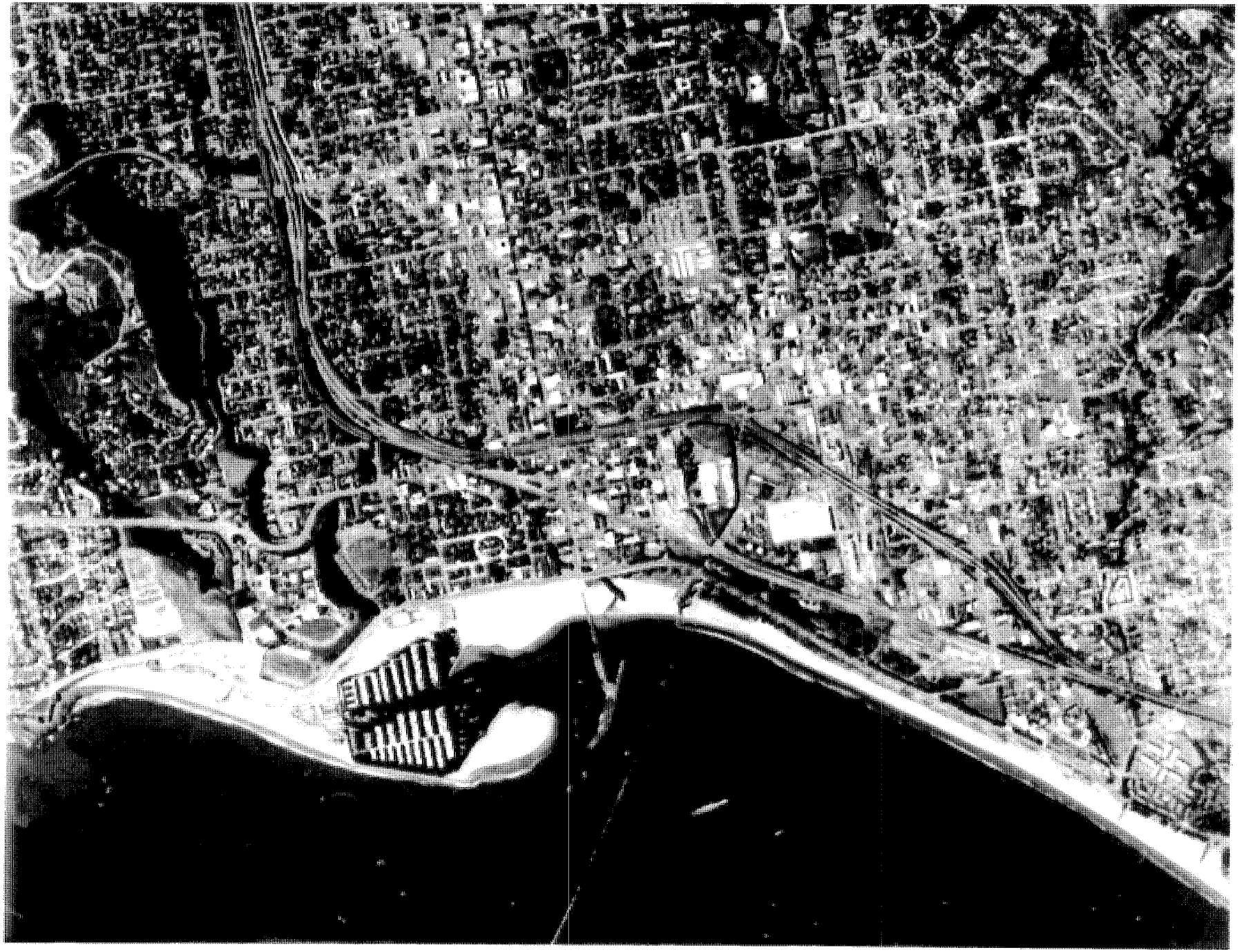

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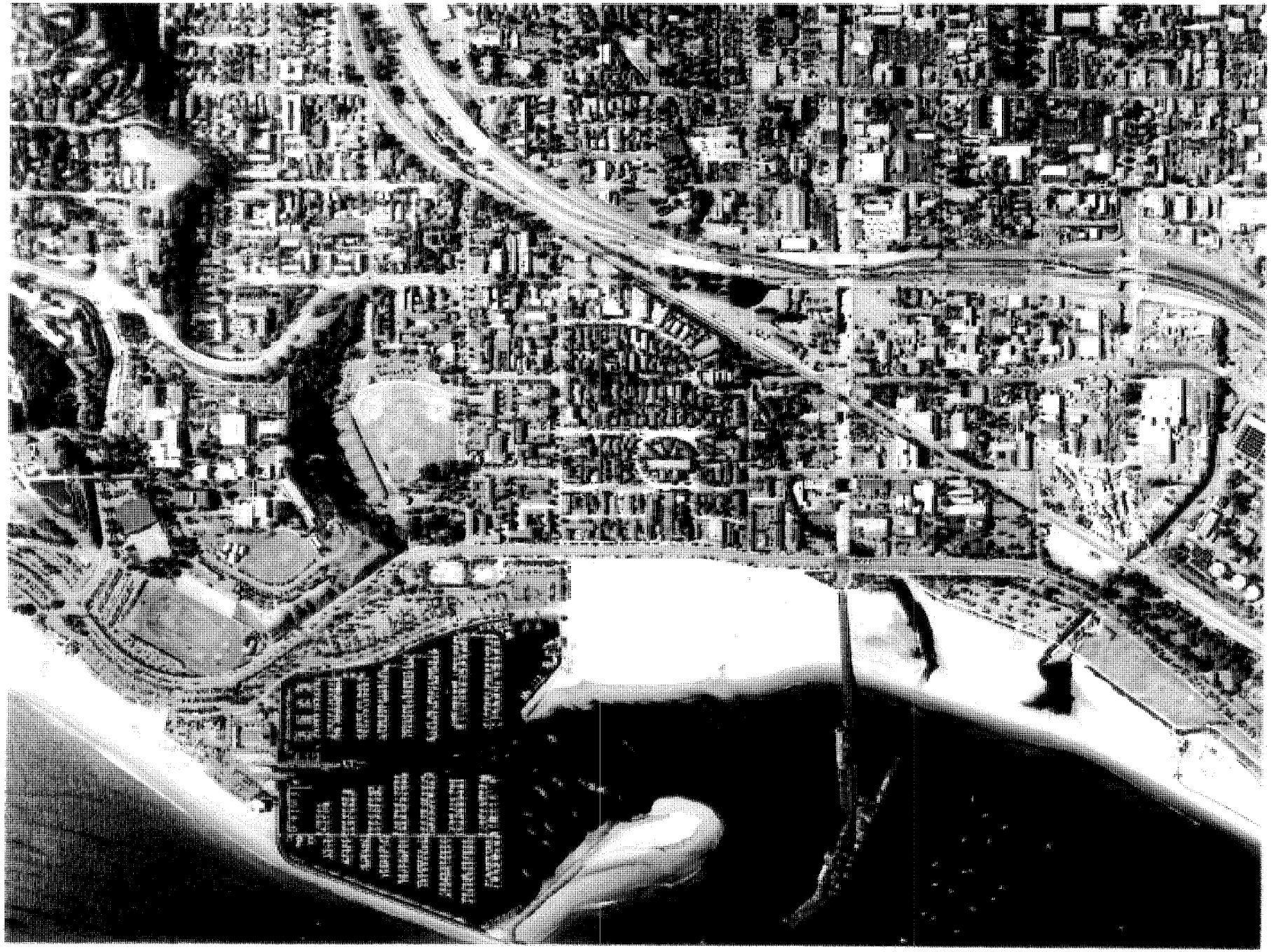
12-8-92

MERGED **12-9-93**

10-24-91



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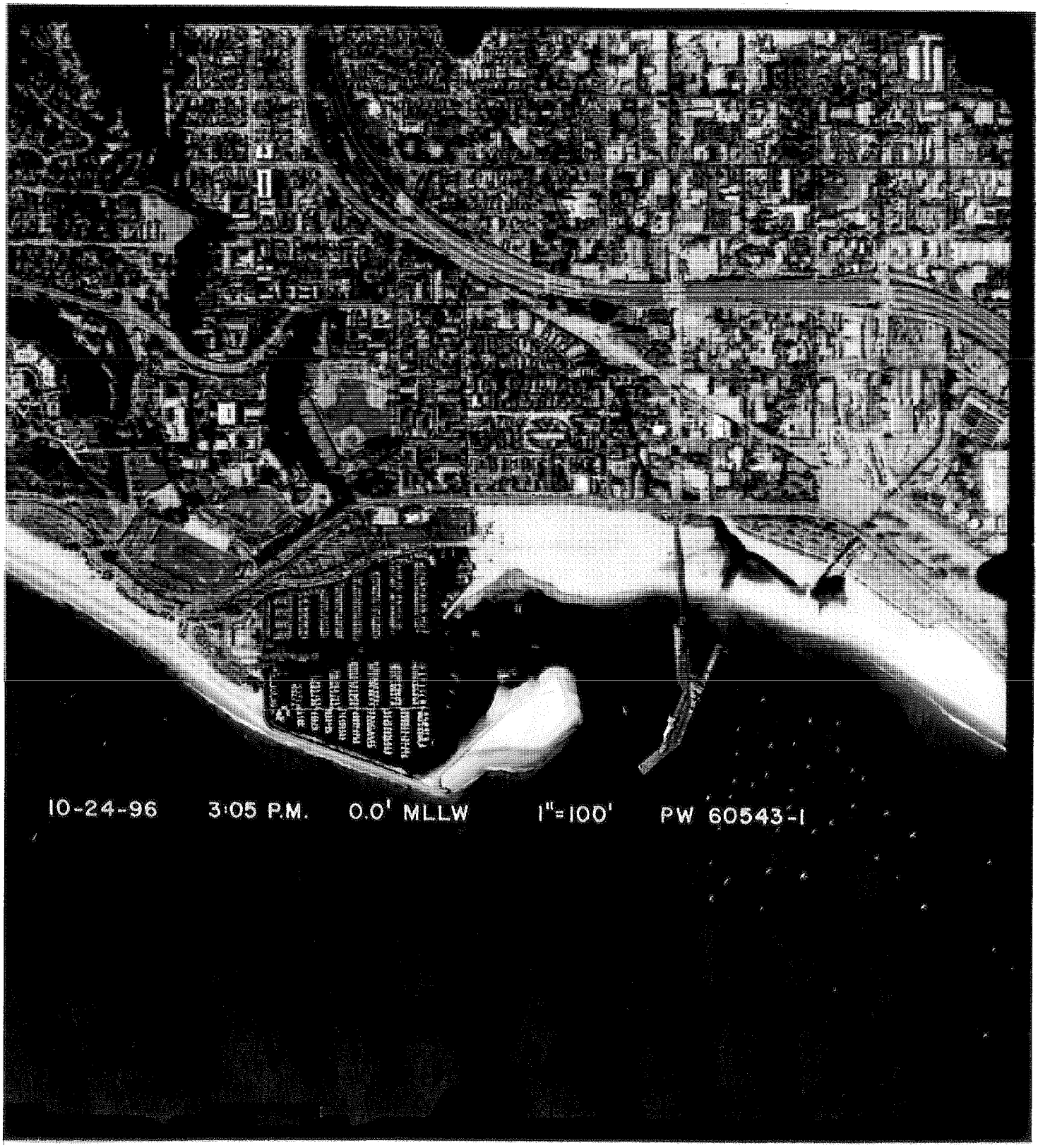

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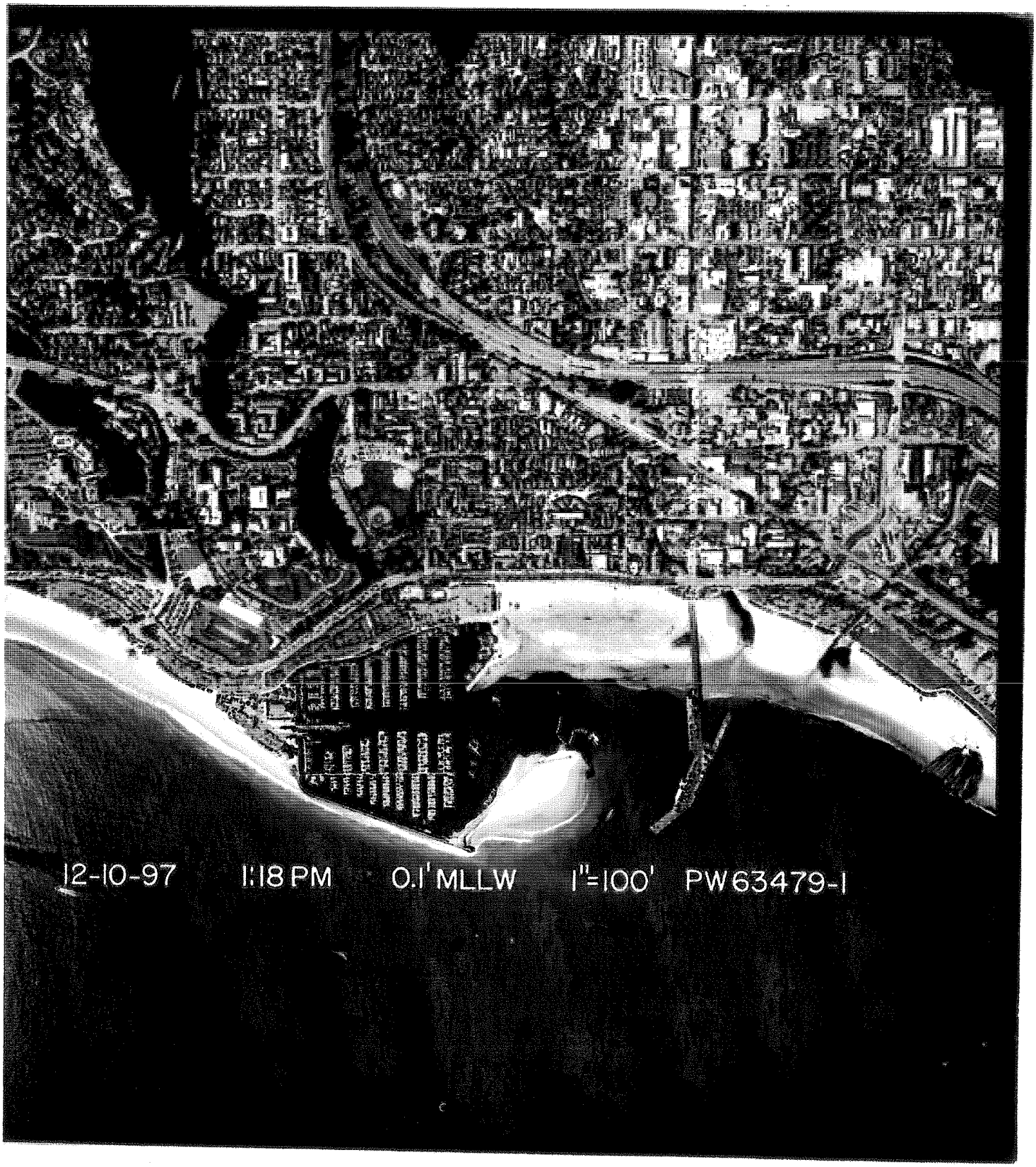

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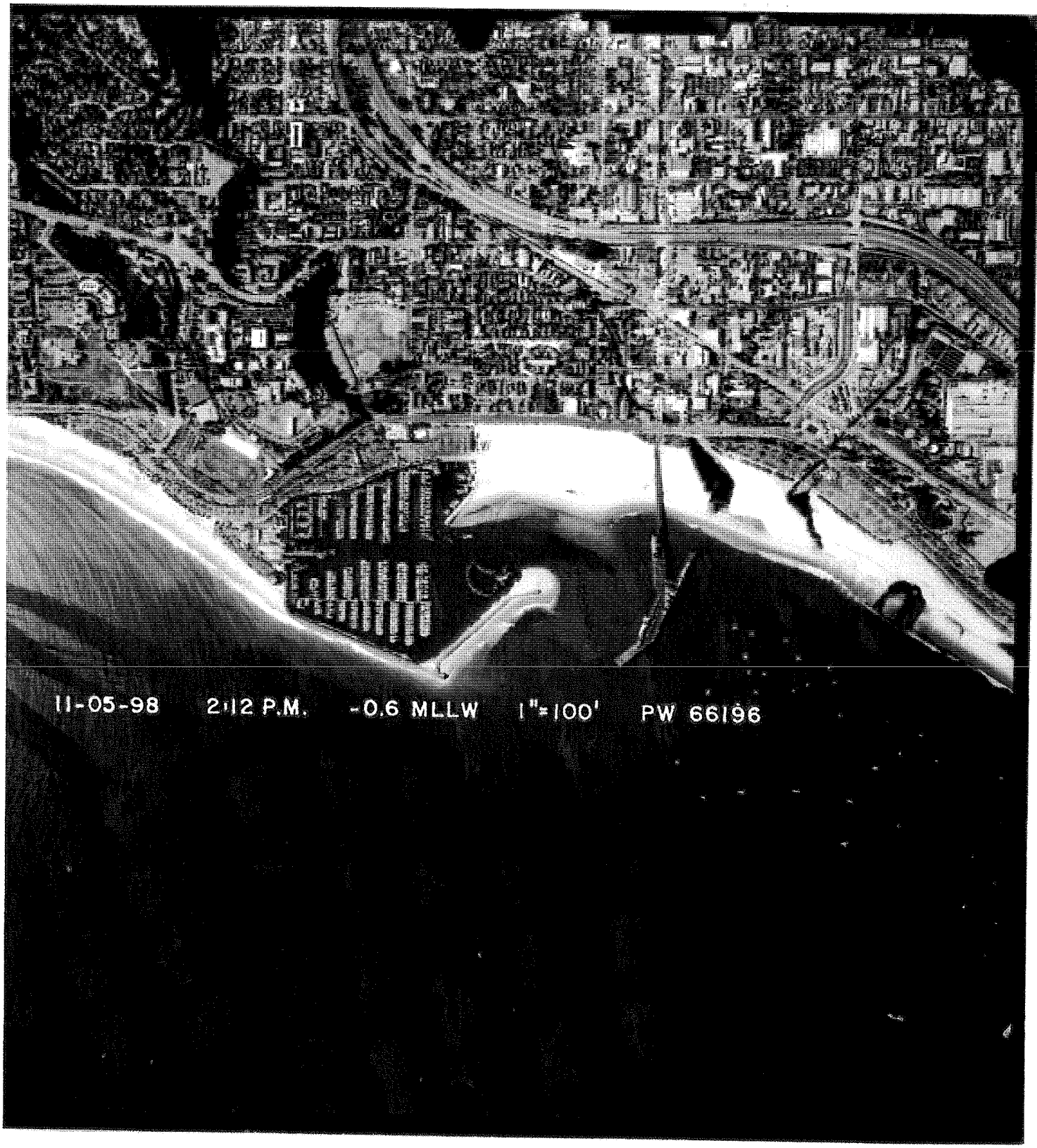

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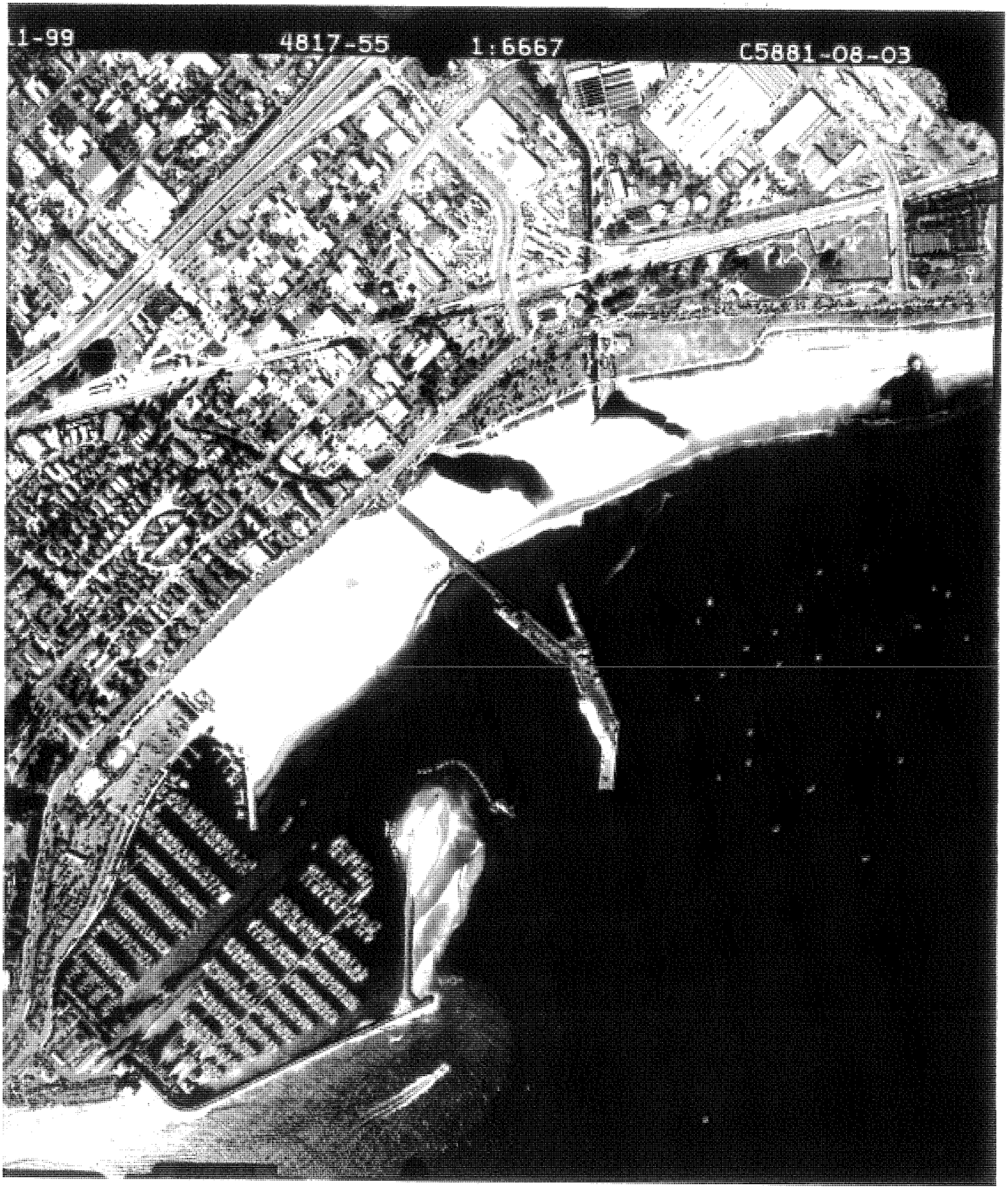

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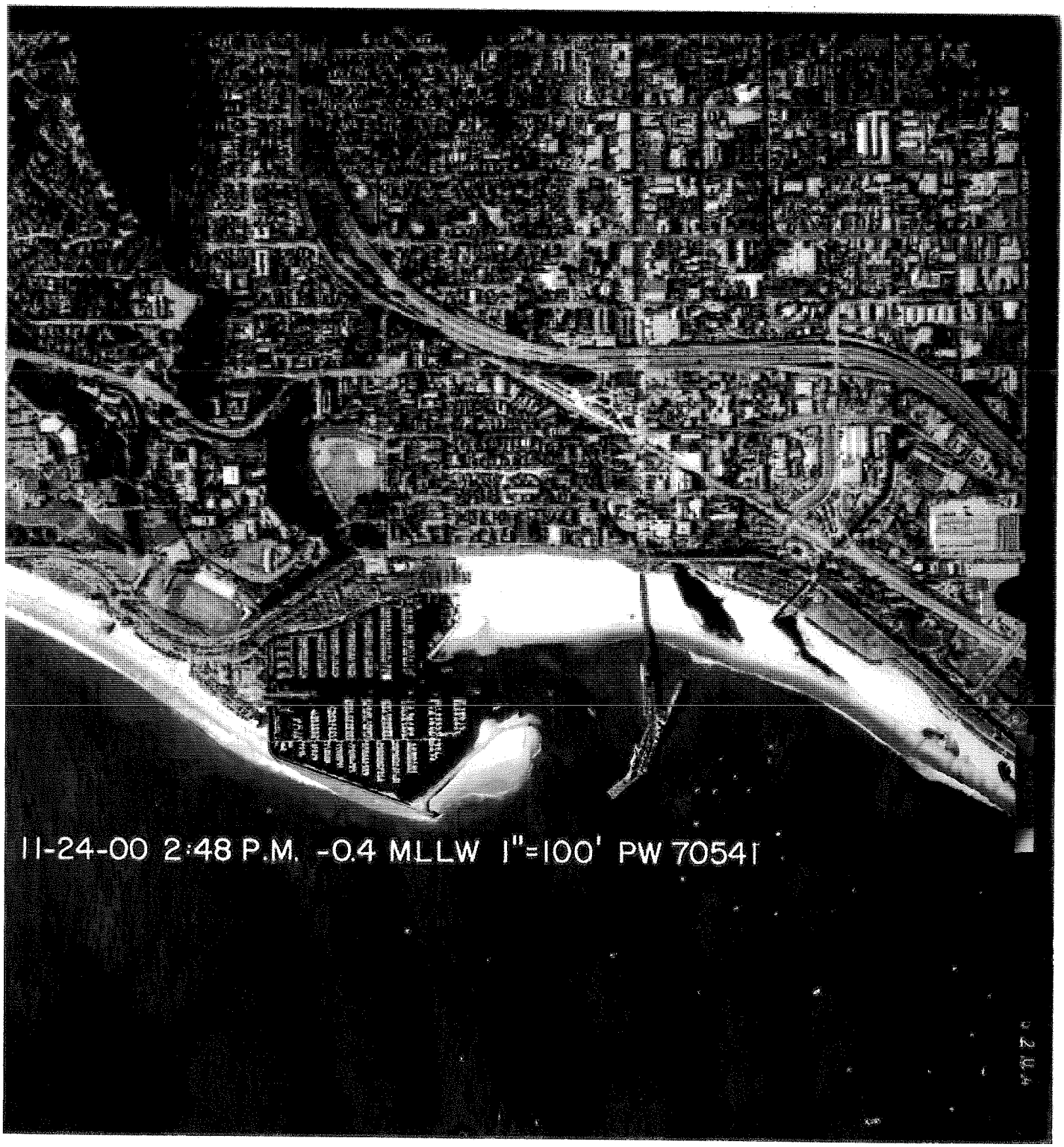

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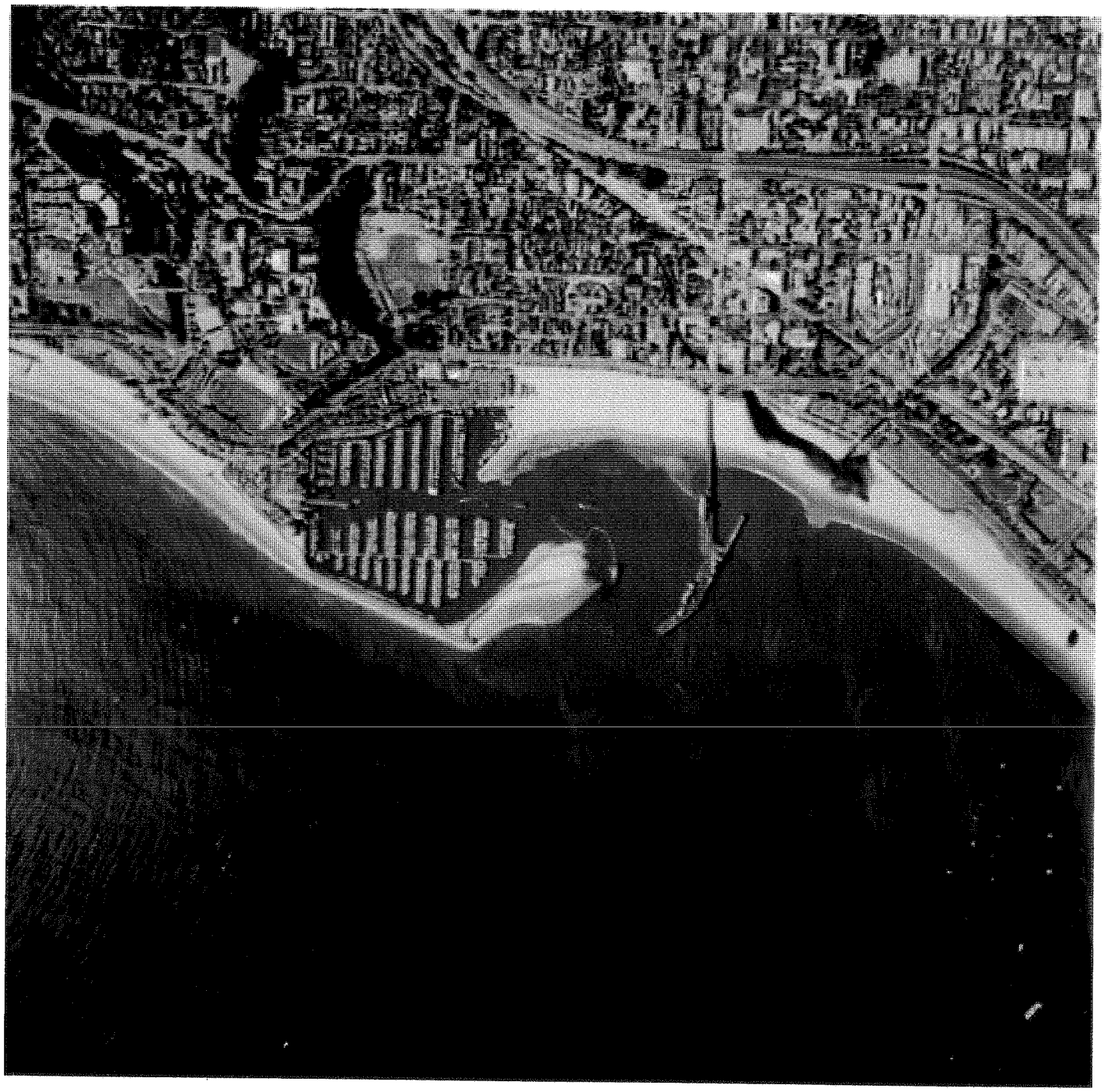
11-18-02



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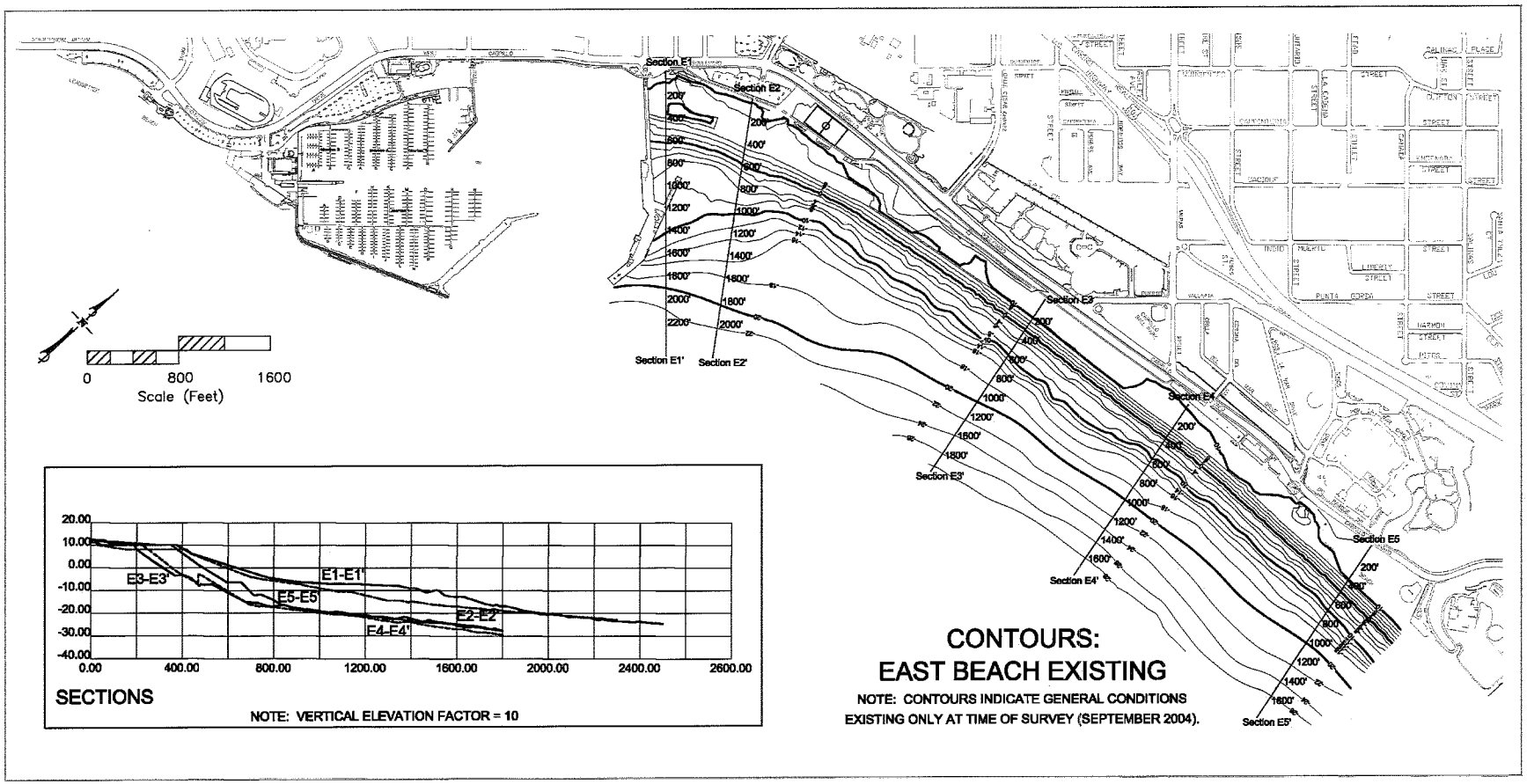
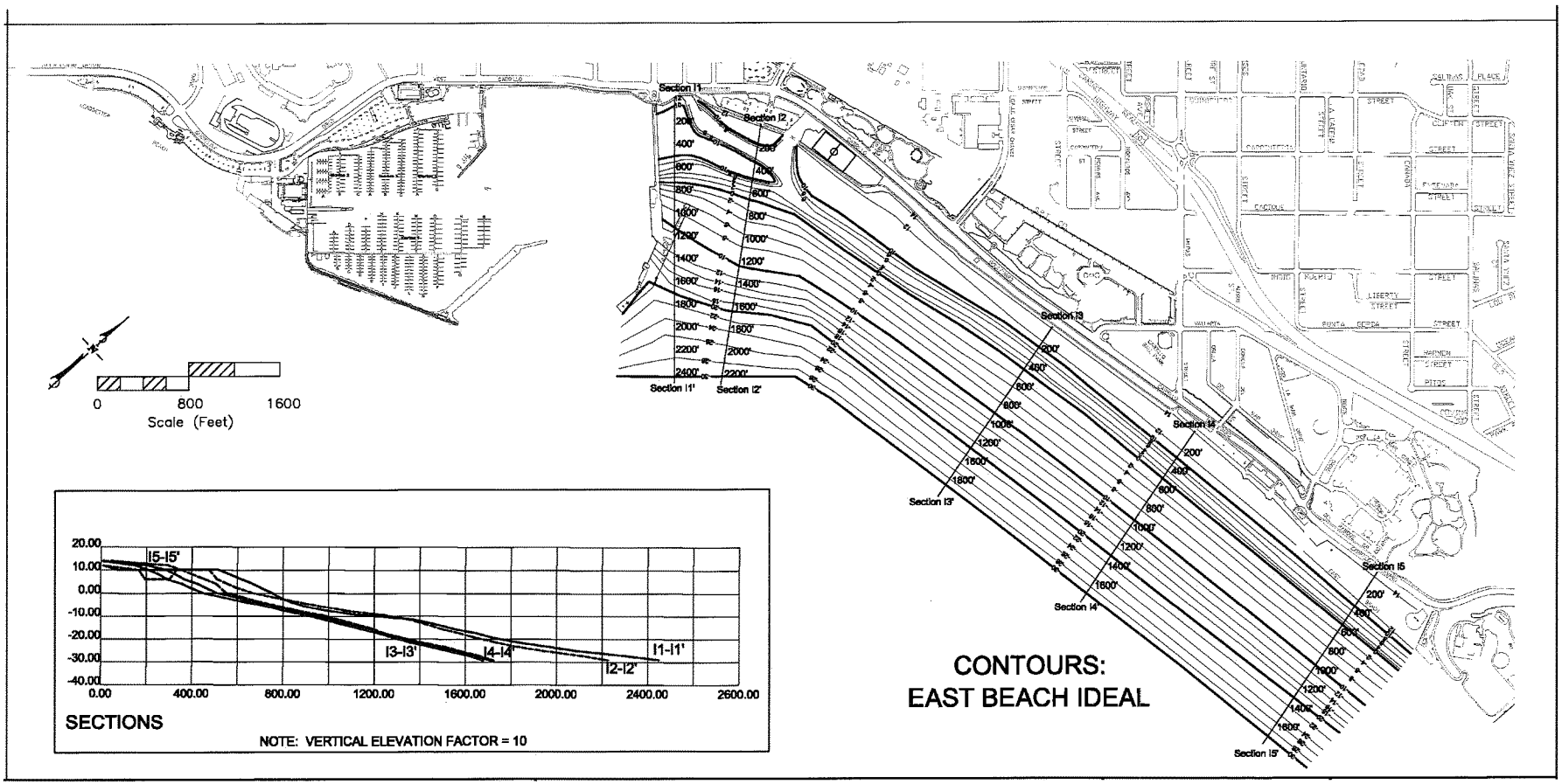
APPENDIX C

Existing and Proposed Ideal Beach Conditions at East Beach from the City Waterfront Department for Renewal of the Sediment Management Program



City Waterfront Department – Facilities Division



Drawings from the Waterfront Department, showing beach ideal conditions to be included in the renewal of the City's current sediment and beach sand management permit from the Corps of Engineers.

City Waterfront Department – Facilities Division

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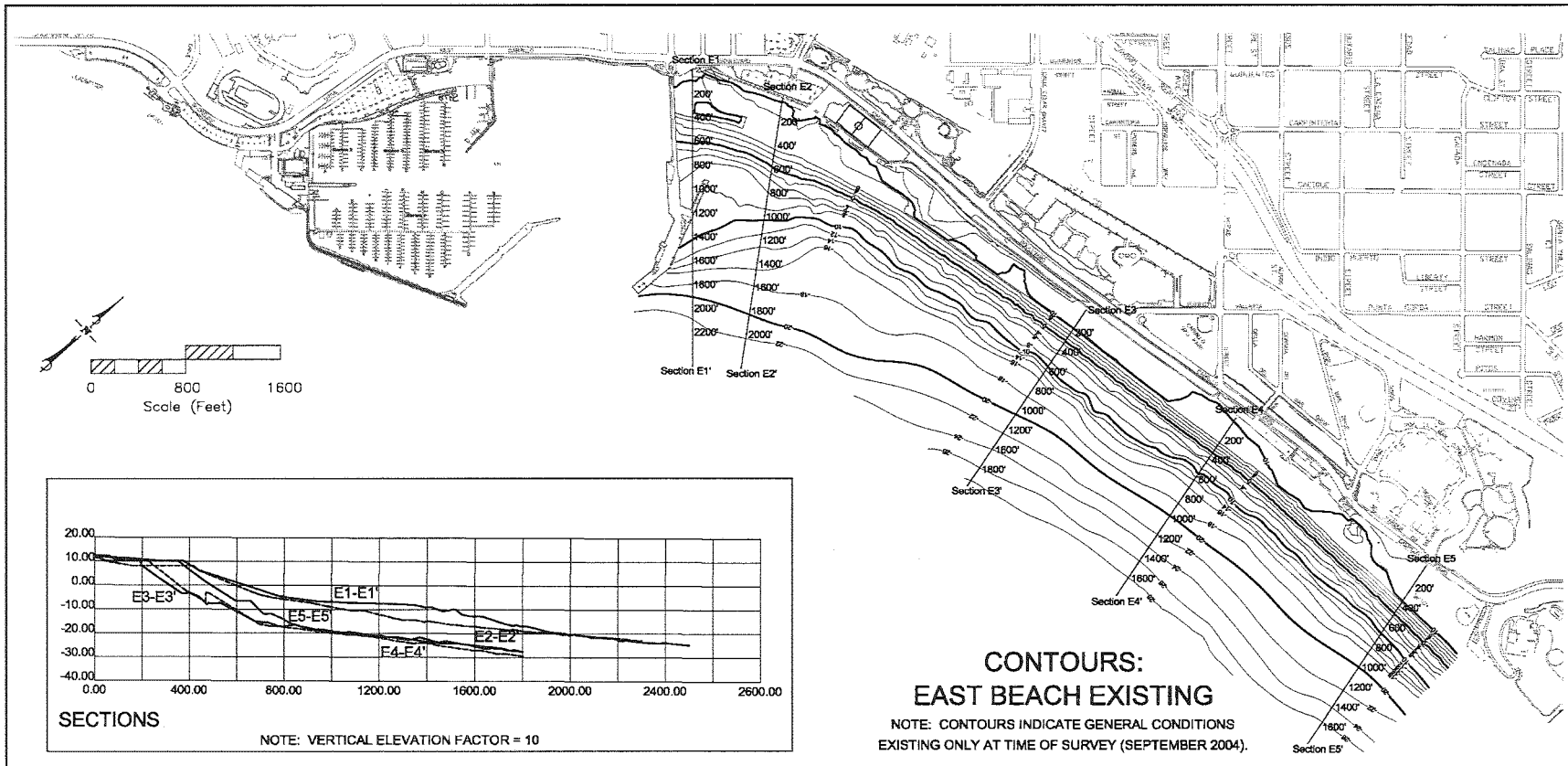
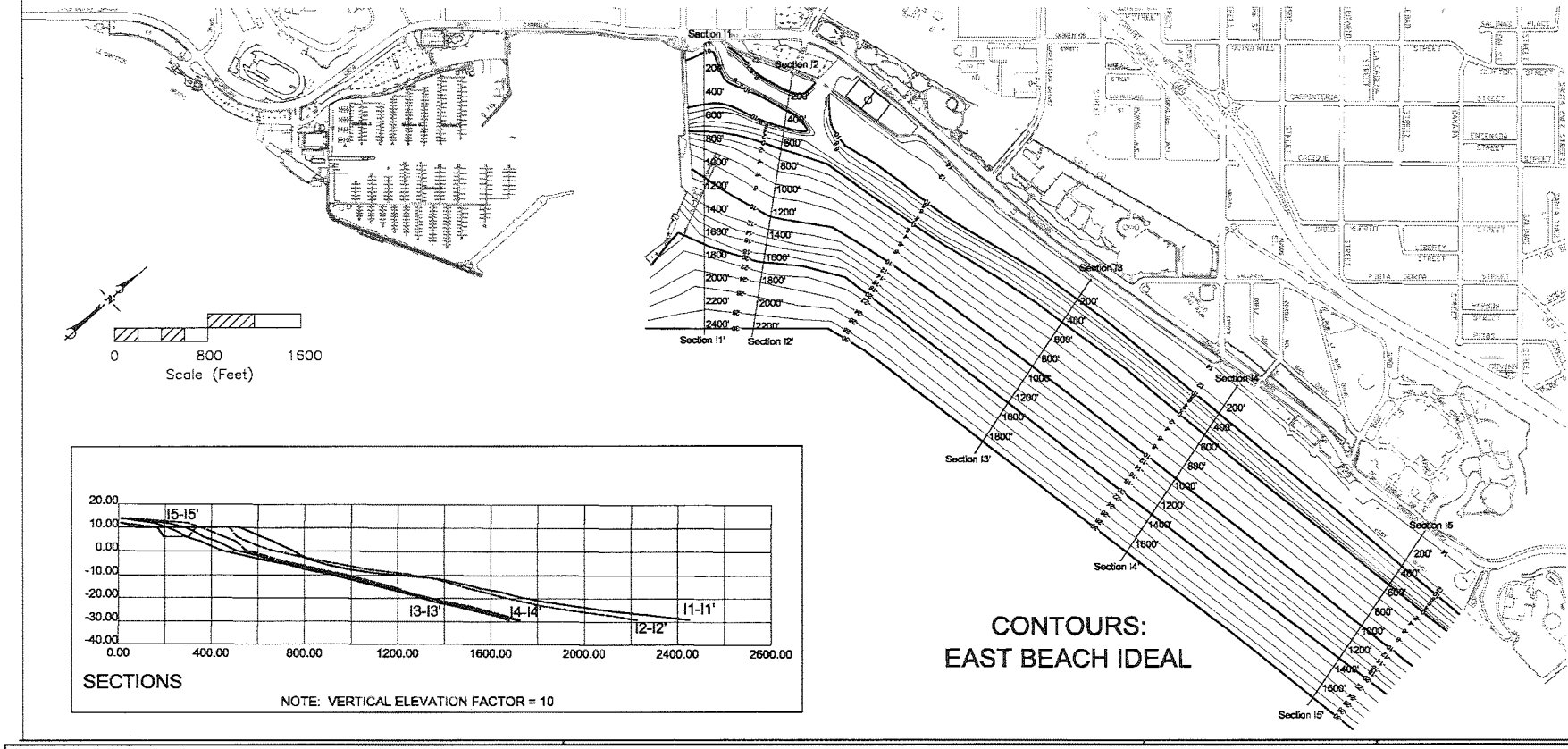
Existing and Proposed Ideal Beach Conditions at East Beach from the City Waterfront Department for Renewal of the Sediment Management Program



City Waterfront Department – Facilities Division



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